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Medical and Work Loss Cost Estimation Methods for the WISQARS Cost of Injury Module

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List of Abbreviations

AHRQ	Agency for Healthcare Research and Quality
BLS	Bureau of Labor Statistics
CDC	Centers for Disease Control and Prevention
C/ME	coroner or medical examiner
CPS	Current Population Survey
CPSC	Consumer Product Safety Commission
DARPI	Division of Analysis, Research, and Practice Integration
DCI	Detailed Claim Information
DOA	dead on arrival
ED	emergency department
GAO	Government Accountability Office
HCUP	Healthcare Cost and Utilization Project
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ICD-10	International Statistical Classification of Diseases and Related Health Problems, 10th Revision
LoS	length of stay
MEPS	Medical Expenditure Panel Survey
NCHS	National Center for Health Statistics
NCIPC	National Center for Injury Prevention and Control
NEDS	Nationwide Emergency Department Sample
NEISS	National Electronic Injury Surveillance System
NEISS-AIP	National Electronic Injury Surveillance System–All Injury Program
NHEA	National Health Expenditure Accounts
NHIS	National Health Interview Survey
NIS	Nationwide Inpatient Sample
NNHS	National Nursing Home Survey
NVSS	National Vital Statistics System
PCE	Personal Consumption Expenditures
PPS	Prospective Payment System
SCI	spinal cord injury
SEDD	State Emergency Department Databases
SID	State Inpatient Databases
SOII	Survey of Occupational Injury and Illness
SPEB	Statistics, Programming, and Economics Branch
TBI	traumatic brain injury
WISQARS	Web-based Injury Statistics Query and Reporting System

Medical and Work Loss Cost Estimation Methods for the WISQARS Cost of Injury Module

1. Introduction

This document describes the methods used to estimate costs of injury in the Web-based Injury Statistics Query and Reporting System (WISQARS™) of the Centers for Disease Control and Prevention (CDC). The WISQARS database is an interactive query system that provides customized reports of injury-related data. It provides national and state statistics on the incidence and costs associated with unintentional and violence-related injuries, both fatal and non-fatal. The WISQARS Cost of Injury Module provides cost estimates for injury-related deaths, hospitalizations, and emergency department (ED) visits by intent and mechanism of injury or by diagnosis and body region.

Part I of the WISQARS Cost of Injury Module uses fatal injury data from the National Vital Statistics System (NVSS; CDC/National Center for Health Statistics [NCHS]) and non-fatal injury data from the National Electronic Injury Surveillance System–All Injury Program (NEISS-AIP; U.S. Consumer Product Safety Commission [CPSC]). The NVSS[1] provides data pertaining to causes of death that are classified and coded according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10;

[1] The NVSS database is collected and disseminated by the NCHS, a division of CDC. It is one of the oldest and most successful examples of intergovernmental data sharing in public health. Its data are provided through contracts between NCHS and vital registration systems operated in the various jurisdictions legally responsible for the registration of vital events—births, deaths, marriages, divorces, and fetal deaths (source: http://www.cdc.gov/nchs/nvss/about_nvss.htm).

World Health Organization).[2] Since 1999, NVSS has used ICD-10 to classify and code causes of death. NEISS-AIP (http://www.cdc.gov/ncipc/WISQARS/nonfatal/datasources.htm; Schroeder & Ault, 2001; CDC, 2001;) is an expansion of the National Electronic Injury Surveillance System (NEISS) operated by CPSC. It collects data on all types of injuries and poisonings treated in U.S. hospital EDs, whether or not they are subsequently admitted to the hospital and whether or not they are associated with consumer products. NEISS-AIP is a collaborative effort by CPSC and the National Center for Injury Prevention and Control (NCIPC).

Part II of the WISQARS Cost of Injury module allows users to input their own incidence data on deaths, non-fatal hospitalized injury cases, and ED-treated-and-released injury cases. For deaths, cost estimates are based on the ICD-10 diagnosis matrix (www.cdc.gov/nchs/injury/ice/injury_matrix10.htm) and the ICD-10 external cause of injury matrix (www.cdc.gov/nchs/injury/ice/matrix10.htm). For non-fatal hospitalized and ED-treated injury cases, cost estimates are based on International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM; http://www.cdc.gov/nchs/icd/icd9cm.htm) using the Barell Injury Diagnosis Matrix (http://www.cdc.gov/nchs/injury/ice/barell_matrix.htm) and the external-cause-of-injury code (E-code) matrix (www.cdc.gov/injury/wisqars/ecode_matrix.html).

This report describes how the lifetime costs of medical treatment and work loss due to injury were estimated for use in the WISQARS Cost of Injury module. After a brief discussion of the background of this project in Section 2, the estimation of medical costs is described in Section 3 and the estimation of work loss in Section 4. In each section, fatal injuries are

[2] The International Classification of Diseases (ICD) is used to classify diseases and other health problems recorded on many types of health and vital records including death certificates and health records. In addition to enabling the storage and retrieval of diagnostic information for clinical, epidemiological, and quality purposes, these records also provide the basis for the compilation of national mortality and morbidity statistics by WHO member states (source: http://www.who.int/classifications/icd/en/).

discussed first, followed by non-fatal injuries. The concluding Section 5 discusses limitations of the costing methods.

1.1 Year of Dollars, Inflator Series, and Discount Rate

All cost estimates in the WISQARS Cost of Injury module are expressed in 2010 dollars. Cost elements used in developing the cost module that came from datasets belonging to different time periods were inflated to 2010 dollars. Health care costs in earlier year's dollars were inflated using components of the Price Indexes for Personal Consumption Expenditures (PCE) by Function, provided by the U.S. Bureau of Economic Analysis (Table 2.5.4, lines 37–52; http://www.bea.gov/iTable/index_nipa.cfm). Work loss costs were inflated using the Employment Cost Index, Total Compensation, Civilian, published by the U.S. Bureau of Labor Statistics (BLS).[3] This index covers compensation of both private industry and government workers. Work loss costs more than one year post-injury were discounted to present value using the 3% discount rate recommended by the Panel on Cost-Effectiveness in Health & Medicine (Gold, Siegel, Russell, & Weinstein, 1996) and by Haddix, Teutsch, and Corso (2003).

2. Background

Every year, injuries impose a significant financial burden on the U.S. health care system. For some injuries, medical treatment and corresponding costs may persist for years or even decades after the initial injury. Injuries can also result in both temporary and permanent disability. When this occurs, injury victims may lose their ability to work or be restricted in the

[3] Office of Compensation Levels and Trends, *Employment Cost Index, Historical Listing – Volume V* (Washington, DC: U.S. Bureau of Labor Statistics, July 2014), Table 4 (http://www.bls.gov/web/eci/ecicois.pdf).

kinds of work they can do. Reduced or restricted ability to work due to injury may result in loss of wages and accompanying fringe benefits, as well as loss of ability to perform one's normal household responsibilities. This document describes how these medical costs and work loss costs are quantified in the WISQARS Cost of Injury Module.

The cost estimates presented here cover three mutually exclusive categories that reflect the severity of injury:

- injuries resulting in death, whether the death occurs inside or outside a healthcare setting.
- injuries resulting in hospitalization with survival to discharge.
- injuries requiring an ED visit but not resulting in hospitalization or death.

Costs were not estimated for injuries treated only in doctor's offices or outpatient departments because WISQARS currently does not include those injuries. The cost analyses were computed from the societal perspective, which means they include all costs regardless of who paid them.

Medical and work loss costs were estimated for each injury death in the 2010 NVSS data (http://www.cdc.gov/nchs/data/nvsr/nvsr61/nvsr61_04.pdf). The resulting NVSS injury database with estimated costs attached is the source of the estimated costs of injury deaths in the WISQARS Cost of Injury Module (http://wisqars.cdc.gov:8080/costT).

For non-fatal injuries, medical and work loss costs were estimated on two databases of the Healthcare Cost and Utilization Project (HCUP): the 2010 Nationwide Inpatient Sample (NIS; http://www.hcup-us.ahrq.gov/nisoverview.jsp; Agency for Healthcare Research and Quality (AHRQ), last updated Dec 2013) for hospital-admitted injuries, and the 2010 Nationwide Emergency Department Sample (NEDS; http://www.hcup-us.ahrq.gov/nedsoverview.jsp; AHRQ, last updated Jan 2014) for non-admitted injuries treated in a hospital ED. ICD-9-CM, which is used to code diagnoses in the HCUP databases, uses a single numeric code to represent each medical condition. In contrast, NEISS uses two separate codes to represent the main injury suffered by the patient, as recorded in the medical record: a diagnosis code (e.g., burn, fracture, laceration) and a body part code. Mappings previously developed for CPSC (Lawrence, Miller, Jensen, Fisher, & Zamula, 2000) were used to assign NEISS diagnosis and body part codes to each injury case of the HCUP databases, based on the ICD-9-CM primary injury diagnosis code of the case (see Appendix I for details). Average medical and work loss costs were then computed from the NIS and the NEDS by NEISS diagnosis and body part, age group, and sex. The resulting average costs from the NIS and the NEDS were then assigned, respectively, to hospital-admitted and ED-treated non-fatal injury cases in the 2010 NEISS-AIP by NEISS diagnosis and body part, age, and sex.

