Final Contractor Report

Pacific Institute for Research and Evaluation (PIRE)

"The Consumer Product Safety Commission's Revised Injury Cost Model"

February 2018

The report, *The Consumer Product Safety Commission's Revised Injury Cost Model*, prepared by PIRE under a contract with the U.S. Consumer Product Safety Commission, documents the numerous changes in data used and methodologies employed since the previous revision in 2000.

This comprehensive report includes all the running changes made in the Injury Cost Model (ICM) since 2000, and summarizes a number of previous task order reports prepared by PIRE updating aspects of the ICM, as well as reports and data developed by other federal agencies used by PIRE in updating the ICM. The major aspects updated include the estimation of medical costs, medically treated injuries, work losses, price indices, discounting, pain and suffering, and quality adjusted life years.

This research was completed in support of CPSC staff work on developing benefits for the prevention of non-fatal acute injuries, i.e., the reductions in the costs of injuries to society. These estimates may be used to support CPSC's actions on voluntary standards, mandatory standards, priority setting, and public information.

This report will be posted on CPSC's website to keep stakeholders informed of the progress of research on injury costs. It will be updated when major changes are made to the ICM.

THE CONSUMER PRODUCT SAFETY COMMISSION'S REVISED INJURY COST MODEL

Bruce A. Lawrence

Ted R. Miller

Geetha M. Waehrer

Rebecca S. Spicer

Mark A. Cohen, Vanderbilt University

William W. Zamula, CPSC

Final Report to the U.S. Consumer Product Safety Commission

Pacific Institute for Research and Evaluation

11720 Beltsville Drive, Suite 900

Calverton, MD 20705–3111

tel 301–755–2700

fax 301–755–2799

February 2018

This report has been funded with federal funds from the United States Consumer Product Safety Commission under contract CPSC-D-15-0013, Task Orders 1, 2, and 3.

The content of this publication does not necessarily reflect the views of the Commission.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AHRQ	Agency for Healthcare Research and Quality
AIS	abbreviated injury scale
ANSI	American National Standards Institute
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CART	classification and regression trees
CDC	Centers for Disease Control and Prevention
CHAMPUS	Civilian Health and Medical Program for the Uniformed Services
CPI	Consumer Price Index
CPS	Current Population Survey
CPSC	Consumer Product Safety Commission
CT	computerized tomography
DCI	Detailed Claim Information
DOA	dead on arrival
DoT	Department of Transportation
DRG	diagnosis-related group
ECI	Employment Cost Index
ED	emergency department
ER	emergency room
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
ICM	Injury Cost Model
III	Injury Impairment Index
LoS	length of stay
MEPS	Medical Expenditure Panel Survey
MRI	magnetic resonance imaging
NAMCS	National Ambulatory Medical Care Survey
NCCI	National Council on Compensation Insurance
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

NHAMCS	National Hospital Ambulatory Medical Care Survey
NHEA	National Health Expenditure Accounts
NHIS	National Health Interview Survey
NHTSA	National Highway Traffic Safety Administration
NIS	Nationwide Inpatient Sample
NNHS	National Nursing Home Survey
NPSRI	National Public Services Research Institute
NVSS	National Vital Statistics System
OPOB	outpatient/office-based
PCE	Personal Consumption Expenditures
PIRE	Pacific Institute for Research and Evaluation
PPS	Prospective Payment System
QALY	Quality-Adjusted Life Year
SCI	spinal cord injury
SEDD	State Emergency Department Databases
SID	State Inpatient Databases
SOII	Survey of Occupational Injury and Illnesses
TBI	traumatic brain injury
UDSMR	Uniform Data System for Medical Rehabilitation
WISQARS	Web-based Injury Statistics Query and Reporting System

1. INTRODUCTION

The U.S. Consumer Product Safety Commission (CPSC) performs a vital health and safety function. As a regulatory agency, CPSC protects the public from unreasonable risk of injury and death associated with consumer products. Some products are exempt from CPSC jurisdiction because they are excluded from the definition of “consumer product”; many of these are regulated by other federal agencies:

- food, drugs, tobacco, cosmetics, medical devices (Food and Drug Administration)
- automobiles, trucks, motorcycles, car seats, tires (National Highway Traffic Safety Administration)
- boats (U.S. Coast Guard)
- aircraft (Federal Aviation Administration)
- firearms, ammunition, explosives (Bureau of Alcohol, Tobacco, Firearms, and Explosives)
- pesticides (Environmental Protection Agency)

In 2013, an estimated 41,200 deaths and 39.8 million medically treated injuries were associated with consumer products under CPSC’s jurisdiction. They accounted for nearly one-third of all unintentional fatal injuries and nearly half of medically attended nonfatal injuries.

In the late 1970s, CPSC developed a model to estimate the cost to society of injuries associated with consumer products. The estimates represented the maximum potential benefits of reducing acute nonfatal injuries. The model did not value deaths, illnesses, or property damage. Frequency estimates came from CPSC’s National Electronic Injury Surveillance System (NEISS).

NEISS is the nation’s principal source of data about injuries related to consumer products. NEISS monitors and provides statistically valid national estimates of the number and nature of nonfatal injuries treated in hospital emergency departments (EDs). Since 2000, the system has drawn surveillance data from approximately 100 hospitals. Properly weighted, these data accurately represent the 14 million consumer product injury victims treated in EDs each year.

CPSC uses estimates of injury costs to analyze a broad range of issues and to communicate to Congress, the public, the media, and others about the potential benefits of CPSC actions.

In 1996, CPSC contracted with the National Public Services Research Institute (NPSRI), a center within the Pacific Institute for Research and Evaluation (PIRE), for a comprehensive update and revision of the injury cost model. In 2000, NPSRI published a comprehensive report on the revised Injury Cost Model (ICM), laying out the conceptual underpinnings of ICM and documenting the methods and data sources used to revise the model. Over the past 15 years, CPSC has contracted with PIRE to provide various updates and improvements to the ICM, which have been documented in a series of separate reports.

The present report updates the ICM methods document to reflect the state of the ICM in 2017. The organizational scheme will largely follow that of the 2000 document. The remaining chapters will cover:

2. The history of the ICM. Summarizes the original model and its development over time, as well as the model's limitations; and the revised model and its evolution up to the present.

3. An overview of the ICM. Explains the model's theory and concepts. Summarizes the model and describes how it updates and improves on the original model.

4. The databases used in the ICM. Describes their sources, contents, and limitations.

5. Incidence estimation. Explains how the ICM estimates the number of injury survivors not treated in EDs.

6. Medical cost estimation. Describes how the ICM estimates medical costs for injury victims by highest level where treated (hospital-admitted, treated in the ED but not admitted, other non-admitted medical treatment only).

7. Work loss estimation. Explains how work losses of victims and their families, friends, and employers were estimated. Values lost wage work, household work, and school.

8. Intangible loss estimation. Derives values for pain, suffering, and lost quality of life by two methods—the primary method used in the ICM and a secondary method potentially useful for sensitivity analysis and comparison with other agencies' estimates.

9. Mapping into NEISS diagnosis codes. Explains how costs that were developed from data in other diagnosis coding systems were translated into the NEISS coding system.

10. Conclusion. Summarizes the limitations of the revised model and suggests an agenda for future research.

2. THE HISTORY OF THE INJURY COST MODEL

The Original Injury Cost Model

This chapter begins with a description of the original injury cost model and its development through 1996. The methodological concerns that influenced the model's design included 1) the importance of the concept of social cost in deriving estimates of injury costs, 2) the need for a disaggregated or modular approach to estimating the separate components of injury costs, and 3) the necessity of formulating the functional relationships in terms of variables contained in NEISS.

The initial specification, estimation, and implementation of the model consisted of three discrete steps. First, at a conceptual level, the elements comprising injury costs were identified and methods for estimating those elements were specified. Ultimately, eleven separate injury cost components were identified, with their sum constituting total injury costs. Second, the data necessary to estimate these components were collected. The three major data sources were the Civilian Health and Medical Program for the Uniformed Services (CHAMPUS) medical claims database, information about injury-associated work loss and restricted activity days from the National Health Interview Survey (NHIS), and a sample of jury awards for pain and suffering. Estimation techniques included regression analysis, direct analytic solutions (i.e., computed estimates based on assumed relationships between data, as opposed to strictly empirical estimates), and computation of sample means from the disaggregation of large databases. The final step in model development was to program the injury cost algorithms to operate on the NEISS data.

The model contained disaggregated injury cost estimates that could be used with NEISS data to estimate injury costs along the various dimensions of the NEISS sample. These dimensions include injury diagnosis and body part, victim age and sex, type of product involved, and through supplemental investigation, injury cause.

METHODS

Originally, the injury cost model was composed of eleven separate cost components, which represented three broad types of injury costs: direct expenditures, indirect costs, and intangibles. The seven direct expenditure components included hospital costs, retreatment costs, health insurance costs, product liability insurance costs, litigation costs, victim transportation costs, and visitor transportation costs. Three other components—victim forgone earnings, visitor opportunity costs, and disability costs—represented the opportunity costs of time spent away from normal activity as a result of the injury. These costs sometimes are collectively termed work losses or indirect costs. Finally, the pain and suffering component places a dollar value on intangible losses. Brief descriptions of the eleven components follow.

Hospital Costs and Retreatment Costs. Hospital costs involved all medical and hospital expenditures for treatment of the victim of a product-related injury. These expenditures included the costs of medical personnel, facilities, and other health resources required to treat the victim during the basic recovery period. Similar to hospital costs were retreatment expenditures associated with the long-run medical care of the victim. These retreatment costs, incurred after the basic recovery period, included expenditures for corrective surgery, treatment of chronic injuries, and so forth.

Health Insurance Costs. Since health insurance provides protection against medical costs incurred as the result of product-related injuries, the costs of providing the insurance and settling claims had to be included in estimates of the societal costs of these types of injuries. In order to avoid double counting, this component excluded claims paid. Health insurance costs include overhead costs such as statistical services, marketing, and public relations, as well as the adjustment costs of handling claims. The model estimated health insurance costs for a given injury type as a fixed component (to account for the average overhead costs of insurance provision) and a variable component, proportional to the associated hospital and medical costs (to account for the influence of the size of the claim on the resultant insurance cost).

Product Liability Insurance Costs. Product liability insurance protects manufacturers and retail establishments against injury cost damages sought by victims of product-related incidents. As in health insurance, the relevant costs were those associated with providing the insurance and settling the claims rather than total premiums paid, again to avoid double counting. On the basis of insurance data and prior studies in this area, estimates were obtained for a fixed overhead component and a variable component proportional to the total costs of the injury. Since not all injuries result in claims, estimates of the probability of filing a claim were developed in order to estimate the expected or average liability insurance costs for any given injury.

Litigation Costs. Litigation costs reflected the legal expenses incurred by injured parties where compensation was sought as the result of alleged negligence in product-related incidents.

Victim Transportation Costs. The transportation cost component involved expenditures associated with transporting injured persons to and from medical facilities.

Victim Forgone Earnings. Forgone earnings reflected the value of the time lost from one’s normal activities as the result of an injury. The associated injury cost component consisted of two groups of multiplicative elements: (1) the number of bed days, work loss days, school loss days, and other restricted activity days; and (2) the opportunity cost per day for each of these categories.

Visitor Costs. Visitor costs consisted of (1) transportation expenditures incurred by friends and relatives making visits during the victim’s recovery period, and (2) the opportunity cost of the time spent transporting the victim to a medical facility or visiting the victim.

Disability Costs. Disability costs reflected the imputed value of work forgone by the injured party permanently or for an extended period and the replacement training costs borne by the victim’s employer.

Pain and Suffering Costs. Pain and suffering refers to the physical and emotional trauma and mental anguish associated with an injury. This component assigned an imputed monetized value of short- and long-term effects endured by the injured party.

DEVELOPMENT

Technology and Economics, Inc., developed the original injury cost model in 1975–1976. Between 1978 and 1980 Technology and Economics refined the model as part of a subcontract to Battelle Columbus Laboratories. In 1986–1992, CPSC revised its estimation procedures for the pain and suffering component of the model using a more recent set of jury verdicts and different regression techniques.

In 1989–1991, CPSC began preparing for a major revision of the model through two purchase orders to the Urban Institute. That work derived estimated probabilities of permanent work-related disability by NEISS diagnosis and hospital admission status. It also provided diagnosis-specific physician ratings of the functional capacity typically lost to injury and translated these losses into quality-adjusted life years (QALYs) lost. This measure, which is described further in Chapters 3 and 8, was designed as an alternative measure of pain, suffering, and quality of life lost to injury.

The Revised Injury Cost Model

The original injury cost model largely relied on cost and utilization data from the 1970s. Although the model's estimates were adjusted for inflation, they did not fully account for major changes in medical technology and health care delivery. Notably, they preceded the advent of diagnosis-related groups (DRGs) as a basis for hospital payment, the Medicare prospective payment system (PPS), managed health care, magnetic resonance imaging (MRI), and even computerized tomography (CT) scans.

The revised injury cost model (ICM) replaced the 1970s data with data from the 1990s. In the two decades following the completion of the original model, increasing computer capability stimulated the growth of new, far more extensive datasets to support injury cost modeling. Consequently, the revised model used different datasets than the original model, largely replacing analytic solutions with data-driven estimates. An example of an analytic solution in the original model is the retreatment cost component: retreatment costs for non-surgical cases were assumed to equal one-half of initial treatment costs. In the revised model, retreatment costs for victims not admitted to the hospital are estimated from diagnosis-specific data. The computations underlying the revised model also explicitly costed some items that the original model did not estimate.

No dataset, however, contains all the necessary cost factors. The modeling effort combined information by diagnosis from NEISS and 15 other large datasets. Frequently, several years of data were pooled to get enough cases for a diagnosis-specific analysis. The revised model derived costs by age group, sex, and hospital admission status for hundreds of injury diagnoses. This detailed breakdown is essential to accurate costing. A 25-year-old victim, for example, faces different losses from a broken leg than an 80-year-old victim.

Unlike the original model, the revised ICM was able to produce estimates of the number and nature of nonfatal injuries that only received medical treatment outside an ED. The model also costed these injuries. The incidence estimates were built from diagnosis-specific ratios of non-

ED cases to ED cases in National Center for Health Statistics (NCHS) datasets and in a family of Missouri health care discharge datasets.

COST COMPONENTS

While the original model consisted of eleven cost components, the detailed cost breakdown proved unbalanced. Several components each detailed less than 1% of an injury's cost. The costs almost always were grouped for reporting purposes. For example, hospital and retreatment costs were summed to obtain health care costs. Experience suggests grouping the eleven cost components into more aggregated categories. Reports generated by the revised ICM would show only four distinct cost components, which are described in the following paragraphs.

Medical Costs. This component includes the original hospital and retreatment cost components, plus ambulance transport and health insurance claims processing. It includes costs of emergency medical treatment and ambulance transport; hospital, physician, and rehabilitation costs including post-discharge costs for hospital-admitted cases; and ancillary costs for prescriptions, medical equipment and supplies, allied health services, home health services, nursing home care, and home health care. Because data are lacking, this component omits costs for trauma-induced mental health treatment of victims and their families.

Work Losses. This component includes the original forgone earnings, visitor forgone earnings, and disability components. It includes the value of victims' lost wage work, including fringe benefits, plus household work, as well as the work lost by family and friends while caring for, transporting, and visiting the injured. Finally, this component includes employer productivity losses, such as the value of the time supervisors must spend juggling schedules or recruiting and training replacements for injured workers.

Pain and Suffering Costs. Conceptually, this component is unchanged from the original model. It places a dollar value on the intangible losses that result from an injury. These include pain, suffering, loss of consortium, and other lost quality of life.

Product Liability Insurance and Litigation Costs. This component includes the original product liability insurance administration and litigation cost components. It includes the administrative costs of compensating product liability insurance claims related to injury, as well as attorney fees; court costs; plaintiff, defendant, and witness time; and out-of-pocket expenses (e.g., for transportation) that arise in litigation related to liability and compensation.

Subsequent Revisions and Updates

In its basic structure, the ICM has changed little since 1998, but some of its components have been updated one or more times over the years. The components that have seen the most revision are the ratios used to extrapolate from the NEISS sample of ED visits to non-ED cases, such as those treated only in a doctor's office, clinic, or outpatient department, and cases admitted to the hospital directly without passing through the ED. The first such revision, performed by Tom Schroeder (1999) of CPSC, introduced the use of decision tree analysis for estimating these ratios. The ratios have been revised three times since then with larger datasets, most recently by

Lawrence (2013). Other components that have been updated multiple times are medical and work loss costs, which are now based on large databases that were not available in 1998.

The revised ICM initially used a discount rate of 2.5%. Since then, a discount rate of 3% has become the norm in regulatory analyses, often supplemented with sensitivity analysis at 7%. The ICM accordingly adopted the standard 3% discount rate in 2008, with provision for alternative estimates at 7%.

The revised ICM, until quite recently, used an index of medical expenditures per capita to inflate medical costs. But over time it became increasingly apparent that this resulted in over-inflated medical costs. In 2014, after comparing several possible medical inflators, PIRE recommended using the health component of the Price Indexes for Personal Consumption Expenditures (PCE) produced by the Bureau of Economic Analysis (BEA), and this was subsequently implemented in the ICM.

The most recent change to the ICM is the dropping of the product liability insurance and litigation costs component. Because this component was so small relative to the others—less than half a percent of total costs—and because the methods behind it do not lend themselves to updating, it is being eliminated from the model.

3. THE INJURY COST MODEL: CONCEPTS AND ANALYTICAL METHODS

The ICM estimates costs from society's point of view. Thus, it estimates aggregate costs, regardless of who pays them. Societal costs are broader than the costs incurred by any one group, such as victims, insurers, or product manufacturers. The costs adhere to the guidelines for estimating the cost of illness set out by Neumann et al. (2016) and Hodgson and Meiners (1979, 1982). These guidelines establish an accounting framework and the conceptual basis for valuing lost work. The ICM's costs also are consistent with Miller, Calhoun, and Arthur (1989), which derived a theory-based accounting framework for injury and illness costs that includes estimates of pain and suffering.

The theory, the cost framework, the costing concepts, and the methods behind the ICM are widely accepted in the peer-reviewed literature. They have been used to cost highway crashes (Miller 1993; Blincoe et al. 2015), drunk-driving crashes (Miller and Blincoe 1994; Zaloshnja et al. 2013), railroad crashes (Miller, Douglass, and Pindus 1994), bicycle injuries (Miller, Douglass, et al. 1994; Miller, Zaloshnja, et al. 2004), occupational injuries (Leigh et al. 2006), criminal victimization (Miller, Cohen, and Rossman 1993; Miller, Cohen, and Wiersema 1996; McCollister et al. 2010), cigarette fire injuries (Miller, Brigham, et al. 1993), poisonings (Miller and Lestina 1997), injuries by diagnosis (Miller, Pindus, et al. 1995), home injuries (Zaloshnja et al. 2005), child injuries by age group and cause (Rice et al. 1989; Miller, Finkelstein, et al., 2012), drug abuse (French et al. 1996), and alcohol abuse (Manning et al. 1991). They have been used for almost 25 years in regulatory analysis throughout the US Department of Transportation (McCormick and Shane 1993; Moran and Monje 2016).

Discount Rate

The costs presented are incidence-based. That means all costs of an injury over the victim's lifespan are included. Whenever costs extend more than a year beyond the injury, the ICM applies a discount rate to compute their present value. Because discounting applies to many cost factors, the choice of a discount rate is a cross-cutting decision that helps to shape the estimates for each cost component.

A 3% real discount rate was used. The 3% rate is consistent with the 3% discount rate recommended by Neumann et al. (2016) and the National Academies of Sciences, Engineering, and Medicine (2016). An upper end choice is conservative, as a higher discount rate yields lower estimated lifetime costs.

Under guidelines set forth by the Office of Management and Budget (1992), benefit-cost analyses of federal programs should include sensitivity analysis of various components, including the discount rate. We have adopted that document's original recommended discount rate of 7% as an alternative discount rate that can be used for sensitivity analysis.

Following the guidance of Neumann et al. (2016), we applied the same discount rate to future QALY losses associated with permanent disability as to future medical and work-related costs.

Discounting of future life years correctly models health decision-making described in general population surveys and revealed by safety behavior (see, e.g., Cropper et al. 1992, Moore and Viscusi 1990, Olsen 1993).

Inflation Adjustments

The ICM produces cost estimates in 2010 dollars. Because the model draws on input data from sources covering many different time periods, it was sometimes necessary to inflate (or deflate) cost figures to 2010 dollars. In addition, when CPSC wants to report costs in dollars of a year other than 2010, it must inflate them. The most obvious choice for inflating medical costs, the medical component of the Consumer Price Index (CPI–Medical), is not the best inflator to use for this purpose. CPI pertains only to the portion of costs borne by consumers, whereas the goal of the ICM is to estimate costs from the point of view of society as a whole. Moreover, the fixed market basket employed by the CPI cannot adequately reflect rapid changes in the healthcare market. The ICM uses the health component of BEA's Price Indexes for Personal Consumption Expenditures (PCE–Health), which is more representative of the healthcare sector as a whole.

For inflating costs of work loss and pain and suffering, the ICM uses the Employment Cost Index for total compensation for all civilian workers (ECI–Civilian), published by the Bureau of Labor Statistics (BLS). The total compensation index is better than a simple wage index because it captures non-monetary benefits, as well as wages and salaries. Table 1 shows both price indexes, PCE–Health and ECI–Civilian. The table's notes document the sources of the indexes.

Summary of Methods

All ICM cost estimates are diagnosis specific—that is, they vary by NEISS injury diagnosis and body part. The estimates also vary by age and sex when cell counts are sufficient to support such differentiation. Costs also vary according to the highest-level setting where medical treatment was received. The treatment-level hierarchy is

1) hospital-admitted;
2) treated in a hospital emergency department (ED) and released; and
3) treated only in a hospital outpatient department or in a non-hospital setting such as a doctor's office, walk-in clinic, or ambulatory surgery center.

Medical costs and pain and suffering are estimated for all three levels of the hierarchy. Because of data limitations, work loss costs do not differentiate between ED and other outpatient settings, but only between hospital-admitted and non-admitted. Injuries not severe enough to require medical treatment are assumed not to result in measurable costs.

The next three subsections provide an overview of how the various cost estimates included in the three cost components of ICM are computed. Chapter 4 provides details about the data sources used. Subsequent chapters provide details about the cost estimates and costing methods.

MEDICAL COSTS

The methods used for estimating medical costs for the ICM draw heavily on costing methods originally developed for the Centers for Disease Control and Prevention (CDC) by Finkelstein et al. (2006). While new costing methods have been developed for ED-treated injuries, costs for hospital-admitted injuries follow the methods of Finkelstein et al., but using newer data. Costs for injuries treated in an outpatient department, doctor’s office, clinic, or ambulatory surgery center (non-ED injuries) have not changed from 2006 except for price level adjustments.

Medical costs for hospital-admitted injury patients. A hospital-admitted injury victim may incur several different types of medical costs. In addition to the facility and non-facility costs of the admission itself, the patient may incur costs for emergency transport, follow-up treatments, readmissions, rehabilitation, nursing home stays, and, for particularly serious injuries, long-term care. Following Finkelstein et al. (2006), we derived estimates of facility costs from hospital charges, as recorded in the 2010 Nationwide Inpatient Sample (NIS), multiplied times hospital-specific cost-to-charge ratios provided by the Agency for Healthcare Research and Quality (AHRQ). We supplemented this with MarketScan® data from Truven Health for non-facility fees, the Medical Expenditure Panel Survey (MEPS) and Detailed Claim Information (DCI) for follow-up costs, and the Prospective Payment System (PPS) for rehabilitation expenses. Costs are also estimated for nursing home stays and long-term care for severe injuries. An overview of the components is presented in Table 6.

Medical costs for patients treated in the ED and released. Because non-admitted injuries are usually less severe than hospital-admitted injuries, they do not entail long-term costs and therefore have fewer components. The cost of the initial ED visit from 2010–2011 MarketScan® data and follow-up cost factors from MEPS and DCI were all merged onto the 2010 Nationwide Emergency Department Sample (NEDS) by diagnosis. An overview of the components is presented in Table 7.

Half of all hospital admissions and ED visits, as well as all transfers in and out of hospital, are assumed to involve transport by ambulance. Therefore, an *ambulance transport cost* is added to all such cases.

Medical costs for non-admitted injury patients. Finkelstein et al. (2006) used the 1996–1999 MEPS data to quantify direct medical costs for injuries not requiring hospitalization. MEPS participants with injury-related expenditures but without an inpatient admission were divided into three categories by primary treatment location, according to this hierarchy: 1) any ED utilization; 2) any office-based utilization but no ED utilization; and 3) any outpatient treatment but no ED or office-based utilization. Even after pooling four years of data, the MEPS sample of non-admitted injuries remained small for some injury diagnoses. Therefore, cases were pooled into diagnosis groups: 51 groups for ED visits, 52 for office-based visits, and 7 for outpatient clinic visits. All medical costs for each patient (including costs incurred at other treatment locations lower in the hierarchy) were then summed, and the average total medical cost across all patients in each location/diagnosis category was calculated. These direct cost estimates were then applied to the National Hospital Ambulatory Medical Care Survey (NHAMCS) and the National Ambulatory Medical Care Survey (NAMCS).

Though the ICM no longer uses these MEPS-based costs for ED-treated injuries (see the preceding subsection on ED-treated patients), the MEPS-based costs are still in use for injuries treated only in doctors' offices and outpatient departments.

Health insurance claims processing costs. The final component of medical costs for all three treatment levels was the claims processing cost. Ratios of insurance to non-insurance costs were computed from data contained in the National Health Expenditure Accounts by payer type (Medicare, Medicaid, private insurance, other). This payer-specific ratio was multiplied times the sum of all other medical costs to obtain the estimated claims processing cost.

LOST WORK

Work loss includes losses by victims, family, friends, and employers. ICM cost estimation differentiated victim work loss between short-term and long-term losses. Short-term work loss is the loss resulting from the victim's physical inability to work while recovering from an injury. Long-term work loss is the loss associated with permanent disability that remains after the injury victim has recovered to the maximum extent possible.

Short-Term Work Loss. Short-term victim work loss consists of two groups of multiplicative factors: (1) the number of lost days of wage work, household work, or school work; and (2) the value per day of each of these categories. All computations were performed by injury diagnosis.

Detailed information is available about short-term work loss duration. By diagnosis, the average number of days lost by an injury survivor was computed from NHIS data on the probability that an injured worker will lose work and BLS data on the average days lost per lost-work injury. Lost household work days were estimated from the work loss estimates in accordance with data showing that workers suffering only from short-term disability return to household work 10% faster than wage work. A key assumption underlying the estimates is that, for a given injury diagnosis, the duration of work loss is independent of whether or not the victim is employed.

Days of lost ability to work were valued with the method recommended by the Panel on Cost-Effectiveness in Health and Medicine (Neumann et al. 2016) and by Hodgson and Meiners (1979, 1982). They suggest valuing a day of lost work from published national statistics about the wage and fringe benefit loss per day of wage work by age and sex. 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.

Long-Term Work Loss. The ICM uses permanent disability probabilities estimated by Pindus et al. (1991) based on a large national sample of worker injuries. The percentage of lifetime work lost to permanent disability came from this same source, supplemented by information from a major study by Berkowitz and Burton (1987).

Permanent disability is valued as a percentage of the present value of expected lifetime work. Lifetime work is valued by summing the discounted present value of expected earnings (wage and fringe benefit compensation plus the value of household work) by age and sex, absent the injury, across the victim's remaining lifespan. In the ICM, this computation averages labor force participation rates over 20 years to account for employment prospects across the business cycle in the estimates.

Employer and Family Losses. Employer losses due to injury were estimated analytically from supervisor and worker wage data in combination with assumptions about the amount of non-productive time resulting from an injury. Costs incurred by family and friends were based on assumptions about time spent transporting and visiting the victim.

PAIN AND SUFFERING COSTS

Intangible costs such as pain, suffering, loss of consortium, and other lost quality of life typically are the largest contributors to injury costs. Because these intangibles cannot be purchased, they also are the most difficult to value. Recognizing their importance and computational challenge, the ICM offers a monetary estimate of the intangible losses computed from the pain and suffering component of jury awards, plus non-monetary estimates of quality-adjusted life years (QALYs), which allow for optional sensitivity analysis.

The monetary value estimates for pain and suffering come from regression analysis of 1,986 jury awards and settlements to victims of non-fatal injuries involving consumer products. The cases were sampled from a proprietary national dataset.[1] They include product liability cases, cases involving bicyclists injured by motor vehicles, and premises liability cases that involved consumer products (e.g., a leg broken in falling down the stairs or tripping over a toy that a child dropped on the sidewalk). Class action suits were excluded from the analysis.

The alternative QALY-based method starts with diagnosis-specific physician ratings of the functional capacity typically lost to injury. The ratings describe losses on bending/grasping/lifting, cognitive, mobility, sensory, cosmetic, and pain scales. These ratings were supplemented by data on a seventh dimension, long-term work-related disability. Using survey data describing how people value the seven scaled dimensions of functioning, the functional losses are translated into QALYs lost.[2]

QALYs measure quality of life losses without placing a dollar value on fatal risk reduction. QALYs are the preferred loss measure in the medical literature (Gold et al. 1996) and in many federal agencies. They are widely used in cost-effectiveness and cost-utility analysis.

---

[1] A proprietary dataset contains copyrighted data that can only be accessed upon completion of a licensing agreement as opposed to government data that typically are readily accessible, provided they are free of personal identifiers.

[2] These estimates use the approach to cost outcome analysis recommended by Gold et al. (1996). Both the National Highway Traffic Safety Administration and the Department of Health and Human Services use QALYs extensively in cost-outcome analyses.

