THE CONSUMER PRODUCT SAFETY COMMISSION'S REVISED INJURY COST MODEL

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1. INTRODUCTION

The U.S. Consumer Product Safety Commission (CPSC) performs a vital health and safety function. A regulatory agency, CPSC protects the public from unreasonable risk of injury and death from most consumer products. Its mission is to keep families safe in and around their homes. Some consumer products are largely exempt from CPSC jurisdiction because they are regulated by other agencies – motor vehicles (US Department of Transportation), boats (Coast Guard), food and drugs (Food and Drug Administration, US Department of Agriculture), and guns, bullets, and cigarettes (Bureau of Alcohol, Tobacco, and Firearms).

Each year there is an average of 22,600 deaths and 29.6 million injuries associated with consumer products under the Commission's jurisdiction. They account for roughly 15 percent of all deaths resulting from injury and half of medically attended nonfatal injuries (CPSC 1996).

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).

CPSC's 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). In early 1997, the system used surveillance data from 101 hospitals. Properly weighted, these data accurately represent the 12–13 million consumer product injury victims treated in EDs each year.

CPSC uses estimates of injury costs to analyze a broad range of Commission activities 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) for a comprehensive update and revision of the injury cost model. This report documents NPSRI's revised Injury Cost Model (hereafter "ICM"). It discusses the conceptual underpinnings of ICM and documents the methods and data sources used to revise the model. It is organized into 11 chapters. The remaining chapters describe:

2. The original injury cost model. Summarizes the model, changes in the model over time, and model limitations.

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

4. The data bases 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. Pain, suffering, and lost quality of life estimation and valuation. Derives values for these important, yet hard-to-measure, intangibles. Validates the primary estimates against independent estimates from an alternate valuation method.

9. Product liability insurance and litigation cost estimation. Describes how these compensation-oriented costs are estimated.

10. 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.

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

2. ORIGINAL INJURY COST MODEL

This chapter describes the original injury cost model and its upgrading prior to 1996. Several methodological factors strongly influenced the model's design. These included the importance of the concept of social cost in deriving estimates of injury costs, the need for a disaggregated or modular approach to estimating the separate components of injury costs, and the necessity of formulating the functional relationships in terms of the NEISS-contained variables.

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 a methodology for estimating those elements specified. Ultimately, 11 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 regarding 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,[1] and utilization 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 contains disaggregated injury cost estimates that can be used with NEISS data to estimate injury costs along the various dimensions of the NEISS sample. These dimensions include diagnosis (a description of the nature of injury and body part injured), victim age and sex, type of product involved, and through supplemental investigation, injury cause.

Methodology

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 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.

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[1] Analytic solutions are estimates derived from assumed relationships between data, as opposed to strictly empirical estimates.

Hospital Costs and Retreatment Costs. Hospital costs involve all medical and hospital expenditures for treatment of the victim of a consumer product-related injury. These expenditures include the costs of medical personnel, facilities, and other health resources required to treat the victim during the basic recovery period. Similar to hospital costs are retreatment expenditures associated with the long-run medical care of the victim. These retreatment costs, incurred after the basic recovery period, include 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 consumer product-related injuries, the costs of providing the insurance and settling claims must be included in estimates of the societal costs of these types of injuries. The component excludes claims paid to avoid double counting. 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 estimates 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 consumer product-related incidents. As in health insurance, the relevant costs are 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 reflect the legal expenses incurred by injured parties where compensation is sought as the result of alleged negligence in consumer product-related incidents.

Victim Transportation Costs. The transportation cost component involves those expenditures associated with transporting persons injured in consumer product-related incidents to and from medical facilities.

Victim Forgone Earnings. Forgone earnings reflect the value of the time lost from an individual's normal activities as the result of an injury. The associated injury cost component consists 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 consist 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 reflect the imputed value for work forgone by the injured party permanently or for an extended period and the replacement training costs borne by business.

Pain and Suffering Costs. Pain and suffering refers to the physical and emotional trauma and mental anguish associated with an injury. Pain and suffering costs assign an imputed monetized value for short-term and long-run effects endured by the injured party.

Development

Technology + Economics, Inc. (T+E) developed the original injury cost model in 1975–1976. Between 1978 and 1980 T+E refined the model as part of a subcontract to Battelle Columbus Laboratories. In 1986–1992, the Commission 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.

3. THE INJURY COST MODEL: CONCEPTS AND ANALYTICAL METHODS

The original injury cost model largely relies on cost and utilization data from the 1970s. Although model estimates are adjusted for inflation, they do not fully account for major changes in medical technology and health care delivery. Notably, they precede the advent of Diagnosis Resource Groups (DRGs) as a basis for hospital payment, the Medicare Prospective Payment System, managed health care, Magnetic Resonance Imaging (MRIs), even Computerized Axial Tomography (CAT scans).

The revised ICM replaces the 1970s data with data from the 1990s. In the 17 years since the original ICM was completed, increasing computer capability has stimulated the growth of new, far more extensive data sets to support injury cost modeling. Consequently, the revised model uses different data sets than the original model, often 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.

Thus, the revised model replaces many of the assumptions used to estimate costs in the original model with cost estimates developed by analysis of actual data. The computations underlying the revised model also explicitly cost items that the original model did not estimate. The original model, for example, assumed that medical equipment and supplies were included in the retreatment cost component.

No data set, however, contains all the necessary cost factors. The modeling effort combined information by diagnosis from NEISS and 17 other large data sets. Frequently, several years of data were pooled to get enough cases for a diagnosis-specific analysis. The revised model derives costs by age group, sex, and hospital admission status for hundreds of injury diagnoses. Yet this detailed breakdown is essential to accurate costing. Someone age 25, for example, faces different losses from a broken leg than someone age 80.