3. Lifetime Medical Costs of Injuries

For some injuries, medical treatment and corresponding costs may persist for years or even decades after the initial injury. The medical costs presented in this study include costs associated with treatment for physical injuries only (apart from any hospital costs for mental health services received during a hospital admission) as data required to estimate costs for mental health and psychological treatment were not available.

3.1 Fatalities

Fatal medical costs were calculated using costs per case by place of death, as per Finkelstein et al. (2006), expanded to include deaths in hospice. Costs were computed separately for six different places of death identified in the 2010 NVSS data:

- On-scene/at home.

- Dead on arrival at a hospital (DOA).
- In a hospital ED.
- In a hospital after inpatient admission.
- In a nursing home.
- In a hospice.

The medical costs incurred, depending on the place of death, might include payments for coroner/medical examiner, emergency medical transport, ED visit, and stays in a hospital, nursing home, or hospice. Table 1 summarizes the components included for each place of death.

Table 1. Data and Methods for Estimating Medical Costs of Fatal Injuries

Place of Death	**Cost Categories**	**Description, Unit Cost (*2010 US $*)**	**Source of Data**
On scene/at home	Coroner/ME (C/ME)	$41 admin, plus $1,513 if autopsy (C/ME)	Hickman et al. (2007) (C/ME)
Dead on arrival (DOA) at hospital	C/ME + Transport (T)	$41[+$1,513] (C/ME) + $429 (T)	2012 GAO survey (T)
In ED	C/ME + T + ED	$41[+$1,513] (C/ME) + $429 (T) + Avg. cost for fatalities in ED by external cause and age (ED)	Estimated using fatalities in the 2007 NEDS (ED)
In hospital after admission	C/ME + T + Fatal inpatient total (FIT)	$41[+$1,513] (C/ME) + $429 (T) + Avg. cost for fatalities in hospital by diagnosis/mechanism group and age (FIT)	2008 NIS for hospital facilities costs; 1996–97 MarketScan® data for non-facility costs (FIT)
In nursing home	C/ME + 2×T + Non-fatal inpatient total (NIT) + Cost of nursing home stay ending in death (NH)	$41[+$1,513] (C/ME) + $858 (2×T) + Avg. inpatient costs for discharges to NH by diagnosis and mechanism (NIT) + Avg. days in NH by body region × $197 cost/day (NH)	2008 NIS and 1996–97 MarketScan® data (NIT); days in NH estimated from 2004 National Nursing Home Survey, mean cost/day from Genworth *2008 Cost of Care Survey* (NH)

In hospice	C/ME + 2×T + Non-fatal inpatient total (NIT) + Cost of hospice stay ending in death (HSP)	\$41[+\$1,513] (C/ME) + \$630 (2×T) + Avg. inpatient costs for discharges to hospice by mechanism and body region (NIT) + \$6,851 (HSP)	2008 NIS and 1996–97 MarketScan® data (NIT), 2007 National Hospice and Home Care Survey (HSP)

All fatalities were assigned coroner/medical examiner (C/ME) costs—a \$41 administrative fee, plus an additional \$1,513 if an autopsy was performed, as indicated by the NVSS autopsy variable. For cases where this variable was coded as missing, we used autopsy probabilities by external cause group based on Hoyert (2011). We estimated C/ME costs from Hickman et al. (2007), which provides survey data on the costs and workload of all U.S. C/ME offices except in Louisiana. In 2004, C/ME offices in the U.S. spent an aggregate budget of \$718.45 million (in 2004 dollars) in the process of responding to 955,870 referred deaths, of which 486,680 were accepted for autopsy. From these figures we calculated the cost per accepted fatality and the cost per referred fatality under the arbitrary assumption that 5% of the total C/ME office budget, or \$35.92 million, was used to determine which cases to accept, keep records about those determinations, and handle public relations and education requests unrelated to specific deaths. This 5% was divided among all referred deaths, and the remaining 95% among only those accepted for autopsy.

For deaths that occurred at home, at the scene of injury, or at any other non-medical location, the C/ME cost represented the entire medical cost. For all other locations—DOA, ED, inpatient, nursing home, or hospice—where it can be inferred that medical treatment of some sort was administered, additional cost components appropriate to the location were added, as described in the remainder of this section.

DOAs and all deaths in the hospital, whether in the ED or as an inpatient, received the $429 median cost of a one-way transport, which came from a 2012 survey of ambulance providers published by the U.S. Government Accountability Office (GAO, 2012). Deaths in a nursing home or hospice were assigned the cost of two emergency transports—one from the scene to the hospital, and a second from the hospital to the facility where death eventually occurred. The ambulance component is described in greater detail below, in Section 3.2.7.

For deaths in the ED, Finkelstein et al. (2006) added the average ED treatment cost of an injury fatality in the ED by injury mechanism and age group, computed from injury deaths in EDs in 1997 in three states (n=363 deaths). To update this cost component, we turned to the fatal, non-admitted injury cases of the 2007 NEDS, successfully estimating costs for 83.6% (n=3,623/4,336, unweighted) of reported fatalities.

All HCUP datasets—including the NEDS—report hospital facility charges submitted to healthcare payers for hospital-based services, rather than payments hospitals received for those services. (Typically, the payment received by a hospital amounts to about half the charge it submits, but this can vary widely.) In order to estimate payments from charges, one multiplies the facility charge times a facility-specific cost-to-charge ratio. AHRQ does not produce cost-to-charge ratios for the NEDS, but through an indirect process we were able to estimate cost-to-charge ratios for most facilities and sampling strata in the 2007 NEDS, as described below.

We began with the 2003 State Emergency Department Databases (SEDD; http://www.hcup-us.ahrq.gov/seddoverview.jsp). To date, the 2003 SEDD is the only ED dataset for which AHRQ has computed cost-to-charge ratios. We used data from the eight states in the 2003 SEDD that provided hospital charges (CT, GA, MD, MN, NE, SC, TN, UT). We estimated the facility cost for each non-fatal injury case by multiplying the reported charge for the ED visit times the facility's cost-to-charge ratio. Since these eight states were not representative of the nation as a whole, we adjusted the estimated costs to national prices using state-specific price adjustors based on the health care component of the ACCRA Cost of Living Index (http://www.coli.org/), produced by the Council for Community and Economic Research.[4] Both average charges and average costs were computed by ICD-9-CM diagnosis and applied to the non-fatal, non-admitted injury subset of the 2007 NEDS. The 2003 SEDD-based charges were much lower than 2007 NEDS charges for comparable diagnoses. The costs also were much lower than average Medical Expenditure Panel Survey (MEPS) costs for ED visits for injury (unpublished data). We concluded that the 2003 SEDD-based ED medical cost estimates were unrealistically low and required adjustment. Therefore, we computed average ratios of 2007 NEDS charges to 2003 SEDD charges for three cause groups (intentional, unintentional motor-vehicle traffic accident, and other unintentional) and used these ratios to adjust the SEDD-based medical costs, which more than doubled the estimated ED medical costs. Having produced this adjusted cost estimate for every non-fatal injury in the 2007 NEDS, we used these costs, along with the total ED visit charges, to estimate cost-to-charge ratios for each facility and sampling stratum in the 2007 NEDS.

We then applied these estimated cost-to-charge ratios to the fatalities in the 2007 NEDS. This enabled us to estimate costs for ED fatalities at the case level by multiplying hospital charges times our estimated cost-to-charge ratios. Average costs were computed by injury mechanism (as per NCHS's ICD-9 Framework for Presenting Injury Mortality Data, http://www.cdc.gov/nchs/injury/ice/matrix.htm) and, where sample size permitted, by age, intent, or body region injured. These estimated costs were then applied to ED deaths in the 2010 NVSS.

[4] The state price adjustors were developed (and are distributed) by the Pacific Institute for Research and Evaluation from Census data and 2008–2010 local price adjusters drawn from the Council for Community and Economic Research's *Cost of Living Index,* volumes 41–43.

For deaths in the hospital, costs of an inpatient admission that ended in death were added to the transport and C/ME costs. These inpatient costs were computed by injury mechanism (fall, motor vehicle, poisoning, suffocation, other), nature of injury (fracture or dislocation, internal organ injury, other), body region (brain, spinal cord, trunk, other) and age group (0–9, 10–24, 25–49, 50–69, 70–84, 85 and older), from injury-related cases in the 2008 NIS in which the patient died in the hospital (n=16,004, unweighted). For each case, the facility cost was estimated by multiplying the NIS hospital charge times the facility-specific cost-to-charge ratio. This estimated facility cost, in turn, was multiplied times another factor to account for non-facility costs—payments to professionals such as surgeons, anesthesiologists, and therapists who bill separately from the hospital. These non-facility factors were based on the 1996 and 1997 MarketScan® Commercial Claims and Encounters Database (http://truvenhealth.com/your-healthcare-focus/life-sciences/marketscan-databases-and-online-tools)**.** This database contains an inpatient hospital admissions file, which summarizes each hospital admission, including total payments, facility payments, length of stay, and detailed diagnosis data. After removing non-fee-for-service claims and claims without a diagnosis of injury, a file of inpatient injury admissions was created (n=19,274). Using these records, we calculated the mean ratio of total medical costs during the inpatient stay to facilities costs by body region as presented in the Barell injury-diagnosis matrix. The ratios of total costs to facilities costs ranged from 1.03 to 1.39, with an overall average of 1.26. The NIS cost estimate for each admission was multiplied times the ratio for the body region corresponding to the patient's primary injury diagnosis to yield estimated total inpatient costs for each injury admission in the 2008 NIS. The non-facility costs of non-fatal hospital admissions were estimated using this same approach (see Section 3.2.1, below). Average costs by selected mechanism, diagnosis, and age group were computed, and these averages were applied to the hospital deaths in the 2010 NVSS data.