Table 1. Price Indexes Used in the Injury Cost Model

Year	Medical	Work Loss
1990	52.136	59.7
1991	56.105	62.3
1992	59.928	64.4
1993	62.949	66.7
1994	65.362	68.7
1995	67.539	70.6
1996	69.115	72.6
1997	70.458	75.0
1998	71.834	77.6
1999	73.579	80.2
2000	75.733	83.6
2001	78.396	87.1
2002	80.574	90.0
2003	83.443	93.5
2004	86.371	97.0
2005	89.050	100.0
2006	91.864	103.3
2007	94.869	106.7
2008	97.321	109.5
2009	100.000	111.0
2010	102.610	113.2
2011	104.736	115.5
2012	106.860	117.7
2013	108.214	120.0
2014	109.766	122.7
2015	111.014	125.1
2016	112.868	127.9

Price Index for Medical Costs: PCE–Health
Bureau of Economic Analysis: *National Income and Product Accounts Tables*
Table 2.5.4. Price Indexes for Personal Consumption Expenditures by Function
Row 37: Health
Index: 2009 = 100
Source: http://www.bea.gov/iTable/iTable.cfm?ReqID=9andstep=1

Price Index for Work Loss and Pain and Suffering: ECI–Civilian
Bureau of Labor Statistics: *Employment Cost Index Historical Listing – Volume III*
Table 4. Employment Cost Index for total compensation, for civilian workers (not seasonally adjusted)
All workers, December column
Index: Dec. 2005 = 100
Source: http://www.bls.gov/web/eci/echistrynaics.pdf

4. DATASETS USED IN THE INJURY COST MODEL

This chapter describes the 16 principal datasets that provide incidence and cost data to ICM. Some of these datasets are primary sources of incidence or cost data. Many provide just one or two narrow data elements needed for a calculation.

This chapter describes each dataset's source, size, contents, and limitations. Then it probes the consistency of datasets with overlapping information. The comparisons make it clear that the datasets are compatible; information from them credibly can be combined.

Before describing the datasets, this chapter briefly discusses how they code injuries and how injury coding affected the analysis. Chapters 6 and 9 further discuss injury diagnosis coding.

Injury Diagnosis and External Cause Coding

This report defines an *injury diagnosis* as the combination of a body part designator (e.g., foot) and a nature of injury diagnosis (e.g., fracture). Three of the 16 datasets employed, including NEISS, use two separate codes to classify the nature of injury and the body part injured. Most medical datasets, by contrast, use the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), which uses a single numeric code to classify both the nature of injury and the body part injured.

Some tables in this report present data by diagnosis group. Because diagnosis coding differed between datasets, and because diagnoses had to be grouped so that the sample size in each group would be large enough to yield stable estimates, the grouped diagnosis categories differ between tables. Since different chapters of the report rely on different datasets, the differences in categories are especially pronounced between chapters.

In addition to diagnosis codes, ICD-9-CM includes external-cause-of-injury codes (E codes or cause codes). These codes designate the mechanism and the intent of the injury. Some states mandate ICD-9-CM cause coding for hospital-treated injury victims. Because it sometimes is ambiguous whether the condition described by an ICD-9-CM diagnosis code is an injury (for example, is dermatitis simply dry skin or an injury inflicted by a caustic chemical?), cause-coded state datasets identify injury victims more clearly than other datasets. Although ICD-9-CM cause codes do not explicitly differentiate injuries related to consumer products, they do identify some injuries (e.g., intentional injuries, environmental injuries like frostbite or snake bite, and transportation injuries) that clearly are not under CPSC jurisdiction. When analyzing cause-coded datasets, we generally restricted our analysis to victims whose injuries might relate to consumer products.

Datasets Analyzed

The ICM draws data primarily from 12 national datasets and 4 compilations of state data. The national datasets are sample surveys. They are designed primarily for surveillance. Many are conducted annually. For annual surveys, we generally pooled several years of data to obtain larger sample sizes by diagnosis group.

The remaining four datasets contain state hospital discharge data. Two of these datasets—the NIS and the NEDS—were compiled by AHRQ to be nationally representative, but the other two are convenience samples of states that happened to provide information we needed. Nearly all states now maintain computerized hospital discharge censuses of inpatient stays, and many have similar data for ED, outpatient, and ambulatory surgery visits. All such datasets are based on the hospital's billing records. In some states these datasets are maintained by a state government agency, while in others they are compiled by a state hospital association. Participation in some is mandated by state health departments or cost-control commissions. Others are voluntary systems with universal compliance.

Starting in the late 1980s, selected hospital discharge systems began requiring inclusion of external-cause-of-injury codes (E codes) on acute injury victims' discharge abstracts. Today, hospitals in all but a handful of states achieve E-coding rates of 85% or better, and some have virtually complete E coding. All state data analyzed for ICM were E coded.

The remainder of this section lists and describes the individual datasets. Table 2 summarizes some of the descriptive information.

This chapter is intended as a reference source for the reader who wants more information about specific datasets. The dataset descriptions are presented in alphabetical order. Because this report usually abbreviates most of the dataset names, the reader might find the list of abbreviations at the beginning of the report useful for keeping them straight.

DCI. 1979–1987 and 1992–1996 Detailed Claim Information (DCI) databases of the National Council on Compensation Insurance (NCCI). This longitudinal proprietary file is a nationally representative sample of workers' compensation lost workday claims (which involve compensation for both medical costs and wage losses). The data come from workers' compensation insurers in a cluster sample that varies slightly by year of injury but typically covers about 15 states. Pindus et al. (1990, 1991) developed data summaries for 1979–1987. The summaries are based on 452,000 injuries, 138,000 of them hospital-admitted. Summaries for 1992–1996, provided by the NCCI, covered 185,775 injuries, which were not differentiated by hospital admission status. Insurers report on claims in the DCI sample six months after the injury and annually thereafter until the claim is closed (meaning no more charges are anticipated or a reserve was set aside—and reported to DCI—to cover predictable future costs). DCI claims are reopened if unanticipated costs arise after closure. DCI lists a single injury diagnosis. Diagnosis coding is done with a variant of the American National Standards Institute (ANSI) Z-16.2 coding system, which is similar to the NEISS diagnosis coding system.

DCI data are the only known source for the percentage of medical payments associated with the first six months of an injury episode (information needed to compute lifetime costs from acute care costs). The DCI record includes all medically related payments including hospital care; professional services; prescriptions, equipment, and long-term care; vocational rehabilitation payments; and length of stay if hospital-admitted. The DCI also reports whether the victim's injury resulted in permanent total or partial work-related disability. For partial disability cases, DCI also gives the estimated impairment percentage, i.e., the fraction by which the victim's work capacity is reduced. The 1979–87 DCI data were the source of our estimate of the share of medical payments that occurred in the first six months and of probabilities of disability. The 1992–96 DCI data supplied our impairment percentages for permanent partial disability cases.

Weaknesses of this database are its restriction to workplace injury—about one-third of all injuries—and to working-age populations. Both DCI datasets are aging.

JVR. 1988–1995 Jury Verdicts Research data. This proprietary dataset summarizes more than 100,000 jury awards, settlements, and arbitrations resulting from personal injury and illness claims between 1988 and 1995. It is believed to contain at least 70% coverage of recent jury verdicts in individual suits (but not class action suits) as well as a less representative selection of settlements. The data are indexed by type of claim, making it easy to identify product liability claims and product-related premises liability claims. Most data are in narrative form. We coded the narratives for 1,986 product-related nonfatal injury cases. With narrative input, data like victim age and whether the victim was hospital-admitted unavoidably are missing from a fairly large number of cases. Sometimes even a breakdown of the award between compensation for medical and wage losses versus pain and suffering is missing.

MarketScan Commercial Claims and Encounters Database. Staff at CDC's National Center for Injury Prevention and Control (NCIPC) analyzed this MarketScan database to compute 1) mean ratios of physician payments to facility payments for inpatients and 2) facility and physician costs for ED-treated patients. (Later research on this topic by NCIPC is described in Peterson, Xu, et al. [2015].) The MarketScan® family of research databases provides a complete picture of patients' health conditions, medical treatment, and outcomes, along with the associated costs to patients, employers, providers, and payers. The Commercial Claims and Encounters database, which was used by NCIPC, consists of individual healthcare claims from employers, health plans, and hospitals. It includes workers covered by employer-sponsored health insurance, along with their spouses and dependents. Data elements include demographics, diagnoses, medical encounter details, drug prescriptions, payment information, and enrollment information.

The MarketScan family of databases was formerly administered by Thomson Medstat, a division of Thomson Reuters. In 2012 the division was sold and became an independent organization, renamed Truven Health Analytics.

MEPS. 1996–2007 Medical Expenditure Panel Survey, Household Component. MEPS is a set of large-scale surveys of families and individuals, their medical providers (doctors, hospitals, pharmacies, etc.), and employers. MEPS collects data on the health services that Americans use, the cost of these services, and how they are paid for. The Household Component collects data from a sample of families and individuals drawn from a nationally representative subsample of households that participated in the prior year's NHIS. The panel design of the survey features several rounds of interviewing covering two full calendar years. Data collected from household respondents are supplemented with data collected directly from the medical providers they identified. The unique advantage of MEPS is that it allows the user to construct an injury episode that includes all medical treatments from all providers, to the extent that they all fit within the two-year interview window. One limitation is that the ICD-9-CM diagnoses are provided at only the three-digit level, which not only limits the level of diagnosis detail but also can sometimes make it difficult to distinguish between two different injury conditions in the same patient. Furthermore, MEPS does not include E codes. It did include flags for certain injury causes, which allowed us to tailor our subset to consumer-product injury, but MEPS discontinued these variables after 2007.

NAMCS. 1999–2000 National Ambulatory Medical Care Survey. This annual national probability sample survey of providers is conducted by the National Center for Health Statistics (NCHS). It gathers information about visits to physician offices and clinics. It collects data on about 35,000 visits annually. The 1999–2000 data include 1,885 injury visits. NAMCS records three ICD-9-CM diagnoses, patient age, patient sex, and expected source of payment. NAMCS indicates if a patient was directly admitted to the hospital by the doctor. NAMCS does not clearly distinguish initial versus follow-up visits. A more important limitation is that NAMCS coded an ED referral as “other disposition”, a category that also contains non-ED cases. This makes it impossible to remove ED cases (whose inclusion would result in double-counting since they are represented by the companion dataset, NHAMCS) without also dropping some non-ED cases. Other limitations are the absence of cause codes and incomplete coverage of providers (e.g., company and school health clinics are excluded).

NEISS. CPSC’s National Electronic Injury Surveillance System database. From an annual sample of approximately 100 hospitals reporting about 340,000 consumer product-related injuries, NEISS makes national estimates of hospital ED visits for selected causes. The database indicates whether the patient was subsequently admitted as an inpatient, but it does not include information about the admission. The ICM is built around NEISS incidence data on consumer product injuries. The NEISS uses a two-column diagnosis coding system (an injury diagnosis code, such as fracture or contusion, and a body part code). Only the victim’s most serious injury is coded. NEISS diagnoses are sometimes not as precise as ICD-9 diagnoses. For example, the duration of unconsciousness following a head injury cannot be specified in NEISS. But this information is often not yet known when the patient is transferred from the ED, so the opportunity for more detailed codes would not always be useful. When CPSC is analyzing a particular hazard, it often carries out follow-up telephone or on-site interviews of NEISS injury victims or their families. These interviews are called in-depth investigations. Sometimes, questionnaires developed for these investigations ask for more detailed information on the nature of injury than is contained in the NEISS record.

In principle, the ICM can be used to estimate injury costs for any NEISS dataset. In this report, we used the 2010–2014 NEISS data as the basis for most of the tables.

NHIS. 1987–1996 National Health Interview Survey. This NCHS survey annually polls 45,000 households containing about 110,000 people. NHIS records where each medically treated or activity-restricting injury or illness that happened in the two weeks prior to interview was treated. NHIS codes the ICD injury description in ICD-9-CM from the victim’s self-reported description, which makes the diagnosis coding imperfect.

Small sample size makes NHIS an unreliable source of data on hospital-admitted injury (Miller, Pindus, et al. 1995). ICM includes NHIS data only from non-admitted cases. Between 1987 and 1996, NHIS recorded 5,359 acute non-admitted injury incidents. NHIS data include victim age, sex, place of occurrence, self-reported diagnosis, highest level of medical treatment, whether the victim was employed, whether the victim lost work, and bed days and other restricted activity days resulting from the injury.

One important NHIS limitation is that information about work loss days is recorded only for the two weeks prior to the interview. No information is provided to differentiate victims who were still unable to work at the time of interview. NHIS sample size is a second limitation. Even a 10-year sample is too small to make stable estimates by diagnosis and highest treatment level, which limits the detail available from the survey. A final major limitation is the inaccuracy of self-reported diagnoses. Exacerbating this problem, NHIS rarely reports multiple diagnoses.

NHAMCS. 1999–2000 National Hospital Ambulatory Medical Care Survey (NHAMCS). This annual national probability sample survey of providers was implemented by the NCHS in 1992. It gathers information about visits to hospital emergency and outpatient departments. It collects data about 35,000 outpatient department visits annually. The 1999–2000 data include 2,804 injury visits to outpatient departments. NHAMCS distinguishes initial from follow-up visits, records three ICD-9-CM diagnoses and an E code for each injury visit, and records discharge status (facilitating the identification of visits that result in an inpatient admission), patient age, patient sex, and expected source of payment.

NHDS. 1987–1992 National Hospital Discharge Survey. This annual NCHS hospital survey obtains information on roughly 200,000 hospital discharges annually. The 1987–1992 data yielded 111,324 injury discharges and 185,093 discharges for diagnoses that sometimes result from illness and sometimes result from injury (for example, dermatitis or coma). We included all cases where at least one discharge diagnosis was an injury. NHDS describes victim age, sex, up to seven diagnoses by ICD-9-CM code, length of stay, discharge destination (e.g., home, nursing home, morgue, etc.), and expected primary payer. The major limitations of NHDS are its lack of injury cause coding (which makes it impossible to determine which injuries were related to consumer products or even whether some patients were injury victims) and its failure to distinguish initial admissions from readmissions.

NNHS. 2004 National Nursing Home Survey. This periodic survey, conducted by NCHS, is collected through face-to-face interviews with the administrators and staff of nursing facilities with three or more beds (Jones, Dwyer, et al. 2009). The facilities may be freestanding or a distinct unit of a larger facility. NCHS sampled 1,174 of the more than 16,000 US nursing facilities, collecting information for up to 12 current residents in each facility, for a total sample of 13,507 current nursing home residents. Data obtained on residents included demographic characteristics, functional and health status, diagnoses, services received, and sources of payment. This dataset comes with a major limitation: It is a snapshot of residents at a given moment, rather than a discharge dataset. Thus, it is not representative of all people treated in nursing homes, but oversamples patients whose stay is longer. Moreover, because the residents' information is recorded during their stay rather than afterwards, the final outcome of the stay—

e.g., length of stay, discharge destination—is not known. Chapter 6 describes the steps we took to overcome this limitation.

NEDS. 2010 Nationwide Emergency Department Sample. The NEDS is part of a family of databases and software tools developed for the Healthcare Cost and Utilization Project (HCUP), a federal-state-industry partnership sponsored by the Agency for Healthcare Research and Quality (AHRQ). The NEDS is the largest all-payer ED database in the US, containing data from approximately 30 million ED visits each year. Its nationally representative sample is drawn from HCUP's State Inpatient Databases (SID) and State Emergency Department Databases (SEDD). In 2010, 28 states contributed data to the NEDS. The sample, drawn from 961 hospitals, contains records of 28.6 million ED visits, which approximate a 20% sample of U.S. hospital-based EDs, stratified by the hospital's census region, trauma designation, urban-rural location, teaching status, and ownership. To avoid double counting, we retained only the treated-and-released cases drawn from the SEDD. (The cases drawn from the SID, which represent patients who were subsequently admitted as inpatients, are better represented by another HCUP dataset, the 2010 NIS.) The 2010 NEDS served as the foundation of all the ICM's costs for ED-treated injuries.

NIS. 2005 and 2010 Nationwide Inpatient Sample. Like the NEDS, the NIS is part of the HCUP family of databases sponsored by AHRQ. It is constructed from the SID as a nationally representative 20% sample, stratified by the hospital's census region, ownership, urban/rural location, teaching status, and bed size. The 2005 NIS contained 8.0 million records drawn from 1,054 hospitals in 37 states. It was used to estimate the ratio of direct admissions to admissions via the ED. The 2010 NIS contained 7.8 million records drawn from 1,051 hospitals in 45 states representing 96% of the US population. It served as the foundation of all the ICM's costs for hospital-admitted injuries.

SID. The 2007 State Inpatient Databases from 13 states: Arizona, California, Florida, Missouri, Nebraska, New Hampshire, Nevada, New York, North Carolina, South Carolina, Tennessee, Utah, and Washington. The SID is another HCUP database. Each participating state's SID contains records of all inpatient admissions in the state in a given year. In 2007, AHRQ tracked revisits for inpatients in these 13 states, providing a rare look at follow-up hospitalizations. Zaloshnja et al. (2011) used the 13-state 2007 SID to compute readmission rates for injuries. The obvious limitation of this dataset is that it is not nationally representative.

SOII. The 1993 Survey of Occupational Illnesses and Injuries. This BLS dataset is a national probability sample of injured workers. It includes injury victims with an occupational injury incident from each US employer except most governments, agricultural enterprises with less than 11 employees, and self-employed individuals without unrelated employees. For 1993, it described work loss duration for 603,936 lost-work occupational injuries in private industry. The data include BLS injury codes, which are close relatives of NEISS injury codes. The survey only collects days lost during the calendar year. PIRE built statistical models that inferred the full duration for injuries with long periods of work loss and for injuries that occur near the end of the calendar year. For this project, the major limitations of the SOII are its restriction to occupational injury and working age populations.

Three-State Hospital Discharge Data. 1997 hospital discharge censuses from three states: California, Maryland, and Pennsylvania. Miller, Langston, et al. (2006) used the pooled injury discharges from these states to estimate the probability of rehabilitation by diagnosis for hospital-admitted injuries. These three states included rehabilitation hospitals in their discharge data, unlike most other states. All injury cases were selected from each state's data, thoroughly cleaned them, and pooled. Fatalities were dropped, as were non-acute injuries. Poisoning and radiation cases were also dropped, as these do not normally result in inpatient rehabilitation. An obvious limitation of the pooled state data is its lack of national representativeness. A second limitation is the inability to accurately distinguish initial injury visits from readmissions.

UDSMR. 1998–2002 Uniform Data System for Medical Rehabilitation. Miller, Langston et al. (2006) used case counts from five years of UDSMR data as weights in computing rehabilitation costs by diagnosis group from PPS lengths of stay and costs per day. The UDSMR, a not-for-profit organization affiliated with the State University of New York at Buffalo, maintains the largest nongovernmental database for medical rehabilitation outcomes in the US. The UDSMR collects data from rehabilitation hospitals and units, long-term care hospitals, skilled nursing facilities, and pediatric and outpatient rehabilitation programs. Approximately 70% of US inpatient rehabilitation facilities subscribe to UDSMR services. UDSMR records include the ICD-9-CM admitting diagnosis, along with demographic, hospitalization, and functional status data.

Table 2. Summary of Data Sources

Database	Source	Population Covered	Diagnosis Coding	Years	Number of Cases	Role in ICM	Comments
Detailed Claim Information (DCI)	National Council on Compensation Insurance	Sample of Workers' Compensation lost work claims	Variant of ANSI Z-16.2	1979-1987	452,000 injury cases, including 138,000 hospital-admitted cases	Percent of medical payments in first 6 months; disability probabilities	Longitudinal data; excludes injuries with work loss less than 3-9 days (varies by state)
				1992-1996	185,775 injury cases	Impairment percentage for permanent partial disability cases	
Jury Verdicts Research (JVR)	Jury Verdicts Research, Inc.	Jury awards, settlements, and arbitrations resulting from personal injury and illness claims	Non-systematic narrative	1988-1995	1,962 product-related nonfatal injury cases selected from database of over 100,000 cases	Pain and suffering	Narratives are largely free-form, creating missing data problems
MarketScan Commercial Claims and Encounters Database	Truven Health	Patient-level healthcare claims from all treatment locations	ICD-9-CM	2010-2011	342,144 inpatient admissions; 4,026,031 ED visits	Inpatient non-facility-to-facility cost ratios; cost of initial ED visit	
Medical Expenditure Panel Survey (MEPS) Household Component	Agency for Healthcare Research and Quality	Nationally representative sample of households	ICD-9 (3 digits)	1996-1999	27,166 outpatient injury episodes	Outpatient/doctor medical costs	
				1996-2007	44,469 outpatient injury episodes	Ratio of outpatient/doctor cases to ED cases	
National Ambulatory Medical Care Survey (NAMCS)	National Center for Health Statistics	Sample of doctor's office and clinic visits	ICD-9-CM	1999-2000	1,885 doctor's office cases	Incidence weights for medical costs for doctor's office visits	Cases also treated in EDs are not distinguished
National Electronic Injury Surveillance System (NEISS)	Consumer Product Safety Commission	Sample of hospital emergency room visits for product-related injuries	Variant of ANSI Z-16.2	1995-1996	201,801 ED visits of adults, ages 20-64	Age-sex weights for computation of mean family/friends work loss	Includes hospital admissions via ED, but not direct admissions
				2010-2014	1,940,105 ED visits	Incidence by hospital admission status	

Database	Source	Population Covered	Diagnosis Coding	Years	Number of Cases	Role in ICM	Comments
National Health Interview Survey (NHIS)	National Center for Health Statistics	Household interview survey	ICD-9 (3 digits) based on respondent description	1987-1992	3,692 non-admit-ted injury cases	Injury counts; work loss probability	Self-report; data cover the 2 weeks prior to interview
				1987-1996	5,359 non-admit-ted injury cases	Breakdown of non-admitted cases	
National Hospital Ambulatory Medical Care Survey (NHAMCS)	National Center for Health Statistics	Sample of hospital emergency room visits	ICD-9-CM	1999-2000	2,804 hospital outpatient cases	Incidence weights for medical costs for hospital outpatient visits	Excludes direct hospital admissions
National Hospital Discharge Survey (NHDS)	National Center for Health Statistics	Annual sample of hospital discharges	ICD-9-CM	1987-1992	111,324 injury-related discharges	Probability that an injury victim is hospital admitted	Lack of cause codes hampers analysis
National Nursing Home Survey	National Center for Health Statistics	Sample survey of nursing home residents	ICD-9-CM	2004	1,234 residents being treated for injuries	Length of nursing home stay	Snapshot of residents, not a discharge census
Nationwide Emergency Department Sample (NEDS)	Agency for Healthcare Research and Quality	Annual 20% national sample of US hospital ED discharges	ICD-9-CM	2010	4,887,954 injury-related discharges from hospital EDs	Foundation for all ED costs	
Nationwide Inpatient Sample (NIS)	Agency for Healthcare Research and Quality	Annual 20% national sample of US hospital inpatient discharges	ICD-9-CM	2005	288,477 injury-related hospital discharges	Ratio of direct admissions to admissions via ED	
				2010	396,285 injury-related hospital discharges	Foundation for all inpatient costs	
State Inpatient Databases (SID)	Agency for Healthcare Research and Quality	Annual census of hospital inpatient discharges in each participating state	ICD-9-CM	2007	625,975 injury discharges involving 598,816 patients in 13 states	Inpatient readmission rate	States: AZ, CA, FL, MO, NE, NH, NV, NY, NC, SC, TN, UT, and WA
Survey of Occupational Illnesses and Injuries (SOII)	Bureau of Labor Statistics	Annual sample of lost-workday occupational incidents	Variant of ANSI Z-16.2	1993	603,936 cases	Days lost per injury	Restricted to workers

Database	Source	Population Covered	Diagnosis Coding	Years	Number of Cases	Role in ICM	Comments
Three-state hospital discharge data	California, Maryland, Pennsylvania	Censuses of hospital inpatient discharges	ICD-9-CM	1997	359,665 rehabilitation discharges	Percent of injury admissions involving rehabilitation	
Uniform Data System for Medical Rehabilitation (UDSMR)	UDSMR	Rehabilitation patients	ICD-9-CM	1998-2002	84,870 patients	Diagnosis group weights for rehabilitation costs	

5. INJURIES NOT TREATED AT EMERGENCY DEPARTMENTS

NEISS samples nonfatal injuries treated in hospital EDs, including those that result in a subsequent inpatient admission. Injury survivors could be treated in many other settings, including physicians' offices, hospital outpatient departments, walk-in clinics, and ambulatory surgery centers. In addition, some injury survivors are admitted to the hospital directly, bypassing the ED. These patients may be transferred from a walk-in clinic or doctor's office, or they may be triaged by emergency medical services to a specialty hospital that lacks an ED but directly admits victims of severe trauma. Any injury that does not result in an ED visit is not captured by NEISS. Therefore, the ICM must estimate the number of injuries treated in non-ED settings. This chapter describes the ICM's non-ED incidence estimation.

Conceptually, the ICM must generate incidence estimates for four groups of injury survivors:

1. Hospitalized survivors admitted through the ED.
2. Hospitalized survivors not admitted through the ED.
3. Survivors treated in the ED and released.
4. Survivors treated only in settings other than the above, including physicians' offices, clinics, hospital outpatient departments, and ambulatory surgery centers.

NEISS can supply direct estimates of injury incidence for categories 1 and 3 through simple weighted case counts. But additional data are required to estimate injury incidence in categories 2 and 4. The ICM, therefore, uses data about the relative frequency of injuries treated in non-ED settings versus injuries treated in the ED. For the ICM to estimate non-ED incidence, then, it needs the ratio of survivors in an incidence group per non-admitted or admitted survivor treated in the ED.

Non-Admitted Survivors Treated Only in Non-ED Settings

Ratios of injured non-admitted survivors treated only in non-ED settings to those treated in the ED were computed from 1996–2007 MEPS data. As described in detail by Lawrence (2013), a subset of 27,166 in-scope injury episodes was constructed from the event files and condition files of the MEPS Household Component. Each episode was classified by

- the highest level of treatment the patient received, according to the hierarchy 1) hospital inpatient stay, 2) emergency room (ER) visit, 3) outpatient visit, 4) office-based medical provider visit; and
- the first-listed injury diagnosis (three-digit ICD-9) on the record for the first medical treatment at the highest level of the treatment hierarchy.

The process of narrowing the dataset to in-scope cases began with dropping all cases that involved a hospital admission. Then cases that were outside CPSC's jurisdiction were dropped, including work-related injuries, motor-vehicle injuries, weapon injuries, and apparent self-inflicted injuries. Next, cases whose diagnoses did not correspond to any NEISS diagnosis were dropped—late effects of injury (905–909) or early complications of injury (958). Injuries that were incurred more than a few days before the patient entered MEPS were dropped, since MEPS had probably missed the initial treatment for these injuries. Finally, cases with person-weights of zero were dropped, since they would have no impact on the weighted estimates. The three-digit ICD-9 primary injury diagnosis of each injury episode was then mapped to NEISS injury diagnosis and body part, as described in chapter 9.

The MEPS dataset was too small to support computing mean ratios of non-ED to ED cases for each combination of diagnosis, age, and sex. Grouping the cases for useable cell counts was achieved by means of decision tree analysis, as pioneered by Schroeder (1999). For this purpose, Lawrence (2013) used the CART (classification and regression trees) routine of Answer Tree 2.1. The dependent variable was a dichotomous variable categorizing the case according to its highest-level treatment—either an ER visit (1) or a visit to a doctor's office or hospital outpatient department (0). The independent variables were age, sex, and NEISS injury diagnosis and body part. By recursively splitting the sample into groups that were relatively homogeneous with respect to the share of cases that were ER visits, CART created groups defined by age, injury diagnosis, body part, and sometimes sex.

Certain values of both NEISS variables were pre-grouped in order to reduce the number of categories that CART was required to operate on. The six NEISS burn categories (46, 47, 48, 49, 51, 73) are largely based on the same MEPS cases, as are the three open wound categories (59, 63, 72). These two natural groupings were combined as BN and OW, respectively (see Table 3, column 2). Electric shock (67) and submersion (69) were combined as EX, as both fall within the same three-digit ICD-9 diagnosis (994), and were thus based on the same MEPS cases. Seven pairs or trios of body parts were also combined—e.g., shoulder (30) and upper arm (80). The body parts in each grouping were adjacent on the body and had very similar ED shares. In some cases they were even based partly on the same MEPS cases.

Standard five-year age groups (0–4, 5–9, 10–14, . . ., 80–84, 85+) were used. Age group was defined as an *ordinal* variable—a categorical variable in which the categories can be ordered or ranked. This constrained CART to keep adjacent age categories together when making a split by age, just as it would do with a quantitative variable. Thus, CART was not permitted to split out a middle age group while combining younger and older ages together.

The final model created using CART was up to 8 levels deep and had 64 terminal nodes (see Table 3). All 64 nodes were defined by NEISS injury diagnosis and body part, and 63 by age. But sex came into play in only 18 of the nodes.

Dividing the MEPS data into the 64 diagnosis/age/sex groups determined by the decision tree analysis, we then computed the weighted percentage of ER cases for each group. These are shown in the next-to-last column of Table 3. They range from 9.7% to 93.3%, with an average of 36.1%. The ER percentages were then converted into ratios of outpatient/office-based (OPOB) cases to ER cases using the formula

$$\text{Ratio} = (100 - \text{ERpctg}) / \text{ERpctg}$$

This ratio is multiplied times the NEISS case weight to obtain the estimated number of OPOB cases per NEISS case.

Example. For a victim of a shoulder fracture (NEISS injury diagnosis 57, body part 30) under age 45, the ratio of non-ED cases to ED cases is 0.576. (This corresponds to node 23 in Table 3.) For every person under 45 who is treated for a shoulder fracture in an ED and released, we estimate that 0.576 other patients are treated in a doctor's office, clinic, or outpatient department. If the NEISS weight of the case is 15.6716, then for purposes of non-ED estimates, the weight used for the case would be 15.6716 × 0.576 = 9.027.