Unlike the original model, the revised ICM uses NEISS data to estimate the number and nature of nonfatal injuries that only were medically treated outside of an emergency department. The system also costs these injuries. The incidence estimates are built from diagnosis-specific ratios of non-ED cases to ED cases in National Center for Health Statistics data sets and in a family of Missouri health care discharge data sets.

Cost Components

Although the original model consisted of 11 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 11 cost components into more aggregated categories for reporting. Reports generated by the revised ICM only show four distinct cost components:

- Medical costs
- Work losses
- Quality of life and pain and suffering costs
- Product liability insurance administration and litigation costs

The content of these cost components is as follows.

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 (including air ambulances); 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 (1) victims' lost wage work and household work, as well as fringe benefits, (2) any lost schoolwork, and (3) the work family and friends lose while caring for, transporting, and visiting the injured. Finally, this component includes employer productivity losses, most notably the costs when supervisors spend time juggling schedules or recruiting and training replacements for injured workers.

Quality of Life and 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, and 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.

The ICM estimates costs from society's viewpoint. That means ICM estimates the aggregate costs, regardless of who pays them. Societal costs are broader than costs to any individual group, such as victims, insurers, or product manufacturers. The costs adhere to the guidelines for estimating cost of illness in Gold et al. (1996) and Hodgson and Meiners (1979, 1982). These guidelines establish an accounting framework and the conceptual basis for valuing lost work. They also are consistent with Miller, Calhoun, and Arthur (1989), which derives a theory-based accounting framework for injury and illness costs that include estimates of pain, suffering and lost quality of life.

The theory, the cost framework, the costing concepts, and the methods for the ICM are widely accepted in the peer-reviewed literature. They have been used to cost highway crashes (Miller 1993), drunk-driving crashes (Miller and Blincoe 1994), railroad crashes (Miller, Douglass, and Pindus 1994), bicycle injuries (Miller et al. 1994), occupational injuries (Miller and Galbraith 1995), criminal victimization (Cohen 1986, Miller, Cohen and Rossman 1993, Miller, Cohen and Wiersema 1996), cigarette fire injuries (Miller et al. 1993), poisonings (Miller and Lestina 1997), injuries by diagnosis (Miller, Pindus, Douglass and Rossman 1995), injuries by age group and sex (Rice, MacKenzie and Associates 1989), drug abuse (French et al. 1996), and alcohol abuse (Manning et al. 1989, 1991). They are used in regulatory analysis throughout the US Department of Transportation (McCormick and Shane 1993).

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 2.5% real discount rate was used. The 2.5% rate is toward the **upper end** of the 1% to 3% range that the US Supreme Court (1983) ruled is appropriate for computing personal injury liability compensation. It also is consistent with the 3% discount rate recommended by Gold et al. (1996).

An upper end choice is conservative. Higher discount rates yield lower estimated lifetime costs.

Following Gold et al.'s (1996) guidance, the same discount rate was applied 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 1995 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 1995 dollars. In addition, when CPSC wants to report costs in dollars of a year other than 1995, it must inflate them. The obvious choice for medical costs, the CPI–Medical index, is not the best inflator to use for this purpose. As Newhouse (1992) points out, the CPI is based on a fixed market basket. In the medical sector, where new treatments are constantly emerging, this will tend to underestimate medical spending growth. Newhouse's solution, now standard, is to use an index of medical expenditures per capita. The ICM employs the medical care services portion of personal consumption expenditures, as published by BEA, divided by the U.S. population.

For inflating costs of work loss and pain and suffering, the ICM uses the total private compensation index published by BLS. This index is better than a simple wage index because it captures non-monetary benefits, as well as wages and salaries. Table 1 shows both the medical care and employment cost indexes, along with the CPI for comparison. Appendix C gives the technical details for updating the inflators.

Summary of Methods

All ICM cost estimates are diagnosis specific (meaning they vary by body part injured and nature of injury diagnosis). The estimates vary by age and sex. Medical costs, quality of life and pain and suffering costs, and product liability insurance administration and litigation costs also vary depending on the highest level (also called the setting) where medical treatment was received. The treatment level hierarchy is (1) hospital-admitted, (2) treated in the hospital emergency department (ED) and released but never hospital-admitted, or (3) treated only in non-hospital settings such as a doctor's office, walk-in clinic, or ambulatory surgery center. Because of data limitations, work losses are differentiated only between hospital-admitted and medically treated non-admitted cases.

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

Medical Costs

Medical costs were estimated by diagnosis and level of medical treatment. This summary describes cost estimation methods for non-admitted injury survivors, including those treated in emergency departments and in doctor's offices, for hospital-admitted injury survivors, and for health insurance claims processing costs for all medically treated injury survivors.

As in the original model, CHAMPUS provided medical payments per non-admitted injury victim with two exceptions. (1) CHAMPUS omits the costs of prescriptions and non-physician care. These costs came from the National Medical Expenditure Survey (NMES). The original model did not correct for this omission in the CHAMPUS data. (2) Unlike the original model, the CHAMPUS data available for the ICM only described spending in roughly the first six months after injury. Pindus et al. (1990) provided a multiplier to estimate lifetime costs from the short-term costs. The multiplier came from an analysis of longitudinal data on medical costs of workplace injuries. NMES and National Health Interview Survey (NHIS) data were used to differentiate the costs of non-admitted injury victims treated in emergency departments from victims treated only in doctors' offices or clinics.