Deaths in a nursing home or hospice were assumed to be preceded by a stay in an acute care hospital. The method described in the previous paragraph was used to estimate hospital costs for each patient in the 2008 NIS who was discharged to a hospice (n=3,336, unweighted) and each patient who was discharged to a nursing home following a severe (AIS≥4) injury (n=4,327, unweighted). Because of the small samples, fewer diagnosis/mechanism groups were used than for deaths in hospital, and there was no age breakdown. For deaths in hospice, hospital costs were computed for four mechanisms (fall, poisoning, suffocation, other) and four body regions (TBI, trunk, hip, other). For deaths in nursing home, hospital costs were computed for four diagnosis groups (amputation/burn/hemorrhage, internal organ, crush/fracture, other), up to five body regions (TBI, SCI, trunk, hip, other), and, when the sample size permitted, three cause groups (fall, motor vehicle, other). The estimated cost of hospital care was added to the C/ME cost and two emergency transport trips, as described previously. The final component of medical cost for these deaths was the cost of the terminal stay in the nursing home or hospice.

For deaths in a nursing home, the cost of the nursing home stay was calculated as cost per day times the length of stay (LoS) in the nursing home. The $197 average cost per day of nursing home care was taken from the Genworth Financial *2008 Cost of Care Survey*. The average LoS in a nursing home was estimated by injured body region (head/neck, trunk, upper limb, hip, upper leg or knee, lower leg or foot, other/unspecified) from resident cases with an admitting diagnosis of injury (n=1,234) from the 2004 National Nursing Home Survey (NNHS; http://www.cdc.gov/nchs/nnhs.htm). The NNHS is based on a survey of residents rather than discharge data, so it did not allow us to identify patients whose stay ended in death. Moreover, the NNHS reported only the patients' LoS as of the survey date, not the final LoS. The sample of patients resident in the nursing home on the survey date could not be assumed to be representative of the larger population of patients who passed through the nursing home. A dozen patients might complete one-month stays while a patient who required a longer convalescence remained for a whole year, but the survey would register only the one short-stay patient who was present with the long-stay patient on the survey date. Therefore, in order to obtain an estimate of the average LoS of all patients discharged from the nursing home, some assumptions were required. We assumed that each surveyed resident represented a nursing home bed that was always filled with a patient identical to the survey respondent. We further assumed that each patient was surveyed at the midpoint of the nursing home stay, unless this would have resulted in a LoS of less than 13 days, which we imposed as a minimum. This allowed us to account for the many residents with a short LoS who would have passed through the nursing home before and after the survey date while residents with a longer LoS remained. We estimated mean nursing home stays ranging from 84 days for hip injuries to 171 days for injuries of other/unspecified body locations. Because the NNHS provided no way to differentiate between patients who died and those who survived, these same lengths of stay were used in computing the nursing home component of non-fatal inpatient medical costs (see Section 3.2.6).

The cost of a terminal hospice stay was estimated using data from the 2007 National Home Health and Hospice Care Survey (http://www.cdc.gov/nchs/nhhcs.htm). This dataset, unlike the NNHS, was based on discharge data, including both charges and payments. Only eight cases involved injury, and just five of these ended in death. We computed the average total payment for these five cases, which came to $6,851.

These costing methods were applied to the injury deaths in the 2010 NVSS data at the case level, depending on the recorded place of death, to produce the estimate of fatal medical cost.

Example 1. Calculation of Estimated Medical Cost for Fatal Injuries

Based on information from a death certificate, the NVSS reported that a woman in her 70s died in a nursing home, the underlying cause of death was a fall, the principal injury diagnosis was a fractured hip, and an autopsy was performed.

For a death in a nursing home, we assume that, following the injury, the victim was first transported by ambulance to the hospital, and then transferred by ambulance to the nursing home where the death occurred. The WISQARS Injury Cost Module, therefore, assigns four cost components: emergency transport, inpatient stay, nursing home stay, and C/ME. A cost of $429 is assigned to each ambulance transport, for a total of $858. For a hip fracture resulting from a fall, the estimated total cost of an inpatient stay ending in transfer to a nursing home is $29,828. A stay in the nursing home costs $197 per day, and for a hip injury the stay is assumed to last 83.9 days, resulting in a nursing home cost of $16,528. Following the death, an autopsy was performed, so the full autopsy cost of $1,554 is included. Thus, the full medical cost of this fatal injury is estimated as

$$\$858 + \$29{,}828 + \$16{,}528 + \$1{,}554 = \$48{,}768.$$

If the patient had instead died during the hospital stay, then the inpatient cost would be that for a victim age 70–84 who suffers a fall resulting in a limb fracture and dies in the hospital—$35,207. Thus, the total medical cost would be estimated as

$$\$429 + \$35{,}207 + \$1{,}554 = \$37{,}190.$$

Since there was no nursing home stay, there was only one ambulance transport in this example.

(Note that in these examples and all subsequent examples of computations, all dollar figures are in 2010 dollars. Furthermore, for ease of presentation all figures are rounded to the nearest dollar before computations, so the total costs in the examples might differ by a few dollars from the costs produced by the WISQARS Cost of Injury Module.)

3.2 Non-Fatal Hospitalized Injuries

The costing methods for non-fatal hospitalized injuries in Finkelstein et al. (2006) were updated and applied to 2010 acute care costs. An overview of the approach is presented in Table 2. The details are provided in the following sections.

Table 2. Data and Methods for Estimating Medical Costs of Non-Fatal Injuries Requiring Hospitalization

Cost Category	Description, Unit Cost (*2010 US $*)	Source/Notes
Facility component of inpatient stay	Inpatient facility charges for the case multiplied times inpatient cost-to-charge ratio for the facility	2010 NIS for charges; cost-to-charge ratios from AHRQ
Non-facility component of inpatient stay	Estimated by comparing ratio of total costs to facilities costs by ICD-9-CM injury diagnosis	2010–11 MarketScan® commercial inpatient admissions claims data
Hospital readmissions	Readmission rates by age group and Barell diagnosis group	2007 SID analysis, reported by Zaloshnja et al. (2011)
Short- to medium-term follow-up costs	Estimated as the ratio of total costs in months 1–18 (on average) to total inpatient costs by 16 diagnosis groups, excluding costs of readmission in the first 6 months	1996–99 MEPS
Follow-up costs beyond 18 months, up to 7 years	Estimated using ratios of total lifetime costs to 18-month costs for 17 diagnosis groups	1979–88 Detailed Claim Information (DCI) data from workers' comp claims

Cost Category	Description, Unit Cost (*2010 US $*)	Source/Notes
Long-term costs beyond 7 years for SCI and TBI	SCI: All post-discharge costs were recomputed using the ratio of pre-to post-discharge costs TBI: Post-7-year costs estimated at 75% of SCI costs	1986 survey data reported in Berkowitz et al. (1990)
Hospital rehabilitation costs	Probabilities and average costs of rehabilitation estimated for 11 injury diagnosis groups	Probabilities from 1997 CA, MD, & PA hospital data; costs estimated using Prospective Payment System reimbursement amounts, as reported in Miller et al. (2004)
Nursing home (NH) costs	Cost/day in NH ($197) times estimated average length of stay by 7 body regions for patients discharged to NH	Mean cost/day from Genworth *2008 Cost of Care Survey*; length of stay estimated from 2004 National Nursing Home Survey
Transport	Half of admissions assumed to have transport costs of $429	Median cost of ambulance transport from 2012 GAO survey
Claims administration	Sum of all costs above is multiplied times payer-specific 2010 ratio of insurance and claims administration expenditures to personal health care expenditures	2011 National Health Expenditure Accounts

3.2.1 Total Costs (Facility and Non-facility) of Initial Admission

The injury subset of the 2010 NIS served as the foundation on which inpatient medical costs were constructed. A number of injury-related records were dropped because they did not meet the criteria for this project. First, 3,250 NIS records were excluded because they lacked useable charges. (In 126 of these records, the hospital reported a total charge, but AHRQ flagged it as suspiciously high or low, given the patient's length of stay.) An additional 20,359 records were dropped because they lacked any injury diagnosis code that could be mapped to NEISS diagnosis and body part codes. (Most of these records had been identified as injury-related on the basis of an injury E code.) This left a subset of 568,664 useable NIS records.