Admitted Survivors Who Bypass the Emergency Department

Occasionally, injury victims are admitted without going through the ED. The two typical situations of this type are hospital admission from a non-ED treatment setting or admission to a burn center (or other specialized acute care facility) that does not have an ED.[3]

The 2005 Nationwide Inpatient Sample (NIS), a database of the Healthcare Cost and Utilization Project (HCUP), was selected for estimating the proportion of non-ED admissions. The NIS provides information on 3 to 4 million inpatient stays from about 980 hospitals. These hospitals represent a 20% sample of non-federal, short-term, general, and other specialty hospitals, drawn in 2005 from 37 participating states. All discharges from sampled hospitals are included in the NIS. All records that indicated a live discharge and an acute injury diagnosis in any of the diagnosis fields were selected. Transfers from other hospitals were excluded in order to avoid double-counting. Intentional and transport-related injuries were dropped, as CPSC does not have jurisdiction over these cases. The resulting subset of the 2005 NIS contained 288,477 cases.

As with non-admitted survivors, we used CART to partition the data by injury diagnosis, body part, age, and sex. Some values of the two NEISS variables were pre-grouped, as described in the previous section. A preliminary CART run was used to partition the dataset by age, resulting in eight age groups: 0, 1–17, 18–57, 58–69, 70–75, 76–81, 82–85, 86+. The dependent variable was a dichotomous variable categorizing whether the patient was admitted via the ED (1) or bypassed the ED (0). These methods are described in more detail by Bhattacharya et al. (2012).

The classification tree that resulted from the CART analysis was 8 levels deep with 60 terminal nodes. All 60 nodes were defined by NEISS injury diagnosis and body part and age, but only 13 of the nodes are differentiated by sex. Table 4 shows the results.

Estimated Total Annual Incidence of Consumer Product Injuries

We applied the estimated ratios to 2010–2014 NEISS data. Table 5 shows the resulting estimates of annual incidence by NEISS injury diagnosis and body part. During these five years, NEISS produces a weighted estimate of 14.3 million consumer product injuries treated in EDs annually. The ICM estimates that an additional 26.6 million consumer product injuries resulted in medical treatment but not an ED visit.

[3] A unique example of such a facility is the Maryland Institute for Emergency Medical Services Systems (MIEMSS), which treats severe trauma victims state-wide. It admits patients based on triage at the scene of injury.

Table 3. Results of Decision Tree Analysis on 1996–2007 MEPS

Node	Predictor Variables				Node Depth	Case Counts		Avg Wgtd ER Pctg	OPOB/ER Ratio
	NEISS Injury Diagnosis	NEISS Body Part	Age	Sex		Raw	Weighted		
1	56;57;71	77;79;81;83;84;85;89;94	0-39		5	1,650.6	17,238,635	42.48	1.354
2	56;57;71	87	0-39		5	115.3	1,142,256	24.98	3.003
3	BN;OW;50;62	77	0-39		5	66.0	672,778	71.90	0.391
4	BN;OW;50;62	79;81;83;84;85;87;89;94	0-24		6	382.5	3,641,667	54.44	0.837
5	BN;OW;50;62	79;81;83;89	25-39		7	129.6	1,446,030	46.97	1.129
6	BN;OW;50;62	84;85;87;94	25-39		7	21.2	236,138	14.29	5.999
7	BN;OW;41;42;50;52;56;57;60;62;71	79;81;85;89	40-90		4	990.5	10,350,801	32.87	2.042
8	OW;56	77;83;84;87;94	40-69		6	273.0	3,162,157	22.46	3.452
9	OW;56	77;83;84;87;94	70-90		6	91.1	1,074,999	9.72	9.288
10	BN;57	77;83;84;87;94	40-49		7	159.7	1,751,719	38.60	1.591
11	50;62;71	77;83;84;87;94	40-49		7	74.0	830,660	23.65	3.228
12	BN;50;57;62;71	77;83;84;87;94	50-90		6	547.0	5,593,410	24.99	3.002
13	OW;41;50;52;60;62	00;30;32;34;36;75;76;92	0-14	M	6	736.0	6,988,854	66.95	0.494
14	OW;41;50;52;60;62	00;30;32;34;36;75;76;92	15-34	M	6	363.2	4,159,026	76.24	0.312
15	OW;41;50;52;60;62	00;30;32;34;36;75;76;92	0-34	F	5	628.5	6,241,957	64.32	0.555
16	OW;41;50;52;60;62	36	35-90		5	106.8	1,105,262	38.87	1.573
17	OW;41;50;52;60;62	34;92	35-49		8	169.3	1,984,474	68.97	0.450
18	OW;41;50;52;60;62	00;30;32;75;76	35-49		8	132.4	1,374,475	54.79	0.825
19	OW;41;50;52;60;62	00;30;32;34;75;76;92	50-74		7	320.9	3,597,045	51.37	0.947
20	OW;41;50;52;60;62	00;30;32;34;75;76;92	75-90	M	7	50.4	517,515	58.71	0.703
21	OW;41;50;52;60;62	30;32;34;92	75-90	F	8	35.2	399,856	64.63	0.547
22	OW;41;50;52;60;62	00;75;76	75-90	F	8	42.1	450,146	93.30	0.072
23	BN;56;57	30;32;75	0-44		6	830.8	8,381,007	63.45	0.576
24	BN;56;57	30;32;75	45-64		7	154.1	1,568,938	46.31	1.159
25	BN;56;57	30;32;75	65-90		7	120.0	1,185,783	64.73	0.545
26	56	92	0-59		8	162.7	1,757,217	60.17	0.662
27	56	92	60-90		8	36.5	414,085	40.69	1.458
28	BN;57	92			7	694.8	7,208,029	42.43	1.357
29	57	34;36;76	0-24		8	836.6	8,497,711	50.85	0.966
30	57	34;36;76	25-90		8	810.8	8,755,067	57.78	0.731
31	BN;56	34;36;76	0-34		8	404.0	4,034,208	52.64	0.900
32	BN;56	34;36;76	35-90		8	278.7	2,991,474	34.98	1.859

Node	Predictor Variables				Node Depth	Case Counts		Avg Wgtd ER Pctg	OPOB/ER Ratio
	NEISS Injury Diagnosis	NEISS Body Part	Age	Sex		Raw	Weighted		
33	42;71	00;30;32;34;36	0-24	M	7	251.4	2,404,110	51.50	0.942
34	42;71	00;30;32;34;36	0-24	F	7	164.1	1,598,196	39.32	1.543
35	42;71	75;76;92	0-24		6	351.3	3,471,601	57.35	0.744
36	42;71	00;92	25-90		6	176.6	1,965,145	51.66	0.936
37	42;71	30;32;34;36;75;76	25-84		7	749.3	8,024,424	31.16	2.210
38	42;71	30;32;34;36;75;76	85-90		7	37.7	394,674	56.06	0.784
39	58;70	36;79;81;84;87;89	0-4		5	70.1	672,397	52.50	0.905
40	58;70	36;79;81;84;87;89	5-29		5	434.4	4,454,260	34.24	1.921
41	55;61;64	79;81;84;89	0-29		6	656.4	7,664,691	16.95	4.901
42	53;54	79;81;84;89	0-29		6	207.2	2,005,191	30.14	2.318
43	53;54;55;61;64	36;87	0-29		5	1,035.7	11,007,634	28.22	2.543
44	58;68;70	30;32;83;85	0-29	M	7	466.1	4,575,735	41.96	1.383
45	58;68;70	30;32;83;85	0-29	F	7	392.9	3,940,029	31.96	2.129
46	53;64	30;83	0-29		7	972.3	10,230,110	31.98	2.127
47	EX;53;64;65	32;85	0-29		7	142.2	1,462,049	20.87	3.791
48	53;58;64;70	34;75;76;77;92;94	0-4	M	7	121.4	1,226,237	57.34	0.744
49	53;58	34;75;76;77;92;94	0-4	F	8	60.5	576,315	24.13	3.143
50	64;70	34;75;76;77;92;94	0-4	F	8	34.7	327,557	54.96	0.820
51	53;58;64;70	34;75;76;77;92;94	5-29		6	1,066.2	11,168,388	38.13	1.623
52	54;55;61	32;75;85	0-29		5	89.7	926,767	70.48	0.419
53	54;55;61	30;34;76;83;92	0-29		5	146.0	1,801,120	53.28	0.877
54	53;58;66;70	30;36;79;81;84;87;89	30-90		4	1,338.4	14,327,096	24.54	3.076
55	54;55;61;64	30;36	30-39	M	7	213.5	2,490,369	15.15	5.603
56	54;55;61;64	30;36	30-39	F	7	224.2	2,372,635	27.84	2.592
57	54;55;61;64	30;36	40-90		6	1,537.2	16,905,722	13.90	6.192
58	54;55;61;64	79;81;84;87;89	30-90		5	1,913.9	21,959,799	10.52	8.510
58	55;58;65;68	32;34;75;76;77;83;85;92;94	30-90	M	5	327.2	3,730,335	37.74	1.650
60	55;58;65;68	32;34;75;92;94	30-90	F	6	69.2	757,448	41.22	1.426
61	55;58;65;68	76;77;83;85	30-90	F	6	441.7	4,628,058	26.91	2.716
62	EX;53;54;61;64;66;70	32;34;75;76;77;83;85;92;94	30-54		6	1,250.3	13,937,643	26.23	2.812
63	EX;53;54;61;64;66;70	32;34;75;76;77;83;85;92;94	55-79		6	667.8	7,266,416	20.63	3.847
64	EX;53;54;61;64;66;70	32;34;75;76;77;83;85;92;94	80-90		5	142.5	1,534,362	35.81	1.792
All						27,166.0	288,559,891	36.10	1.770

Table 4. Results of Decision Tree Analysis on 2005 NIS

Node	Predictor Variables				Node Depth	Records*	Avg Wgtd ED Pctg	Direct/ED Ratio
	NEISS Injury Diagnosis	NEISS Body Part	Age	Sex				
1	BN,55,74	38,75,81,84,89	0-75		4	16,888	48.57	1.05
2	55	31,76,79,85,88,92	0-75		5	597	66.16	0.53
3	BN,74	31,76,79,85,88,92	0-75		5	30,633	53.16	0.86
4	BN,55,74	31,38,75,76,79,81,84,85,88,89,92	76-85		3	3,462	65.02	0.55
5	58,68,70,71	38,75,81,85	0		7	471	58.39	0.69
6	53,56,64	38,75,81,85	0		7	412	30.58	2.24
7	53,56,58,61,64,68,70,71	38,75,81,85	1-17		6	5,991	69.64	0.43
8	50,52	38,75,81,85	0-17		6	963	84.94	0.18
9	OW,54,57,62,66,67,69,72	38,75,81,85	0-17		6	7,806	77.79	0.28
10	50,56,57,62,68,70,71	38,75,81,85	18-111		6	116,607	82.02	0.22
11	53,58,61,64,66,72	38,81,85	18-111		7	8,206	72.76	0.38
12	53,58,61,64,66,72	75	18-111		7	12,936	82.16	0.22
13	OW,52,54,67,69	38,75,81,85	18-111		5	13,863	86.21	0.16
14	56,70	31,76,79,84,88,89,92	0-57	F	8	5,642	62.99	0.59
15	56,70	31,76,79,84,88,89,92	58-81	F	8	3,996	75.75	0.34
16	57,60,61,64,71	31,76,79,84,88,89,92	0-81	F	7	15,768	71.54	0.40
17	56,57,60,61,64,70,71	31,76,79,84,88,89,92	82-111	F	6	12,424	78.78	0.27
18	56,57,60,61,64,70,71	31,76,79,84,88,89,92	0	M	7	618	46.60	1.12
19	56,57,60,61,64,70,71	31,76,79,84,88,89,92	1-17	M	7	4,436	70.65	0.41
20	56,57,60,61,64,70,71	31,84,88	18-111	M	7	11,092	80.64	0.24
21	56,57,60,61,64,70,71	76,79,89,92	18-111	M	7	25,088	77.57	0.29
22	OW,50,53,54,58,62,66,72	31,76,79,84,88,89,92	0		5	1,282	40.80	1.43
23	OW,62,72	79,84,92	1-111		7	10,933	74.03	0.35
24	50,53,54,58,66	79,84,92	1-85		8	10,913	77.60	0.29
25	50,53,54,58,66	79,84,92	86-111		8	3,451	85.16	0.18
26	50,53,58,66	31,76,88,89	1-17		8	2,742	63.97	0.57
27	50,53,58,66	31,76,88,89	18-111		8	57,830	81.63	0.23
28	OW,54,62,72	88	1-111		8	4,616	76.47	0.31
29	OW,54,62,72	31,76,89	1-111		8	19,699	83.95	0.19

Node	Predictor Variables				Node Depth	Records*	Avg Wgtd ED Pctg	Direct/ED Ratio
	NEISS Injury Diagnosis	NEISS Body Part	Age	Sex				
30	BN	35	0-17		8	666	37.84	1.62
31	64	35	0-17		8	174	10.34	8.87
32	BN,64	35	18-57		7	2,478	36.60	1.71
33	BN,64	35	58-81		6	1,306	46.32	1.17
34	BN	30	0-81		6	2,796	39.06	1.54
35	64	30	0-81		6	1,989	22.07	3.55
36	BN,64	35	82-111		5	376	67.55	0.48
37	BN,64	30	82-111		5	363	58.95	0.68
38	BN	33,77,82	0-75		6	9,720	49.32	1.00
39	BN	32,36,37,80,83,87,93	0-75		6	24,553	39.40	1.51
40	64	32,33,36,37,77,80,82,83,87,93	0-75		5	3,182	57.89	0.73
41	BN	32,33,36,37,77,80,82,83,87,93	76-111		5	2,063	48.86	1.05
42	64	36,80,82,87	76-111		6	635	67.24	0.49
43	64	32,33,37,83,93	76-111		6	521	81.77	0.23
44	55	35,77,80,83	0-81		6	785	46.11	1.17
45	42,57,61,74	00,35,77,80,83	0-69		7	9,779	58.52	0.71
46	42,57,61,74	00,35,77,80,83	70-81		7	4,454	64.53	0.55
47	OW,53,56,70,71,72	35,77,80,83	0-81		6	32,500	67.47	0.49
48	50,54,58,66	35,77,80,83	0-81		6	2,473	75.13	0.34
49	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,35,77,80,83	82-85		5	5,085	71.21	0.41
50	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,35,77,80,83	86-111		5	7,498	76.11	0.32
51	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,30,37,82	0		6	202	25.25	2.87
52	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,32,33,36,87,93	0		6	336	40.18	1.43
53	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,33,82,87,93	1-75	F	7	12,073	67.79	0.48
54	OW,53,56,70,71,72,74	30,32,36,37	1-75	F	8	14,917	64.17	0.56
55	50,54,55,57,58	30,32,36,37	1-75	F	8	14,027	71.67	0.40
56	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,30,36,37,82,93	1-75	M	7	42,408	70.76	0.41
57	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,32,33,87	1-75	M	7	15,143	75.82	0.32
58	50,53,55,57,58,61,66	30,32,33,36,37,82,87,93	76-85		6	9,225	74.31	0.35
59	OW,54,56,62,70,71,72,74	30,32,33,36,37,82,87,93	76-85		6	11,781	68.57	0.46
60	OW,42,50,53,54,55,56,57,58,61,62,66,70,71,72,74	00,30,32,33,36,37,82,87,93	86-111		5	14,909	76.40	0.31
All						657,782	75.78	0.40

Table 5. Estimated Annual Injuries, 2010-2014, by Highest Treatment Level and Injury Diagnosis or Body Part

NEISS Injury Diagnosis	Office, Clinic, Outpatient	Emergency Department	Hospital Admission	
			Direct	via ED
41 Ingested Foreign Obj	39,965	75,046	4,332	9,003
42 Aspirated Foreign Obj	11,552	9,445	1,937	2,748
46 Burn, Electrical	3,924	3,355	307	312
47 Burn, Not Specified	2,481	1,828	175	132
48 Burn, Scald	74,985	61,962	7,502	7,209
49 Burn, Chemical	20,991	17,765	854	821
50 Amputation	12,311	18,563	1,919	6,103
51 Burn, Thermal	123,661	107,119	12,661	12,457
52 Concussion	127,850	239,515	2,960	17,795
53 Contusion/Abrasion	5,873,918	2,304,158	21,826	72,003
54 Crushing	63,064	36,372	258	751
55 Dislocation	548,252	211,390	7,157	13,596
56 Foreign Body	384,391	264,002	1,979	4,891
57 Fracture	1,767,427	1,619,600	145,565	424,588
58 Hematoma	180,580	92,414	2,915	9,907
59 Laceration	1,779,907	2,633,037	16,172	59,380
60 Dental Injury	20,553	39,369	333	937
61 Nerve Damage	322,918	44,256	989	2,913
62 Internal Injury	548,795	970,613	39,201	172,658
63 Puncture	201,553	152,371	1,127	2,982
64 Strain/Sprain	10,902,550	2,459,772	13,633	17,467
65 Anoxia	97,788	31,855	1,358	4,844
66 Hemorrhage	29,535	13,101	440	1,516
67 Electric Shock	19,909	5,769	114	616
68 Poisoning	231,745	125,321	10,059	29,127
69 Submersion	12,941	3,461	1,127	4,333
71 Other/Not Stated	2,546,036	1,493,576	52,855	163,256
72 Avulsion	95,613	85,421	1,304	3,542
73 Radiation	11,004	11,355	70	70
74 Dermat/Conjunctivitis	150,012	88,137	371	467
Total	26,206,211	13,219,947	351,499	1,046,423

NEISS Body Part	Office, Clinic, Outpatient	Emergency Department	Hospital Admission	
			Direct	via ED
00 Internal	51,518	84,491	6,269	11,751
30 Shoulder	1,639,556	599,856	11,759	20,614
31 Upper Trunk	2,160,070	713,265	33,670	114,680
32 Elbow	641,249	315,334	6,390	17,558
33 Lower Arm	577,679	447,454	11,769	28,842
34 Wrist	747,678	508,149	5,695	15,248
35 Knee	2,234,885	758,025	15,331	23,269
36 Lower Leg	788,848	422,184	18,770	42,143
37 Ankle	2,443,459	855,051	11,435	27,879
38 Pubic Region	91,507	52,018	1,417	4,321
75 Head	1,399,815	1,804,164	50,675	226,369
76 Face	1,166,239	1,136,524	18,388	56,005
77 Eyeball	411,679	193,792	2,079	4,122
79 Lower Trunk	4,741,165	1,093,950	75,027	231,087
80 Upper Arm	164,537	117,025	13,718	23,749
81 Upper Leg	325,825	113,968	10,072	39,504
82 Hand	905,582	766,609	7,724	14,023
83 Foot	1,449,462	680,489	7,645	12,119
84 25-50% of Body	415	126	1005	969
85 All Parts Body	498,307	250,439	20,273	70,462
87 Not Stated	168,484	55,831	5,414	12,848
88 Mouth	150,885	240,830	1,707	5,016
89 Neck	1,219,748	228,877	7,021	21,346
92 Finger	1,280,427	1,311,945	5,987	17,202
93 Toe	628,122	298,814	1,747	3,851
94 Ear	319,070	170,738	512	1,448
Total	26,206,211	13,219,947	351,499	1,046,423

6. MEDICAL COST ESTIMATION

This chapter describes the derivation of the ICM's estimates of medical costs. Separate estimates were developed for injuries resulting in hospital admission, non-admitted injuries treated in the ED and released, and non-admitted injuries treated only in other settings, such as a doctor's office, clinic, or outpatient department. The estimates are specific to consumer product injuries and are usually tailored to the age and sex of the victim.

From society's perspective, costs of fee-for-service medical care are defined as the amount that patients and other payers pay for the care. For capitated care, costs per service are assumed to equal the costs for comparable services delivered on a fee-for-service basis. The payment, or reimbursement, is the amount the provider collects for the services rendered. Total payments (by patients and other payers) measure societal costs of medical treatments. Payments for the same X-ray by the same provider vary from patient to patient depending on their payment source. Average payments across all patients represent costs (including a fair provider profit) accurately. Average payments by specific payers, however, may not closely mirror the overall average, especially for hospital care.

This chapter describes the medical care costing methods and cost estimates. It starts with admitted cases, followed by non-admitted ED and non-ED cases. Table 9 at the end of the chapter summarizes lifetime medical costs by place of treatment (hospital-admitted, non-admitted ED, and other non-admitted) and NEISS injury diagnosis or body part.

Medical Costs of Hospital-Admitted 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 6. The details follow.

Table 6. 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)

Cost Category	Description, Unit Cost (*2010 US $*)	Source/Notes
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
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, and PA hospital data; costs estimated using Prospective Payment System reimbursement amounts, as reported in Miller, Langston, et al. (2006)
Nursing home (NH) costs	Cost/day in NH ($205) times estimated average length of stay by 7 body regions for patients discharged to NH	Mean cost/day from 2010 MetLife *Market Survey of Long-Term Care Costs*; length of stay estimated from 2004 National Nursing Home Survey
Transport	Ambulance cost of $464 for transfers in and transfers out; half of non-transfer admissions assumed to have transport cost of $464	Median Medicare total payment for 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

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:

- 3,250 NIS records were excluded because they lacked useable charges.

- 192,637 records were dropped because the injuries were outside the purview of CPSC, including intentional injuries, motor vehicle and most other transport-related injuries, natural/environmental injuries, admissions whose expected payer was workers' compensation, and poisonings of persons over 4 years old.
- 15,159 records were dropped because they lacked any injury diagnosis code that could be mapped to NEISS injury diagnosis and body part codes. (Most of these records had been identified as injury-related on the basis of an injury E code, rather than a diagnosis.)

This left a subset of 381,380 useable NIS records.

The 2010 NIS reported the inpatient facility charge for each admission. For each case, this charge was multiplied times the 2010 Medicare cost-to-charge ratio provided by AHRQ for that hospital. These ratios are hospital-specific for 64% of the acute injury records in the NIS subset. 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, and McKenzie 2002). For California's Kaiser hospitals, which do not report charges, the average facility cost by diagnosis at other urban non-profit California hospitals in the 2010 NIS was used.

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. This factor accounted for non-facility costs—payments to professionals such as surgeons, anesthesiologists, and therapists who bill separately from the hospital, and whose charges therefore are not included in the NIS. These non-facility factors were based on the 2010 and 2011 Truven Health MarketScan® Commercial Claims and Encounters Database. The inpatient hospital admissions file of this database 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, National Center for Injury Prevention and Control (NCIPC) staff created a file of inpatient injury admissions and calculated the mean ratio of total medical costs to facilities costs by ICD-9-CM diagnosis code. The ratios of total costs to facilities costs ranged from 1.08 to 1.38, with an overall average of 1.14. The NIS cost estimate for each admission was multiplied times the ratio corresponding to the patient's primary injury diagnosis to yield the estimated total cost of the initial hospital admission.

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). Each participating state's SID covers all inpatient stays in that state. 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 as $r = 1-$(patients/admissions) by Barell[4] 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

[4] The Barell Injury Diagnosis Matrix classifies ICD-9-CM injury diagnoses into 36 body regions and 12 natures of injury. See https://www.cdc.gov/nchs/injury/ice/barell_matrix.htm.

fractures, ages 75+). Follow-up admissions were assumed to have the same costs, on average, as initial admissions. (This assumption was necessary because the NIS does not distinguish initial from follow-up admissions.) The cost of readmissions was incorporated by dividing the total inpatient cost of each case by $1-r$, where r is the estimated readmission rate.

SHORT- TO MEDIUM-TERM FOLLOW-UP COSTS

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 the total estimated inpatient cost for each non-fatal injury in the 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 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. Therefore, to obtain robust direct cost estimates, the sample of 381 injuries was 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 et al. (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.

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 (2000) 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, the DCI estimates appear applicable to childhood injury cases.

As per Finkelstein et al. (2006), ratios were computed 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, Lawrence, et al. 2000). This implies an average long-term multiplier of 1.30.

LONG-TERM COSTS OF SPINAL CORD AND TRAUMATIC BRAIN INJURIES

For some types of injuries, especially spinal cord injuries (SCI) and traumatic brain injuries (TBI), a substantial portion of total medical costs occurs more than seven years after the injury (Miller, Pindus, et al. 1995). Lifetime SCI and TBI costs came 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 pertained 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, Langston, et al. (2006) 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 that TBI patients who received inpatient rehabilitation would follow the same cost pattern as the SCI patients after seven years post-injury, but with costs equal to 75% of SCI levels. Based on the data from Berkowitz et al. (1990), at a 3% discount rate, 46.92% of the medical costs of TBI are estimated to occur in the first seven years. Therefore, the seven-year costs of TBI victims were divided by this percentage to arrive at lifetime medical costs. The relationship between SCI and TBI costs is explored further in Miller, Langston, et al. (2006).

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 estimation process through addition rather than multiplication.

Costs of inpatient rehabilitation were estimated using direct costs for 11 injury diagnosis groups developed by Miller, Langston, et al. (2006). 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, Langston, et al. (2006) used PPS data on lengths of stay and cost per day, weighted by case counts from the 1998–2002 Uniform Data System for Medical Rehabilitation, to develop direct cost estimates of rehabilitative treatment. They used 1997 hospital discharge data from three states (CA, MD, PA) to compute the probability, by diagnosis group, that an inpatient admission would involve rehabilitation. The product of the probability of rehabilitation and the direct cost of rehabilitation was added to the estimated cost of non-fatal injuries.

The *patient disposition* variable of the NIS indicates injury admissions that ended in discharge directly to a nursing home. For these cases, the cost of the nursing home stay was calculated as cost per day times the length of stay (LoS) in the nursing home. The $205 average cost per day of nursing home care was taken from the 2010 MetLife *Market Survey of Long-Term Care Costs*. 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 1,234 resident cases with an admitting diagnosis of injury from the 2004 National Nursing Home Survey (NNHS). The NNHS is based on a survey of residents rather than discharge data, so it did not allow us to identify and exclude 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. It was assumed that 1) each surveyed resident represented a nursing home bed that was always filled with a patient identical to the survey respondent; and 2) 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 was imposed as a minimum. This accounted 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. Estimated mean nursing home stays ranged from 84 days for hip injuries to 171 days for injuries of other/unspecified body locations. For NIS cases where the detailed patient disposition was missing but that were in the broader category that included nursing home ("another type of facility"), the estimated nursing home cost was multiplied times the share of known cases in that disposition 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.

TRANSPORT COSTS

The estimate of transportation costs to the hospital came from a 2012 U.S. Government Accountability Office (GAO) survey of ambulance providers. This report found that the Medicare median payment to ground ambulance providers in 2010 was $464 per transport, including "add-on payments". This cost is used in the ICM for both hospital-admitted and ED-treated injuries. The estimate is conservative because the distribution of ambulance costs is skewed, such that the mean cost would be greater than this median. Patients who were transferred from another medical facility were assumed to have been transported by ambulance and assigned the full $464 cost. Otherwise, since there was no way to identify which inpatients were transported by ambulance, it was assumed that half of hospital admissions involved ambulance transport; thus, half of the median cost, $232, was added to every case. Patients discharged to a nursing home were assigned the cost of an additional transport to represent the trip from the hospital to the nursing home.

CLAIMS ADMINISTRATION COSTS

Estimates of the claims processing expenses incurred by private insurers and government payers like Medicare and Medicaid drew on the 2011 National Health Expenditure Accounts (NHEA). The 2010 ratio of *total administration and total net cost of health insurance expenditures* to *personal health care* was computed 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 of the NIS, which was used to assign the claims administration percentage to each case, provides 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.

UPDATED BURN ADJUSTMENTS

Not all burns are alike, and medical costs can differ markedly among different types of burns. NEISS injury diagnoses identify six types of burns: electrical (46), not specified (47), scald (48), chemical (49), thermal (51), and radiation (73). By contrast, ICD-9-CM diagnoses, for the most part, do not identify burns by type. However, the type of burn can usually be inferred from the ICD-9-CM external-cause-of-injury code.

Because the ICM medical costs are estimated by diagnosis from a dataset coded in ICD-9-CM, all six types of burns would be assigned very similar costs by the procedures outlined in the preceding sections. To differentiate burn costs by type, the ICM previously employed a set of factors to adjust the medical costs of hospitalized scald, chemical, and thermal burns, which were based on external cause of injury codes for burns in 1994–95 hospital discharge data from Maryland and New York. The old burn adjustment factors are summarized in Table 9 of Miller, Lawrence, et al. (2000). For the most part, the costs of scalds and chemical burns were adjusted downwards and those of thermal burns upwards.

The 2010 NIS was used to estimate updated burn adjustment factors. Because 79% of burns in the NIS are scalds or thermal burns—and most of the rest are of unspecified type—adjustment factors were estimated only for scalds and thermal burns. The lack of adjustment factors for other types of burns will have little impact on ICM estimates, as 95% of burns in the 2013 NEISS are coded as scalds or thermal burns. Ratios were computed of the mean cost of scalds and thermal burns to the mean cost of all burns by body region and, when sample size permitted, age group. The ratios are shown in Table 8. As with the prior generation of burn adjustment factors, the costs of thermal burns are greater than the mean and those of scalds less. But the new adjustments for thermal burns are smaller than the old adjustments.

Example. A 40-year-old woman was admitted to the hospital with a fracture of the scapula. After her two-day stay, the hospital billed Medicaid for $31,800. The average cost-to-charge ratio associated with this hospital is 0.2539. This means that, on average, this hospital collects only 25.39% of what it bills. Thus, the expected payment to the hospital for the initial visit is $8,074. For a scapula fracture, on average, payments to professionals who bill separately from the hospital are 14.9% of the facility payment. Including these payments, the expected cost of the initial visit is $9,277.