For hospital-admitted injury, medical care costs have two major components. The first is inpatient cost, computed as length of stay multiplied by hospital cost per day including professional fees. The second includes ambulance, ancillary, and post-discharge costs such as prescriptions, canes, and follow-up medical care. Length of stay by diagnosis came from National Hospital Discharge Survey (NHDS) data. These data, however, do not differentiate consumer product injuries. Data from five cause-coded statewide hospital discharge censuses were used to adjust length of stay to account for the impacts of consumer-product origin, victim age, and victim sex. Consumer product injury victims generally have significantly different – and, in aggregate, lower – lengths of hospital stay than other victims with comparable primary diagnoses. The differences probably reflect differential injury forces and frequencies of injury to multiple body regions. For example, a leg fractured in a fall off a step is broken with less force than one shattered in a highway crash, and the victim is less likely also to need treatment for facial wounds inflicted by flying glass.

Costs per hospital day also are specific to consumer product injury. They came from New York and Maryland, the only states where cost-control commissions require hospitals to report publicly and accurately their costs by patient. The discharge abstracts in these states indicate injury diagnoses and causes. The costs were price-adjusted from state to national estimates with American Hospital Association data on mean hospital costs per day by state. Professional fees were estimated with a ratio of professional fees to hospital payments computed from CHAMPUS data. Diagnosis-specific regression models then were developed that separated the costs of consumer-product injuries into a fixed cost per admission and a variable cost per day (which was multiplied by the adjusted NHDS length of stay in computing costs per case).

Ambulance, ancillary, and post-discharge costs during acute care came from NMES. These factors were computed as percentages of hospital costs. Pindus et al. (1990) provided short-term to lifetime medical care cost multipliers.

The cost algorithm for hospital-admitted patients improves on the original model primarily in four ways: (1) it uses hospital costs specific to consumer product injury, (2) it captures ancillary costs, (3) it replaces analytic estimates of long-term (retreatment) costs with direct measures from Pindus et al. (1990), and (4) it rests more firmly on nationally representative data sources.

Health insurance claims processing costs as a percentage of claims costs came from insurance statistics.[2] The percentages vary by payer. To compute an overall percentage, they were weighted with the distribution of payers for consumer product injuries by highest level of medical treatment (hospital-admitted, treated at the ED and released, or other non-admitted treatment only).

Lost Work

Work loss includes losses by victims, family, friends, and employers. ICM cost estimation differentiated victim losses between short-term work loss and long-term loss due to permanent work-related disability. 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, as well as the number of other restricted activity days; and (2) the loss per day for each of these categories. All computations were done by injury diagnosis.

Detailed information is available about short-term work loss days. By diagnosis, the number of days an injury survivor loses in the short term was computed from NHIS data on the probability that a worker will lose work when injured and Bureau of Labor Statistics (BLS) data on the average days lost per lost-work injury.

Lost household work days were estimated from the work loss information and data showing that workers suffering only from short-term disability return to household work 10% faster than wage work. The NHIS and BLS data guided development of analytic estimates for the other categories. A key assumption underlying the estimates is that a given injury costs the victim the same number of days of ability to work, 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 (Gold et al. 1996) 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. Household work hours per day by age and sex were estimated with published regression equations that are widely

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[2] A large number of data sources were used in estimating health insurance claims processing costs, as detailed in Chapter 6.

accepted for this purpose (Peskin 1984). Published data also describe the distribution of household work hours among tasks (e.g., cooking, yard work). National wage data by occupation were used to value these hours.

Long-Term Work Loss. Permanent work-related disability probabilities came from a large national sample of worker injuries.[3] 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.

ICM improves on the original disability component by replacing analytic estimates of permanent disability costs with the data-driven estimates described above and by introducing 20-year-average values into the lifetime earnings calculation.

Employer 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. These costs were not analyzed explicitly in the original model; they were subsumed in the disability component.

Quality of Life and Pain and Suffering Costs

Pain, suffering, and lost quality of life typically is the largest contributor to injury costs. Because these intangibles cannot be purchased, they also are the most difficult to value. Recognizing their importance and computational challenge, ICM offers a monetary estimate of the intangible losses computed from the pain and suffering component of jury awards, plus optional sensitivity analysis that provides non-monetary estimates of quality-adjusted life years when estimates are available.

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 data set[4]. They include product liability

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[3] Pindus et al. (1991) estimated the probabilities used in ICM.

[4] A proprietary data set contains copyrighted data that can only be accessed upon completion of a licensing agreement as opposed to government data that typically are readily

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-driven method used in the sensitivity analysis 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. Using survey data describing how people value the six scaled dimensions of functioning, the functional losses are translated into quality-adjusted life years (QALYs) lost.[5]

The primary improvement in pain and suffering estimates over earlier versions results from the substantial increase in the number of jury awards available for analysis. The revised model also produces credible QALY information. QALYs measure quality of life losses without placing a dollar value on fatal risk reduction, dollar values which many health policy analysts feel vary too widely to be credible. 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.

Product Liability Costs

Product liability costs include two components: insurance and legal. The *product liability insurance* component reflects costs associated with defending the insured manufacturer or seller, the costs of claims investigation and payment, and general underwriting and administrative expenses. It excludes insurance sales costs. No single product or type of injury dominates the consumer product injury picture. Consequently, although sales costs certainly are part of the aggregate costs of consumer product injury, they are essentially fixed costs, not marginal costs that decline when injuries are averted. Estimates of insurance costs are derived from aggregated insurance industry data.

As in the original model, *legal costs* include court and claiming expenses, plaintiff attorney fees, and time spent by plaintiffs, defendants, and witnesses. Estimates are based on survey research data on the probability of reaching different stages of litigation (e.g., filing a lawsuit, trial) and the variable costs at each stage of litigation.

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accessible, provided they are free of individual identifiers.