The 2010 NIS reported the inpatient facility charge for each admission. For each record in the NIS, this charge was multiplied times the 2010 Medicare cost-to-charge ratio provided by AHRQ for that hospital (http://www.hcup-us.ahrq.gov/db/state/costtocharge.jsp). These ratios are hospital-specific for 63% of the acute injury records in the 2010 NIS. For hospitals whose facility-specific ratio could not be calculated, a weighted group average ratio specific to the hospital's state, ownership, urban/rural location, and number of beds was used, as recommended by AHRQ (Friedman, De La Mare, Andrews, & McKenzie, 2002). To estimate facility charges for California's Kaiser hospitals, which do not report charges, we used the average facility cost by diagnosis at other urban non-profit California hospitals in the 2010 NIS.

The estimated facility cost for each hospital admission was then multiplied times a ratio of total inpatient cost to facility cost to obtain the total cost of the admission. Non-facility costs—payments to professionals who bill separately from the hospital—are discussed in detail above in Section 3.1, in the paragraph on medical costs of deaths in hospital. For non-fatal hospitalizations, however, we used updated Truven Health MarketScan® data from 2010 and 2011, rather than the older 1996–97 data used for fatal hospitalizations. These ratios, estimated by ICD-9-CM diagnosis code, were provided by CDC staff of the Statistics, Programming, and Economics Branch (SPEB), Division of Analysis, Research, and Practice Integration (DARPI), NCIPC.

3.2.2 Inpatient Readmission Costs

In order to account for follow-up admissions, we used readmission rates based on the 2007 State Inpatient Databases (SID) from 13 states (AZ, CA, FL, MO, NE, NH, NV, NY, NC, SC, TN, UT, and WA), as reported by Zaloshnja et al. (2011). The SID covers all inpatient stays in participating states. In 2007 AHRQ tracked revisits for inpatients in these 13 states, providing a rare look at follow-up hospitalizations. Zaloshnja et al. computed readmission rates (1−[patients/admissions]) by Barell nature of injury and body part and age group (0–14, 15–29, 30–74, 75+). Readmission rates averaged 4.3% but ranged as high as 21% (for hip fractures, ages 75+). We assumed that, on average, follow-up admissions have the same costs as initial admissions. (We were forced to make this assumption because the NIS does not distinguish initial from follow-up admissions.) We divided the total inpatient cost of each case by $(1-r)$, where r is the estimated readmission rate, to incorporate the cost of readmissions.

3.2.3 Short- to Medium-Term Follow-Up Costs for Inpatient Admissions

To develop estimates of short- to medium-term costs for injuries requiring an inpatient admission but not discharged to a nursing home, Finkelstein et al. (2006) multiplied total estimated inpatient costs for each non-fatal injury reported in NIS (as derived above) times the ratio of all costs in the first 18 months after injury, on average (including costs for inpatient services, ED visits, ambulatory care, prescription drugs, home health care, vision aids, dental visits, and medical devices), to the total inpatient costs (including admissions and readmissions) for injury by diagnosis and mechanism of injury. These ratios were derived from 1996–99 MEPS data. MEPS is a nationally representative survey of the civilian non-institutionalized population that quantifies individuals' use of health services and corresponding medical expenditures for two consecutive years following enrollment. Because the MEPS analysis was limited to injuries of admitted patients with at least 12 months of follow-up and the MEPS data include costs for up to 24 months, the MEPS sample captures injuries with an average of 18 months of post-injury treatment.

Although MEPS is the best source of available data for capturing nationally representative injury costs across treatment settings (e.g., hospitals, physician's office, pharmacy), even after pooling four years of data the sample size for many injuries with low incidence rates was small (n=381, unweighted). Therefore, to obtain robust direct cost estimates, injuries were collapsed into 16 ICD-9-CM diagnosis groups, ranging in size from 5 to 61 unweighted cases, prior to quantifying average costs. Using the MEPS data and the methods described in the preceding paragraph from Finkelstein (2006), the average ratio of 18-month costs to total inpatient costs (including readmissions) was calculated for the 16 diagnosis groups. The ratios ranged from 1.02 to 2.13, with an overall average of 1.35. The ratios were then multiplied times the corresponding 2010 inpatient cost estimates detailed in the preceding sections to arrive at 18-month costs for injuries requiring an inpatient admission.

3.2.4 Long-Term Follow-Up Costs

While short- to medium-term costs capture the majority of costs for most injuries, some injuries continue to require treatment beyond 18 months, and the costs are not inconsequential. Rice et al. (1989) estimated long-term medical costs from costs in the first six months using multipliers derived from the longitudinal 1979–88 Detailed Claim Information (DCI) database of the National Council on Compensation Insurance, which covered worker's compensation claims spread across 16 states (n=463,174). The DCI file was unique: nothing similar in size, geographic spread, and duration has become available subsequently. Because occupational injury includes a full spectrum of external causes (e.g., motor vehicle crash, violence, fall), the DCI data by diagnosis presumably captured the medical spending pattern for an injury to a working-age adult reasonably accurately. Their applicability to childhood injuries, however, was unclear. To address this concern, Miller, Romano, and Spicer (2000b) compared cost patterns of adult versus child injury using 1987–89 MarketScan® data on private health insurance claims. They found that the ratios of 30-month costs to initial hospitalization costs for children's episodes by diagnosis did not differ significantly from the comparable ratios for adults. Thus, we concluded the DCI estimates were applicable to childhood injury cases.

For lack of a better alternative, following Finkelstein et al. (2006), we computed ratios from the DCI expenditure patterns to adjust estimates of costs in the first 18 months to arrive at estimates of the total medical costs (including long-term) associated with injuries. This method implicitly assumed that while treatment costs varied over time, the ratio of lifetime costs to 18-month costs remained constant between the time the DCI data were reported and 2010.

Based on the ten years of DCI data, the average ratio of lifetime costs to costs in months 1–18 was calculated for 17 ICD-9-CM diagnosis groups. The cost estimates for the first 18 months after the injury, as described in the previous section, were multiplied times the DCI-based ratios to arrive at the estimate of total costs for years 1–7 post-injury. Overall, at a 3% discount rate, 77% of the costs of hospital-admitted injuries were incurred in months 1–18 (Miller et al., 2000a). This implies an average long-term multiplier of 1.30.

3.2.5 Long-Term Costs of Spinal Cord Injuries (SCI) and Traumatic Brain Injuries (TBI)

For several types of injuries, and especially for SCI and TBI, a substantial portion of the total medical costs occur more than seven years after the injury is sustained (Miller et al., 1995). WISQARS incorporates lifetime SCI and TBI costs from Berkowitz et al. (1990).

For severe SCI, the ratio of lifetime costs to costs of the initial admission (plus emergency transport) was multiplied times the cost of the initial admission to estimate lifetime medical costs (apart from claims administration expenses). This special procedure for severe SCI cases replaces the readmission, medium-term, and long-term cost methods described in the three previous sections, as well as the nursing home and rehabilitation costs described in the next section. Ratios were computed separately for complete quadriplegia, partial quadriplegia, complete paraplegia, and partial paraplegia based on data collected by Berkowitz et al. (1990), who surveyed a nationally representative sample of SCI survivors (n=758) and their families in 1986. The survey referred to patients residing in institutions, those living at home, and those in independent living centers. The respondents (victims, families, or guardians) provided details of care payments during the past year, including payments for medical, hospital, prescription, vocational rehabilitation, durable medical equipment, environmental modification, personal assistant, and custodial care. The long-term cost estimates for SCI rely on the assumption that the now-dated Berkowitz data on medical costs by year post-injury mirror the expected lifetime costs for recent SCI victims.

Miller et al. (2004) estimated inpatient rehabilitation costs by diagnosis group, including SCI and TBI, finding that among patients receiving rehabilitation, the cost per case for TBI averaged 75% of the cost for SCI. TBI patients, however, were far less likely to receive inpatient rehabilitation (6% versus 31%). Finkelstein et al. (2006) assumed the TBI patients who received inpatient rehabilitation would follow the same cost pattern more than seven years post-injury as the SCI patients, but with costs equal to 75% of SCI levels. Based on the Berkowitz data, we estimated that, at a 3% discount rate, 46.92% of the medical costs of TBI are incurred in the first seven years. Therefore, we divided the seven-year costs by this percentage to arrive at lifetime medical costs of TBI. For further exploration of the relationship between SCI and TBI costs, see Miller et al. (2004).

3.2.6 Rehabilitation and Nursing Home Costs

Conceptually, all of the foregoing costs (except long-term SCI costs) follow a framework in which each step builds on the previous steps through application of a multiplier. None of these multipliers accounted for the costs of inpatient rehabilitation or nursing home stays. These costs are independent of the series of multipliers, and they enter the process through addition rather than multiplication.

Costs of inpatient rehabilitation were estimated using direct costs for 11 injury diagnosis groups developed by Miller et al. (2004). These costs were based on the Health Care Financing Administration (now the Center for Medicare and Medicaid Services) Prospective Payment System (PPS) reimbursement schedule that governs all payments, including professional fees, for U.S. inpatient rehabilitation. Miller et al. (2004) used PPS data on lengths of stay and cost per day to develop direct cost estimates of rehabilitative treatment. They used 1997 hospital discharge data from three states (CA, MD, PA) to compute the probability of inpatient rehabilitation by diagnosis group. The product of the probability of rehabilitation and the direct cost of rehabilitation was added to the estimated cost of non-fatal injuries as previously described.