Women of age 30–74 who suffer a shoulder fracture have an average readmission rate of 6.2%, and anyone who suffers a fracture of the upper limb has an average 18-month follow-up percentage of 25.9%. Thus, the expected medical cost in the first 18 months is ($9,277/(1−0.062))×1.259 = $12,452. For a shoulder fracture, the long-term cost averages 12.7% above the 18-month cost. Thus, the expected long-term medical cost is $14,033.

The preceding cost does not include rehabilitation and nursing home costs. For a shoulder fracture that requires rehabilitation, the expected rehabilitation cost is $12,437. We cannot tell whether a particular patient received rehabilitation therapy, so we multiply the average cost times the probability that rehabilitation is required, which, for a shoulder fracture, is 2.237%. Thus, the expected rehabilitation cost is $278. A patient discharged from the hospital to a nursing home with a shoulder injury requires an average of 124.9 days of nursing home care at $205 per day. However, the hospital discharge record shows that this patient was not discharged to a nursing home, so the nursing home cost is $0.

The average cost of an ambulance trip is $464. We assume a 50% probability that a patient arrived by ambulance for the initial hospital visit. Since this patient did not transfer into or out of the hospital, there is no additional ambulance trip. So, the expected ambulance cost is $232. Adding rehabilitation, nursing home, and ambulance costs to the long-term medical cost produces an expected lifetime cost of $14,543.

The final cost component is the claims processing cost. When the primary expected payer is Medicaid, the expected claims processing cost is 8.59% of all costs. Including claims processing, therefore, the expected total lifetime cost of this shoulder fracture is $15,792.

Note that this cost estimate is specific to a particular injury episode. It depends on what hospital the patient was treated in, how much the hospital charged, and what payer covered the treatment. Another patient with a similar diagnosis might therefore have a very different estimated cost.

Medical Costs of Injuries Treated in the ED and Released

Table 7 summarizes the methods for quantifying costs of non-fatal injuries treated in an ED and released without inpatient admission (hereafter referred to simply as *ED-treated injuries*).

Table 7. 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 payments, both facility and professional, by 3-digit ICD-9 diagnosis; differentiated by age, sex, and cause using ratios based on the 2008 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	1996–99 MEPS
Follow-Up Costs Beyond 18 Months	Estimated using ratios of total lifetime costs to 18 month costs by diagnosis/age group	1979–88 Detailed Claim Information (DCI) data from worker's comp claims
Emergency Transport	Half of ED visits assumed to have transport costs of $464	Median Medicare total payment for 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 staff from CDC's National Center for Injury Prevention and Control (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 by primary injury diagnosis. The NEDS subset was restricted to acute, 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 average medical costs than other injuries, including consumer product injuries. The MarketScan®-based cost estimates, however, were differentiated only by diagnosis. Therefore, in order to further differentiate medical costs by age, sex, and cause of injury, ratios based on PIRE's 2008 estimates of ED medical costs for CDC's Web-based Injury Statistics Query and Reporting System (WISQARS) were used. The WISQARS costs were based on the 2003 State Emergency Department Databases from eight states. 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 MarketScan®-based mean costs, but with proportional variation of costs by age, sex, and cause identical to the 2008 WISQARS costs. This procedure was especially important for producing costs for the ICM because it removed the influence of intentional and motor-vehicle injuries, whose costs were embedded in the raw MarketScan®-based mean cost estimates.

For the ICM estimates, the NEDS injury subset was further narrowed by eliminating ED visits for intentional injuries, most transport-related injuries, natural/environmental injuries, work-related injuries, and poisonings of persons over age 4. Cases whose ICD-9-CM diagnoses did not correspond to any NEISS injury diagnosis were also eliminated. This left a subset of 4,887,954 useable NEDS records.

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, Lawrence, et al. 2000). Half of patients were assumed to receive emergency transport, so half of the median cost of a one-way emergency transport, $232, was added to the medical cost of each case. Finally, payer-specific claims administration costs were computed. More detail on all of the costs described briefly in this paragraph can be found above, in the section on hospital-admitted costs.

> **Example.** In 2010–2011, the mean total payment for an ED visit for a scapula fracture was $1,954. Deflated to 2010 dollars, this comes to $1,940. For a woman of age 40, the age-sex adjustment is 0.8368, so the adjusted ED visit cost is $1,623. Multiplying this times the follow-up factor for a shoulder fracture, 3.400, we obtain the medium-term

cost, $5,518. Multiplying this times the long-term factor for a shoulder fracture, 1.055, yields the long-term cost, $5,822. We assume a 50% probability that the patient arrived at the hospital by ambulance, so we add half the cost of an ambulance ride, $232. Thus, the estimated lifetime cost of the injury is $6,054. The final cost component is the claims processing cost. If the primary expected payer is private insurance, the expected claims processing cost is 14.02% of all costs. Including claims processing, therefore, the expected total lifetime cost of the shoulder fracture is $6,903.

Medical Costs of Injuries Treated in Other Outpatient Settings

Medical costs for injuries treated only in non-ED outpatient settings, such as doctors' offices, clinics, and outpatient departments, are based on 1996–99 MEPS data. Finkelstein et al. (2006) divided MEPS participants with injury-related expenditures but without an inpatient admission into three categories by primary treatment location, according to this hierarchy: 1) any ED utilization; 2) any office-based utilization but no ED utilization; and 3) any outpatient treatment but no ED or office-based utilization. Even after pooling four years of data, the MEPS sample of non-admitted injuries remained small for some injury diagnoses. Therefore, Finkelstein et al. pooled injuries into diagnosis groups: 51 groups for ED visits, 52 for office-based visits, and 7 for outpatient clinic cases.

Having classified each patient into one of these 110 location/diagnosis-group categories, Finkelstein et al. (2006) added up all medical costs for each patient (including costs incurred at other treatment locations lower in the hierarchy), and then calculated the average total medical cost across all patients in each location/diagnosis category. This procedure avoids double-counting costs for patients treated in multiple locations.

By diagnosis, the mean costs for doctors' office visits (category 2) were merged onto 1999–2000 National Ambulatory Medical Care Survey (NAMCS) data, and the mean costs for visits to hospital outpatient departments (category 3) were merged onto 1999–2000 National Hospital Ambulatory Medical Care Survey (NHAMCS) data. The sample sizes were too small to support breakdowns of costs by age and sex.

Finkelstein et al. (2006) omitted medical claims processing costs, which the ICM includes. Therefore, by primary expected payer, claims processing percentages were merged onto the NAMCS/NHAMCS cases with a known payer. Mean percentages were computed by Barell nature of injury, and these percentages were merged back onto the NAMCS/NHAMCS data by Barell nature of injury, including cases for which payer was unknown. Medical costs were then adjusted using the claims processing percentage, and mean medical costs were computed by Barell nature of injury and body part. The Barell Matrix recodes ICD-9-CM injury diagnoses into a two-dimensional classification system similar to NEISS injury diagnosis and body part. Taking advantage of this similarity, we mapped medical costs directly from Barell to NEISS. NEISS tends to have more detail in nature of injury; therefore, in a number of instances, multiple NEISS categories were mapped from a single Barell category (e.g., both laceration and puncture were mapped from open wound).

Summary of Unit Medical Costs

Table 9 summarizes lifetime medical cost per survivor of a consumer product injury by place of treatment, injury diagnosis, and body part. Medical costs are highest for patients admitted to the hospital and are higher for those treated in the ED than in other outpatient settings. Nerve damage and internal organ injury are associated with high unit costs, as are the head and neck. This points to the high costs of traumatic brain injury (TBI) and spinal cord injury. The final column of Table 9 shows aggregate medical costs (in millions of dollars). Fractures ($26 billion) and sprain/strain ($16 billion) are prominent by this measure because they are so prevalent, while internal organ injuries ($20 billion) and head injuries ($24 billion) rank high because TBI can be costly, even when treated in the ED and released. Lower trunk injuries ($16 billion) include hip fractures, which are both prevalent and costly.

Table 8. Adjustment Factors Applied to the Medical Cost of Hospital-Admitted Scald and Thermal Burns

		Adjustment Factors	
Body Region	Age	Scald	Thermal
Head, face, eye, neck	Unk	0.6897	1.1137
	0-19	0.9330	1.0901
	20-54	0.8434	1.0301
	55-69	0.5393	1.0209
	≥70	0.5393	1.0209
Trunk	Unk	0.7864	1.2240
	0-19	0.9201	1.2966
	20-54	0.8158	1.0858
	55-69	0.8075	1.0777
	≥70	0.9906	1.0052
Arm	Unk	0.7788	1.1095
	0-19	0.9944	1.0063
	20-54	0.8031	1.0688
	55-69	0.6628	1.0931
	≥70	0.6628	1.0931
Wrist, hand	Unk	1.0314	0.9868
	0-19	1.2228	0.9288
	20-54	1.0301	0.9858
	55-69	0.8428	1.4068
	≥70	0.8428	1.4068

		Adjustment Factors	
Body Region	Age	Scald	Thermal
Leg, foot	Unk	0.9307	1.0502
	0-19	0.9983	1.0017
	20-54	0.9309	1.0451
	55-69	0.9596	1.0233
	≥70	0.8958	1.0817
Internal	Unk	0.3727	1.1773
	0-19	0.3727	1.1773
	20-54	0.3727	1.1773
	55-69	0.3727	1.1773
	≥70	0.3727	1.1773
Multiple	Unk	0.5642	1.1424
	0-19	0.5233	1.1520
	20-54	0.5233	1.1520
	55-69	0.6348	1.1263
	≥70	0.6348	1.1263
Unspecified	Unk	0.9039	1.0825
	0-19	0.9877	1.0147
	20-54	0.7405	1.1108
	55-69	0.7801	1.0704
	≥70	0.8943	1.0691

Source: 2010 NIS.

Table 9. Lifetime Total Medical Cost per Consumer-Product Injury, by Place of Treatment and Injury Diagnosis or Body Part Injured, 2010–2014 (*2010 dollars*)

	Non-Admitted		Hospital Inpatient		
NEISS Injury Diagnosis	Doctor/Clinic /Outpatient	Emergency Department	Direct Admission	Admission via Emgcy Dept	Aggregate Annual Cost (*millions*)
41 Ingestion	$715	$2,381	$23,334	$23,370	$519
42 Aspiration	$219	$1,298	$63,631	$63,688	$313
46 Burn, Electric	$233	$1,828	$23,380	$23,293	$21
47 Burn, Not Spec	$248	$1,849	$26,798	$26,391	$12
48 Burn, Scald	$245	$1,896	$21,435	$21,263	$450
49 Burn, Chemical	$237	$1,803	$24,247	$23,954	$77
50 Amputation	$227	$3,543	$22,224	$21,746	$244
51 Burn, Thermal	$238	$1,837	$28,913	$29,110	$955
52 Concussion	$665	$2,614	$20,933	$21,199	$1,150
53 Contusion/Abrasion	$433	$1,553	$24,611	$25,046	$8,463
54 Crushing	$2,122	$1,870	$27,927	$28,215	$230
55 Dislocation	$1,471	$3,689	$32,398	$32,084	$2,254
56 Foreign Body	$251	$1,342	$20,688	$21,670	$598
57 Fracture	$1,119	$3,586	$31,269	$32,213	$26,014
58 Hematoma	$368	$1,618	$23,012	$24,089	$522
59 Laceration	$493	$1,623	$18,424	$19,637	$6,614
60 Dental Injury	$471	$1,619	$20,891	$21,255	$100
61 Nerve Damage	$913	$3,271	$207,309	$214,980	$1,271
62 Internal Organ Inj	$658	$4,608	$72,662	$72,808	$20,253
63 Puncture	$384	$1,493	$16,556	$17,209	$375
64 Strain/Sprain	$853	$2,222	$27,732	$25,053	$15,582
65 Anoxia	$1,046	$1,372	$34,187	$29,477	$335
66 Hemorrhage	$752	$6,099	$39,017	$38,719	$178
67 Electric Shock	$1,046	$1,780	$49,403	$49,403	$67
68 Poisoning	$385	$1,608	$11,353	$13,411	$796
69 Submersion	$1,046	$1,741	$32,184	$33,531	$201
71 Other/ Not Stated	$957	$2,230	$30,309	$32,498	$12,676
72 Avulsion	$427	$1,604	$22,708	$22,771	$288
73 Radiation	$234	$1,731	$27,629	$27,517	$26
74 Dermat/Conjunc	$187	$1,109	$19,808	$20,212	$143
All Diagnoses	$743	$2,311	$33,969	$37,042	$100,728

NEISS Body Part	Non-Admitted: Doctor/Clinic /Outpatient	Non-Admitted: Emergency Department	Hospital Inpatient: Direct Admission	Hospital Inpatient: Admission via Emgcy Dept	Aggregate Annual Cost (*millions*)
00 Internal	$604	$2,260	$35,784	$32,798	$832
30 Shoulder	$1,184	$4,002	$27,575	$26,039	$5,204
31 Upper Trunk	$802	$2,436	$26,234	$26,101	$7,346
32 Elbow	$512	$3,270	$19,929	$19,977	$1,837
33 Lower Arm	$522	$2,181	$19,558	$19,250	$2,063
34 Wrist	$514	$2,320	$21,565	$21,524	$2,014
35 Knee	$1,248	$2,068	$27,595	$27,039	$5,409
36 Lower Leg	$623	$2,272	$30,769	$31,292	$3,347
37 Ankle	$581	$1,812	$28,966	$29,549	$4,125
38 Pubic Region	$722	$2,186	$19,152	$18,439	$287
75 Head	$496	$3,387	$63,766	$63,193	$24,342
76 Face	$429	$1,911	$22,163	$22,770	$4,355
77 Eyeball	$373	$1,347	$18,094	$18,500	$529
79 Lower Trunk	$790	$2,406	$31,438	$31,351	$15,982
80 Upper Arm	$948	$5,238	$30,189	$31,056	$1,921
81 Upper Leg	$1,206	$2,063	$37,040	$38,954	$2,540
82 Hand	$478	$1,625	$17,357	$17,055	$2,052
83 Foot	$644	$1,635	$23,688	$23,161	$2,507
84 25-50% of Body	$266	$2,050	$38,423	$38,686	$76
85 All Parts Body	$697	$1,705	$35,781	$40,969	$4,386
87 Not Stated	$799	$2,152	$49,213	$50,800	$1,174
88 Mouth	$454	$1,633	$20,835	$21,461	$605
89 Neck	$914	$2,486	$44,999	$45,675	$2,975
92 Finger	$550	$1,645	$16,903	$16,943	$3,254
93 Toe	$708	$1,690	$21,468	$21,108	$1,069
94 Ear	$517	$1,713	$20,585	$21,217	$499
All Body Parts	$743	$2,311	$33,969	$37,042	$100,728

7. WORK LOSS ESTIMATION

The work loss component of the revised ICM comprises four categories of work losses:

- Short-term work loss of victims (VS) are the losses resulting from the victim's physical inability to work while recovering from an injury.
- Long-term work loss of victims (VL) are the losses associated with permanent disability that remains after the injury victim has recovered to the maximum extent possible.
- Work loss of family and friends (FF) includes the time family and friends spend transporting, visiting, and caring for the victim.
- Employer costs (EM) represent the productivity that employers lose when employees are injured. The losses are varied. Notably, 1) co-workers spend time talking about the injury instead of producing, 2) supervisors spend time modifying work schedules and hiring and training temporary or permanent replacements for injured employees, and 3) replacement staff often are inefficient until they get training and experience.

Each of the first three categories of work loss includes diversions from both wage work and household work. Although school work also is lost, from a lifetime perspective, the value of school is largely to improve the student's expected lifetime earnings. To avoid double-counting earnings loss, no additional value is attached to long-term school loss from permanently disabling injury. From a short-term perspective, the school system is carefully organized so that brief absences affect performance negligibly. For this reason, the revised ICM does not explicitly value short-term school losses. Instead, for children 14 and under (those in elementary and middle school), the value of work lost by an injured student's caregivers, included in the family and friends component, is assumed to include the value of any necessary tutoring. The sections that follow describe the details for estimating each category of work loss. Figure 1 summarizes the formulas used in the calculations.

Short-Term Work Loss of Victims

The estimated value of short-term work loss is computed the product of three factors:

- The probability of work loss.
- The days lost if a work loss occurs.
- The average value of a day's work (including fringe benefits and household production).

This section describes how we estimated work-loss probabilities and the duration of work loss for wage and household work. Then it describes how the losses are valued. It also continues the example from the medical cost chapter, providing loss estimates for a 40-year-old woman with a fractured shoulder,[5] whether hospital-admitted or non-admitted.

---

[5] Medical costs in the previous chapter were calculated for ICD-9 diagnoses, whereas the work-loss costs in this chapter are calculated for NEISS diagnoses. NEISS diagnosis 5730, fracture of shoulder, is less specific than ICD-9 diagnosis 811, fracture of scapula.

Probability of Short-Term Work Loss (Wage and Household). All hospital-admitted injuries obviously cause some wage and/or household work loss. For medically treated, non-admitted injury victims, we used 1987–1996 NHIS data to estimate the probability of losing work. To achieve adequate sample size, we grouped ICD-9 diagnoses into 26 groups for analysis. For each diagnosis group, we estimated the probability that an injury of an employed person would result in at least one lost day of wage work by means of a logistic regression on the unweighted NHIS data. The regressions estimated the probability of work loss as a function of victim sex and age group, whether the injury was occupational, whether treated in the ED, and the NHIS sampling stratification variables (US region, level of urbanization, and whether the locality was oversampled for blacks). Where appropriate, we also included dummy variables for body region and/or nature of injury.

We evaluated the regression equations at the mean values of the stratifiers and with the occupational variable set to 0 to remove the influence of occupational injuries. The estimation procedure tailored the work-loss probabilities to consumer product injury by excluding motor vehicle cases, as well as by controlling for occupational injury origin. It also differentiated the probabilities by age group and sex. The probabilities were higher in the 18–34 age group than in other age groups but did not differ significantly by sex. Work-loss probabilities by diagnosis group did not differ significantly by treatment level (ED versus other outpatient treatment settings). Therefore, we apply the same short-term work-loss probabilities to all medically treated non-admitted injuries without regard to where they were treated. All injuries that prevent someone from working for pay presumably also force them to lose household work. Table 10 shows the mean work-loss probabilities for medically treated, non-admitted injury survivors. They range from less than 10% for foreign bodies to 50% for trunk fractures, lower limb fractures, and knee/leg sprains and 61% for back sprain.

> **Example**. The probability of losing work after fracturing a shoulder is 100% for admitted cases and 36.7% for non-admitted cases.

Duration of Short-Term Wage Work Loss. NHIS is not a good source for duration of work loss given that a loss occurs. It collects work loss for only the two weeks preceding the interview. Annual loss could be computed if we assume injury frequency is uniform across a year, but the NHIS sample size is small enough to discourage this computation.

To estimate work days lost per injury with work loss, we analyzed data from BLS's 1993 Survey of Occupational Injuries and Illnesses (SOII). Two limitations of this dataset required workarounds. First, the survey collects only days lost during the calendar year of the injury. This means the data understate losses for *open cases*—episodes in which work loss continues past the end of the year, such as those that occur in late December and those that result in especially lengthy work losses. To estimate mean work-loss duration by diagnosis, age group, and sex, we had to infer the duration of these open cases. Second, the SOII does not indicate whether the victim was hospitalized. However, we were able to segment the mean work loss by admission status using a ratio of work loss for admitted to non-admitted victims from MEPS data.

Estimating the duration of the open cases was statistically challenging. By applying DCI probabilities of permanent total disability by diagnosis, we randomly excluded some of the workers who had not yet returned to work in order to simulate those who never would return. For the remaining workers, we then estimated when they would return to work. The estimation used sophisticated non-linear regression models called duration models. The duration models were based on the Weibull distribution rather than the more familiar normal distribution. Weibull distributions typically are used to model how long a condition persists (for example, how long someone stays in the hospital or the expected time before a pipe fails). A problem can arise with these models if the victims in the SOII differ in demographic or job characteristics that the survey does not record and that affect return to work. To handle this problem, the models include an adjustment called a heterogeneity correction made with another non-normal distribution, the Gamma distribution. Separate models estimated losses for detailed diagnoses in 13 diagnosis groups. The models were applied to estimate the duration of open cases.[6] Using all the cases, we then computed mean losses by detailed diagnosis.

The models also provided age and sex adjustment factors by diagnosis to account for demographic variation. Each adjustment factor is stated as a percentage above or below the mean work loss duration for the diagnosis. Adjustments for age and sex are given separately but are cumulative with each other.

Although the SOII data are limited to injuries that occur on the job, a separate analysis of 1996–1999 MEPS data (Finkelstein et al. 2006) found that the duration of work loss did not differ significantly with respect to 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.

The SOII data do not provide a basis for differentiating work-loss duration by admission status. But analysis of the 1996–1999 MEPS data found that work loss was 4.96 times as long for hospitalized injuries as for non-hospitalized injuries (Finkelstein et al. 2006). We used this MEPS ratio to segment the mean work loss estimates by admission status. We started with the SOII-based estimate of mean work loss duration (T*) for all medically treated injury survivors with work loss, whether hospital-admitted (h) or non-admitted (n):[7]

$$T^* = \{[q \times T^*_h] + [(1 - q) \times p \times T^*_n]\} / r$$

where

T^* = mean wage work loss duration for all survivors with work loss
T^*_h = wage work loss duration for hospital-admitted victims
T^*_n = wage work loss duration for non-admitted victims with work loss
p = probability non-admitted victim has some work loss
q = probability victim is hospital-admitted
r = proportion of *all* victims with work loss = $q + [(1 - q) \times p]$

---

[6] With non-linear regressions, estimating the value of an open case requires numerical integration of a non-linear equation. Occasionally the iteratively estimated non-linear model with the heterogeneity correction would not converge, forcing us to use a model without this correction.

[7] Although the ICM specifies work losses for each relevant combination of diagnosis group, sex, and age group, here we omit the corresponding subscripts in the interest of simplification.

Applying the MEPS ratio of work loss duration for hospital-admitted versus non-admitted victims, $T^*_h = 4.96 \times T^*_n$. Substituting for T^*_h in the equation above and solving for T^*_n:

$$T^* = \{[(4.96 \times q) + (1 - q) \times p] \times T^*_n\} / r$$
$$T^*_n = (r \times T^*) / \{(4.96 \times q) + [(1 - q) \times p]\}$$

Tables 10 and 11 show the mean values of p and T, respectively, by diagnosis group. We estimated q using 1987–1992 NHDS counts of hospital-admitted survivors and 1987–1992 NHIS counts of medically treated, non-admitted survivors.

A caveat about the SOII data is that the existence of Workers' Compensation creates some modest incentive to malinger in returning to work (see e.g., Butler and Worrall 1985, Currington 1994, Johnson and Ondrich 1990, Krueger 1990, Johnson, Butler, and Baldwin 1995). This incentive may not exist for injuries outside the workplace. We were unable to adjust the estimated work-loss durations to account for this problem.

Table 11 summarizes how the duration of short-term work loss varies, by 13 broad BLS diagnosis groups, for injury victims who lose work. Work losses average more than 40 days for diagnosis groups that include amputations, internal organ injuries, nerve damage, fractures, dislocations, and crushing injuries. Poisonings and environmental injuries like frostbite and heat stroke involve the shortest work losses, averaging 7 to 8 days.

The left panel of Table 12 summarizes estimated probabilities of work loss for non-admitted injuries (p) and mean work-loss durations for lost-work injuries (T*) by sex and NEISS injury diagnosis. Burns and sprains/strains have the highest probabilities of non-admitted work loss. Non-admitted ingested/aspirated foreign object and anoxia injury victims have the lowest probabilities of work loss, but these injuries cause some of the longest work losses when an absence occurs. Other injuries associated with mean work losses exceeding 35 days include amputations, dislocations, fractures, and nerve damage. Chemical burn, foreign body, puncture, and submersion victims have the shortest average work loss—less than 10 days.

The right panel of Table 12 summarizes the same work-loss data by NEISS body part. Knee, ankle, lower trunk/back, and neck injuries entail the highest probabilities of work loss from non-admitted injuries; ear and internal injuries entail the lowest probabilities. Average work-loss durations exceed 35 days for shoulder, upper arm, internal, and lower trunk/back injury victims with work loss, but are less than 10 days for face, eye, and ear injury victims with work loss.

> **Example**. Our analysis of the SOII data (summarized in Tables 11 and 12) shows that the mean duration of wage-work loss from a lost-work shoulder fracture is 61.8 days. For this injury, the work-loss duration does not vary by sex, but for someone of age 35–54 it is 6% higher than the overall mean. Therefore, the mean work-loss duration (T*) for a woman age 40 is 65.5 days. Of medically treated shoulder fractures, 3.65% are hospital-admitted (q=.0365). Recall that 36.7% of non-admitted cases result in work loss (p=.367). That means the percentage of *all* medically treated shoulder fracture victims who incur work losses (r) is .390 (.0365 + [.9635 × .367]). Estimated mean duration of work loss per non-admitted victim age 35–54 with work loss (T^*_n) is 47.8 days ([.390 × 65.5 days] /

[(4.96 × .0365) + (.9635 × .367)]). The average work loss duration for admitted cases (T^*_h) is 4.96 times as long, or 237.0 days.

Duration of Short-Term Household Work Loss. We estimated the number of days of lost household work (T′) from the number of days with lost wage work (T*). To do so, we applied the two-step procedure in Miller (1993) and Miller, Cohen, and Wiersema (1996). First, lost wage-work days are multiplied times 365/243, since people do household work daily, 365 days a year, but typically do wage work on only 243 days a year.[8] Second, the product is multiplied times 0.9 because Waller et al. (1990) and Marquis (1992) found people could not do housework on 90% of the days when injury prevented them from doing wage work. This procedure assumes that injuries with the same diagnosis and highest treatment level are equally severe for employed victims and other victims.

Example. If the woman's fractured shoulder results in work loss, it is expected to cause 320.4 days of household work loss if hospital-admitted (T'_h = 237.0 × 0.9 × 365/243) and 64.6 days of household work loss if non-admitted (T'_n = 47.8 × 0.9 × 365/243).

Value per Day of Work Lost. To place a monetary value on temporary wage work loss, we multiplied the estimated days of work lost times average earnings per day of work, given the victim's age and sex. We used earnings data by sex and year of age from the March Supplement of the Current Population Survey (CPS), averaged across a full business cycle from 2002 through 2009. These earnings estimates covered the whole population, including those who were not in the labor force. We inflated all earnings figures to 2010 dollars using the Employment Cost Index, Total Compensation, Civilian (ECI–Civilian), published by the BLS (Lawrence 2014). 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 (Obama 2011, Table B-28). 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. (More detail on caregiver losses appears below, in the section on work loss of family and friends.) 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). 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.

Example. The mean daily earnings of a 40-year-old woman are $149.48 ($36,323 / 243 days) and the mean daily value of household production is $60.44 ($22,061 / 365 days). If she is hospitalized with a shoulder fracture her expected losses will be $35,427 (237.0 days × $149.48/day) in wage work plus $19,365 (320.4 days × $60.44/day) in household work. For a non-admitted shoulder fracture, her estimated work loss cost would be $2,622 (36.7% probability of work loss × 47.8 days × $149.48/day) in wage work and $1,433 (36.7% probability of work loss × 64.6 days × $60.44/day) in household work.

---

[8] The 243-day figure excludes holidays and leave—days for which injured workers lose neither work nor income.

Long-Term Work Loss of Victims

When injury results in long-term (i.e., permanent) disability, the victim will lose productivity every year until death. The expected value of long-term work loss resulting from an injury is the product of three factors:

- The probability of permanent disability.
- The percentage of earning power lost to the disability.
- The value of the lifetime of work the victim would have done absent the injury.

Probabilities of permanent total and permanent partial disability by diagnosis and hospital-admission status were estimated by Pindus et al. (1991). The probabilities came from 1979–1987 DCI data from multiple states about permanent disability among workers' compensation lost-workday claimants. Depending on the state, workers must lose at least three to nine days of work to become claimants, with four days being the average minimum across all DCI states. For non-admitted cases, the DCI probabilities were multiplied times probabilities of losing work to injury from 1987–1992 NHIS data and probabilities of losing at least four days to a lost-work injury computed from the 1993 SOII data (net of admitted cases). Since all admitted cases presumably involve lost-workday claims, their DCI probabilities were not modified.

The DCI data lacked usable permanent disability information about poisoning (because industrial and consumer product exposures to toxics are quite different), dermatitis, and conjunctivitis. We conservatively assumed that poisoning never resulted in permanent disability. For dermatitis (other than severe sunburns) and conjunctivitis we used the smallest disability probabilities associated with superficial injuries.

Total permanent disability results in 100% earnings loss. For partial permanent disability, the percentage of impairment was estimated from the 1992–1996 DCI data, broken down by diagnosis, but not by age, sex, or admission status. The average earnings loss in DCI permanent partial disability cases was 13.9%. We assume an equal loss in lifetime household production.

Following Rice at al. (1989) and Finkelstein et al. (2006), we assumed that the DCI-based disability probabilities and impairment percentages 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 the probability that an injury 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. 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.

For hospital-admitted cases of severe TBI and spinal cord injury (SCI) we also accounted for the lost productivity resulting from reduced life expectancies, as described in Lawrence (2015b). We defined SCI and TBI as *severe* if the highest abbreviated injury scale (AIS; AAAM 1980, 1985, 1990) severity score for the admission was at least 4 (on a scale of 1–6). We accelerated the estimated mortality rates of severe SCI and TBI survivors by applying standardized mortality ratios to the normal decrement in the life table. We recomputed lost earnings and household production for these cases using the shorter life expectancies, resulting in higher estimated work loss costs.