[5] 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. Inflators Used in the ICM

	Medical Care Expenditures per Capita *(dollars)*	Compensation Index *(June 1989=100)*	Consumer Price Index *(1982-84=100)*
1980	796	64.8	82.4
1981	926	71.2	90.9
1982	1,030	75.8	96.5
1983	1,143	80.1	99.6
1984	1,246	84.0	103.9
1985	1,352	87.3	107.6
1986	1,441	90.1	109.6
1987	1,572	93.1	113.6
1988	1,754	97.6	118.3
1989	1,937	102.3	124.0
1990	2,163	107.0	130.7
1991	2,339	111.7	136.2
1992	2,555	115.6	140.3
1993	2,714	119.8	144.5
1994	2,829	123.5	148.2
1995	2,968	126.7	152.4
1996	3,067	130.6	156.9
1997	3,172	135.1	160.5
1998	3,305	139.8	163.0
1999*	3,446	144.6	166.6

*Preliminary - subject to substantial revision.

4. DATA SETS USED AND THEIR CONSISTENCY

This chapter describes the 18 principal data sets that provide incidence and cost data to ICM. Some of these data sets 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 data set's source, size, contents, and limitations. Then it probes the consistency of data sets with overlapping information. The comparisons make it clear that the data sets are compatible; information from them credibly can be combined.

Before describing the data sets, this chapter briefly discusses how they code injuries and how injury coding affected the analysis. Chapters 6 and 10 further discuss injury diagnosis coding.

Injury Diagnosis and 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 18 data sets analyzed, including NEISS, use two separate codes to describe the body part injured and the nature of injury diagnosis. Most medical data sets instead use International Classification of Diseases, 9th Edition (ICD-9) diagnosis codes which describe body part injured and nature of injury with a single code.

Many tables in this report present data by diagnosis group. Because diagnosis coding differed between data sets and diagnoses had to be grouped so that the sample size in each group would be large enough to yield stable estimates[6], the grouped diagnosis categories differ between tables. Since different chapters of the report rely on different data sets, the differences in categories are especially great between chapters.

In addition to diagnosis codes, ICD-9 includes optional external-cause-of-injury codes (E-codes or cause codes). These codes may designate either the place where the victim was injured or the cause of the injury. Some states mandate ICD-9 cause coding for hospital-admitted or hospital-treated injury victims. Because it sometimes is ambiguous whether an ICD-9 diagnosis code describes an injury (for example, is dermatitis simply dry skin or an injury inflicted by a caustic chemical?), cause-coded state data sets identify injury victims more clearly than other data sets. Although ICD-9 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

[6] Estimates without excessive standard errors.

jurisdiction. When analyzing cause-coded data sets, we generally restricted our analysis to victims whose injuries might relate to consumer products.

Data Sets Analyzed

ICM draws data primarily from 10 national data sets and 7 state data sets. The national data sets 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.

One of the state data sets is a census of Missouri emergency department discharges. The remaining six state data sets contain hospital discharge data. These six states are among the roughly 30 states that maintain computerized hospital discharge abstract censuses. Often these data sets are compiled by state hospital associations. Participation in some is mandated by state health departments or cost-control commissions. Others are voluntary systems with universal compliance.

These censuses have multiple purposes. Foremost is their role in quality-control review of hospital care. They also are designed for surveillance, inter-facility comparison, and in some states, cost control. 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. By 1996, a dozen states required E-coding and had at least a year of data with compliance levels of 90% or higher. All state data analyzed for ICM are E-coded.

Most of the data sets were used to estimate components of medical costs. Two national data sets – the National Health Interview Survey (NHIS) and the Detailed Claims Information (DCI) data base of the National Council on Compensation Insurance – yielded both medical cost and work loss information. Work loss data also came from the annual Bureau of Labor Statistics (BLS) Survey of Occupational Illness and Injury. NHIS and three Missouri data sets provided information on the incidence of injuries not treated at hospitals.

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

This report abbreviates the data set names. This chapter is a reference source for readers who want more information about specific data sets. For the reader's convenience, the data set descriptions are alphabetized by their abbreviated names. The abbreviated names also appear in the glossary.

- BLS Annual Survey. 1993 Annual Survey of Occupational Illness and Injury from the Bureau of Labor Statistics (BLS). This data set 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. This project 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 BLS Annual Survey are its restriction to occupational injury and working age populations.

- CHAMPUS. 1992–1994 Civilian Health and Medical Program of the Uniformed Services reimbursement summaries (summary tables only, not individual claims). CHAMPUS summarizes medical utilization, reimbursements, and self-pay for roughly 2,000,000 military retirees and civilian dependents of military personnel (but *not* currently active military personnel themselves, who receive free medical care as part of their compensation). It excludes Veteran's Administration hospital treatment and on-base medical care. CHAMPUS is the most representative data source available for current information on physician payments associated with hospital care or on diagnosis-specific payments for visits to physicians and EDs. The summary reports cover 24,150 hospital admissions for injury and 2,256,583 injury episodes treated in non-admitted settings (including follow-up care for victims who were admitted). The reports are by primary diagnosis coded at the 3-digit summary level with ICD-9 codes. Restriction to 3 digits limits the diagnostic detail available; sometimes it does not reveal the body part injured. Data representativeness is reduced because CHAMPUS covers few males ages 18–45 and few people over age 65. With the increase in women in the military, however, CHAMPUS coverage of working-age males (as military spouses) is increasing.

- DCI. 1979–1987 and 1992–1996 Detailed Claims Information (DCI) data bases of the National Council on Compensation Insurance. 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 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 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 if 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 data base are its restriction to workplace injury – about one-third of all injuries – and to working-age populations. The 1979–1987 data also are aging.

- JVR. Jury Verdicts Research data. This proprietary data set 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 break down of the amount awarded between compensation for medical and wage losses versus pain and suffering is missing.