The *patient disposition* variable of the NIS indicates injury admissions that ended in discharge directly to a nursing home. For these cases, we computed nursing home costs as described above in Section 3.1. (Since the nursing home data used for these estimates did not provide any way to differentiate between those who died in the nursing home and those who survived, there was no basis for estimating separate fatal and non-fatal costs.) For cases where the detailed patient disposition was missing but that were in the broader category that included nursing home (“another type of facility”), we multiplied the estimated nursing home cost times the share of known cases in that category that were discharged to a nursing home by Barell body part and nature of injury. Estimated nursing home costs were added to the previously described medical cost estimates.

3.2.7 Transport Costs

In order to measure transportation costs to the hospital, WISQARS draws on a 2012 GAO survey of ambulance providers (http://www.gao.gov/assets/650/649018.pdf). This report found that the median cost of ground ambulance providers in 2010 was $429 per transport. This cost is used in WISQARS for fatal, hospital-admitted, and ED-treated injuries. It is rather conservative because 1) the distribution of ambulance costs is skewed, so the mean would be greater than the median; and 2) this "cost" estimate did not cover ambulance providers' full costs—it left them with an average loss of 1%, which Medicare alleviated by "add-on payments" of $35 per transport. Since there was no way to identify which inpatients were transported by ambulance, we assumed that half of hospital admissions involved ambulance transport and added half of the $429 median cost to every case.

3.2.8 Claims Administration Costs

To estimate the claims processing expenses incurred by private insurers and government payers like Medicare and Medicaid, we drew on the 2011 National Health Expenditure Accounts (NHEA, http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/NHE2011.zip). Using data from 2010, we computed the ratio of *total administration and total net cost of health insurance expenditures* to *personal health care* by source of payment: Medicare (6.26%), Medicaid (8.59%), private insurance (14.02%), workers' compensation (23.75%), and other (4.35%). The overall mean was 8.29%. While the NHEA would have permitted ratios to be calculated for additional payer categories, the uniform payer variable in the NIS has much less detail. Claims administration ratios of 0.00% were assigned to the payer categories “self-pay” and “no charge”. The total of all preceding costs was multiplied times the payer-specific ratio to produce the estimate of claims administration expenditures.

Example 2. Calculation of Estimated Medical Cost for Hospital-Admitted Injuries

From a hospital discharge record in the NIS we learn that a 79-year-old woman was admitted to the hospital following a fall in which she suffered a hip fracture (ICD-9-CM diagnosis code 820). At the end of her hospital stay she was discharged to a nursing home. Medicare was the primary expected payer for her treatment.

The hospital reported a total charge of \$29,620. The average cost-to-charge ratio for this hospital was 0.41785. For a hip fracture, non-facility payments are estimated to be 15.455% of facility payments. Thus, the estimated total payment for the initial hospital stay is

$$(\$29{,}620 \times 0.41785) \times 1.15455 = \$14{,}290.$$

The estimated readmission rate for a hip fracture patient age 75 or greater is 0.037. Therefore, the total expected cost of all inpatient stays is

$$\$14{,}290 / (1-0.037) = \$14{,}839.$$

The costs of follow-up medical care are accounted for by the medium- and long-term multipliers. The total inpatient cost is multiplied times the medium-term multiplier to obtain costs of medical care through 18 months, and this product in turn is multiplied times the long-term multiplier to obtain lifetime medical costs. For a hip fracture, the medium-term multiplier is 1.3503 and the long-term multiplier is 1.153. Applying these factors yields the long-term medical cost:

$$\$14{,}839 \times 1.3503 \times 1.153 = \$23{,}103.$$

Three cost components were not accounted for by this series of multipliers. First, it is assumed that 50% of admissions involve ambulance transport to the hospital. We therefore apply half of the median transport cost of \$429 to every case, or \$215. Second, for a hip fracture there is an 8.615% probability that the patient will require inpatient rehabilitation costing \$12,393. Thus, the expected rehabilitation cost is \$1,068. Third, because the patient was discharged to a nursing home, there is also a nursing home cost. As in the fatal example, a stay in the nursing home costs \$197 per day, and for a hip injury the stay is assumed to last 83.9 days, resulting in a nursing home cost of \$16,528. Adding these three components to the long-term total yields

$$\$23{,}103 + \$215 + \$1{,}068 + \$16{,}528 = \$40{,}914.$$

The final cost component is the claims administration cost, which depends on the primary expected payer—in this example, Medicare. On average, the cost of claims administration for Medicare is 6.26% of the claim. Thus, in this example it would be \$2,561. Adding this to previous total gives a grand total of \$43,475.

3.3 Non-Fatal Injuries Treated in an Emergency Department and Released

Table 3 summarizes the methods for quantifying costs of non-fatal injuries treated in EDs and released without inpatient admission (hereafter referred to simply as *ED-treated injuries*).

Table 3. Data and Methods for Estimating Medical Costs of Non-Fatal, Non-Admitted Injuries Treated in Emergency Departments

Cost category	Description, Unit Cost (*2010 US \$*)	Source/Notes
ED Visit	Total ED charges, both facility and professional, by 3-digit ICD-9 diagnosis; differentiated by age, sex, and cause using ratios based on the previous WISQARS cost module	2010–11 MarketScan® commercial outpatient services claims data

Follow-up Visits and Medication, Months 1–18	Estimated as the ratio of all costs in the first 18 months after injury to costs of the initial ED visit by diagnosis grouping	1996–1999 MEPS
Follow-Up Costs Beyond 18 Months	Estimated using ratios of total lifetime costs to 18 month costs by diagnosis/age group	1979–1988 Detailed Claim Information (DCI) data from worker's comp claims
Emergency Transport	Half of ED visits assumed to have transport costs of $429	Median cost of ambulance transport from 2012 GAO survey
Claims administration	Sum of all costs above is multiplied times payer-specific 2010 ratio of insurance and claims administration expenditures to personal health care expenditures	2011 National Health Expenditure Accounts

The cost of the initial ED visit, based on claims for outpatient services in the 2010–11 MarketScan® Commercial Claims and Encounters Database, was provided by CDC staff of SPEB/DARPI/NCIPC. ED visits were identified using the *service category* variable. The payments for all services rendered in the ED during a visit were summed, including services billed by departments other than the ED. These payments included both those for ED facility charges and those for professional fees billed separately by specialists. The mean total and facility payments per visit were computed by ICD-9-CM diagnosis. Overall, the average facility payment was $870 and the average total payment was $1,073. The MarketScan®-based mean cost of the initial ED visit was merged onto a subset of the 2010 NEDS, a multi-state sample of patients treated in a hospital ED, by primary injury diagnosis. The NEDS subset was restricted to non-fatal injuries that did not result in a subsequent hospital admission.

Medical costs are known to vary by age and sex, and intentional and motor-vehicle injuries are known to result in higher medical costs than other injuries. The MarketScan®-based cost estimates, however, were differentiated only by diagnosis. Therefore, we further differentiated them by age, sex, and cause of injury. For this purpose, we used ratios based on the previous generation of WISQARS medical costs for ED-treated injuries. For a given diagnosis, for each age-sex-cause cell, the old ED visit cost assigned to that cell was divided by the mean old ED visit cost for the diagnosis to produce a ratio, which was then multiplied times the MarketScan®-based mean cost to produce a cost estimate tailored to the patient's age, sex, and cause of injury. These adjusted costs were then re-normalized (i.e., scaled up or down slightly) for each diagnosis in order to reproduce the original MarketScan®-based mean cost by diagnosis. The result was a 2010 NEDS dataset whose mean ED visit costs by diagnosis were identical to the new MarketScan®-based mean costs, but with proportional variation of costs by age, sex, and cause identical to the old WISQARS costs.

The switch to MarketScan®-based ED medical costs is a major change from the previous generation of the WISQARS Cost of Injury Module, and it has resulted in an average increase of more than 100% in the estimated cost of an ED visit. The old method was similar to that used for hospital-admitted medical costs: the hospital-reported total charge was multiplied times a hospital-specific cost-to-charge ratio to produce an estimate of ED facility cost, and this was multiplied, in turn, times a ratio of total cost to facility cost. In recent years, however, hospital EDs have shifted a growing share of charges for ED visits to other hospital departments and medical specialists, whose charges do not appear on the ED record in AHRQ's HCUP datasets, the NEDS and the SEDD. Thus, the traditional method has produced worsening underestimates of ED visit costs. Furthermore, AHRQ has not produced ED-specific cost-to-charge ratios since 2003. Cost estimates produced by the former method were, therefore, increasingly out of step with current ED visit costs. By using the 2010–11 MarketScan®-based mean costs by diagnosis, adjusted for age, sex, and cause of injury, we obtain considerably more realistic estimates of the cost of medical treatment in a hospital ED.