Lifetime earnings were estimated, using the CPS-based average earnings by age and sex described in the previous section, 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. Survival probabilities by age and sex came from Arias (2014). Lifetime household production loss was computed in a similar manner, using the valuations from Grosse et al. (2009) described in the previous section. Earnings at future ages, including salary and the value of fringe benefits, were adjusted upwards to account for a historical 1% productivity growth rate (Haddix et al. 2003). Productivity growth in household production, by contrast, has been negligible, so, following Finkelstein et al. (2006), we did not adjust for it. Future work loss costs were discounted to present value using the 3% discount rate recommended by the Panel on Cost-Effectiveness in Health and Medicine (Neumann et al. 2016) and by Haddix et al. (2003).

Table 13 shows the present value of lifetime wage work and household work by age group and sex. The expected value of lifetime work is higher for younger people because they have the most productive years remaining. In present value terms, young workers have higher lifetime work values than children who have not started working. Although their total expected work is equal, the children's work is all in the future and must be discounted. Predictably, men have higher average wage work losses but lower household work losses than women.

> **Example**. A hospital-admitted fractured shoulder victim has a 1.25% probability of total permanent disability ($d_{t,h}$) and a 23.82% probability of partial permanent disability ($d_{p,h}$). The corresponding probabilities for a non-admitted victim who misses at least four days of work are 0.00% and 2.33%. The probability that a non-admitted case results in work loss (p) is 36.7% and the probability that such a work loss lasts at least four days is 77.8%. We conservatively assume that any worker injured severely enough to be permanently disabled will miss at least four days of work. Therefore, the probabilities of permanent disability for a non-admitted victim are $d_{t,n} = .0000 \times .367 \times .778 = .0000$ and $d_{p,n} = .0233 \times .367 \times .778 = .00665$. A victim with partial permanent disability suffers an average 13.45% loss of earning capacity. The present value of expected lifetime work (K) for a 40-year-old female is $717,275 in earnings and $423,279 in household production, which sum to $1,140,554. The value of expected long-term work loss for an admitted injury (VL_h) is
>
> $$VL_h = K \times [d_{t,h} + (i \times d_{p,h})]$$
> $$= \$1{,}140{,}554 \times [(.0125 + (.1345 \times .2382)] = \$50{,}798$$
>
> For a non-admitted injury, the losses would amount to
>
> $$VL_n = K \times [d_{t,n} + (i \times d_{p,n})]$$
> $$= \$1{,}140{,}554 \times [(.0000 + (.1345 \times .00665)] = \$1{,}020$$

Work Loss of Family and Friends

To value visitor and caregiver work loss, we started with the value of daily work (wages plus fringe benefits plus household work) by age group and sex (described earlier in this chapter, in the section on short-term work losses). Using the 1995–1996 NEISS age and sex distribution for ED-treated consumer-product-injury victims ages 20–64, we computed the average daily value of wage and household work. The estimated loss for each day of lost work was $98. This loss was the average across weekdays and weekends and across labor force participants and non-participants. It included $76 in lost wages and fringe benefits and $22 in lost household production. It equated to roughly $6 per waking hour. Inflated from 1995 dollars to 2010 dollars, this amounts to $9.62.

To represent the time lost by family and friends while transporting and visiting injury victims, we used the time-loss estimates in the original 1980 ICM. Those estimates assume that initial injury treatment causes family and friends to spend an average of two person-hours transporting the victim and waiting while the victim is treated (Technology and Economics 1980). In addition, for admitted cases the model assumes three hours of family travel and visiting time per bed day. We assume an admitted victim spends one post-discharge day in bed for every day spent in the hospital, so bed days are twice the length of stay in the hospital. For non-admitted cases, we assume two hours for transportation but nothing for visitor time because we do not believe visitor costs typically are associated with non-admitted cases. Therefore, transportation time costs \$19.24 per case (2 hours × \$9.62/hour). Visitor time costs for admitted cases are \$28.86 per bed day (3 hours × \$9.62/hour).

In addition to visitor and transportation costs, caregiver costs are associated with bed days at home. The model estimates caregiver costs for children under age 15, but not for adults. When a child cannot attend school or day care because of an injury, a caregiver almost always is needed. A recent study of head injury victims found that in every instance where an injured child was attended to by an employed adult caregiver, if the child missed school, the adult missed work (Becker et al. 2000). The model assumes that an injured child requires a caregiver for the same number of days an employed adult victim of a comparable injury would lose from wage or household work. As described above in the section on short-term work losses, for children, 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. Even though caregiver costs are conceptually part of family and friends work loss, they are computed and displayed as part of short-term victim work losses.

> **Example**. A hospital-admitted shoulder-fracture victim averages 4.2 days per admission. Thus, each such case results in an average of 4.2 hospital days and an additional 4.2 post-discharge bed days, for a total of 8.4 bed days. Visitor costs are estimated at \$261.66 (\$19.24 + \$28.86 × 8.4). For a non-admitted case, family cost includes only transportation time at \$19.24.

Employer Costs

We estimated employers' productivity losses resulting from non-occupational employee injury by refining the assumption-driven methods in Miller and Galbraith (1995). This cost factor appears to be modest in size. Employers incur a variety of costs resulting from non-occupational injuries to employees. This section discusses how the ICM estimates these costs.

Employers lose productivity whenever an employee works at less than usual capacity or is diverted to less demanding tasks (Miller 1997). Uninjured co-workers also may lose productivity (Rikhardsson and Impgaard 2004). During an employee's temporary absence, colleagues may assume the additional workload. As a result, the employer may have to pay overtime. In other cases, work may be rescheduled, awaiting the injured employee's return. If replacements must be hired, the injury imposes costs for training temporary or permanent staff. Replacements for injured employees may cost further productivity because they are less skilled or have a start-up period. Some employees—an award-winning chef, for example—have irreplaceable skills (Miller 1997). Injuries outside of work, even injuries to family members, distract victims and co-workers, prompting them to talk and worry about the injury victim rather than producing. Finally, supervisors and executives lose valuable time assisting injured employees, rescheduling production, hiring temporary or permanent replacements, or providing training. Further reductions in profitability may result from interference with production, failure to fill orders on time, loss of bonuses, or payments of forfeits (Miller and Rossman 1990).

Employer costs of injury previously have been estimated in two related journal articles, Miller and Galbraith (1995) and Miller (1997). The thrust of these articles was to assess whether employer costs might be an important cost factor. The estimates were built from four assumptions:

- One-quarter of the time that other employees lose because an employee suffers a non-occupational injury is supervisory time.
- An employee's death or permanent disability costs an employer 4 months of wages plus fringe benefits. Recruitment, retraining, and lost special skills are the major components of this cost.
- A hospital-admitted injury costs one month of wages plus fringe benefits for other employees.
- Non-occupational injuries involve 3 days of productivity loss for other employees if they involve victim work loss and 1.5 days if they are medically treated but do not result in lost work.

The Miller and Galbraith (1995) assumption of 4 months (83 days) lost by supervisors and co-workers per permanently disabling injury seems reasonable, but their other estimates seem a bit high. Accordingly, we reduced the prior assumed supervisor and co-worker time losses for non-occupational injuries as follows:

- For hospital-admitted injury of an employed person, 10 days.
- For other injuries with wage work loss, 3 days.
- For other medically treated injury without wage work loss beyond time to seek medical treatment, .25 days (i.e., 2 hours).
- For lost-housework-day injury of a person who is not employed, 2 days (due to the caregiver's absence from work, which forces the caregiver's supervisor to adjust schedules and distracts other employees from their tasks).[9]

Miller and Galbraith (1995) estimate that the value of the mix of supervisory and non-supervisory wages and fringe benefits per lost supervisor/co-worker day (M) is $130.80 (in 1994 dollars); inflating to 2010 dollars yields $215.52. Under the above assumptions for number of days lost under various injury scenarios, we can calculate order-of-magnitude estimates of total costs (C) for each of the following five scenarios:

- Employed, permanently disabled, admitted or non-admitted: $C_1 = 83 \times M = \$17,888$
- Employed, *not* permanently disabled, hospital-admitted: $C_2 = 10 \times M = \$2,155$
- Employed, temporary work loss, non-admitted: $C_3 = 3 \times M = \$647$
- Employed, no work loss, non-admitted: $C_4 = 0.25 \times M = \$54$
- Not employed: $C_5 = 2 \times M = \$431$

---

[9] Given that some of these unemployed injury victims who are presumed to require caregivers might be adults, this assumption creates a middle ground when combined with our assumption that family and friends incur caregiver costs only for victims up to 14 years old.

To determine the employer costs (EM) for any victim, whether hospital-admitted (EM_h) or non-admitted (EM_n), we require the probabilities of occurrence of each of the above five scenarios (v_1, v_2, v_3, v_4, v_5).

Admitted injury victims could incur component costs C_1, C_2, and C_5. Non-admitted injury victims could incur all cost components except C_2. That is:

$EM_h = v_{1,h} \times C_1 + v_2 \times C_2 + v_5 \times C_5$ (if hospital-admitted)
$EM_n = v_{1,n} \times C_1 + v_3 \times C_3 + v_4 \times C_4 + v_5 \times C_5$ (if non-admitted)

where the v multipliers are:

$v_{1,h} = e \times d_h$ (if hospital-admitted)
$v_{1,n} = e \times d_n$ (if non-admitted)
$v_2 = e \times (1 - d_h)$
$v_3 = e \times (p - d_n)$
$v_4 = e \times (1 - p)$
$v_5 = (1 - e)$

The probability of permanent disability (d_h) for an admitted injury is the sum of the probabilities of partial ($d_{p,h}$) and total ($d_{t,h}$) disabilities, which were defined in the long-term work loss section of this chapter. Similarly, the probability of permanent disability for a non-admitted injury (d_n) is the sum of its non-admitted partial ($d_{p,n}$) and total ($d_{t,n}$) components. The probability of temporary work loss for an employed, non-admitted injury victim is the difference between the proportion of all non-admitted victims who lose work (p) and the proportion of non-admitted victims who are permanently disabled (d_n). The proportion of the population that is employed at wage work is e.

Example. For the 40-year-old female shoulder fracture victim, the probability of being employed (e) is 0.745, and the probability she is not employed is 0.255. Under victim long-term costs, we estimated her probabilities of permanent partial (d_p) and permanent total (d_t) disability.

$d_h = d_{p,h} + d_{t,h} = .2382 + .0125 = .2507$
$d_n = d_{p,n} + d_{t,n} = .00665 + .0000 = .00665$

$v_{1,h} = .745 \times .2507 = .1868$
$v_{1,n} = .745 \times .00665 = .00495$
$v_2 = .745 \times (1 - .2507) = .5582$
$v_3 = .745 \times (.367 - .00665) = .2685$
$v_4 = .745 \times (1 - .367) = .4716$
$v_5 = .255$

$EM_h = (.1868 \times \$17,888) + (.5582 \times \$2,155) + (.255 \times \$431) = \$4,654$

$EM_n = (.00495 \times \$17,888) + (.2685 \times \$647) + (.4716 \times \$54) + (.255 \times \$431) = \$427$

Total work loss (WL) is the sum of its four components: short-term work loss (VS), long-term work loss (VL), work loss of family/friends (FF), and employer costs (EM). For the 40-year old female shoulder fracture victim, this loss is:

$WL = VS + VL + FF + EM$

$WL_h = \$54,792 + \$50,798 + \$262 + \$4,654 = \$110,506$ (if admitted)

$WL_n = \$4,055 + \$1,020 + \$19 + \$427 = \$5,521$ (if non-admitted)

Victim losses dominate total work-loss costs. Visitor work losses contribute negligibly to the total—less than 0.4%.

Total Cost of Work Loss

Table 14 summarizes the total expected cost of work losses, averaged across all demographic groups. This includes all victim losses—both short-term and long-term losses of both wage work and household work—as well as family and employer costs. Long-term victim losses are discounted at 3%. The first portion of the table summarizes costs per victim by NEISS nature of injury and admission status. Hospital-admitted survivors generally have higher work losses than non-admitted survivors. Among admitted survivors, the highest costs are for electric shock, followed by submersion, nerve damage, and amputation. The lowest cost is for poisoning, in part because we were unable to estimate its associated permanent disability probabilities very well.

The second portion of Table 14 presents the value of expected total victim work losses by body part injured. Injuries of the head, finger, and eyeball resulted in especially large work losses.

The greatest total costs to society are associated with fractures, sprains/strains, internal organ injuries, and injuries of the head and lower trunk. Sprains/strains and fractures are usually not particularly costly, but they are quite prevalent, as are injuries of the lower trunk, which includes the lower back. Internal organ injury and head are the diagnosis and body part, respectively, that are usually associated with traumatic brain injury, which can be quite costly.

Figure 1. Injury Cost Model Work Loss Equations

Work loss includes four major components:

- **(VS)** Injury victims may experience *short-term work losses* as a consequence of their physical inability to work while being treated for and recovering from an injury. The lost work includes both paid employment (earnings) and household work.
- **(VL)** *Injury victims* may experience *long-term work losses*, such as those associated with full or partial permanent disability following the injury recovery period.
- **(FF)** *Family and/or friends* of the injury victim may incur work loss because of time spent transporting, visiting, and caring for the victim.
- **(EM)** *Employer* costs include losses by supervisors and co-workers to modify schedules and otherwise accommodate the absence of the victim.

Estimation of victim short-term loss

$\mathbf{VS_h} = [(T^*_h \times w^*) + (T'_h \times w')]$ (for hospital-admitted victims)

$\mathbf{VS_n} = p \times [(T^*_n \times w^*) + (T'_n \times w')]$ (for non-admitted victims)

where,

T^* = mean duration of *wage* work loss across all victims with wage work loss
T^*_h = duration of *wage* work loss for hospital-admitted victims
T^*_n = duration of *wage* work loss for non-admitted victims with wage work loss

T' = mean duration of *household* work loss across all victims with wage work loss
T'_h = duration of *household* work loss for hospital-admitted victims
T'_n = duration of *household* work loss for non-admitted victims with wage work loss

w^* = valuation of lost *wage* work
w' = valuation of lost *household* work

p = probability non-admitted victim will lose work
q = probability victim is hospital-admitted
r = proportion of all victims with work loss $= q + [(1 - q) \times p]$

and

$T^*_n = (r \times T^*) / \{(4.96 \times q) + [(1 - q) \times p]\}$
$T^*_h = 4.96 \times T^*_n$
$T'_n = 0.9 \times (365/243) \times T^*_n$
$T'_h = 0.9 \times (365/243) \times T^*_h$

Estimation of victim long-term loss

VL_h $= K \times [d_{t,h} + (i \times d_{p,h})]$ (for hospital-admitted victims)
VL_n $= K \times [d_{t,n} + (i \times d_{p,n})]$ (for non-admitted victims)

where,

- K = present value of lifetime work (by age group and sex)
- $d_{t,h}$ = probability of long-term *total* disability for hospital-admitted victims
- $d_{t,n}$ = probability of long-term *total* disability for non-admitted victims
- $d_{p,h}$ = probability of long-term *partial* disability for hospital-admitted victims
- $d_{p,n}$ = probability of long-term *partial* disability for non-admitted victims
- i = percent lifetime earnings loss by victims with long-term partial disability

Estimation of family/friend work loss

FF $= (W \times v) + (H \times v \times B)$

where,

- W = initial transportation/waiting time = 2 hours
- v = value of time = $9.62 per hour
- H = visiting time per bed day = 3 hours
- B = number of bed days = twice the number of inpatient days (=0 if non-admitted)

Therefore,

FF $= \$19.24 + (\$28.86 \times B)$

Estimation of employer costs from victim work loss

EM_h $= e \times [(d_h \times C_{pd}) + ((1 - d_h) \times C_{td,h})] + (1 - e) \times C_{cg}$
(for hospital-admitted victims)

EM_n $= e \times [(d_n \times C_{pd}) + ((p - d_n) \times C_{td,n}) + (1 - p) \times C_{nd}] + (1 - e) \times C_{cg}$
(for non-admitted victims)

where,

- e = probability victim is (wage) employed
- d_h = combined probability of full or partial *permanent* disability for hospital-admitted victim $= d_{t,h} + d_{p,h}$
- d_n = combined probability of full or partial *permanent* disability for non-admitted victim $= d_{t,n} + d_{p,n}$
- p = probability of *temporary* work loss for non-admitted victim

- C_{pd} = cost of full and partial permanent disability = $17,888
- $C_{td,h}$ = cost of temporary disability = $2,155
- $C_{td,n}$ = cost of temporary disability = $647
- C_{nd} = cost if no work loss = $54
- C_{cg} = cost for caregiver work loss effect = $431

Table 10. Unweighted Count of Workers Suffering Medically Treated, Non-Admitted Injuries and Weighted Probability Their Injuries Caused Work Loss, by ICD-9 Diagnosis Group

ICD-9 Diagnosis	Unweighted Count	Probability of Work Loss
800–804, 850–854	22	0.4090
805–809	16	0.4859
810–819	70	0.3669
820–829	66	0.4988
830–839	24	0.4602
840, 841	35	0.4548
842	40	0.1975
843, 844	50	0.5053
845	93	0.4577
846, 847	145	0.6091
848	29	0.3572
870–874	75	0.2471
875–880	12	0.4148
881, 882, 884	82	0.2980
883	151	0.1835
890, 891, 904	39	0.3075
892, 893	36	0.1783
910, 918, 920, 921	71	0.3897
911–917, 919	39	0.2417
922	20	0.3158
923	47	0.2886
924	82	0.3512
925–9, 860–9, 950–9	111	0.4068
930–939	39	0.0967
940–949	50	0.4490
990–994	7	0.2324

Source: 1987–1992 NHIS.

Table 11. Estimated Days of Work Lost per Person Losing Work, by BLS Diagnosis Group

Diagnosis Group	Estimated Mean Days	Estimated Median Days
Traumatic injuries to bones nerves, spinal cord	44.5	13
Fractures, crushings, dislocations to head and neck	35.6	9
Fractures, crushings, dislocations to other body parts	43.1	20
Sprains, strains, tears, etc. to muscles, tendons, ligaments, joints, etc. in back	31.5	6
Sprains, strains, tears, etc. to muscles, tendons, ligaments, joints, etc. in other parts	28.6	6
Open wounds – bites, cuts, avulsions, punctures*	11.5	3
Amputations, enucleations, gunshot wounds, injuries to organs and blood vessels of trunk	42.6	24
Surface wounds – abrasions, bruises, blisters, foreign body injuries, friction burns*	12.5	3
Burns – chemical, heat, electrical	13.4	4
Intra-cranial injuries – concussion, contusion, cerebral hemorrhage*	21.6	5
Environmental injuries – frostbite, hypothermia, heat fatigue, etc.*	7.3	2
Other injuries – drowning, suffocation, electrocution, embolism*	28.9	6
Poisonings – animal and insect bites*	8.3	2

* Results using Weibulls unadjusted for heterogeneity.

Source: Computed from 1993 BLS Survey of Occupational Injuries and Illnesses, with durations estimated for cases that still were open when the survey was completed.

Table 12. Average Days of Work Lost per Lost-Work Injury and Probability Non-Admitted Injury Victims Will Lose Work, by Injury Diagnosis or Body Part Injured

	Days of Lost Work		Probability of
NEISS Injury Diagnosis	Males	Females	Losing Work
41 Ingested Foreign Object	37.3	37.1	0.10
42 Aspirated Foreign Object	37.3	37.1	0.10
46 Burns, electrical	28.1	28.1	0.45
47 Burns, not specified	14.6	14.6	0.45
48 Burns, scald	14.8	14.7	0.45
49 Burns, chemical	8.2	8.1	0.45
50 Amputation	37.2	37.2	0.19
51 Burns, thermal	11.8	11.6	0.45
52 Concussions	19.5	19.0	0.41
53 Contusions, Abrasions	12.6	12.8	0.33
54 Crushing	22.7	22.7	0.40
55 Dislocation	40.0	40.0	0.46
56 Foreign Body	6.1	6.3	0.20
57 Fracture	48.8	48.8	0.42
58 Hematoma	15.2	15.3	0.36
59 Laceration	10.9	10.9	0.25
60 Dental Injury	37.3	37.1	0.25
61 Nerve Damage	43.0	43.0	0.41
62 Internal Organ Injury	22.6	22.1	0.41
63 Puncture	9.3	9.2	0.23
64 Strain or Sprain	24.0	24.1	0.45
65 Anoxia	37.3	37.1	0.10
66 Hemorrhage	22.3	22.4	0.28
67 Electric Shock	24.5	24.3	0.23
68 Poisoning	11.2	10.9	0.41
69 Submersion	9.4	9.1	0.23
70 Not Stated	37.3	37.1	0.37
71 Other	25.9	25.7	0.36
72 Avulsion	18.4	18.4	0.21
73 Burns, radiation	14.5	14.5	0.45
74 Dermatitis, Conjunctivitis	15.0	15.2	0.24
All Diagnoses	21.2	21.2	0.34

NEISS Body Part	Days of Lost Work Males	Days of Lost Work Females	Probability of Losing Work
00 Internal	37.3	37.1	0.10
30 Shoulder	40.0	40.1	0.38
31 Upper Trunk	28.8	28.9	0.38
32 Elbow	23.8	24.0	0.34
33 Lower Arm	31.5	31.6	0.34
34 Wrist	30.5	30.6	0.30
35 Knee	27.4	27.5	0.42
36 Lower Leg	33.5	33.6	0.38
37 Ankle	20.0	20.2	0.45
38 Pubic Region	23.6	23.7	0.33
75 Head	14.5	14.4	0.35
76 Face	9.8	9.8	0.29
77 Eyeball	8.3	8.4	0.35
79 Lower Trunk	39.1	39.2	0.48
80 Upper Arm	38.0	38.0	0.35
81 Upper Leg	28.4	28.4	0.39
82 Hand	15.4	15.4	0.31
83 Foot	18.3	18.4	0.33
84 25-50% of Body	18.5	18.4	0.35
85 All Parts of Body	20.8	20.5	0.32
87 Not Stated	32.4	32.3	0.36
88 Mouth	12.9	12.8	0.26
89 Neck	31.1	31.1	0.56
92 Finger	15.0	15.1	0.24
93 Toe	17.8	17.9	0.38
94 Ear	7.1	7.1	0.20
All Body Parts	21.2	21.2	0.34

Sources: Estimated from 1993 SOII and 1987–1992 NHIS.

Table 13. Present Value of Lifetime Earnings (Including Fringe Benefits) and Household Production, at a 3% Discount Rate, by Age Group and Sex (*2010 dollars*)

Age Group	Earnings		Household Production	
	Male	Female	Male	Female
< 1	$1,102,115	$631,812	$205,239	$359,354
1–4	$1,166,189	$667,728	$221,981	$372,910
5–9	$1,275,139	$729,941	$246,460	$416,273
10–14	$1,407,249	$805,521	$269,369	$462,033
15–19	$1,552,226	$886,975	$289,412	$522,289
20–24	$1,670,080	$943,451	$304,411	$549,239
25–29	$1,699,669	$932,013	$310,061	$548,496
30–34	$1,634,529	$868,344	$304,126	$521,037
35–39	$1,491,656	$780,080	$288,233	$477,484
40–44	$1,290,555	$671,749	$268,664	$431,991
45–49	$1,059,334	$545,374	$248,460	$392,175
50–54	$809,341	$402,406	$229,992	$360,842
55–59	$548,793	$253,819	$213,100	$330,483
60–64	$307,415	$126,168	$191,362	$293,962
65–69	$149,992	$54,066	$164,912	$250,451
70–74	$78,457	$24,102	$133,645	$202,589
75–79	$38,565	$11,459	$100,868	$156,312
80–84	$17,950	$6,393	$72,931	$115,711
≥ 85	$3,300	$2,599	$46,982	$71,836

Source: Computed with national demographic data, a standard age-earnings model, and the method for valuing household production recommended by Douglass et al. (1990).

Table 14. Lifetime Total Work-Loss Cost per Consumer-Product Injury by Victim's Admission Status and Injury Diagnosis or Body Part Injured, 2010–2014 (*2010 dollars*)

	Non-Admitted		Hospital Inpatient		
NEISS Injury Diagnosis	Doctor/Clinic /Outpatient	Emergency Department	Direct Admission	Admission via Emgcy Dept	Aggregate Annual Cost (*millions*)
41 Ingestion	$742	$745	$50,989	$50,908	$765
42 Aspiration	$640	$639	$22,832	$22,749	$120
46 Burn, Electric	$2,053	$1,976	$33,294	$32,664	$35
47 Burn, Not Spec	$2,132	$2,087	$38,726	$37,231	$21
48 Burn, Scald	$1,803	$1,745	$34,243	$33,839	$744
49 Burn, Chemical	$1,949	$1,785	$35,591	$35,151	$132
50 Amputation	$7,210	$8,315	$242,098	$237,696	$2,158
51 Burn, Thermal	$1,942	$1,884	$34,838	$33,971	$1,306
52 Concussion	$2,015	$2,045	$63,073	$63,853	$2,070
53 Contusion/Abrasion	$1,037	$1,002	$22,026	$20,019	$10,321
54 Crushing	$3,438	$3,059	$98,132	$97,361	$426
55 Dislocation	$4,281	$3,846	$58,626	$58,284	$4,372
56 Foreign Body	$694	$775	$53,475	$51,598	$830
57 Fracture	$3,912	$4,068	$56,341	$53,534	$44,433
58 Hematoma	$937	$916	$21,428	$19,286	$507
59 Laceration	$1,100	$1,095	$50,782	$47,607	$8,489
60 Dental Injury	$3,931	$3,985	$91,543	$93,415	$356
61 Nerve Damage	$1,979	$2,025	$255,180	$262,480	$1,746
62 Internal Organ Inj	$1,590	$1,481	$173,136	$170,057	$38,459
63 Puncture	$807	$866	$66,064	$65,450	$564
64 Strain/Sprain	$3,605	$2,966	$57,155	$47,240	$48,209
65 Anoxia	$811	$861	$158,750	$128,839	$946
66 Hemorrhage	$722	$713	$30,171	$29,542	$89
67 Electric Shock	$879	$889	$289,525	$286,547	$232
68 Poisoning	$714	$718	$4,749	$6,124	$482
69 Submersion	$478	$477	$257,248	$255,568	$1,405
71 Other	$2,541	$2,482	$48,176	$47,002	$20,396
72 Avulsion	$876	$870	$29,032	$29,727	$301
73 Radiation	$2,042	$1,945	$41,056	$40,752	$50
74 Dermat/Conjunc	$909	$883	$33,597	$33,601	$242
All Diagnoses	$2,551	$2,056	$65,152	$70,037	$190,208

NEISS Body Part	Non-Admitted		Hospital Inpatient		Aggregate Annual Cost (*millions*)
	Doctor/Clinic /Outpatient	Emergency Department	Direct Admission	Admission via Emgcy Dept	
00 Internal	$719	$733	$42,289	$44,323	$885
30 Shoulder	$3,743	$3,401	$58,334	$54,261	$9,982
31 Upper Trunk	$2,983	$2,596	$39,999	$40,472	$14,282
32 Elbow	$1,874	$2,262	$54,469	$55,749	$3,242
33 Lower Arm	$2,038	$2,592	$68,332	$73,103	$5,250
34 Wrist	$1,902	$2,395	$78,960	$82,586	$4,348
35 Knee	$2,968	$2,588	$56,268	$44,957	$10,504
36 Lower Leg	$2,351	$2,438	$67,787	$69,913	$7,103
37 Ankle	$1,703	$2,069	$63,343	$62,949	$8,410
38 Pubic Region	$1,787	$1,739	$49,433	$51,524	$547
75 Head	$1,259	$1,357	$151,256	$146,699	$45,083
76 Face	$1,142	$1,253	$41,227	$43,761	$5,965
77 Eyeball	$913	$928	$121,422	$125,626	$1,326
79 Lower Trunk	$3,914	$3,381	$35,559	$34,239	$32,836
80 Upper Arm	$3,069	$2,764	$53,700	$47,377	$2,690
81 Upper Leg	$2,721	$1,963	$35,020	$33,862	$2,801
82 Hand	$1,522	$1,641	$53,286	$58,701	$3,871
83 Foot	$2,219	$2,206	$54,240	$52,689	$5,771
84 25-50% of Body	$2,072	$2,055	$41,068	$40,398	$82
85 All Parts Body	$979	$1,025	$46,311	$49,673	$5,184
87 Not Stated	$1,921	$1,882	$61,888	$55,379	$1,475
88 Mouth	$2,044	$2,201	$73,976	$73,672	$1,334
89 Neck	$4,050	$3,504	$69,250	$69,326	$7,708
92 Finger	$1,470	$1,309	$120,041	$126,818	$6,499
93 Toe	$1,855	$1,902	$72,726	$74,661	$2,148
94 Ear	$1,523	$1,469	$76,759	$75,006	$884
All Body Parts	$2,551	$2,056	$65,152	$70,037	$190,208

8. INTANGIBLE LOSS ESTIMATION

Traditionally, illness and injury costs have been estimated as the sum of medical care, insurance claims processing, litigation, and work loss costs. This cost framework, which is called human capital costs, originated with Adam Smith in 1776.

Human capital costs lack comprehensiveness. They value only the monetary aspects of our lives. They fail to value the intangibles like the pleasure lost because a quadriplegic will never again pet a cat or hug a spouse. As a second example, an injury that does not require medical treatment and restricts the victim although the victim is still able to work has a human capital cost of $0. Nevertheless, victim quality of life may be reduced—for example, by having to cancel a tennis game or piano lesson. The victim may also be in pain. By ignoring the intangible losses, human capital costs systematically undercount costs.

An appealing way to overcome this problem is to add intangibles to human capital costs. One approach values the losses directly in dollars guided by an analysis of jury verdicts for similar cases. A second approach, the quality-adjusted-life-year or QALY approach, measures the intangibles in non-monetary terms. A third approach, which we examined but concluded should not be included in ICM, estimates a family's willingness to pay for the health and safety of a member and adds the costs external to the family (essentially, the medical and litigation costs, plus any income replacement the family receives). Miller, Calhoun, and Arthur (1989) show that this framework operationally equates to placing a dollar value on (monetizing) the QALYs, then adding human capital costs.