- Missouri Discharge Data (2 data sets). 1994 Missouri ED and Hospital Discharge Censuses. CPSC was able to obtain discharge files with personal identifiers that could be used to link records across provider types[7] and to analyze readmission rates. Excluding fatal incidents, the data sets describe 627,135 non-admitted injury ED visits and 51,106 injury hospital admissions. The records include patient demographics, one external cause code, and nine 5-digit ICD-9-Clinical Modification (ICD-9-CM) diagnoses. They contain no financial data. The limitations of these files are their restriction to one state and one year (a problem when examining utilization patterns), as well as the absence of personal identifiers on one-eighth of the non-admitted records. Also, because Missouri requires only one external-cause code for each injury discharge, it is difficult to accurately differentiate injuries related to consumer products.

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[7] Providers are the sources of medical care, including hospital in-patient departments, hospital emergency departments, doctors' offices, walk-in clinics, and ambulatory surgery centers.

- NAMCS. 1992–1994 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 1992–1994 data include 4,800 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. More important, referral to emergency room where treated and released is coded as "other disposition", a category that also contains 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 data base. From an annual sample of 101 hospitals reporting about 340,000 injuries, NEISS makes national estimates of hospital emergency department visits for selected causes. The system records which of these visits result in admission. The ICM is built around NEISS incidence data on consumer product injuries. The NEISS uses a two-column diagnosis coding system (a body part code and a nature of injury code such as fracture or contusion). Only the victim's most serious injury is coded. Because coding is done in the ED, diagnoses are sometimes not as precise as ICD-9 diagnoses. For example, the duration of a coma often is not known when the patient is transferred from the ED to the trauma service or neurological service. 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.

- NHAMCS. 1992–1994 National Hospital Ambulatory Medical Care Survey - Emergency Department Sample (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 ED visits annually. The 1992–1994 data include 36,686 injury visits to EDs. 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 (admitted and dead are key), 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.

- 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 and restricted activity days is recorded only for the two weeks prior to the interview. No information is provided to differentiate victims whose activities still were restricted 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; when it does, it is difficult to link the second diagnosis to the victim.

- NMES. 1987 National Medical Expenditure Survey. NMES was conducted by the Agency for Health Care Policy and Research. The most recent survey of its type, it records or estimates the costs of all visits to medical providers during 1987 by a national probability sample of 14,000 households containing about 35,000 people. NMES gathers data from both households and their medical providers. Diagnoses are coded in ICD-9-CM from provider records. Expenditures for outpatient visits in NMES come from three sources: (1) when charges were only partially paid by third-party payers such as insurers and Medicare, expenditures equal payments including co-pay; (2) when there was no explicit charge for medical services, for example, services provided by governments, charities, or HMOs, NMES imputes a cost from the expenses associated with similar services; and (3) otherwise, expenses are represented by charges.

  NMES provides the only known nationally or regionally representative data that describe post-discharge medical, prescription, home health, non-medical therapist, and other ancillary expenses, or costs per ambulance transport. It also describes utilization patterns.

The largest limitation of NMES is its sample size. The data include only 397 admitted injury victims and 5,439 medically treated non-admitted victims. NMES data also are aging. A final limitation is the restriction to medical treatment received in one calendar year, 1987, which reduces NMES' ability to describe utilization patterns. On average, the data describe treatment and medical spending in the first six months after injury. The descriptions, however, cover varying periods after injury. They are spread uniformly from cases tracked only on the day of injury (for injuries on December 31, 1987) to cases tracked for 365 days (for injuries on January 1, 1987).

- Pooled 5-State Hospital Discharge Data. Five state hospital discharge censuses. We pooled and thoroughly cleaned data describing all 586,669 live injury discharges from five states: California in 1993, Maryland in 1994–1995, New York in 1994, Washington in 1989–1991, and Vermont in 1990. Importantly, in addition to the kinds of data NHDS collects, these data sets indicate which discharges were for acute injury. More than 90% of cases with ICD codes 800–995 have external cause codes (a total of 499,101 cases). The E-codes allowed us to differentiate consumer product injuries; we applied the classification criteria CPSC developed in Kessler and Reiff (1995) but included all instead of a percentage of qualifying injuries that occurred in recreation, residential institutions, public buildings, and other specified places. The pooled data include 292,436 live injury discharges potentially related to consumer products. Our algorithm for identifying consumer product injury requires at least two E-code fields; typically, the first E-code describes the primary external cause while another identifies the place of occurrence. Because it has only one E-code field, we excluded Missouri from the pooled data set.

  Like NHDS, pooled state data include length of stay and patient demographics. The Maryland and New York files also contain accurate, current hospital care costs. 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.

Data Consistency and Validity

Many ICM cost estimates were derived by combining data from at least two data sets or using data sets that may not be nationally representative. To be credible, these computations require reasonable consistency between the data sets. Fortunately, although each data set used in the computations offers some unique information, the data sets also typically contain overlapping information. The overlap allows us to probe consistency. This section documents the consistency of demographic, length of hospital stay, and medical cost data in selected study data sets. Some of its evidence comes from past validations of data sets used in the ICM. The validation efforts affirm the credibility and representativeness of ICM data.

Demographics. Because the pooled 5-state hospital discharge data include about five times as many cases, more clearly identify discharges related to injury, describe injury cause, and sometimes include personal identifiers or cost information, we often preferred them over NHDS data. An obvious issue is the representativeness of the pooled state data. As Figure 1 shows, the age and sex distributions in NHDS and the 5-state data are virtually identical.

Length of Hospital Stay. Injury victims in the pooled 5-state hospital discharge data average slightly shorter stays than in national data from NHDS or CHAMPUS. Nevertheless, as Table 3 shows, average length of stay varies widely between the state hospital discharge data sets. New York has much longer stays than the other states (perhaps in response to the state's tight controls on cost per day). California and Maryland have the shortest stays. These patterns hold at the diagnosis level as well as across diagnoses.