As with costs for hospitalized injuries, the cost of the initial visit was multiplied times medium-term and long-term factors to obtain lifetime costs. To account for follow-up visits and medication in the first 18 months post-injury, ratios based on 1996–99 MEPS data for 51 ICD-9-CM diagnosis groups were used. The ratios ranged from 1.02 to 5.44, with an overall average of 1.78. For follow-up costs beyond 18 months, 1979–88 DCI ratios were used. At a 3% discount rate, 88% of the costs for non-admitted cases occurred in months 1–18 and the average multiplier was 1.14 (Miller et al., 2000a). (More detail on these MEPS and DCI ratios can be found in Sections 3.2.3 and 3.2.4 above, where the parallel ratios for inpatients, which come from the same sources, are described.) As with hospital costs, half of patients were assumed to receive emergency transport, so half of the $429 median cost of a one-way emergency transport was added to the medical cost of each case (see Section 3.2.7 above for details). Finally, we added payer-specific claims administration costs (see Section 3.2.8 above for details).

Example 3. Calculation of Estimated Medical Cost for ED-Treated Injuries

From an ED discharge record in the NEDS we learn that a woman in her 70s was treated in the ED following a fall that resulted in a hip fracture (ICD-9-CM diagnosis code 820). Medicare was the primary expected payer.

For a female patient age 70 or greater, the mean cost of an ED visit for a hip fracture is $1,788. The cost of the initial ED visit is multiplied times the medium-term multiplier to obtain costs of follow-up medical care through 18 months, and this product in turn is multiplied times the long-term multiplier to obtain lifetime medical costs. The medium-term multiplier for a hip fracture is 2.0078 and the long-term multiplier is 1.089. Applying these factors yields the long-term medical cost:

$$\$1{,}788 \times 2.0078 \times 1.089 = \$3{,}909.$$

To this we add emergency transport and claims administration costs. As with hospitalized injuries, we assume there is a 50% probability of receiving emergency transport to the ED. We therefore apply half of the median transport cost of $429 to every case, or $215. Finally, we compute the claims administration cost for Medicare, which is 6.26% of the total claim. Thus, the total estimated medical cost for this case would be

$$(\$3{,}909 + \$215) \times 1.0626 = \$4{,}382.$$

3.4 Applying the Estimated Non-Fatal Medical Costs to the 2010 NEISS-AIP

Medical costs were estimated as described for all non-fatal injury cases in the 2010 NIS and the 2010 NEDS. The costs by admission status, age group, sex, and diagnosis were further differentiated by major cause using three cause groups: motor vehicle traffic-related injuries, intentional injuries (e.g., assaults and self-harm), and all other injuries (including unintentional non-motor-vehicle injuries and all injuries with missing cause codes). A few diagnosis categories not commonly found among intentional and motor vehicle injuries—notably burns—were not differentiated but were placed into the “all other injuries” category. All cases were assigned NEISS diagnosis and body part codes using a procedure developed by Lawrence et al. (2000), as described in Appendix I. Then average costs were computed by admission status, cause group, NEISS diagnosis and body part, sex, and age group. Sometimes age/sex/diagnosis cells were combined together to obtain large enough cell counts (at least 10 unweighted cases and usually at least 30) for obtaining stable national estimates.

4. Lifetime Work Losses Due to Injuries

Injuries can result in both temporary and permanent disability. When this occurs, injury victims may lose part or all of their productivity potential. Work losses due to injury may include loss of wages and accompanying fringe benefits, and the loss of ability to perform one's normal household responsibilities. For non-fatal injuries, work losses represent the value of goods and services not produced because of injury-related illness and disability. To the degree that injuries prevent or deter individuals from producing goods and services in the marketplace, the public sector, or the household, the value of these losses is a cost borne by society.

Fatal work losses represent the value of goods and services never produced because of injury-related premature death. These work loss costs were estimated by applying expected lifetime earnings by age and sex to deaths from injury sustained in 2010 (n=180,811), including an imputed value for lost *household production*. Household production refers to any activity performed by a household member that has value, but is not directly compensated. Examples may include, but are not limited to, cleaning and cooking, yard work, and child/elder care. Consistent with the human capital approach for quantifying the burden of injuries (Rice et al., 1989), estimates of non-fatal work losses involve applying average earnings to work days lost and the market value of housekeeping services to time lost in home production. Non-fatal injuries may result in both short-term work loss and lifetime work loss. The latter includes the value of output lost in later years by persons disabled as a result of injury sustained in 2010.

The work loss estimates for the WISQARS Cost of Injury module were updated from Finkelstein et al. (2006). Non-fatal work losses were stratified into two categories: short-term losses, which represent lost wages and accompanying fringe benefits and household services occurring in the first six months after an injury, and long-term losses, which represent the respective wage and household loss occurring after six months from the time of the injury. The decision to use six months as the transition point between short-term and long-term work losses was driven by the availability of data on duration of work loss.

Because men earn higher wages than women, even in the same job (BLS, 2001) or for injuries with the same prevalence between men and women, the work loss estimates were greater for men. Finkelstein et al. (2006) view this as more of a shortcoming of the labor market than an inherent problem with the human capital approach. Regardless, this undervaluation of women’s labor is reflected in the estimates.

4.1 Fatalities

To estimate the years of life lost and the forgone earnings for someone who sustained a fatal injury, we followed the method used in Finkelstein et al. (2006). We updated this approach by using the most recent life tables published by NCHS (Arias, 2014), along with new earnings estimates based on more recent data. Lifetime productivity loss was estimated as the discounted sum of expected annual earnings over the victim’s remaining potential working life. For a given year, expected earnings are the product of the sex-specific probability of surviving to the next year of age times sex-specific expected earnings for someone of that age. We used this formula with earnings data by sex and year of age derived from the March Supplement of the Current Population Survey (CPS, http://www.census.gov/cps/), averaged across a full business cycle from 2002 through 2009. We inflated all earnings figures to 2010 dollars (see Section 1.1 for inflator details). We added fringe benefits of 23.33% of wages based on the average ratio of wage supplements to wages for 2002–2009 from the national income accounts (*Economic Report of the President*, 2011, Table B-28). Earnings at future ages, including salary and the value of fringe benefits, were adjusted upwards to account for a historical 1% work growth rate (Haddix et al., 2003) and then discounted to present value using a 3% discount rate.

Parallel calculations valued lost household work. Estimates of the value of household production were taken from Grosse et al. (2009), which used data from the American Time Use Survey to estimate time spent on household services and the earnings of workers who perform various services that are equivalent to household production. Historically, productivity growth in household production has been negligible, so, following Finkelstein et al. (2006), we did not adjust for it.

In all cases, Finkelstein et al. (2006) assumed that the probability of surviving past the age of 102 is zero. In equation form, lifetime earnings for someone of age a and sex b ($Earn_{a,b}$) is computed as

$$Earn_{a,b} = \sum_{k=a}^{102} \left\{ P_{a,b}(k) \times Y_{k,b} \times \left(\frac{1+g}{1+d} \right)^{k-a} \right\}$$

where $P_{a,b}(k)$ = the probability that someone of age a and sex b will live until age k; $Y_{k,b}$ = the average value of annual earnings (including fringe benefits) or of annual household production at age k for someone of sex b; g = the productivity growth rate (0.01 for earnings, 0.00 for household production); and d is the discount rate (0.03).

These costing methods were applied to the 2010 NVSS data at the case level to produce the fatal work loss costs to be used in WISQARS.

4.2 Non-Fatal Injuries

For non-fatal injuries, work loss estimates included the sum of the value of wage and household work lost due to short-term disability in the acute recovery phase and the value of wage and household work lost due to permanent or long-term disability for the subset of injuries that cause lasting impairments that restrict work choices or preclude return to work.

4.2.1 Short-Term Work Losses

Finkelstein et al. (2006) quantified temporary or short-term work loss for non-fatal injuries using the approach presented in Lawrence et al. (2000). Lawrence et al. combined the probability of an injury resulting in lost workdays from 1987–1996 National Health Interview Survey (NHIS) data with the mean work days lost (conditional on having missed at least one day) per injury estimated from the BLS's 1993 Survey of Occupational Injury and Illness (SOII) (n=ca. 600,000 injured workers). The SOII requires employers to report to BLS all injuries in the past year that resulted in at least one day of work loss, along with the duration of the work loss. However, if an injured worker's convalescence continued past the end of the year, when the reporting period ended, the full duration of that worker's work loss would not be captured. On average, therefore, BLS work-loss reports cover six months post-injury. Lawrence et al. (2000) used a Weibull regression model to estimate the total duration of work loss for cases still open at the end of the year. The SOII data were used to estimate average work loss, conditional on having missed at least one day of work. In order to compute the mean work loss for all cases including those without work loss, the SOII-based estimates were then combined with the 1987–1996 NHIS data on probability of work loss. To facilitate this combination, Finkelstein et al. (2006) mapped BLS body part and nature of injury codes to ICD-9-CM diagnosis codes. They assigned the average work loss across all SOII cases to cases with ICD-9-CM diagnosis codes of "Unspecified" or "Other Specified." Averaged across all injuries, total estimated temporary work loss was 24.5 days per injury.

Although the SOII data are limited to injuries that occur on the job, Finkelstein et al.'s (2006) separate analysis of 1996–99 MEPS data (based on a much smaller sample) found that the duration of work loss did not differ significantly by whether or not the injury occurred on the job. This suggested that the SOII-NHIS work loss estimates could credibly be applied to estimate work loss associated with non-work-related injuries.