The intangible losses are quite important. When valued in dollars, they comprise 65–80% of total injury costs (Miller 1998). Because these losses are both large and difficult to measure, the ICM places special emphasis on measuring them and assessing their reliability. To assess reliability, the model examines how values vary between the available valuation methods. As this chapter describes, ICM estimates the intangible losses from jury verdicts. It also applies the QALY approach to provide an alternative, which can be used in sensitivity analysis.

Values Based on Jury Verdicts

The jury verdict approach directly estimates dollar values for the intangibles. The values come from nonfatal-injury jury verdicts for non-economic damages—damages other than medical costs and work losses. Cohen (1988), Viscusi (1988), and Rodgers (1993) established the theoretical framework for estimating pain and suffering from jury verdicts. The basic notion is that pain and suffering to an injury survivor can be approximated by the difference between the amount of compensatory damages awarded by a jury minus the actual out-of-pocket costs associated with the injury.[10] Lopez, Dexter, and Reinert (1995), Cohen (1988), Miller, Cohen, and Rossman (1993), Miller, Cohen, and Wiersema (1996), Bovbjerg, Sloan, and Blumstein

---

[10] In fatality cases, the victim is not present to recover. State laws limit fatal injury awards in widely varying ways, making it difficult and possibly inappropriate to value pain and suffering with fatal awards.

(1989), Rodgers (1993), and Miller, Brigham, et al. (1993) previously used regressions on jury verdicts to value pain and suffering for serious birth defects, assault, rape, medical malpractice, consumer product injury, and burns.

Valuing losses with jury-based values only makes sense if jury verdicts are reasonably predictable. Juries are informed in detail about the victim's health status and prognosis. As a group, they debate the veracity of plaintiff and defense views on this question. They then attempt to set compensation at a level the group agrees is fair. When large numbers of cases are analyzed, the pain and suffering component of U.S. jury verdicts to injury survivors is quite predictable. Miller, Cohen, and Wiersema (1996) estimated pain and suffering for physical assaults from jury verdict regressions, then compared the results with the monetized QALY estimates by ICD-9 diagnosis code from Miller, Pindus, et al. (1995). Estimates for individual diagnoses by hospitalization status varied significantly in some cases; averaged across diagnoses, however, the mean estimates for physical assaults from the two methods differed by only 5%. Moreover, both Miller, Cohen, and Wiersema (1996) and the study of consumer-product-injury jury verdicts described below are able to explain more than half the variation in pain and suffering awards among samples of 500–1,000 jury verdicts to injury survivors.

The remainder of this section describes the jury verdict database and analysis in greater detail. Juries are generally instructed to award an amount that will make the victim "whole," and are given details on the nature of the injury, its prognosis, out-of-pocket losses, and associated pain and suffering.

Data on jury awards, settlements and mediation were collected from Jury Verdict Research (JVR).[11] All cases involving consumer products were collected—even if the product's manufacturer was not subject to litigation. As shown in Table 15, we sampled 1,986 JVR cases that matched these criteria. Of these cases, 828 involved a specified consumer product. The remaining 1,158 cases generally involved some form of premises liability. The premises liability cases related to injuries that involved consumer products (e.g., someone tripping over a hose and falling down stairs, or slipping on a freshly waxed floor). Of the 828 product-related injuries, the largest product categories were bicycles (173),[12] hand tools (83), elevators (62), mopeds (46),[13]

---

[11] Many jury awards did not differentiate pain and suffering costs from past and future medical and work losses (monetary losses). We tried to estimate the monetary losses with data from awards, settlements, and mediation. Regression models that predicted pain and suffering from known monetary losses had better predictive power than those that also included cases where we estimated how the total award was split between monetary loss and pain and suffering (the full sample of awards). Therefore, we believe the more restricted sample yields a model that more accurately reproduces jury estimates of pain and suffering. Only that model is reported here.

[12] Although 173 cases involved bicycles, 111 of these cases also involved moving motor vehicles. The regression includes a dummy variable to identify automobile-involved incidents.

[13] All but three of the 46 moped cases also involved motor vehicles.

ladders (42), furniture (39), lawn mowers (33), beverage containers (32), and all-terrain vehicles (ATVs) (28). Other product categories contained 10 or fewer cases.[14]

About 54.8% of injured consumers whose sex was identified were male and 45.2% female. These figures are close to national estimates of consumer product injury victims as reported in the 1994 NEISS dataset, where 57.2% of injury victims were reported to be males. Children under age 13 represent about 14.7% of those whose age was identified, compared to 33.1% in the NEISS dataset.[15] Injuries to individuals ages 65 or over represent 8.4% of injured consumers identified by age in the JVR dataset, compared to about 9.3% in the NEISS data. About 56.8% of the injury victims were known to be employed at the time of injury. Minors represented about 28.3%,[16] while the unemployed, retired, students, or homemakers represented 15% of the total.

All cases involved awards or judgments that were made between the years of 1988 and 1995. In order to calculate pain and suffering estimates, all monetary values were updated to 1995 dollars (using wage-specific and medical cost-specific inflation adjustments).

Table 16 summarizes past losses, awards, and pain and suffering for all jury awards (n=1,154) and settlements (n=781). The mean compensatory jury award was $619,747, while the median award was $108,767. Past wage losses averaged $64,987 for the 338 cases that had data on wage losses, while past medical costs averaged $55,035 for the 710 cases with medical cost estimates. Median losses are considerably lower, $17,961 for wages and $13,544 for medical costs. Only about 20% of cases (223) estimated future losses. However, when future losses were estimated, they were substantial, with mean losses of $575,324 and median losses of $102,518.

Table 16 also contains estimates of pain and suffering which are computed by subtracting past and future losses from the compensatory jury awards. Pain and suffering is not estimated for cases where the award is less than past and future losses.[17] For the 655 cases where pain and suffering could be estimated, the mean pain and suffering is $625,459, while the median is $96,761. Note that the mean pain and suffering estimate shown in Table 16 is higher than the mean jury award. However, the mean jury award is based on 1,154 cases. When we restrict the

---

[14] The original JVR dataset contained an additional 403 injuries involving a bicycle and motor vehicle accident, and an additional 6,646 cases of premises liability involving some form of consumer product. Because of the large number of cases, the burden of coding, and the fact that these cases did not involve liability of a consumer product itself, we took random samples of 21% of the bicycle and vehicle collisions and 15% of the premises liability cases.

[15] We considered whether the reason for the lower percentage of children in our sample might be the exclusion of many premises liability cases, as noted in a prior footnote. But we found that premises liability cases actually involved fewer children than consumer product liability cases.

[16] Although 28.3% were noted to be minors, only 21.6% were identified as either being in the under age 13 or age 13–18 categories. The reason for this discrepancy is that some individuals were identified in the JVR case summaries as being minors, but not enough information was available to classify their age further.

[17] Past losses presumably exceed awards in some cases because jurors were not convinced about fault or the legitimacy of past loss claims.

comparison to the 655 cases that explicitly state pain and suffering, the mean jury award is higher, $709,568 compared to $625,459 for pain and suffering (and the median award is $123,761 compared to $96,761 for pain and suffering).[18]

Pain and suffering estimates are based on an assumption that JVR data include all past and future compensable losses, since we have constructed pain and suffering by subtracting these reported losses from the total compensatory award. Some cases indicate medical losses but no lost wages —even if the plaintiff was employed. Thus, it is possible that JVR did not state some losses in these cases explicitly, in which case pain and suffering is overestimated. Unfortunately, it is impossible to distinguish between cases in which losses were excluded and those in which there were simply no losses.

Since past and future losses are mostly estimates reported by the plaintiff for purposes of litigation, they may be overstated. To the extent that losses reported by JVR overstate the actual out-of-pocket losses, the pain and suffering estimates are likely to be underestimates. Furthermore, if plaintiffs overstate losses, jurors might discount these claims when awarding damages.[19]

Table 17 compares the mean and median jury awards and medical losses (in jury award cases) by type of product injury. Recall that the average award overall was about $620,000. Eight product types had average awards that were more than 50% greater than average: propane gas ($5.3 million), swimming pools ($3.7 million), lawn mowers ($2.2 million), ATVs ($2 million), ladders ($1.4 million), toys ($1.1 million), hand tools ($1 million) and elevators ($980,000). Five product categories had average awards that were about 50% or less of the average: bicycles ($320,000),[20] exercise equipment ($234,000), automatic doors ($233,000), escalators ($159,000), and large kitchen appliances ($110,000).

Since mean awards may be skewed by one or two very large awards, the median is often a better measure for understanding the severity of "typical" cases that go to trial. Recall that the median overall jury award was about $110,000, considerably less than the $620,000 average award. Eight product categories had median awards that were more than three times the overall median: swimming pools ($1.8 million), propane gas ($1.6 million), ATVs ($1.4 million), toys ($672,000), lawn mowers ($515,000), ladders ($358,000), hand tools ($348,000), and cleaners

---

[18] An additional 63 cases involve awards just equal to past losses, indicating a zero pain and suffering award. If these cases are factored into the analysis, the mean jury award is $619,747 and the median award is $108,767, while the mean pain and suffering award is $562,742 and the median pain and suffering award is $75,188.

[19] Many states have contributory negligence rules that require a reduction in the actual award to account for the percentage of plaintiff negligence. We have *not* reduced awards to account for contributory negligence. To do so would dramatically and incorrectly decrease the pain and suffering estimates in many cases.

[20] Cases involving motor vehicles had a lower average award of $154,320 (n=57), while those not involving motor vehicles had a higher average award of $588,843 (n=35).

($337,000). Only three categories had awards with median losses that were about half of the overall median or less: heaters ($58,000), bicycles ($50,000),[21] and mopeds ($54,000).

In addition to those listed in Table 17, there were 77 cases involving products with less than 10 cases each. The bulk of miscellaneous cases involving large awards were for burn or electrical injuries: two cases of disposable lighters ($4 million each), six cases involving clothing (average award $1.8 million), five cases involving water heaters ($2.5 million average), and two cases involving lighting fixtures (average $850,000). Two other large cases involved helmets, with an average award of $7.4 million.

We derived a measure of pain and suffering for each case by subtracting total past and future losses from the actual compensatory damage award. In 63 cases, the total award was less than or equal to the claimed past and estimated future medical and work losses. We believe the juries in these cases either felt the loss estimates were exaggerated or implicitly factored in contributory negligence. Since our purpose is to predict the pain and suffering resulting from injury rather than to predict the amounts juries award, we omitted these cases from further analysis, obtaining a final sample of 655 cases.

The natural logarithm of pain and suffering was estimated using a log-linear regression model.[22] Table 18 reports the regression results.[23] In addition to the demographic, product-specific, and injury-specific variables, Table 18 includes a few legally defined variables to control for important differences in the nature of jury awards across the country. In particular, we include a dummy (zero-one) variable to account for states in which nonmonetary damages (e.g., pain and suffering) are capped, and one for states in which punitive damages are capped. These variables are defined to have a value of one only during years in which the relevant cap was in existence. Neither variable has a significant coefficient. Note that although we do not include punitive damages in our jury award (as they are based on a theory of punishment, not compensation), it is possible that juries in states in which punitive awards are outlawed or severely limited would partially offset this limitation by increasing their compensatory awards. That does not appear to be the case in this sample. We also coded the type of defendant to control for the possible tendency of juries to award more when defendants are wealthy (a business), the “deep pockets” effect. The regressions report the existence of this effect, although the coefficients are not strongly significant. Finally, we included other dummy variables to distinguish premises liability

[21] Cases involving motor vehicles had a lower median award of $40,000 (n=57), while those not involving motor vehicles had a higher median award of $56,000 (n=35).

[22] Pain and suffering estimates from regressions on the full sample including cases where medical and work losses were estimated (not shown here) were higher than estimates from the subset of cases with known jury verdict details. Tobit regressions that included the cases with no pain and suffering awarded yielded lower estimates than regressions that excluded these cases.

[23] Because both pain and suffering and past and future losses are expressed in log-linear form, the coefficient on losses is what economists call an *elasticity*. The other coefficients show the percentage change in pain and suffering cost (from the reference case where all zero-one variables are set to zero and other variables are evaluated at their mean values) for a unit change in the variable.

and automobile-related liability from product liability.[24] Premises or auto liability cases reduce the pain and suffering award somewhat, perhaps because of differing views of the extent of plaintiff versus defendant negligence in cases like these.[25]

Table 18 can be used to estimate pain and suffering for any type of injury sustained in a consumer-product-related incident. Table 19 computes a few selected pain and suffering estimates based on typical injuries. For example, a minor contusion, abrasion, or laceration without medical costs results in a pain and suffering estimate of $100. This increases when some medical costs or lost wages are present, so that pain and suffering is $1,180 with $100 in past losses and $3,900 with past losses of $1,000. Not surprisingly, the same monetary costs associated with a more severe injury such as an arm or hand fracture results in higher pain and suffering, $14,150. Loss of a finger or toe with $2,000 in past costs results in $57,000 pain and suffering. Severe brain damage injuries result in pain and suffering of $342,000 to $2,076,000, depending on the magnitude of past and future losses.[26]

COMPUTATION OF THE PAIN AND SUFFERING ESTIMATES

As previously with medical costs, pain and suffering costs were estimated on injury subsets of the 2010 NIS and NEDS, narrowed to reflect injuries under CPSC jurisdiction by eliminating intentional injuries, most transport-related injuries, natural/environmental injuries, work-related injuries, poisonings of persons above age 4, and cases whose ICD-9-CM diagnoses did not correspond to any NEISS injury diagnosis. The NIS and NEDS subsets were narrowed further by dropping all cases that lacked medical costs and work losses, since both are required as inputs by the pain and suffering calculations. This left useable subsets of 381,875 NIS records and 4,676,915 NEDS records.

After mapping NEISS diagnosis and body part codes onto the 2010 NIS and NEDS, we estimated the pain and suffering cost of each case using the regression model summarized in

---

[24] We also ran regressions that included product-specific variables instead of the liability-type variables. These regressions were not used in ICM because the sample size on many types of product injuries is extremely small. Thus, for example, although the median jury award for toy injuries shown in Table 17 was $672,812, this is based on four cases. Although the coefficient on toy-related injuries was large, positive and significant, that variable drops out in a step-wise regression. More importantly, since not all toy-related injuries are likely to be as serious as those in the sample, it would be unreasonable to use this specification for estimating the pain and suffering caused by other toy-related injuries.

[25] Because JVR often does not state age, and the age coefficients in preliminary regressions were far from significant (in this model and the variants noted above, where their signs sometimes varied), we decided against including age group variables in the Table 18 regression. In Table 18, we group past and future losses. Preliminary regressions that separated these losses yielded similar results.

[26] As a robustness check, we estimated similar pain and suffering values using the other model specifications and found that predicted pain and suffering estimates were close regardless of the specification.

Table 18. Most of the variables are dummy variables for various diagnoses and body parts, which were assigned the appropriate values based on NEISS diagnosis and body part codes. Legal variables (e.g., damage cap), which were not available in the NIS and the NEDS, were assigned their mean values from the JVR data. We assumed defendants were individuals, not businesses or governments. We computed new employment rates for the US population by age and sex, averaged across the years 2006–2014, based on the CPS (www.bls.gov/cps/tables.htm), Table 3 (Employment status of the civilian noninstitutional population by age, sex, and race).

The final term in the regression model is the natural logarithm of the sum of medical and work loss costs. Both types of costs were deflated from 2010 to 1995 dollars using ECI–Civilian. As in the 2000 ICM, we used medical costs without payer administrative costs. In order to account probabilistically for long-term disability, we ran two estimates of pain and suffering for each case—one with only short-term work loss and one with both short-term and long-term work loss. We then computed a weighted average of the two estimates, weighting by the probability of long-term disability and its complement. This process was necessitated by the non-linear nature of this term in the regression model.

The estimated pain and suffering cost of each case in 1995 dollars was then inflated to 2010 dollars using ECI–Civilian. Mean pain and suffering costs were computed from the NIS and NEDS cases by NEISS diagnosis and body part, sex, and age group.

Table 20 summarizes mean pain and suffering costs by level of treatment separately by NEISS nature of injury or NEISS body part. The losses are largest for hospital-admitted patients, generally followed by those treated in the ED. Nerve damage, which includes spinal cord injury, imposes the greatest pain and suffering of any injury type. Internal organ injuries, which include traumatic brain injury (TBI), also impose very large losses, as do amputations. By body part, head injuries and injuries affecting 25–50% of the body (typically severe burns) impose the greatest pain and suffering. Pain and suffering is lowest for non-admitted, non-ED cases of foreign body, dermatitis, hematoma, and contusion/abrasion, and for ED-treated dermatitis. The largest shares of aggregate pain and suffering costs to society come from sprain/strain ($208 billion), internal organ injury ($198 billion), and fracture ($163 billion) by diagnosis, and from head ($231 billion) and lower trunk ($155 billion) by body part. Sprain/strain is the most common type of injury, while TBIs and hip fractures are very severe in their consequences.

> **Example**. Pain and suffering was estimated with the regression equation in Table 18 and the estimated costs of a fractured shoulder for a woman age 40–45. The equation was evaluated at the mean employment rate for women in their early 40s, 71.9%. The medical losses inserted in the equation excluded claims processing costs, and the work losses were confined to losses that juries compensate—victim wage, household production, and fringe benefit losses. Medical costs and work losses were deflated from 2010 dollars to 1995 dollars. The types of liability (premises, product, auto) were evaluated at their mean values in the sample data. The estimate was for a trunk injury without legislatively imposed damage caps and with only an individual defendant (to control for the suspected tendency of sympathetic juries to pad an award when a defendant has deep pockets). We estimated pain and suffering for victims who were permanently disabled by the shoulder fracture and for victims who were not. We then multiplied the estimates times the

probabilities of disability and no disability, respectively, and summed them to get the ICM's pain and suffering estimates.[27] These pain and suffering calculations were performed separately for hospital-admitted cases and ED-treated cases. (For non-admitted cases treated in non-ED settings, the previous generation of pain and suffering costs were retained. These costs follow the same methods, but with old medical and work-loss inputs.)

Estimated pain and suffering costs are $62,323 for the hospital-admitted case without permanent disability and $124,793 for the permanently disabling case, in 1995 dollars. With the 25.07% permanent disability probability for an admitted shoulder fracture, the mean value of pain and suffering is $77,984 ($62,323 × .7493 + $124,793 × .2507). Similar computations yield pain and suffering estimates of $23,269 for the victim treated in the ED and released, and $18,233 for the victim treated only at a doctor's office or clinic. These estimates in 1995 dollars were then inflated back to 2010 dollars.

Quality-Adjusted Life Years

A QALY is a health status measure used to account for the impact of a health state on both quality and quantity of life. QALYs indicate how people value their health status. The concept of a QALY incorporates the quality-of-life impact from an injury or illness. It is derived from a comprehensive model of health that accounts for multiple dimensions of physical, psychological, and social well-being. A QALY is valued at 1.0 for perfect health and at 0.0 for death, typically with negative values (fates worse than death) allowed. Thus, loss of one year of QALY is equivalent to losing a year of life in perfect health due to premature mortality.

QALYs are routinely used worldwide in evaluating the outcomes of clinical trials of medical interventions, in deciding which pharmaceuticals to approve, and in studying the return on investment in preventive health and safety measures (Miller 2000). The National Highway Traffic Safety Administration (NHTSA), for example, uses QALY estimates in its analyses that compare the cost and utility of regulatory alternatives (see, for example, Blincoe, Seay, et al. 2002).

The QALY estimates used in the ICM, like those used by NHTSA, are based on the Injury Impairment Index (III). The III was originally developed for physicians to rate the consequences of injury (Hirsch, Eppinger, et al. 1983). The US Department of Transportation (DoT) has used the III in regulatory impact analyses for decades (e.g., Trottenberg and Rivkin 2011). The III-based QALY estimates in the ICM match DoT's current estimates by detailed injury diagnosis but reflect the diagnosis mix of consumer product injuries rather than that of transport injuries.

[27] This two-stage computation is necessary because the regression variable is the natural logarithm of past and future losses, which is non-linear. Since medical and work losses vary widely between the permanently disabled group and the group that will fully recover, the mean pain and suffering cannot be estimated accurately by evaluating the regression equation with the mean medical and work losses across victims in the two disability groups.

The III estimates were built in five steps (Miller 1993; Miller, Pindus, et al. 1995):

1. A six-dimensional scale was developed for rating the functional capacity losses that typically result from an injury over time (Hirsch, Eppinger, et al. 1983). The scale assessed impacts on mobility, cognitive, bending/grasping/lifting, pain, sensory, and cosmetic aspects of functioning. For example, the mobility scale points are 0–intact mobility, 1–impaired mobility with intact functional ability, 2–impaired mobility with mildly abnormal function; partially dependent on mechanical assistance, 3–severely impaired mobility with abnormal function; dependent on mechanical assistance and wheelchair, occasionally needs attendant, and 4–complete mobility loss; entirely dependent on attendant or otherwise confined to bed.
2. Four physicians with expertise in orthopedics, neurology, surgery, and plastic surgery rated the typical losses due to injury, collectively generating loss ratings for each AIS 2–5 injury diagnosis in the very detailed Occupant Injury Code/Abbreviated Injury Score 1985 (OIC/AIS85) system (Hirsch, Eppinger, et al. 1983). They estimated the level(s) of functional impairment and the length of time at each level (e.g., 100 days at mobility level 3, followed by 100 days at level 2) for three time periods: the first year, years 2–5 post-injury, and all years beyond the fifth.
3. Estimates were added for new AIS-90 diagnoses (Carsten 1986) and for victims with a maximum AIS of 1 (derived from the work-loss impacts of the injuries, Miller, Pindus, et al. 1995).
4. A seventh dimension was added to measure long-term disability. To develop a seventh dimension of functioning, data on the probability of permanent total work-related disability and the probability and severity of permanent partial work-related disability were estimated from a 452,000-person sample of occupational injury victims and added for each injury.
5. The seven dimensions of impairment were converted into a single QALY measure of lost utility by applying published population survey estimates of the perceived utility associated with different dimensions of functional loss and of different levels of function, both within dimensions and across dimensions. These weights were derived from a systematic review of the literature completed in 1989 (Miller, Pindus, et al. 1995). This step yielded estimates of the QALY loss in each of the three post-injury periods—year 1, years 2–5, and years 6 and later—which were discounted to present value and summed. Estimates were computed separately for hospitalized and non-hospitalized injuries. The estimates vary by admission status for two reasons. First, some ICD-9-CM diagnoses map to multiple AIS levels. For such diagnoses, admitted cases were assigned the highest AIS and non-admitted cases the lowest. Second, several ICD-9-CM diagnosis codes might map to a single NEISS diagnosis/body part. We separately combined and averaged the impairments for the admitted cases versus the non-admitted based on the differing case mixes by admission status.

Spicer, Miller, et al. (2011) rescored the III impairment ratings using new utility weights to combine the seven dimensions into a single QALY measure (step 5 above). They systematically reviewed numerous studies from 1982–2005 that presented loss estimates based on multiple scorings for 13 health status scales. From these studies they extracted the utility weights for each level of each dimension that corresponded to a dimension of the III and computed the median utility score for each. The new scoring of the III based on these median utility scores resulted in a smaller estimated loss in the mobility dimension and greater estimated losses in the pain and sensory dimensions. Overall, when the revised utility weights were applied to NHTSA crash data, the estimated QALY losses were 4.6% to 11.5% less than the estimates using the old weights. NHTSA is using the revised III in its crash costs and associated regulatory analyses (Blincoe, Miller, et al. 2015).

The ICM's QALYs, following Pindus, Miller, and Douglass (1991) and Miller, Pindus, et al. (1995), combine the six-dimensional losses (steps 2 and 3) with the losses related to permanent work-related disability (step 4) using this formula:

$$QALY_t = 1 - (1 - IIIimp_t) \times [1 - .021 \times (PTotPerm + PPtPerm \times \%imp)]$$

where:

> $QALY_t$ is the QALY loss in time period t (measured separately for year 1, for years 2–5 collectively, and for years 6 until death collectively)
>
> $IIIimp_t$ is the 6-dimensional III-based QALY loss in time period t, which generally ranges from 0 to 1 (but could be larger for fates that have a greater impact on the family than death, notably a head injury that leaves the patient in a persistent vegetative state)
>
> .021 is the QALY weighting factor for loss of ability to work, excluding earnings loss, from Drummond, Stoddart, and Torrance (1987)[28]
>
> PTotPerm is the probability of total permanent disability
>
> PPtPerm is the probability of partial permanent disability
>
> %imp is the average percentage of earning power lost to partial permanent disability

Total QALYs lost were computed (at a 3% real discount rate with mid-year discounting) as

$$QALY_{tot} = [0.9853 \times QALY_1] + [3.6626 \times QALY_{2\text{-}5}] + [(PVyrs – 4.6479) \times QALY_{6+}]$$

where:

$$0.9853 = (1/1.03)^{½}$$

$$3.6626 = (1/1.03)^{1½} + (1/1.03)^{2½} + (1/1.03)^{3½} + (1/1.03)^{4½}$$

$$4.6479 = 0.9853 + 3.6626$$

---

[28] Note that .021 replaces the .33 used in earlier ICM QALYs. Using a weight of .33 for work-related disability incorporates all work loss into the QALY measure. This was in accordance with the recommendations of the Panel on Cost-Effectiveness in Health and Medicine (Gold et al., 1996). But this recommendation was reversed by the Second Panel on Cost-Effectiveness in Health and Medicine (Neumann et al., 2016), which recommends keeping earnings losses separate rather than subsuming them in QALYs. The ICM already accounts for earnings losses separately, so omitting earnings loss from the QALY measure does not omit earnings loss from the ICM. The disability factor is greater than zero because some workers gain satisfaction, self-respect, or other non-monetary increases in quality of life from working, apart from earnings.

PVyrs is the present value of the victim's expected lifespan according to a standard life table, discounted at a 3% discount rate

Note that mid-year discounting entails an extra six months' discounting for each year's QALY loss—thus the fractional exponents. This makes for slightly lower cost estimates than year-end discounting.

Example. For a woman of age 35–54 who is hospitalized for a shoulder fracture, $QALY_1$=0.06150, $QALY_{2\text{-}5}$=$QALY_{6+}$=0.04085, and PVyrs=21.6720. Therefore, the estimated QALY loss would be

$[0.9853 \times 0.06150] + [3.6626 \times 0.04085] + [(21.6720 - 4.6479) \times 0.04085] =$

$0.0606 + 0.1496 + 0.6954 = 0.9056$

So the lost quality of life resulting from a hospital-admitted shoulder fracture is equivalent to the loss of 0.9056 years of life—about 11 months.

UPDATED QALY LOSSES FOR MEDICALLY TREATED INJURIES

The impairment ratings for the three post-injury periods were merged onto subsets of the 2010 NIS and NEDS by primary injury diagnosis. Our NIS and NEDS subsets were restricted to non-fatal acute injuries. The NEDS subset was further restricted to injuries that did not result in a subsequent hospital admission. In order to better match the consumer product injuries in which CPSC is interested, the NIS and NEDS subsets were further narrowed by eliminating intentional injuries, most transport-related injuries, natural/environmental injuries, work-related injuries, and poisonings of persons older than 4 years. We also eliminated cases whose ICD-9-CM diagnoses did not correspond to any NEISS injury diagnosis and cases for which the QALY estimate was missing. This left useable subsets of 384,389 NIS records and 4,684,519 NEDS records.

The three impairment ratings were combined with work-related disability estimates to form QALY estimates for the three post-injury periods. These were then combined into a single QALY loss for each patient as described above.

NEISS diagnosis and body part codes were merged onto the NEDS data, and mean QALYs were computed by NEISS diagnosis and body part, sex, and age group (0–19, 20–54, 55–69, ≥70). Empty cells were filled by extrapolating from adjacent non-empty cells using ratios from similar diagnosis/body part combinations. Where a diagnosis/body part combination used in NEISS was entirely absent from the QALY estimates, we borrowed the QALY estimates of a similar diagnosis/body part combination. (Any diagnosis present in NEISS but not in the NIS or NEDS is necessarily rare, so few cases were affected.)

The III ratings differentiate between hospital-admitted and non-admitted patients. The latter category covers both patients treated in the ED and those treated in other outpatient settings, such as doctor's offices. Applying the III ratings to the NEDS produces QALY estimates that are best matched to an ED-treated population, such as the NEISS sample. But, because the III ratings are not ED-specific, it would be reasonable to apply these QALY estimates to the non-ED injuries extrapolated from NEISS by the ICM, just as we do with victim work loss costs.

The QALY estimates were merged onto 2010–2014 NEISS data by NEISS diagnosis and body part, sex, and age group. Table 21 presents the resulting estimates of QALY losses by admission status and NEISS body part or injury diagnosis. QALY losses are greatest for injuries to the head and to multiple body parts. The injury diagnoses associated with the greatest QALY losses are submersion, hemorrhage, nerve damage, amputation, crushing, and internal organ injury. The mean QALY loss for hospital-admitted injuries is 1.86 years, while that for ED-treated injuries is 0.17 years.

The QALY losses presented in the tables, like those we provided to CPSC for the ICM, are in years. But QALYs can be easily monetized—it is a simple matter of multiplying the QALY estimate times the cost per QALY, which depends on the value of a statistical life (VSL). Using CPSC's current VSL of $8.7 million (in 2014 dollars), the cost per QALY is $292,442 in 2010 dollars, or $322,263 in 2014 dollars.