NHDS and CHAMPUS have similar average lengths of stay, suggesting that the small number of elderly and of males ages 18–45 covered by CHAMPUS does not cause serious representativeness problems. Length of stay is quite variable, with standard deviations almost double the mean. This variability increases our certainty that the small differences in mean lengths of stay between NHDS, CHAMPUS, and the pooled 5-state data are not meaningful. Their agreement suggests it is credible to combine data on hospital-admitted cases from these sources.

In Table 3, differences in means between years or data sets may result from case mix differences rather than differences in length of stay for comparable diagnoses. For example, when the mean NHDS length of stay is computed by multiplying mean length of stay for each diagnosis by the 1990–1992 case count for that diagnosis, the 1987–1989 and 1990–1992 mean lengths of stay differ by only 0.01 days. As a second example, mean length of injury stay was stable from 1984–1986 to 1990–1992 in NHDS. Computed with the 1984–1986 diagnosis mix, however, average NHDS length of stay dropped from 6.3 days in 1984–1986 to 5.8 days in 1990–1992. It appears that cost-control efforts reduced length of stay for comparable diagnoses, but also reduced admissions for diagnoses with short average stays.

Medical Costs. A prior study (Miller et al. 1995) tested medical cost consistency among some of the data sets used in ICM. Although ICM uses data from more recent years than the prior study, we believe consistency of older data from these data sets yields insight into the credibility of ICM data sources. Where practical, this section also assesses the consistency of the more recent medical cost data used in ICM.

The older comparisons are from Miller et al. (1995), which estimated medical costs by diagnosis and hospital admission status. These cost estimates were validated against costs per case from Rice et al. (1989). Rice et al.'s costs were more clearly nationally representative but were not diagnosis-specific.

For non-admitted cases, Miller et al. (1995) used first year medical payments including co-pay from CHAMPUS, which implicitly included an average of 1.9 medical visits per case. Rice et al. combined NHIS visit counts (which average 2.0 visits per case) with payments per visit inflated from the National Medical Care Utilization and Expenditure Survey data (the 1980 version of NMES). As Table 4 shows, the two data sources yielded virtually identical costs per case (computed with the same diagnosis mix). Their consistency strongly suggests CHAMPUS costs for ED/doctor visits are nationally representative.

For admitted cases, both Miller et al. (1995) and Rice et al. (1989) used NHDS/Maryland data on first-year length of stay. Miller et al. (1995) used total medically related DCI payments per hospital day. This procedure implicitly assumes that other costs were proportional to length of stay. Total DCI payments include hospital per diem, professional fees, nursing home payments, prescriptions, equipment, and attendant care. Rice et al. used hospital costs per day from Maryland; an add-on of 25% for professional fees; payments for prescriptions, other items, and outpatient physician and physical therapy visits from NMCUES; plus data on minor cost factors from various sources. The two estimates of medical costs per injury with hospital admission differ by less than 2% (Table 4). Their similarity suggests it is reasonable to assume both the DCI data and the hospital costs in Maryland hospital discharge data are representative.

Table 5 compares estimated costs per live hospital discharge for injury from Maryland and New York with cost estimates from prior studies. After adjusting for the overall temporal trend in cost per hospital day,[8] estimated costs per injury discharge are relatively stable over time. CHAMPUS costs have fluctuated around the DCI average. Average pooled Maryland and New York costs are within 3% of the DCI average. Costs in New York are slightly above CHAMPUS or DCI costs while Maryland costs are slightly below them. The consistency of costs and lengths of stay in DCI, the state hospital discharge data sets, and CHAMPUS data again means it is credible to mix data from these sources. Their consistency also suggests these sources are reasonably representative of the nation.

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[8] The adjustment used annual American Hospital Association data on average cost per hospital day by state, as published in the US Statistical Abstract (Bureau of the Census annual).

Table 2. Summary of Data Sources

Database	Population Covered	Coding Scheme	Number of Cases	Years	Data Elements Used	Comments
BLS Annual Survey of Occupational Illnesses and Injuries (Bureau of Labor Statistics)	Annual sample of lost-workday occupational incidents	Variant of ANSI Z-16.2	603,936 cases	1993	Days lost per injury	Restricted to workers
CHAMPUS Civilian Health and Medical Program of the Uniformed Services (Department of Defense)	Annual summary of claims for about 2,000,000 military dependents and retirees	ICD-9 3 digit level; used codes 800-995 only	2,256,583 injury episodes treated in non-admitted settings 24,150 injury hospital admissions	1992-1994	Ratio of professional fees to hospital payments; payments per non-admitted case	Longitudinal for one year; inpatient and outpatient claims are not linked; few males 18-45; few over 65
DCI Detailed Claims Information data base (National Council on Compensation Insurance)	Sample of Workers' Compensation lost work claims	Variant of ANSI Z-16.2	452,000 injury cases, including 138,000 hospital-admitted cases 185,775 injury cases	1979-1987 1992-1996	Percent medical payments in first 6 months; disability probabilities Percent disabled for permanent partial disability cases	Longitudinal data; excludes injuries with work loss less than 3-9 days in different states
JVR Jury Verdicts Research proprietary personal injury verdicts and settlements data	Virtual census of jury awards for tort, plus selected settlements and arbitrations	Non-systematic narrative	Over 100,000 cases 1,962 product-related injury cases coded by NPSRI	1988-1995	Pain and suffering, medical and work losses	Narratives are largely free-form, creating missing data problems