Analysis of the MEPS data found that work loss was roughly five times longer for hospitalized injuries than for non-hospitalized injuries. Using this ratio, Finkelstein et al. (2006) decomposed work-loss durations into separate estimates for admitted and non-admitted injuries. Averaged across all injuries (including those with no work loss), the estimated temporary work loss was 11.1 days per injury.

To place a monetary value on temporary wage work loss, the estimated days of work lost were multiplied times average earnings per day of work, given the victim's age and sex, from the CPS, as described above in Section 4.1. For children under age 15, whose own lost earnings are negligible, it was assumed that they required an adult caretaker, whose lost work days were valued as those of a female 25 years older than the child. Household workdays lost were estimated as 90% of wage workdays lost, based on findings from an unpublished nationally representative survey on household work losses following injury (S. Marquis, the Rand Corporation, personal communication, 1992). This ratio and the value of household work from Grosse et al. (2009), described above in Section 4.1, were used to impute a value to household work lost.

4.2.2 Long-Term Work Losses

Finkelstein et al. (2006) considered permanent total disability and permanent partial disability separately. For permanent total disability, the present value of age-and-sex-specific lifetime earnings and household production from the fatality analysis were multiplied times the probability of permanent disability for each type of injury. For permanent partial disability, the earnings estimate times the probability of permanent partial disability was multiplied times an additional factor identifying the average extent of disability resulting from that type of injury. The total and partial disability costs were then summed to compute the net work loss associated with permanent disability.

The probabilities of permanent total and partial disability by body part and nature of injury were from Miller, Pindus, Douglass, and Rossman (1995) and were based on pooled multi-state workers' compensation data from the 1979–88 DCI. The average extent of disability by diagnosis came from Lawrence et al. (2000) and was based on 1992–96 DCI data. DCI records the disability status for each sampled case. Following Rice at al. (1989), Finkelstein et al. (2006) assumed that these probabilities are the same for injuries that do and do not occur on the job and that these probabilities have not changed significantly over time. This method also assumes that the probability that an injury (e.g., a skull fracture) will cause someone never to do wage or household work again is the same for children, adults, and the elderly (though the years of work lost obviously will vary with the age of onset) and that victims will experience the same percentage reduction in household work ability that they experience in wage work ability.

To verify that the DCI data produce reasonable estimates, Finkelstein et al. (2006) conducted a literature review to compare their estimates to estimates from other sources. They identified only a few sources of published disability estimates, which were generally dated and limited to specific populations. The DCI data suggested probabilities of permanent disability similar to those of the handful of other studies of long-term work loss.

Although dated and restricted to occupational injury, the DCI data have several advantages that outweigh their disadvantages. As a result of their large sample, the DCI data can be used to compute probabilities for a far wider range of specific diagnoses than all the disability studies in the literature combined. Despite its restriction to occupational injury, the DCI sample also is more representative of the mix of injuries admitted to hospitals than the few studies in the literature, notably those restricted to patients triaged to trauma centers. The DCI data also are virtually the only source of information about permanent disability resulting from medically treated, non-admitted injuries (n=318,885 valid worker's compensation claims). Averaged across all injuries, the estimated percentage of lifetime productivity potential lost due to permanent injury-related disability was 0.26% per injury.

For hospital-admitted cases of traumatic brain injury (TBI), we computed modified disability probabilities using a logistic model developed by Selassie et al. (2008). The model took account of the severity of TBI (as per the Barell matrix, which distinguishes three levels of TBI), the presence of comorbid conditions, whether the patient was transferred from the initial acute hospital to another medical facility, and the patient's age and sex. This new disability probability was then decomposed into separate probabilities of total and partial disability according to the total/partial ratio of the old disability probabilities. In cases where the TBI diagnosis was a secondary diagnosis, the new probability was kept only if it exceeded the old probability based on the non-TBI primary injury diagnosis.

4.2.3 Calculating Total Work Loss Costs

Work loss costs were computed as described for all non-fatal injury cases in the 2010 NIS and the 2010 NEDS. Short- and long-term costs were summed to compute total work loss costs. The NIS (but not the NEDS) was partitioned by cause group (intentional, motor vehicle, other), as with medical costs. Similar to the procedure used for medical costs, average costs were computed by NEISS diagnosis and body part, sex, and age group. If age/sex cells were missing for a given NEISS diagnosis/body part combination, ratios of costs between age/sex cells for a similar NEISS diagnosis/body part were used to fill the empty cells. If there were no cases at all in the NIS or NEDS for a given NEISS diagnosis/body part combination for which costs were required (because it appeared in the 2010 NEISS-AIP), costs were borrowed from a similar NEISS diagnosis/body part combination.

5. Limitations of Methods for Medical and Work Loss Estimates

The WISQARS cost estimates are subject to several limitations. First, the estimates focus exclusively on medical costs and work loss costs. They do not account for non-health costs (e.g., criminal justice, educational impacts, property damage etc.), pain and suffering, quality of life loss, or injury costs borne by family and caretakers. Also excluded are costs of mental health treatment (e.g., for post-traumatic stress disorder) after the initial admission.

Second, a major limitation was the requirement to use data from many different sources. Although these were the best available data at the time of the analysis, some sources are old (notably the long-term cost factors, which are based on data from the 1980s), others are based on non-representative samples, and all are subject to reporting and measurement error. These problems may have resulted in bias in the cost estimates. The costing approach was designed to minimize the potential bias. More current and nationally representative data would have been preferable but were not available.

Third, for very severe burns, amputations, and other injuries requiring lifetime medical care, other than SCI and TBI, data on long-term costs after seven years were not available. This will bias our lifetime cost estimates downwards.

Fourth, an additional limitation of having to use multiple datasets was the inability to generate standard errors around the cost estimates. These costs are associated with great uncertainty, and users are cautioned that the actual costs for any given injury category could be substantially higher or lower than the WISQARS estimates.

The methods for estimating work loss costs had many additional limitations. Because women, the elderly, and children have lower average earnings, the human capital approach applied undervalued injuries to these groups. The approach also placed lower values on the work of full-time homemakers than the work of people participating in the labor market, which further depressed the value placed on women's losses relative to men's losses. It also undervalued disability among those of retirement age, and did not value temporary disability among children, as they had not yet entered the labor force. Discounting future work losses to present value meant that the loss of a lifetime of work by a 2-year-old was considered equivalent to loss of a lifetime of work by a 43-year-old. Although the child loses many more years of work, those years are far in the future and heavily discounted. The work loss cost calculations are also based on a year 2009 life table, which essentially assumes that life expectancy would have remained constant over each person's expected lifespan absent injury. Moreover, victims of serious and fatal injury may tend to be risk-takers (for example, thrill-seekers, heavy drinkers, or drug abusers) whose life expectancy may be shorter than for the average population, which would further bias the results. And, as noted above, some of the estimates are computed using fairly dated data that are based on a working population. Additionally, the estimates do not include the value of work lost by people other than the injured person (with the exception of an adult caregiver for children). These losses may include the time family, friends, and professionals spend caring for the injured person, time spent investigating the injury, and worker retraining. All of these limitations suggest that the costs should be interpreted with caution.

References

Agency for Healthcare Research and Quality. (Last updated December 2013). *Nationwide Inpatient Sample*. Agency for Healthcare Research and Quality, Rockville, MD. Accessed June 2014, from the World-Wide Web: http://www.hcup-us.ahrq.gov/nisoverview.jsp

Agency for Healthcare Research and Quality. (Last updated January 2014). *Nationwide Emergency Department Sample*. Agency for Healthcare Research and Quality, Rockville, MD. Accessed June 2014, from the World-Wide Web: http://www.hcup-us.ahrq.gov/nedsoverview.jsp

Arias, E. (2014). United States Life Tables, 2009, *National Vital Statistics Reports, 62*(7). Hyattsville, MD: National Center for Health Statistics.

Berkowitz, M., Harvey, C., Greene, C., & Wilson, S. (1990). *The Economic Consequences of Spinal Cord Injury*. Washington, DC: Paralysis Society of America of the Paralyzed Veterans of America.

Bureau of Labor Statistics. (2001). *Highlights of Women's Earnings in 2000* (BLS Report 952). Washington, DC: Bureau of Labor Statistics.

CDC/National Center for Health Statistics. (Last updated July 2014). *NVSS (National Vital Statistics System Homepage)*. Accessed July 2014, from the World-Wide Web: http://www.cdc.gov/nchs/nvss.htm

CDC/National Center for Health Statistics. (Last updated June 2013). *ICD-9-CM (Classification of Diseases and Functioning and Disability Homepage)*. CDC/National Center for Health Statistics. Accessed July 2014, from the World-Wide Web: http://www.cdc.gov/nchs/icd.htm

Centers for Disease Control and Prevention. (2001). National estimates of nonfatal injuries treated in hospital emergency departments—United States, 2000. *Morbidity and Mortality Weekly Report*, *50*, 340–346.