LIMITATIONS

Although III-based QALY losses have long been used in regulatory analysis, they are based on expert judgment. They have been validated through comparisons of aggregate QALY loss with QALY loss estimates from other sources (Spicer, Miller, et al., 2011). However, they have not been validated more robustly by comparing the ratings to mean losses by a cohort of patients tracked over time. The estimates for minor injury, such as contusions and abrasions, are underestimates, in that they consider only impairments that affect ability to work. The ED-treated QALY estimates are affected by the overestimation of the non-admitted long-term disability probabilities (discussed in the previous chapter), though the impact will be small because the coefficient on work-related disability in the QALY formula is just .021.

Table 15. Distribution of Product Injuries in Jury Awards, Settlements, and Mediation

Product	Cases	Percent
Bicycle w/Motor Vehicle	111	5.6%
Bicycle w/o Motor Vehicle	62	3.1%
Hand Tool	83	4.2%
Elevator	62	3.1%
Moped *	46	2.3%
Ladder	42	2.1%
Furniture	39	2.0%
Lawn Mower	33	1.7%
Beverage Container	32	1.6%
ATV	28	1.4%
Cleaner	15	0.8%
Small Kitchen Appliance	15	0.8%
Swimming Pool	14	0.7%
Escalator	13	0.7%
Exercise Equipment	13	0.7%
Automatic Door	12	0.6%
Propane Gas	12	0.6%
Toys	11	0.6%
Heaters	10	0.5%
Large Kitchen Appliance	10	0.5%
Ski Equipment	9	0.5%
Other (< 10 cases)	156	7.9%
Premises Liability	1,158	58.3%
Total	1,986	100.0%

* All but three moped cases involved motor vehicles.

Table 16. Summary of Past and Future Losses and Awards in Settlements and Jury Awards (*1995 dollars*)

	Cases	Mean	Median	Minimum	Maximum
Settlements					
Monetary Settlement	781	$320,705	$28,305	$0	$29,000,000
Past Medical Costs	379	$46,302	$7,123	$139	$5,119,028
Past Wage Losses	110	$38,992	$7,281	$88	$1,713,503
Future Losses	46	$590,432	$17,005	$108	$12,968,525
Jury Awards					
Compensatory Award	1,154	$619,747	$108,767	$12	$41,000,000
Past Medical Costs	710	$55,035	$13,544	$51	$5,567,596
Past Wage Losses	338	$64,987	$17,961	$55	$1,822,178
Future Losses	223	$575,324	$102,518	$1	$14,601,291
Pain and Suffering	655	$625,459	$96,761	$224	$40,268,344

Note 1. Settlements are cases that settled out of court, while jury awards involve cases that ultimately went to trial.

Note 2. The rows are independent of each other—different but overlapping sets of cases appear in each row.

Table 17. Summary of Jury Awards (for Jury Award Cases) and Past Medical Loss (for Jury Award Cases with Separately Stated Medical Loss) by Type of Product (*1995 dollars*)

	Jury Award			Medical Loss		
Product	Cases	Mean	Median	Cases	Mean	Median
Bicycle	92	$319,628	$50,000	57	$48,646	$7,900
–Bicycle w/MV	57	$154,320	$56,000	24	$22,830	$4,733
–Bicycle w/o MV	35	$588,843	$40,000	33	$84,143	$10,956
Hand tools	58	$1,026,166	$348,579	35	$66,548	$28,861
Elevator	44	$981,430	$162,500	26	$88,246	$6,635
Ladder	32	$1,449,983	$358,200	22	$56,908	$14,320
Lawn Mowers	24	$2,214,991	$515,000	15	$57,467	$33,000
Moped	24	$741,976	$53,597	24	$55,390	$9,627
–Moped w/MV	22	$760,677	$54,315	22	$62,933	$8,930
–Moped w/o MV	2	$24,000	$24,000	2	$10,133	$10,133
Beverage Container	18	$577,696	$102,111	12	$13,888	$8,250
Furniture	17	$370,284	$128,047	12	$14,447	$10,435
ATV	16	$2,039,859	$1,383,500	9	$118,441	$58,000
Propane Gas	11	$5,348,975	$1,600,000	8	$208,784	$122,500
Exercise Equipment	9	$234,422	$85,000	8	$15,236	$12,500
Small Kitchen App	9	$404,062	$126,000	5	$16,127	$2,500
Escalator	9	$159,518	$75,000	5	$18,288	$8,700
Heaters	9	$401,269	$58,105	4	$2,962	$2,680
Swimming Pool	8	$3,710,541	$1,778,666	4	$97,858	$118,500
Ski Equipment	7	$668,970	$150,000	2	$96,396	$96,396
Cleaner	6	$409,333	$337,500	3	$8,037	$7,000
Automatic Door	5	$233,270	$157,210	4	$21,086	$21,472
Toys	4	$1,102,907	$672,812	2	$16,545	$16,545
Large Kitchen App	3	$110,144	$100,000	2	$16,366	$26,155
Other (< 10 cases)	77	$1,248,912	$400,000	49	$164,951	$17,515
Not Classified	672	$320,461	$70,000	412	$20,623	$9,971

Table 18. Regression Predicting Pain and Suffering from Jury Verdicts

Variable	Coefficient	t-Statistic	p-Value	Mean Value
Constant	6.156	15.887	.000	
Female	−.166	−1.458	.145	.4552
Employed	.061	.483	.630	.7608
Brain	.752	3.035	.003	.0756
Moderate/Severe Brain*	.353	.857	.392	.0247
Facial Fracture	−.139	−.485	.628	.0355
Facial Scarring	.718	1.690	.092	.0170
Dental	−.720	−1.579	.115	.0139
Serious Eye/Ear	.917	3.566	.000	.0480
Paralyzed	1.613	4.649	.000	.0293
Other Nerve	.358	1.618	.106	.0633
Other Head/Neck Fracture	.220	.707	.480	.0309
Fracture of Digit	−.203	−.520	.603	.0185
Loss of Digit	1.188	3.641	.000	.0293
Other Amputation	1.608	3.534	.000	.0139
Arm/Hand Fracture	.154	.905	.366	.1235
Leg/Foot Fracture	.248	1.550	.122	.1435
Limb Sprain/Strain/Lacerat	−.390	−1.151	.250	.0309
Limb Disloc/Crush/Ligament	.291	1.282	.200	.0725
Other Back	−.208	−1.419	.156	.2130
Internal Injury	−.033	−.082	.934	.0185
Trunk Fracture	.455	2.025	.043	.0590
Burn	.746	2.881	.004	.0571
Laceration/Puncture	−.262	−1.216	.224	.0760
Minor Contus/Abras Only	−1.142	−2.080	.038	.00926
PTSD/Emotional Distress	.376	1.454	.146	.0448
Aggravate Existing Condition	.268	1.083	.279	.0478
Premises Liability	−.375	−2.873	.004	.6049
Auto Involved	−.594	−2.170	.030	.0602
Damage Cap	−.372	−1.719	.086	.0617
Punitive Damage Cap	.054	.358	.720	.1420
Business Defendant Only	.141	1.016	.310	.6559
Government Defendant Only	−.204	−.780	.436	.0556
Individual Defendant Only	−.433	−1.910	.057	.0988
Ln (Medical + Work Losses)	.516	16.037	.000	10.31

648 Observations, 612 Degrees of Freedom
Adjusted R-squared = .557
F (35,612) = 24
P(F) = 0.00000
* Moderate/Severe Brain is additive with Brain.

Injury Variable Definitions

Brain	Concussion, hematoma, other minor inj.
Moderate/Severe Brain	Moderate to severe brain injury (additive with Brain)
Facial Fracture	Fracture or other serious face injury
Facial Scarring	Residual scarring to the face
Dental	Any injury to the teeth
Serious Eye/Ear	Serious injury to sight or hearing
Other Sensory	Minor injury involving partial or full loss of senses
Paralyzed	Any paralysis, paraplegia, or quadriplegia
Other Nerve	Nerve damage
Other Head/Neck/Back Fracture	Fractures to neck or head, including TMJ
Loss of Digit	Loss of finger or toe
Other Amputation	Loss of limb(s) except finger or toe
Arm/Hand Fracture	Fracture of arm or hand (not fingers)
Leg/Foot Fracture	Fracture of leg or foot (not knee or toes)
Other Limb	Injuries to limbs except most fractures, amputations, nerve damage; includes fractures to fingers and toes, and dislocated shoulders
Other Back	Ruptured disc, sprained vertebrae, etc.
Internal Injury	Injury to internal organ(s)
Trunk/Shoulder Fracture	Fracture to back, pelvis, ribs, spine or chest
Burn	Any burn injury
Puncture	Puncture injury not elsewhere classified (exclude internal inj.)
Minor Contus/Abras Only	Abrasions, contusions, lacerations, hematoma, not elsewhere classified only
PTSD	Post-traumatic stress disorder
Emotional Distress	Emotional distress claimed
Other/Miscellaneous	Other miscellaneous injuries

Table 19. Predicted Pain and Suffering for Some Illustrative Hypothetical Injuries (*1995 dollars*)

Injury Type	Medical and Work Loss	Pain and Suffering
Minor Contus/Abras Only	$0	$100
Minor Contus/Abras Only	$100	$1,180
Minor Contus/Abras Only	$1,000	$3,900
Arm/Hand Fracture	$1,000	$14,150
Loss of Digit	$2,000	$57,000
Burn	$15,000	$103,500
Moderate Brain Damage	$150,000	$342,000
Severe Brain Damage	$2,500,000	$2,076,400

Table 20. Pain and Suffering Cost per Survivor of Consumer-Product Injury by Injury Diagnosis or Body Part Injured, 2010–2014 (*2010 dollars*)

	Non-Admitted		Hospital Inpatient		
NEISS Injury Diagnosis	Doctor/Clinic/ Outpatient	Emergency Department	Direct Admission	Admission via Emgcy Dept	Aggregate Annual Cost (*millions*)
41 Ingestion	$10,654	$16,276	$73,791	$73,777	$2,631
42 Aspiration	$7,688	$12,232	$80,018	$80,072	$579
46 Burn, Electric	$37,710	$37,642	$152,616	$151,149	$368
47 Burn, Not Spec	$31,398	$38,937	$164,769	$161,684	$199
48 Burn, Scald	$26,917	$36,901	$142,233	$140,832	$6,387
49 Burn, Chemical	$25,102	$39,298	$154,346	$153,786	$1,483
50 Amputation	$85,599	$101,963	$537,811	$530,049	$7,213
51 Burn, Thermal	$25,951	$37,846	$159,635	$158,846	$11,263
52 Concussion	$30,549	$44,024	$180,605	$182,416	$18,231
53 Contusion/Abrasion	$3,578	$4,862	$21,080	$21,056	$34,198
54 Crushing	$28,592	$27,140	$144,690	$149,263	$2,940
55 Dislocation	$30,465	$36,496	$126,434	$125,597	$27,030
56 Foreign Body	$2,295	$4,323	$24,626	$25,058	$2,195
57 Fracture	$23,639	$30,648	$121,671	$122,021	$160,938
58 Hematoma	$3,423	$4,879	$20,445	$20,546	$1,332
59 Laceration	$8,295	$12,191	$58,229	$58,034	$51,251
60 Dental Injury	$7,881	$9,239	$43,549	$44,766	$582
61 Nerve Damage	$90,973	$91,567	$896,125	$932,168	$37,031
62 Internal Organ Inj	$46,064	$70,216	$470,097	$469,604	$192,941
63 Puncture	$7,284	$11,439	$63,506	$63,992	$3,473
64 Strain/Sprain	$15,235	$15,880	$64,948	$63,793	$207,156
65 Anoxia	$11,780	$14,104	$114,720	$106,086	$2,271
66 Hemorrhage	$4,085	$8,763	$25,270	$25,180	$285
67 Electric Shock	$13,547	$15,823	$149,647	$151,712	$471
68 Poisoning	$10,690	$14,012	$35,428	$39,715	$5,747
69 Submersion	$11,530	$13,643	$126,372	$127,637	$892
71 Other	$10,995	$13,630	$77,264	$81,279	$65,704
72 Avulsion	$24,736	$34,730	$90,174	$90,485	$5,770
73 Radiation	$37,601	$43,061	$170,874	$170,097	$927
74 Dermat/Conjunc	$2,825	$4,302	$18,045	$21,780	$820
All Diagnoses	$13,996	$19,990	$144,208	$163,005	$852,308

NEISS Body Part	Non-Admitted: Doctor/Clinic/ Outpatient	Non-Admitted: Emergency Department	Hospital Inpatient: Direct Admission	Hospital Inpatient: Admission via Emgcy Dept	Aggregate Annual Cost (*millions*)
00 Internal	$9,989	$15,824	$75,715	$75,249	$1,979
30 Shoulder	$17,091	$23,270	$83,597	$88,363	$58,010
31 Upper Trunk	$14,039	$16,309	$103,728	$101,558	$67,637
32 Elbow	$7,790	$18,983	$85,152	$86,235	$11,079
33 Lower Arm	$10,176	$19,445	$103,585	$101,202	$14,195
34 Wrist	$11,254	$18,101	$103,048	$104,808	$18,003
35 Knee	$13,367	$13,770	$81,857	$72,986	$62,259
36 Lower Leg	$11,082	$17,345	$121,095	$118,683	$22,030
37 Ankle	$10,133	$14,544	$115,683	$116,694	$52,163
38 Pubic Region	$7,167	$9,492	$79,111	$73,474	$1,536
75 Head	$23,058	$46,752	$390,230	$387,076	$104,105
76 Face	$5,921	$11,556	$74,290	$60,941	$16,542
77 Eyeball	$4,875	$8,449	$63,951	$59,358	$4,280
79 Lower Trunk	$20,657	$19,878	$114,353	$112,813	$213,037
80 Upper Arm	$14,602	$27,529	$101,170	$96,382	$7,581
81 Upper Leg	$12,058	$14,837	$108,286	$107,108	$10,039
82 Hand	$9,637	$14,732	$102,302	$89,802	$19,035
83 Foot	$10,914	$13,774	$110,316	$97,699	$33,326
84 25–50% of Body	$35,216	$48,817	$202,847	$202,437	$437
85 All Parts Body	$10,163	$14,492	$66,440	$70,918	$12,823
87 Not Stated	$6,455	$9,851	$54,755	$50,121	$2,768
88 Mouth	$7,296	$11,677	$58,633	$55,856	$2,402
89 Neck	$19,998	$20,198	$144,689	$145,432	$50,816
92 Finger	$10,746	$14,544	$205,932	$220,256	$29,985
93 Toe	$11,387	$14,342	$134,929	$135,767	$14,776
94 Ear	$6,306	$7,804	$55,121	$55,940	$4,080
All Body Parts	$13,996	$19,990	$144,208	$163,005	$834,920

Table 21. Quality-Adjusted Life Years Lost per Survivor of Consumer-Product Injury by Nature of Injury or Body Part Injured, 2010–2014

	Non-Admitted		Hospital Inpatient		
NEISS Injury Diagnosis	Doctor/Clinic /Outpatient	Emergency Department	Direct Admission	Admission via Emgcy Dept	Aggregate Annual QALY Loss
41 Ingestion	0.00282	0.00284	0.94289	0.94151	12,887
42 Aspiration	0.00179	0.00194	0.39894	0.39767	1,904
46 Burn, Electric	0.07537	0.08121	1.25403	1.25419	1,344
47 Burn, Not Spec	0.07822	0.08887	1.32606	1.30745	761
48 Burn, Scald	0.07917	0.08917	1.60712	1.67654	35,605
49 Burn, Chemical	0.05655	0.06641	1.36544	1.37649	4,663
50 Amputation	0.04758	0.04818	6.87469	6.92470	56,928
51 Burn, Thermal	0.07574	0.08474	1.54058	1.55009	57,257
52 Concussion	1.15000	1.15178	2.61106	2.58894	476,696
53 Contusion/Abrasion	0.00492	0.00496	0.29354	0.25626	65,203
54 Crushing	1.58726	1.68515	1.45176	1.39734	162,813
55 Dislocation	1.69669	1.26342	1.35756	1.02785	1,220,977
56 Foreign Body	0.02603	0.03720	0.93993	0.85764	25,878
57 Fracture	0.19155	0.21968	1.09385	1.07814	1,311,337
58 Hematoma	0.00489	0.00495	0.33988	0.28982	5,202
59 Laceration	0.09478	0.09644	0.84922	0.78889	483,214
60 Dental Injury	0.18688	0.18798	1.52149	1.48111	13,136
61 Nerve Damage	1.75587	1.66186	8.69025	8.74494	674,621
62 Internal Organ Inj	0.68652	0.69074	6.51427	6.33688	2,396,681
63 Puncture	0.04187	0.04756	1.22854	1.15511	20,516
64 Strain/Sprain	0.02864	0.03269	0.55396	0.42967	407,751
65 Anoxia	0.00985	0.00980	2.58346	1.96886	14,320
66 Hemorrhage	1.60182	2.26281	2.50328	2.32165	81,574
67 Electric Shock	0.04522	0.04491	4.30274	4.12380	4,189
68 Poisoning	0.00599	0.00601	0.01283	0.01627	2,745
69 Submersion	0.05086	0.05076	5.38191	5.23303	29,574
71 Other	0.04740	0.05036	0.67714	0.62021	332,935
72 Avulsion	0.05014	0.05183	0.42212	0.43679	11,319
73 Radiation	0.04407	0.04808	1.73876	1.77581	1,277
74 Dermat/Conjunc	0.01044	0.01096	0.28228	0.27959	2,768
All Diagnoses	0.12170	0.16675	1.62889	1.86292	7,916,076

	Non-Admitted		Hospital Inpatient		
NEISS Body Part	Doctor/Clinic /Outpatient	Emergency Department	Direct Admission	Admission via Emgcy Dept	Aggregate Annual QALY Loss
00 Internal	0.00259	0.00274	0.77483	0.81434	14,792
30 Shoulder	0.03252	0.04623	0.59992	0.60500	100,570
31 Upper Trunk	0.03336	0.03611	0.69559	0.58908	188,789
32 Elbow	0.04289	0.07143	1.26875	1.27853	80,582
33 Lower Arm	0.05690	0.09431	1.55866	1.54954	138,105
34 Wrist	0.04258	0.06624	1.07438	1.08396	88,145
35 Knee	0.42630	0.36879	0.98125	0.72628	1,264,223
36 Lower Leg	0.05834	0.06174	0.86790	0.83724	123,658
37 Ankle	0.05624	0.07186	0.85839	0.86090	232,679
38 Pubic Region	0.38740	0.66133	1.71182	1.71871	79,702
75 Head	0.39490	0.55241	5.59671	5.37088	3,048,845
76 Face	0.17972	0.22495	1.31470	1.22776	558,190
77 Eyeball	0.02627	0.03015	3.74838	3.88977	40,483
79 Lower Trunk	0.12440	0.08418	0.61236	0.56789	859,064
80 Upper Arm	0.05478	0.09870	1.23413	1.09545	63,510
81 Upper Leg	0.09554	0.13419	1.33892	1.29887	111,218
82 Hand	0.04474	0.05552	1.00483	0.93202	103,913
83 Foot	0.06423	0.07245	0.82525	0.73444	157,607
84 25-50% of Body	0.06066	0.06031	2.64935	2.62181	5,235
85 All Parts Body	0.01716	0.01796	0.78206	0.80328	85,504
87 Not Stated	0.03015	0.02999	1.12047	0.91737	24,607
88 Mouth	0.15409	0.16844	1.32579	1.26111	72,403
89 Neck	0.05804	0.05308	1.32789	1.28830	119,766
92 Finger	0.06698	0.06344	2.84373	3.04633	238,434
93 Toe	0.05231	0.06384	0.70675	0.68342	55,801
94 Ear	0.11522	0.12089	1.51081	1.43519	60,254
All Body Parts	0.12170	0.16675	1.62889	1.86292	7,916,076

9. MAPPING FROM ICD-9-CM TO NEISS

The Injury Cost Model operates by merging cost estimates onto individual NEISS cases by NEISS injury diagnosis, NEISS body part, and, when appropriate, victim sex and age group. NEISS codes the victim's most severe injury into a two-column coding system. The injury is coded as a two-digit injury diagnosis (e.g., fracture, laceration) and a two-digit body part (e.g., elbow, toe). That means every injury is coded with the same body part categories. NEISS is designed for coding injuries treated in a hospital emergency department.

As Chapter 4 explains, most of the datasets in the cost computations—MEPS, NHIS, and the various HCUP datasets—code injuries using the International Classification of Diseases, Ninth Revision (ICD-9). ICD-9 is not limited to injury-related morbidity or mortality. It is organized around nature of injury or illness as the primary dimension, with body part secondary for injuries. The Clinical Modification, ICD-9-CM, sometimes provides greater coding detail by adding a fourth or fifth digit. In contrast to NEISS, ICD-9 body part descriptors are not uniform. Sometimes body parts are described in the first three digits, but often they are described by the fourth or fifth digit. For example, for a fracture of the lower limb, ICD-9-CM specifies the particular bone involved. For an open wound of the lower limb, however, the relevant body part groupings are: hip and thigh; knee, ankle, and leg (except thigh); foot; and toe.

NEISS codes often lack the diagnostic detail of ICD-9-CM categories. For example, where NEISS would code any fracture of the lower arm as 5733 (57 = fracture, 33 = lower arm), ICD-9 would distinguish between fractures of the radius and the ulna; the upper end, shaft, or lower end of each bone; and whether the fracture is open or closed. ICD-9 also contains codes for injuries that have only a generic NEISS match, most notably injuries to internal organs and to nerves. In some instances, however, NEISS has more specific injury types than the ICD. For example, the ICD-9 category Open Wound matches three NEISS categories: Avulsion, Laceration, and Puncture.

Because most of our medical data sources use ICD-9-CM, the ICM required us to map from ICD-9-CM diagnosis to NEISS injury diagnosis and body part. In most cases, this was straightforward, because we were going from a more detailed to a less detailed coding system. Difficulties arose, however, because of differences in how the body was divided into parts. The next section illustrates how information is mapped between two simple body-part coding systems. The following section provides details of the ICD–NEISS mapping and provides an example.

A Simple Body Part Mapping

Developing maps between coding systems was essential to this study. The problem is similar to the problem of comparing chicken prices between retailers. Suppose you want to buy half a chicken. The first store, SuperMarket, offers:

Breast quarters	$.89 each
Leg quarters	.59 each

Its competitor, The Grocer, offers:

Breasts	$1.09/lb
Wings	.89/lb
Thighs	.49/lb
Drumsticks	.89/lb
Backs	.45/lb

To determine where it would be least costly to buy which parts, you first need to map the parts between systems. Breasts and wings obviously are in breast quarters, thighs and drumsticks in leg quarters. Backs, however, are split between the leg and breast quarters.

Once the mapping is complete, you still need weights—in this case quite literally—to combine the data into a comparable format. Suppose backs are split equally between quarters, left and right breasts each weigh .6 pounds, wings each weigh .2 pounds, and a back weighs .5 pounds. Then The Grocer would charge:

$$(.6 \times \$1.09) + (.2 \times \$.89) + [(.5 / 4) \times \$.45] = \$.88825$$

for a breast quarter. The two stores price breast quarters almost identically.

The only differences between this example and our mapping between coding systems are that this example involves only a few codes and the names of these codes are quite familiar. ICD-9 and NEISS used hundreds of codes cloaked in medical jargon.

ICD–NEISS Mapping

The appendix describe the range of ICD-9 codes mapped into NEISS codes. We built two maps from ICD-9-CM to NEISS—one from five-digit ICD-9-CM codes, and another from three-digit ICD-9-CM codes. *Dorland's Illustrated Medical Dictionary* (1988), *Stedman's Medical Dictionary* (1990), the *NEISS Coding Manual* (1997), and the NEISS injury coder's helpline were used in constructing the maps. We also drew heavily on earlier maps developed by Pindus et al. (1990, 1991) and Miller, Pindus et al. (1995).

We began the mapping not with raw ICD diagnosis codes, but with roughly 700 ICD diagnosis groups formed at earlier stages of analysis to ensure that each group had a reasonable sample size. In the simplest case, a single ICD group mapped to a single NEISS code. In more complex cases, an ICD group mapped to multiple NEISS codes, some of which were also mapped from other ICD groups. For some ICD codes, notably late effects of injury (905–909), a single ICD group may map to many NEISS codes. For example, late effects of tendon injuries (905.8) maps to 72 different NEISS codes.

> **Example.** The NEISS code for fracture of the shoulder, 5730 (57=fracture, 30=shoulder), is mapped from three three-digit ICD-9-CM fracture codes, 810 (clavicle), 811 (scapula), and 818 (ill-defined fractures of upper limb). While 810 maps only to 5730, 811 also maps to 5731 (31=upper trunk) and 818 maps to six other NEISS codes. Therefore, each case with a primary injury diagnosis of 810 is assigned a NEISS code of 5730. Each case

with a primary injury diagnosis of 811, on the other hand, is split into two records, each with half of the original weight. One of the half-weight records is assigned a NEISS code of 5730, while the other is assigned a NEISS code of 5731. Each case with a primary diagnosis of 818 is split into seven records, each with one-seventh of the original weight, and assigned a different NEISS code.

In the 2010 NIS, for women of ages 20–54 there are 131 cases with diagnosis 810; 21 cases with diagnosis 811; and 3 cases with diagnosis 818. The respective average medical costs (in 2010 dollars) of the three diagnoses for women 20–54 were $21,408; $27,872; and $19,808. The average case weight is about 5 (and to simplify the equation below we will assume each case has a weight of exactly 5). The medical cost is computed as follows:

$$[(655 \times \$21{,}408) + (105/2 \times \$27{,}872) + (15/7 \times \$19{,}808)] / (655 + 105/2 + 15/7) = \$21{,}898$$

Therefore, the ICM assigns a medical cost of $21,898 to a hospital-admitted shoulder fracture suffered by a woman of age 20–54.

10. CONCLUSION

Strengths of the Current ICM Estimates

While the current Injury Cost Model (ICM) retains the basic form of the 2000 model, it improves on the older model in a number of ways:

- Medical costs for hospital-admitted injuries are now based on the case-level charges in hospital discharge data and facility-specific cost-to-charge ratios.
- Nursing home costs are now included in the medical cost estimates.
- Incidence estimates for injuries treated in settings other than the ED are now based on larger datasets, which allow for more detailed diagnosis and demographic breakdowns.
- For reporting purposes, costs have been streamlined into three easy-to-understand categories: medical costs, work loss, and pain and suffering.
- The QALY estimates, included in the ICM to provide an alternative to pain and suffering, are now as comprehensive in their coverage as the cost estimates, so that every case can be assigned an estimated QALY loss.
- Medical costs and victim work loss now employ the same data and methods that are used by NHTSA, the National Center for Injury Prevention and Control, and the National Safety Council, which allows for broad comparability of injury costs within the injury prevention community.

Based on the 1995 NEISS sample of 282 thousand nonfatal injuries treated in hospital EDs (including those subsequently admitted), the 2000 version of the ICM estimated a total of 29.9 million medically treated, nonfatal consumer product injuries costing $646 billion (in 2010 dollars). The current version of the ICM estimates there were 32.6 million medically treated, nonfatal consumer product injuries, costing $723 billion. The 9% increase in estimated injuries is due to the new ratios of non-ED to ED cases. The estimated average total cost per injury rose slightly, from $21,616 to $22,167—an increase of just 2.6%.

The ICM provides cost estimates for both the ED-treated injuries that are covered by CPSC's NEISS and non-ED injuries treated in doctor's offices, walk-in clinics, outpatient departments, and other settings. The ICM also estimates costs for admissions that bypass the ED. Injuries treated in the ED (and thus sampled by NEISS) account for 35 percent of total injuries, but 53 percent of total costs. Costs for ED-treated injuries were, on average, more than double the cost of those treated in other settings. This difference is explained by the relatively high proportion of ED-treated injuries admitted to the hospital (7.3 percent) versus those treated initially in non-ED settings or admitted directly to the hospital (1.3 percent) and by the higher costs associated with treatment in an ED relative to treatment in doctors' offices and clinics.

Limitations of the ICM

Earlier chapters described numerous ICM limitations and assumptions. Additionally, for certain cost estimates for certain diagnoses—e.g., medical costs for crushing injuries of the shoulder and the elbow (ICD-9 codes 927.0, 927.1)—the HCUP data contained too few cases to be assured of statistical reliability, despite our best efforts to combine injury and victim categories. As a result, certain cost estimates may be problematic. These instances are relatively rare, and the impact on any analysis is likely to be limited by the mapping process, which tends to spread the impact of cost estimates over several NEISS codes. Furthermore, injury categories that are sparsely represented in the HCUP data also tend to be rare in NEISS. For example, NEISS averages just three cases per year of crushing injuries of the shoulder (5430) and the elbow (5432). Thus, the impact of such injuries on any analysis is likely to be minor.

Since the ICM injury costs are based on NEISS incidence estimates, they also necessarily embody the limitations of the NEISS estimates. NEISS estimates based on small numbers of cases in the sample will lack statistical reliability, and ICM estimates of aggregate costs for such injuries should be regarded with caution.

The injuries with the greatest long-term impact on victims—and therefore the greatest costs—are traumatic brain injuries and spinal cord injuries. Yet, because the effects of these severe injuries persist far beyond the time horizon of most injuries, it is difficult to assess the lifetime costs. Furthermore, medical advances in treating these injuries are difficult to incorporate into lifetime cost estimates. Medical cost and pain and suffering estimates based on long-term studies of past victims might not be applicable to future victims.

Further Research

The many updates and improvements to the Injury Cost Model over the past 15 years have addressed some of the limitations of the 2000 model, but potential areas of further development remain. Long-term follow-up of NEISS cases may help to address some of these areas, such as the impact of children’s injuries on parents or caregivers. In addition, follow-up of selected groups of NEISS injuries could provide a method for validating the ICM cost estimates. These longitudinal projects are, by their nature, rather time-consuming.