Database	Population Covered	Coding Scheme	Number of Cases	Years	Data Elements Used	Comments
Missouri Discharge Data Sets	Census of discharges	ICD-9-CM 5 digits cause-coded	51,106 hospital-admitted and 627,135 ED-only injury cases	1994	Hospital readmission rate	Personal identifiers allowed accurate linkage of records
NAMCS National Ambulatory Medical Care Survey (NCHS)	Sample of doctor's office and clinic visits	ICD-9-CM 5 digits	4,800 injury cases	1992-1994	Payer distribution (e.g., Blue Cross, Medicaid, self-pay) Direct hospital admissions	Cases also treated in EDs are not distinguished
NEISS National Electronic Injury Surveillance System (CPSC)	Sample of hospital emergency room visits-consumer product and workplace injuries	Variant of ANSI Z-16.2	About 340,000 consumer product injury cases annually	1995-1996 1983-1986 (work-place)	Incidence by hospital admission status	Excludes direct hospital admissions
NHAMCS National Hospital Ambulatory Medical Care Survey (NCHS)	Sample of hospital emergency room visits	ICD-9-CM 5 digits cause-coded	36,686 injury cases	1992-1994	Payer distribution	Excludes direct hospital admissions
NHIS National Health Interview Survey (NCHS)	Household interview survey	ICD-9 based on respondent description	3,692 non-admitted injury cases 5,359 non-admitted injury cases	1987-1992 1987-1996	Injury counts; work loss probability; untreated restricted activity case data Breakdown of non-admitted cases	Self-report; data cover the 2 weeks prior to interview

Database	Population Covered	Coding Scheme	Number of Cases	Years	Data Elements Used	Comments
NHDS National Hospital Discharge Survey (NCHS)	Annual sample of hospital discharges	ICD-9-CM 5 digits	111,324 injury-related discharges	1987-1992	Hospital admission incidence; mean length of stay; % discharged to nursing home; payer distribution	Lack of cause codes seriously hampers analysis
NMES National Medical Expenditure Survey (NCHS)	Household interview survey, with provider follow-up	ICD-9-CM 5 digits	397 hospital-admitted, 5,439 non-admitted injury cases	1987 (most recent)	Medical costs by hospital admission status and nature of expense; visits per case	Cases identified by self-reports from 14,000 households
Pooled 5-state hospital discharge censuses	Annual census of hospital discharges	ICD-9-CM 5 digits cause-coded	586,669 live injury discharges including 292,436 consumer product injury discharges	CA 1993 MD 1994-1995 NY 1994 VT 1990 WA 1989-1991	% of cases related to consumer products, length of stay, cost data from MD and NY	Regressions modeled effects of age, sex, and consumer product injury

Figure 1. Comparison of Age & Sex Distribution: NHDS vs. Pooled 5-State Hospital Discharge Data

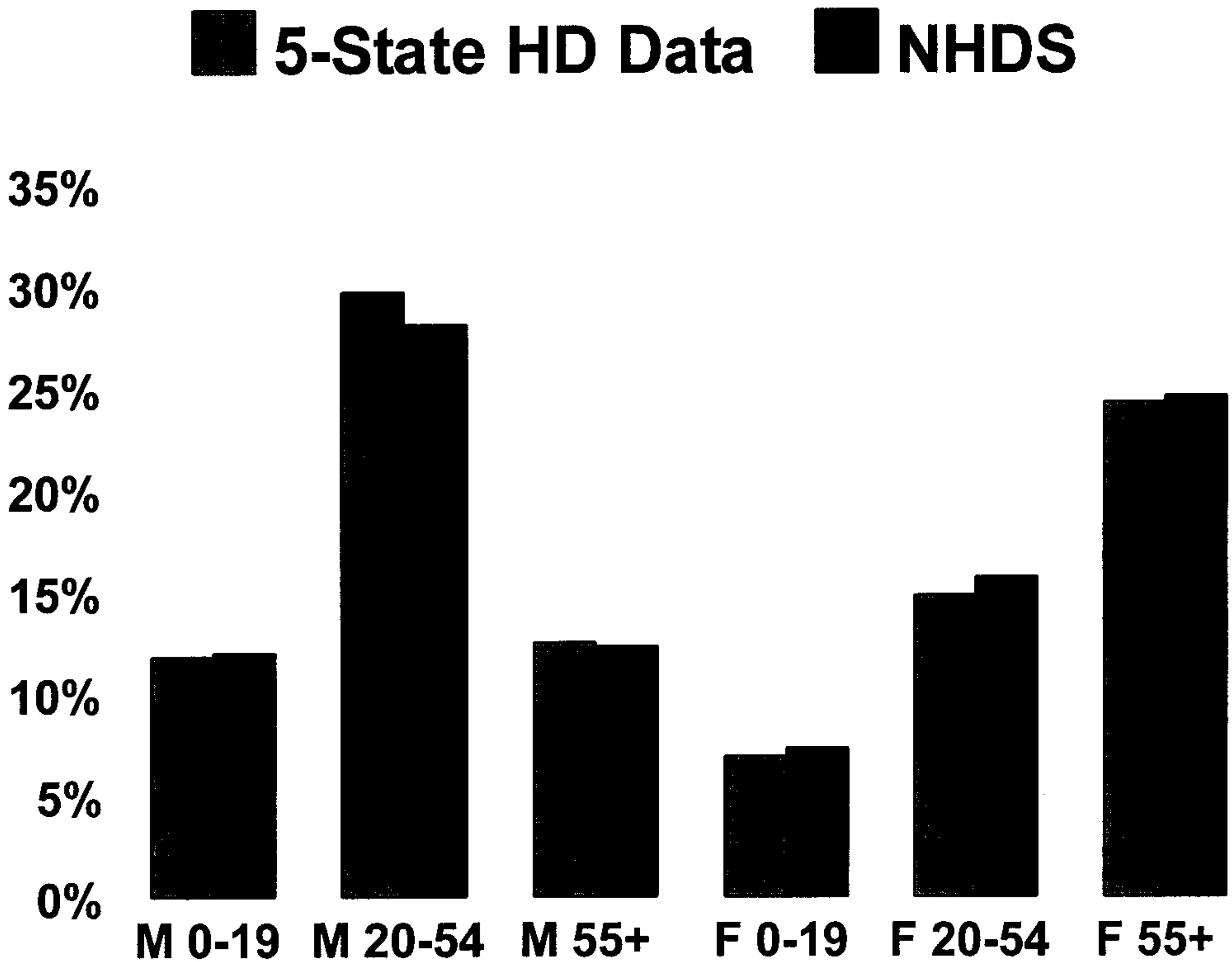

Table 3. Number of Cause-Coded Live Injury* Discharges and Statistics on Length of Stay in NHDS and Six State Hospital Discharge Censuses