Centers for Disease Control and Prevention. (Last updated July 2014). *CDC-WISQARS (Web-based Injury Statistics Query and Reporting System)*. Accessed July 2014, from the World-Wide Web: http://www.cdc.gov/injury/wisqars/index.html

Centers for Disease Control and Prevention. (Last updated April 2014). *CDC-WISQARS (Proposed Matrix of E-code Groupings)*. Centers for Disease Control and Prevention. Accessed July 2014, from the World-Wide Web: http://www.cdc.gov/injury/wisqars/ecode_matrix.html

Current Population Survey, March Supplement, various years. Washington, DC: U.S. Department of Commerce, Bureau of the Census, 2006. Accessed October 13, 2011 from DataFerrett: http://dataferrett.census.gov/index.html

Economic Report of the President, 2011. Washington: Government Priting Office. Accessed October 17, 2011 from the Word-Wide Web: http://www.gpoaccess.gov/eop/download.html

Finkelstein, E. A., Corso, P. C., Miller, T. R., Fiebelkorn, I. A., Zaloshnja, E., & Lawrence, B. A. (2006). *Incidence and Economic Burden of Injuries in the United States, 2000*. New York: Oxford University Press.

Friedman, B., De La Mare, J., Andrews, R., & McKenzie, D. H. (2002). Practical options for estimating cost of hospital inpatient stays. *Journal of Health Care Finance, 29*(1), 1–13.

Gold, M. R., Siegel, J. E., Russell, L. B., & Weinstein, M. C. (Eds.). (1996). *Cost-Effectiveness in Health and Medicine: Report of the Panel on Cost-Effectiveness in Health and Medicine*. New York, NY: Oxford University Press.

Grosse, S. D., Krueger, K. V., & Mvundura, M. (2009). Economic productivity by age and sex: 2007 estimates for the United States. *Medical Care, 47*(7 Suppl 1), S94–S103.

Haddix, A. C., Teutsch, S. M., & Corso, P. S. (2003). *Prevention Effectiveness, A Guide to Decision Analysis and Economic Evaluation*. (Second ed.). New York: Oxford University Press.

Hickman, M. J., Hughes, K. A., Strom, K. J., & Ropero-Miller, J. D. (2007). *Medical Examiners and Coroners Offices, 2004*, Special Report: Bureau of Justice Statistics, U.S. Department of Justice.

Hoyert, D. L. (2011). Unpublished supplemental table accompanying *The Changing Profile of Autopsied Deaths in the United States, 1972–2007*. NCHS data brief, no 67. Hyattsville, MD: National Center for Health Statistics.

Lawrence, B. A., Miller, T. R., Jensen, A. F., Fisher, D. A., & Zamula, W. W. (2000). Estimating the costs of non-fatal consumer product injuries in the United States. *Injury Control & Safety Promotion—2000, 7*(2), 97–113.

Miller, T. R., Langston, E. A., Lawrence, B. A., Becker, L. R., Snowden, C. B., Granger, C. V., Russell, C., Kreutzer, J. S., & Marwitz, J. (2004). *Rehabilitation Costs and Long-Term Consequences of Motor Vehicle Injury* (Draft Final Report). Washington, DC: National Highway Traffic Safety Administration.

Miller, T. R., Lawrence, B. A., Jensen, A. F., Waehrer, G. M., Spicer, R. S., Lestina, D. C., & Cohen, M. A. (2000a). *The Consumer Product Safety Commission's Revised Injury Cost Model* (Final Report to CPSC). Landover MD: Public Services Research Institute.

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

Miller, T. R., Romano, E. O., & Spicer, R. S. (2000b). The cost of childhood unintentional injuries and the value of prevention. *The Future of Children, 10*(1), 137–163.

National Pediatric Trauma Registry. (2002). *Biannual Report, December 2001*. Boston, MA: Tufts University.

Office of Compensation Levels and Trends. (2014). *Employment Cost Index, Historical Listing – Volume V.* Washington, DC: U.S. Bureau of Labor Statistics. Accessed August 6, 2014, from the World-Wide Web: http://www.bls.gov/web/eci/ecicois.pdf

Rice, D. P., MacKenzie, E. J., Jones, A. S., Kaufman, S. R., deLissovoy, G. V., Max, W., McLoughlin, E., Miller, T. R., Robertson, L. S., Salkever, D. S., & Smith, G. S. (1989). *Cost of Injury in the United States: A Report to Congress*. San Francisco, CA: Institute for Health & Aging, University of California, and Injury Prevention Center, The Johns Hopkins University.

Schroeder, T., & Ault, K. (2001). *NEISS All Injury Program: Sample Design and Implementation*. Washington, DC: U.S. Consumer product Safety Commission.

U.S. Consumer Product Safety Commission. (Last updated August 2009). *NEISS (National Electronic Injury Surveillance System)*. Accessed August 13, 2009, from the World-Wide Web: http://www.cpsc.gov/LIBRARY/neiss.html

U.S. Government Accountability Office (2012). *Ambulance Providers: Costs and Medicare Margins Varied Widely; Transports of Beneficiaries Have Increased*. Report to Congressional Committees GAO-13-6. Accessed July 2, 2014, from the World-Wide Web: http://www.gao.gov/assets/650/649018.pdf

Wainer, H. (1976). Robust statistics: A survey and some prescriptions. *Journal of Educational Statistics*, *1*(4), 285–312.

Zaloshnja, E., Miller, T. R., Coben, J., & Steiner, C. (2011). Readmission rates for hospitalized injuries in the United States. Working paper.

Appendix I

Mapping between ICD-9-CM Codes and NEISS Diagnosis and Body Part Codes

This appendix describes the procedure for mapping from ICD-9-CM codes to NEISS diagnosis and body part codes developed by Lawrence et al. (2000) under contract for CPSC.

In the HCUP datasets, diagnoses were coded using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM), which uses a single numeric code to represent each medical condition. Since HCUP records might list multiple diagnoses for a single hospital admission or ED visit, the first-listed injury diagnosis was chosen as the case's classifying diagnosis. NEISS, like many other specialized systems for coding injury conditions, uses two separate codes to represent the principal condition: a diagnosis code (e.g., burn, fracture, laceration) and a body part code. Therefore, to estimate costs by NEISS diagnosis and body part, the ICD-9-CM primary injury diagnosis of each HCUP case had to be mapped to NEISS codes.

Mapping is not a straightforward process because there is not a one-to-one correspondence between codes in the two systems. In some instances, ICD-9-CM is more detailed, while in other instances, NEISS is more detailed. For example, NEISS lumps all poisonings into a single code, while ICD-9-CM has separate codes for more than 200 substances. In this instance, many ICD-9-CM diagnoses are mapped to a single NEISS diagnosis. When mapping from ICD-9-CM to NEISS, this is not a problem, as it results in a single NEISS diagnosis for each HCUP case. On the other hand, NEISS distinguishes six different types of burns (electrical, scald, chemical, thermal, radiation, and unspecified), while ICD-9-CM has just one category for burns. In this instance, a single ICD-9-CM diagnosis must be mapped to six NEISS diagnoses. To handle this, the original HCUP burn case was transformed into six cases, each with a different NEISS code. In order to maintain the original weighted case count when mapping, each new NEISS-coded case received one-sixth of the original case weight.

Using the NEISS-coded versions of the HCUP datasets, mean costs then were calculated by age group (0–19, 20–54, 55–69, 70+), sex (female, male), and NEISS diagnosis (30 two-digit codes) and body part (26 two-digit codes). The two types of NEISS codes combine to make more than 500 four-digit NEISS codes. In instances where cell counts were small, for estimation of medical costs similar cells were combined, most often by combining adjacent age groups, but sometimes by combining male and female or by combining similar diagnoses. For a few nature of injury categories (e.g., amputation, crushing), the HCUP cell counts were too small to obtain hospital-admitted medical costs by age, sex, and four-digit NEISS diagnosis. For these cases, the hospital-admitted costs were computed using a two-step procedure. First, the mean cost for each four-digit diagnosis code and the cost differentials by age-sex for the entire nature of injury category (e.g. all burns) were estimated. Second, the age-sex differentials for each category were applied to the average cost of each four-digit diagnosis code to differentiate by age and sex. For estimation of work loss costs, empty cells were filled by applying ratios of costs between age/sex cells from similar diagnoses.

In building the WISQARS costs, these processes were applied to twelve datasets: two admission statuses (hospital-admitted, ED-treated-and-released) by three cause groups by two types of costs (medical, work loss). The three cause groups were: motor vehicle traffic-related injuries, intentional injuries (e.g., assault and self-harm), and all other injuries (including unintentional non-motor-vehicle injuries and all injuries with missing cause codes). A few diagnosis categories not commonly found among intentional and motor vehicle injuries—notably burns—were not differentiated but were placed into the "all other injuries" category. The result was a file of medical and work loss costs by admission status, cause group, NEISS diagnosis and body part, sex, and age group. In order to test for completeness, the estimated costs were merged onto the 2010 NEISS-AIP data, revealing a number of cases with rare diagnoses to which costs were not assigned. For these rare diagnoses, costs were copied from similar diagnoses. For cases where the patient's sex or age was missing, average costs were estimated by age and NEISS diagnosis/body part or by sex and NEISS diagnosis/body part, respectively. Using this approach, all cases in the 2010 NEISS-AIP file were assigned medical and work loss costs.