The ICM does not estimate costs for a large body of injuries where no medical treatment was sought, but injury victims restricted their activities for at least a half-day. These injuries are self-diagnosed and the severities of the injuries are difficult to assess. These activity-restricting injuries consist primarily of cracked ribs, strains, contusions, and superficial injuries. While costs for these relatively minor injuries are difficult to assess, they number in the millions. Additional study of these injuries may suggest innovative costing methods. However, any costs developed are likely to be a small fraction of total costs estimated by the ICM.

Finally, this study has not estimated costs for a variety of illnesses resulting from exposure to chemicals in consumer products. These illnesses range from flu-like symptoms resulting from indoor air quality problems to cancers resulting from exposure to certain chemicals. CPSC conducted a cost of illness study in 1980 dealing primarily with several types of illness caused by asbestos. That study used the human capital method for costing illnesses that was commonly employed in the public health field at the time. Since then, measures of lost quality of life have become more accepted. It may be time to revisit the costing of illnesses.

An essential difference between evaluating the costs of chemically related illness vs. injuries is the lack of a surveillance system such as the NEISS to measure the incidence or prevalence of these illnesses. Identifying the causes for illnesses is also much more problematic than identifying the causes of injuries, except in rare cases such as illnesses related to asbestos exposure.

REFERENCES

AAAM. *The Abbreviated Injury Scale*. Des Plaines, IL: Association for the Advancement of Automotive Medicine, 1980, 1985, 1990.

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. United States Life Tables, 2010. *National Vital Statistics Reports* 63:7. Hyattsville, MD: National Center for Health Statistics, 2014.

Becker LR, Teti LO, Crivelli J, Nelkin V, Miller TR. Consumer Product Safety Commission Head Injury Study Final Report. Landover, MD: Public Services Research Institute, September 2000.

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

Berkowitz M, Burton J, Jr. *Permanent Disability Benefits in Workers' Compensation*. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research, 1987.

Bhattacharya S, Lawrence BA, Miller TR, Zaloshnja E, Jones P. Ratios for Computing Medically Treated Injury Incidence and Its Standard Error from NEISS Data, Draft Final Report to CPSC. Calverton, MD: Pacific Institute for Research and Evaluation, 2012.

Blincoe LJ, Miller TR, Zaloshnja E, Lawrence BA. *The Economic and Societal Impact of Motor Vehicle Crashes, 2010, Revised* (DOT HS 812 013). Washington, DC: National Highway Traffic Safety Administration, 2015.

Blincoe LJ, Seay AG, Zaloshnja E, Miller TR, Romano EO, Luchter, Spicer RS. *The Economic Impact of Motor Vehicle Crashes, 2000* (DOT HS 809 446). Washington, DC: National Highway Traffic Safety Administration, 2002.

Bovbjerg RR, Sloan FA, Blumstein JF. Valuing Life and Limb in Tort: Scheduling Pain and Suffering. *Northwestern University Law Review* 83:4, 908-976, 1989.

Butler RJ, Worrall JD. Work Injury Compensation and the Duration of Non-Work Spells. *Economic Journal* 95:379, 714-724, 1985.

Carsten O. *Relationship of Accident Type to Occupant Injuries* (UMTR-86-15). Ann Arbor, MI: University of Michigan Transportation Research Institute, 1986.

Clinton WJ. *Economic Report of the President, 1997*. Washington, DC: Government Printing Office, 1997.

Cohen MA. Pain, Suffering, and Jury Awards: A Study of the Cost of Crime to Victims. *Law and Society Review* 22, 537-555, 1988.

Cropper ML, Aydede SK, Portney PR. Rates of Time Preference for Saving Lives. *American Economic Review* 82:2, 469-472, 1992.

Curington WP. Compensation for Permanent Impairment and the Duration of Work Absence: Evidence from Four Natural Experiments. *Journal of Human Resources* 29:3, 888-910, 1994.

Dorland's Medical Dictionary, Shorter Edition. Philadelphia, PA: The Saunders Press, 1980.

Drummond MF, Stoddart GL, Torrance GW. *Methods for the Economic Evaluation of Health Care Programs*, New York, NY: Oxford University Press, 1987.

Finkelstein EA, Corso PS, Miller TR, Fiebelkorn IC, Zaloshnja E, Lawrence BA. *The Incidence and Economic Burden of Injuries in the United States, 2000.* New York: Oxford University Press, 2006.

French MT, Mauskopf JA, Teague JL, Roland J. Estimating the Dollar Value of Health Outcomes from Drug Abuse Interventions. *Medical Care* 34:9, 890-910, 1996.

Friedman B, De La Mare J, Andrews R, and McKenzie DH. Practical options for estimating cost of hospital inpatient stays. *Journal of Health Care Finance* 29:1, 1-13, Fall 2002.

Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. *Cost-Effectiveness in Health and Medicine*. New York, NY: Oxford University Press, 1996.

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

Hirsch A, Eppinger R, Shame T, Van Nguyen T, Levine R, MacKenzie J, Marks M, Ommaya A. *Impairment Scaling from the Abbreviated Injury Scale*. Washington, DC: National Highway Traffic Safety Administration, 1983.

Hodgson T, Meiners M. *Guidelines for Cost of Illness Studies in the Public Health Service*. Washington, DC: Task Force on Cost of Illness Studies, U.S. Public Health Service, 1979.

Hodgson T, Meiners M. Cost-of-Illness Methodology: A Guide to Current Practices and Procedures. *Milbank Memorial Fund Quarterly* 60:3, 429-462, 1982.

Johnson WG, Ondrich J. The Duration of Post-Injury Absences from Work. *Review of Economics and Statistics* 72:4, 578-586, 1990.

Johnson WG, Butler RJ, Baldwin M. First Spells of Work Absences Among Ontario Workers. In *Research in Canadian Workers' Compensation*, Thomason T, Chaykowski R, eds. Kingston, Ontario: Industrial Relations Centre Press, Queens University, 1995.

Jones AL, Dwyer LL, Bercovitz AR, Strahan GW. The National Nursing Home Survey: 2004 Overview. *Vital and Health Statistics* 13:167. Hyattsville, MD: National Center for Health Statistics, 2009.

Kessler E, Reiff L. *Estimates of Consumer Product Related Deaths, 1984-1992*. Washington, DC: Consumer Product Safety Commission, 1995.

Kreuger A. *Workers' Compensation Insurance and Duration of Workplace Injuries* (Working Paper No. 3253). Cambridge, MA: National Bureau for Economic Research, 1990.

Lawrence BA. *Revised Incidence Estimates for Nonfatal, Non-Hospitalized Consumer Product Injuries Treated Outside Emergency Departments* (Draft Final Report to CPSC). Calverton, MD: Pacific Institute for Research and Evaluation, 2013.

Lawrence BA. *Updated Medical Costs for the Injury Cost Model* (Draft Final Report to CPSC). Calverton, MD: Pacific Institute for Research and Evaluation, 2015a.

Lawrence BA. *Updated Price Indexes for the Injury Cost Model* (Draft Final Report to CPSC). Calverton, MD: Pacific Institute for Research and Evaluation, 2014.

Lawrence BA. *Updated Survival Probabilities for the Injury Cost Model* (Draft Final Report to CPSC). Calverton, MD: Pacific Institute for Research and Evaluation, 2015b.

Lawrence BA, Miller TR, Jensen AF, Fisher DA, Zamula WW. Estimating the costs of non-fatal consumer product injuries in the United States. *Injury Control & Safety Promotion—2000*, 7:2, 97–113, 2000.

Lawrence BA, Miller TR, Zaloshnja E, Jones, PR (2008). *Estimates of the Incidence and Costs of Fire-Related Injuries*, Final Report to CPSC (under review).

Leigh JP, Waehrer G, Miller TR, McCurdy SA. Cost Differences Across Demographic Groups and Types of Occupational Injuries and Illnesses. *American Journal of Industrial Medicine* 49:10, 845-853, 2006.

Lopez A, Dexter RN, Reinert JC. Valuation of Developmental Toxicity Outcomes. *The Environmental Professional* 17, 186-192, 1995.

Manning W, Keeler E, Newhouse JP, Sloss E, Wasserman J. *The Costs of Poor Health Habits*. Cambridge MA: Harvard University Press, 1991.

Marquis S. The RAND Corporation. Personal Communication, 1992.

McCollister KE, French MT, Fang H. The cost of crime to society: New crime-specific estimates for policy and program evaluation. *Drug and Alcohol Dependence* 108(1):98-109, 2010.

McCormick WB, Shane JN. *Treatment of Value of Life and Injuries in Preparing Economic Evaluations*. Memorandum to Assistant Secretaries and Modal Administrators. Washington, DC: U.S. Department of Transportation, 1993.

Miller TR. Costs and Functional Consequences of U.S. Roadway Crashes. *Accident Analysis and Prevention* 25:5, 593-607, 1993.

Miller, TR. Estimating the Costs of Injury to U.S. Employers. *Journal of Safety Research* 28:1, 1-13, 1997.

Miller TR. Injury Cost Estimation: A Pain in the Neck. In *Measuring the Burden of Injury: Proceedings of February 1996 Conference*, Ryan G, Dyke P, eds. Nedlands: Road Accident Prevention Research Unit, University of Western Australia, 1998.

Miller TR. Valuing Non-Fatal Quality of Life Losses with Quality-Adjusted Life Years: The Health Economist's Meow. *Journal of Forensic Economics* 13:2, 145-168, 2000.

Miller TR, Blincoe L. Incidence and Cost of Alcohol-Involved Crashes in the United States. *Accident Analysis and Prevention* 26:5, 583-591, 1994.

Miller TR, Brigham P, Cohen M, Douglass J, Galbraith M, Lestina D, Nelkin V, Pindus N, Smith-Regojo P. Estimating the Costs to Society of Cigarette Fire Injuries. In *Report to Congress in Response to the Fire Safe Cigarette Act of 1990*. Washington, DC: Consumer Product Safety Commission, 1993.

Miller TR, Calhoun C, Arthur WB. Utility-Adjusted Impairment Years: A Low-Cost Approach to Morbidity Valuation. In *Estimating and Valuing Morbidity in a Policy Context: Proceedings of June 1989 AERE Workshop* (EPA-230-08-89-065). Washington, DC: U.S. Environmental Protection Agency, 1989.

Miller TR, Cohen MA, Rossman SB. Victim Costs of Violent Crime and Resulting Injuries. *Health Affairs* 12:4, 186-197, 1993.

Miller TR, Cohen MA, Wiersema B. *Victim Costs and Consequences: A New Look*. Washington, DC: National Institute of Justice, 1996.

Miller TR, Douglass JB, Galbraith MS, Lestina DC, Pindus NM. Costs of Head and Neck Injury and a Benefit-Cost Analysis of Bicycle Helmets. *Head and Neck Injury,* P-276. Warrendale, PA: Society for Automotive Engineers, 1994.

Miller TR, Douglass J, Pindus N. Railroad Injury: Causes, Costs, and Comparisons with Other Transport Modes. *Journal of Safety Research* 25:4, 183-195, 1994.

Miller TR, Finkelstein EA, Zaloshnja E, Hendrie D. The Cost of Child and Adolescent Injuries and the Savings from Prevention. In *Injury Prevention for Children and Adolescents: Research, Practice, and Advocacy, Second Edition*., Liller K, ed. Washington DC: American Public Health Association, 2012.

Miller TR, Galbraith M. The Costs of Occupational Injury in the United States. *Accident Analysis and Prevention* 27:6, 741-747, 1995.

Miller TR, Galbraith M. Injury Prevention Counseling by Pediatricians: A Benefit-Cost Comparison. *Pediatrics* 96:1, 1-4, 1995.

Miller TR, Langston E, Lawrence B, Becker L, Snowden C, Granger C, Russell C, Kreutzer J, Marwitz J. *Rehabilitation Costs and Long-Term Consequences of Motor Vehicle Injury* (DOT HS 810 581). Washington, DC: National Highway Traffic Safety Administration, 2006.

Miller TR, Lawrence BA, Jensen AF, Waehrer GM, Spicer RS, Lestina DC, and Cohen MA. *The Consumer Product Safety Commission's Revised Injury Cost Model* (Final Report to CPSC). Landover MD: Public Services Research Institute, 2000.

Miller TR, Lestina DC. The Costs of Poisoning in the U.S. and the Savings from Poison Control Centers: A Benefit-Cost Analysis. *Annals of Emergency Medicine* 29:2, 239-245, 1997.

Miller TR, Pindus NM, Douglass JB, Rossman SB. *Databook on Nonfatal Injury: Incidence, Costs, and Consequences*. Washington, DC: The Urban Institute Press, 1995.

Miller TR, Romano EO, Spicer RS. The cost of childhood unintentional injuries and the value of prevention. *The Future of Children* 10:1, 137-163, 2000.

Miller TR, Rossman SB. Safety Programs: Saving Money by Saving Lives. *Best's Safety Directory 1991,* 31st Edition, vol. 1, 52–9, 1990.

Miller TR, Zaloshnja E, Lawrence BA, Crandall J, Ivarsson J, Finkelstein AE. Pedestrian and Pedalcyclist Injury Costs in the United States by Age and Injury Severity. *Annual Proceedings, Association for the Advancement of Automotive Medicine* 48, 265-284, 2004.

Moore M, Viscusi WK. Models for Estimating Discount Rates for Long-Term Health Risks Using Labor Market Data. *Journal of Risk and Uncertainty* 3:4, 381-402, 1990.

Moran MJ, Monje C. *Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses – 2016 Adjustment* (Memorandum to Secretarial Officers and Modal Administrators). Washington DC: Office of the Secretary of Transportation, August 8, 2016.

National Academies of Sciences, Engineering, and Medicine. *Advancing the Power of Economic Evidence to Inform Investments in Children, Youth, and Families*. Washington, DC: The National Academies Press, 2016.

NEISS Coding Manual. Washington, DC: U.S. Consumer Product Safety Commission, 1997, 2016.

Neumann PJ, Sanders GD, Russell LB, Siegel JE, Ganiats TG, eds. *Cost-Effectiveness in Health and Medicine, Second Edition.* New York: Oxford University Press, 2016.

Obama BH. *Economic Report of the President, 2011*. Washington, DC: Government Printing Office, 2011.

Office of Management and Budget. Circular No. A-94 Revised, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," 1992. https://www.whitehouse.gov/omb/circulars_a094

Olsen JA. Time Preferences for Health Gains: An Empirical Investigation. *Health Economics* 2, 257-266, 1993.

Peterson C, Xu L, Florence C, Grosse SD, Annest JL. Professional Fee Ratios for US Hospital Discharge Data. *Medical Care* 53:10, 840-849, 2015.

Pindus NM, Miller TR, Douglass JB. Disability Follow-Up Study, Final Report to the Consumer Product Safety Commission. Washington, DC: The Urban Institute, 1991.

Pindus NM, Miller TR, Leon T. *Estimates of Injury Costs and Disability for Injuries Reported in the National Electronic Injury Sampling System (NEISS),* Final Report to the Consumer Product Safety Commission. Washington, DC: The Urban Institute, 1990.

Rice DP, MacKenzie EJ, Jones AS, Kaufman SR, deLissovoy GV, Max W, McLoughlin E, Miller TR, Robertson LS, Salkever DS, Smith GS. *Cost of Injury in the United States: A Report to Congress*. San Francisco, CA: Institute for Health and Aging, University of California, and Injury Prevention Center, The Johns Hopkins University, 1989.

Rikhardsson PM, Impgaard M. Corporate cost of occupational accidents: an activity-based analysis. *Accident Analysis and Prevention* 36:2, 173-182, 2004.

Rodgers G. Estimating Jury Compensation for Pain and Suffering in Product Liability Cases Involving Nonfatal Personal Injury. *Journal of Forensic Economics* 6:3, 251-262, 1993.

Schroeder T. *Updating the Injury Cost Model: Computing Doctor to ER Rates from the 1987–1996 Data*. Washington, DC: Consumer Product Safety Commission, 1999.

Selassie AW, Zaloshnja E, Langlois JA, Miller TR, Jones P, Steiner C. Incidence of long-term disability following traumatic brain injury hospitalization, United States, 2005. *Journal of Head Trauma Rehabilitation* 23:2, 123–131, 2008.

Smith A. *The Wealth of Nations*, Canaan E, ed. New York, NY: Basic Books, 1937; originally published, 1776.

Spicer RS, Miller TR, Hendrie D, & Blincoe LJ. Quality-adjusted life years lost to road crash injury: updating the injury impairment index. *Annals of Advances in Automotive Medicine* 55, 365–77, 2011.

Stedman's Medical Dictionary. Baltimore: Williams and Wilkins, 1990.

Technology and Economics, Inc. *The Consumer Product Safety Commission Injury Cost Model*. Washington, DC: Consumer Product Safety Commission, 1980.

Trottenberg P & Rivkin R. Treatment of the Economic Value of a Statistical Life in Departmental Analyses – 2011 Interim Adjustment. July 29, 2011.

U.S. Government Accountability Office. *Ambulance Providers: Costs and Medicare Margins Varied Widely; Transports of Beneficiaries Have Increased*. Report to Congressional Committees GAO-13-6. Washington, DC: October 2012.

Viscusi WK. Pain and Suffering in Product Liability Cases: Systematic Compensation or Capricious Awards? *International Review of Law and Economics* 8, 203-220, 1988.

Waller J, Payne S, Skelly J. Disability, Direct Cost, and Payment Issues in Injuries Involving Woodworking and Wood-Related Construction. *Accident Analysis and Prevention* 22:4, 351-360, 1990.

Zaloshnja E, Miller TR, Blincoe LJ. Costs of Alcohol-Involved Crashes, United States, 2010. *Annals of Advances in Automotive Medicine* 57, 3-12, 2013.

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

Zaloshnja E, Miller TR, Lawrence BA, Romano E. The Costs of Unintentional Home Injuries. *American Journal of Preventive Medicine* 28:1, 88-94, 2005.

APPENDIX A: Additional Injury Diagnoses

TABLE A1. ICD-9-CM Diagnoses Outside 800–994 Range That Are Always Acute Injuries When E-Coded

ICD Diagnosis	Description
294.0	Amnestic syndrome
310.2	Postconcussion syndrome
366.2	Traumatic cataract
507.1	Pneumonitis due to inhalation of oils and essences
508.0	Acute pulmonary manifestations due to radiation
521.2	Abrasion of teeth
525.1	Loss of teeth
692–693	Dermatitis and other eczema
719.0	Effusion of joint
719.5	Stiffness of joint
722.0–722.2	Displacement of intervertebral disc
724.2–724.8	Other and unspecified disorders of back
726.1	Rotator cuff syndrome of shoulder, related disorders
780.0	Coma and stupor
799.0	Asphyxia
V71.3–V71.4	Observation following accident
V71.5–V71.6 *	Observation following alleged rape, seduction, or other inflicted injury

* Omitted from CPSC study – not consumer product-related.

TABLE A2. ICD-9-CM Diagnoses Outside 800–994 Range That Are Sometimes Acute Injuries When E-Coded

ICD Diagnosis	Description
344	Paralytic syndromes (incl. quadriplegia, paraplegia, diplegia, monoplegia)
348.1	Anoxic brain damage
349.0	Reaction to spinal or lumbar puncture
354–355 *	Mononeuritis (incl. carpal tunnel syndrome)
361	Retinal detachments and defects
363.6	Choroidal hemorrhage and rupture
363.7	Choroidal detachment
369	Blindness and low vision
384.2	Perforation of tympanic membrane
385.83	Retained foreign body of middle ear
388.1	Noise effects on inner ear
428.1 †	Left heart failure
430	Subarachnoid hemorrhage
431	Intracerebral hemorrhage
432	Other and unspecified intracranial hemorrhage
459.0	Hemorrhage, unspecified
470	Deviated nasal septum
500–505 *	Pneumoconiosis
506	Respiratory conditions due to chemical fumes and vapors
507	Pneumonitis due to solids and liquids
508	Respiratory conditions due to other and unspecified external agents
514 †	Pulmonary congestion and hypostasis
525.1	Loss of teeth due to accident, extraction, or local periodontal disease
578	Gastrointestinal hemorrhage
608.2	Torsion of testis
634	Spontaneous abortion
640	Hemorrhage in early pregnancy
641	Antepartum hemorrhage, abruptio placentae, and placenta previa
644	Early or threatened labor
646.8–646.9	Other or unspecified complication of pregnancy
648.9	Other conditions complicating pregnancy, childbirth, or puerperium
656.7	Other placental conditions
661	Abnormality of forces of labor
681–682	Cellulitis and abscess
717	Derangement of knee
718	Derangement of other joint
719.4	Pain in joint
724.1	Pain in thoracic spine
728.9	Unspecified disorder of muscle, ligament, fascia
729.5	Pain in limb
729.6	Residual foreign body in soft tissue
733.1 *	Pathological fracture
733.8	Malunion and nonunion of fracture
781.4	Transient paralysis of limb
784.7	Epistaxis
786.50	Unspecified chest pain
789.0	Abdominal pain
995.2	Unspecified adverse effect of drug, medicinal and biological substance, NEC

* Omitted from CPSC study – not consumer product-related.
† Only if fire-related.

APPENDIX B: Programs and Datasets of the Injury Cost Model

The ICM is operationalized as a set of SAS programs and datasets. In 2017 the ICM was restructured to make its operations simpler and more flexible. This appendix describes the programs and datasets that currently make up the ICM.

The first SAS program in the ICM's sequence, **IcmCost_2018d3.sas**, merges on the non-ED/ED incidence ratio (see chapter 5), unit costs in 2010 dollars (see chapters 6–8), and QALY estimate (see chapter 8) to each NEISS case in the selected subset.[29] It first converts the NEISS age variable to age in years and then creates **AgeGrp**, as follows:

Age in Years	AgeGrp
Unknown	0
0	1
1-4	2
5-9	3
10-15	4
15-19	5
20-24	6
25-29	7
30-34	8
35-39	9
40-44	10
45-49	11
50-54	12
55-59	13
60-64	14
65-69	15
70-74	16
75-79	17
80-84	18
85-124	19

Next, it outputs each NEISS case to one of three temporary datasets. Cases that lack a positive weight or that have a recorded age greater than 125 years are dropped, as are cases whose patient disposition (**Disp**) is not recorded or fatal. These cases are relegated to a subset (*nocost1*) that does not receive further processing. All other cases are assigned to either the ED subset (*ed1*) or the inpatient subset (*ip1*), based on **Disp**, for further processing. Later, the variable **Hosp** will be created to record which subset the case was assigned to:

[29] The selection of NEISS cases to be analyzed is not part of the ICM. It is presumed to have taken place before the NEISS subset is passed to the ICM for costing.

Disposition	Description	Subset	Hosp
1	Treated and released, or examined and released without treatment	ed1	0
2	Treated and transferred to another hospital	ip1	1
4	Treated and admitted for hospitalization (within same facility)	ip1	1
5	Held for observation (includes admitted for observation)	ip1	1
6	Left without being seen/Left against medical advice	ed1	0
8	Fatality, including DOA, died in the ED	nocost1	NA
9	Not recorded	nocost1	NA

After classifying and printing the cases in the *nocost1* subset, the program determines the **node** value of each case in the *ed1* and *ip1* subsets. These values, which are assigned as per Tables 3 and 4 at the end of chapter 5 of this report, identify the data cells by which the non-ED/ED ratios were estimated. The two DATA steps that assign the **node** values are long—they account for most of the lines of code in the program. Each of these routines begins by creating **diag2** and **bdpt2**, which are slightly collapsed versions of the NEISS variables **diag** and **bdpt**. The inpatient routine also creates **age8**, an age grouping used only in this context (described in chapter 5). The ED routine then assigns **node** values (1–64) by **diag2**, **bdpt2**, **agegrp**, and **sex**. In parallel fashion, the inpatient routine assigns **node** values (1–60) by **diag2**, **bdpt2**, **age8**, and **sex**.

The ED subset is then split into two subsets. Cases to which a value of **node** was successfully assigned go to *ed2,* and cases for which the value of **node** is missing go to *ed3*. Datasets containing values of **EDPct** are then merged onto both datasets. The dataset *EDPct* is merged onto *ed2* by node:

#	Variable	Type	Len	Format	Description
1	Node	Num	3		Node value (1-64) assigned to non-admitted case
2	EDPct	Num	8	8.5	Percentage of non-admitted cases that are ED-treated

Likewise, the dataset *EDPctDiag* is merged onto ed3 by **diag2**.

#	Variable	Type	Len	Format	Description
1	Diag2	Char	2		NEISS injury diagnosis, slightly collapsed
2	EDPct	Num	8	8.5	Percentage of non-admitted cases that are ED-treated

The two ED subsets are then recombined, and **Ratio** and **DocWt** are computed:

$$\text{Ratio} = (100 - \text{EDPct}) / \text{EDPct}$$
$$\text{DocWt} = \text{Wt} \times \text{Ratio}$$

Ratio is the estimated number of non-NEISS cases for every NEISS case. Just as one NEISS case represents **Wt** ED cases, it also represents **DocWt** non-ED cases.

In similar fashion, the dataset *HospNodes* is merged onto the inpatient subset by **Node** value:

#	Variable	Type	Len	Format	Description
1	Node	Num	3		Node value (1-60) assigned to hospital-admitted case
2	Ratio	Num	8	8.6	Ratio of direct admissions to admissions via ED

There is no need to compute **Ratio**, since it is merged onto inpatient cases directly. **DocWt** is computed as for ED cases above.

The ED and inpatient subsets are then recombined, and **hosp** is created to distinguish between ED and inpatient cases in the combined dataset. Finally, the dataset *AllCosts3*, containing costs and QALYs, is merged on by **hosp**, **diag**, **bdpt**, **sex**, and **agegrp**:

#	Variable	Type	Len	Format	Description
1	hosp	Num	3		0=ED-treated, 1=inpatient
2	diag	Char	2		NEISS injury diagnosis
3	bdpt	Char	2		NEISS body part
4	sex	Num	3		0=unknown, 1=male, 2=female
5	agegrp	Num	3		(See age table above)
6	Med2010	Num	8	10.2	Medical cost for NEISS cases in 2010 dollars
7	dMed2010	Num	8	10.2	Medical cost for non-NEISS cases in 2010 dollars
8	STWork2010	Num	8	8.2	Victim short-term work loss in 2010 dollars
9	LTWork2010	Num	8	10.2	Victim long-term work loss in 2010 dollars
10	Fam2010	Num	8	7.2	Family & friends work loss in 2010 dollars
11	Emp2010	Num	8	8.2	Employer losses in 2010 dollars
12	Pain2010	Num	8	10.2	Pain & suffering for NEISS cases in 2010 dollars
13	dPain2010	Num	8	10.2	Pain & suffering for non-NEISS cases in 2010 dollars
14	QALY3m	Num	8	13.1	Quality-adjusted life years lost

The costs and QALYs contained in *AllCosts3* were all computed at the default 3% discount rate, and the costs are in 2010 dollars. The final DATA step of this program inflates costs to the year's dollars that CPSC is currently using and monetizes the QALY value using a dollar value based on CPSC's current value of statistical life. The resulting temporary dataset *icmcost3*, is passed on to the second program.

The second SAS program in the ICM's sequence, **IcmTab1_2018d3.sas**, simply prints tables of weighted incidence and costs. It begins by computing various cost totals and averages by combining costs in *icmcost3*.

Next, it computes the weighted incidence and mean costs of NEISS cases—medical, work loss, pain and suffering, and total—and outputs this information to a small dataset of just three records—one for ED-treated cases, one for hospital-admitted cases, and one for all cases—called *ecost*. The incidence counts from this dataset are stored in *ecount*, and then *ecost* is trimmed to just two records by dropping the record computed from all cases, and each record is given a label. This series of steps is then mostly repeated to create the small dataset *dcost*, which contain costs and incidence for the non-ED cases not captured by NEISS. The only difference between these datasets is that *ecost* was created using the normal NEISS weight, **Wt**, while *dcost* was created using **DocWt**.

These steps are partially repeated two more times to create *mcost* and *tcost*, using as a weight the sum of **Wt** and **DocWt**. Each of these datasets contains just one record—the first a set of unit costs averaged across all four places of treatment, and the second a set of aggregate costs for all medically treated injuries.

All four of the *-cost* datasets are then combined into *zcost*, whose contents are then printed. The full output, shown here, will make this all clearer:

TABLE 1. Cost Components
for Medically Treated Nonfatal Consumer-Product Injuries
by Place of Treatment (2014 dollars)
Costs and Dollar Inflators Updated July 2016
MEPS non-hospitalized ratios, HCUP-NIS hospitalized ratios
3% Discount Rate for Long-Term Work Loss and Pain & Suffering

Place of Treatment	National Estimate	Medical Cost	Work Loss	Pain and Suffering	Average Total Cost
Doctor / Clinic	131,030,919	$795	$2,765	$15,170	$18,730
Emergency Department	66,099,734	$2,472	$2,229	$21,668	$26,368
Hospital-Adm Direct	1,757,731	$36,338	$70,627	$156,316	$263,281
Hospital-Adm via ED	5,232,116	$39,625	$75,918	$176,695	$292,238
AVERAGE	.	$2,639	$5,050	$22,630	$30,320
TOTAL	204,120,499	$538,769,850,425	$1,030,900,438,549	$4,619,231,941,991	$6,188,902,230,965

The first and third lines of the table come from *dcost*. The second and fourth come from *ecost*. The fifth comes from *mcost* and the sixth from *tcost*.

The program's final step prints three incidence figures from *ecount*:

Number of NEISS non-admitted records: 1,790,525
Number of NEISS hospital-admitted records: 149,580
NEISS estimate: 71,331,849

As might be inferred from the suffix of the names of the two programs, these are 2018 vintage programs that operate on data estimated using a 3% discount rate. A major revision of the program might result in a change of year in the program's name.

The names of the parallel ICM programs that compute estimates at the alternative 7% discount rate end in **d7** rather than **d3**. Likewise, the dataset containing the costs and QALYs for the 7% estimates is called *AllCosts7*.