		Length of Stay (*Days*)	
Data Set	Cases	Mean	Std. Dev.
NHDS 1984–86 †	41,292	6.4	NA
NHDS 1987–89	43,523	6.4	11.10
NHDS 1990–92	48,197	6.3	10.12
CHAMPUS 1986–88 †	60,000	6.0	NA
CHAMPUS 1992–94	24,150	6.3	NA
DCI 1979–87 †	138,000	6.2	NA
Combined Data from 4 States	374,324	6.1	11.28
California 1993	178,557	4.8	8.51
Maryland 1994–95	66,986	4.8	7.22
New York 1994	124,879	8.5	15.43
Vermont 1990	3,902	6.5	10.40
Washington 1989–91 §	124,777	5.9	9.90
Missouri 1994	36,285	5.7	6.82

NA = not available

* For this table, injury is defined as a primary ICD-9-CM diagnosis between 800 and 995.

† Estimate from Miller, Pindus et al. (1995)

§ Washington mean and standard deviation are for cases with a primary *or secondary* injury diagnosis.

Table 4. Comparison of Lifetime Medical Payments per Injury in Rice et al. (1989) and Miller, Pindus et al. (1995) (in 1989 dollars)

	Miller et al.	Rice et al.
All	$681	$680
Hospital Admitted	10,723	10,590
Not Admitted	248	252

Source: Miller et al. 1995, p. 34.

Table 5. Comparison of Hospital Payments (Including Professional Fees) per Injury Hospital Admission among Data Sets (in 1995 dollars)

Data Set	Cost/Case
CHAMPUS 1986-88 *	$10,830
CHAMPUS 1992-94	9,760
DCI 1979-87 *	10,304
MD/NY Average	10,646
Maryland 1994-95	8,594
New York 1994	11,720

* Estimate from Miller, Pindus, et al. (1995).

5. ESTIMATION OF INJURIES NOT TREATED AT EMERGENCY DEPARTMENTS

NEISS samples nonfatal injury victims (injury survivors) treated in hospital emergency departments (EDs) or admitted through the ED. Survivors could be treated in many other settings including ambulatory surgery centers, physicians' offices and clinics, company clinics, or poison control centers (telephone centers that triage victims and supervise home treatment). In addition, a few injury survivors are admitted to the hospital directly, by-passing the ED (and the NEISS system). These survivors 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. The revised ICM estimates the number of injury survivors who were treated in places other than emergency departments, and then costs their injuries.[9] This chapter describes the incidence estimation; subsequent chapters describe the cost estimation. Separate incidence estimates are generated for two groups:

- Survivors treated only in non-hospital settings, including physicians' offices, clinics, and ambulatory surgery centers.
- Hospital-admitted survivors not admitted through the ED.

Conceptually, ICM estimates case counts for each of these groups from NEISS weighted injury estimates and data about the relative frequency of cases treated only in these non-ED settings versus cases 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. This chapter describes the ratio estimation methods and the ratios for the four groups of survivors. Then it attempts to validate selected estimates.[10]

Survivors Treated Only in Non-Hospital Settings

Ratios of injury survivors treated only in non-hospital settings to non-admitted survivors treated in the ED were computed from 1987–1996 NHIS data. NHIS captures all treatment, and it differentiates ED and hospital treatment from treatment in other settings. The non-ED NHIS count includes walk-in clinics, doctor's offices, health centers, school clinics, and company clinics. NHIS separately counts untreated injuries that restricted activity for half a day or longer.

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[9] The revised ICM provides costs only for medically treated injuries. Analysis of the 1987–1992 NHIS revealed that for every 4.65 medically treated injury survivors, there is an additional survivor who restricts activities but does not seek medical treatment.

[10] Validation was attempted whenever more than one nationally representative data set provided information that could be used to compute incidence ratios.

We computed ratios of non-ED cases to ED cases and used decision-tree analysis to break down these ratios by ICD-9 diagnosis group, sex, and age group (0–9, 10–34, 35 and over). Motor vehicle crash victims were excluded from the data used to compute the ratios.[11]

In the mid-1970s, the National Center for Health Statistics added a one-time NHIS supplement on consumer product injuries. At that time, 41–42% of medically treated injury survivors were treated in the ED. A 1977 NAMCS supplement placed the percentage at 45%. Since that time, though health-care cost controls have tried to reduce use of hospital inpatient and ED care, these treatment setting shares have changed little. From 1987–1996 NHIS data, we estimate that 40–41% of medically treated injury survivors (excluding motor vehicle injury victims) were treated in the ED (including victims admitted to the hospital through the ED).[12]

Table 6 shows the estimated ratios of counts of non-ED cases to non-admitted ED cases by diagnosis grouping and victim age and sex. The diagnosis groupings in Table 6 and most other tables in this report that come from health care data systems are in ICD-9 rather than NEISS diagnosis codes. Chapter 4 explains why and how the data were grouped. Chapter 10 explains how the grouped ICD-9 estimates were mapped to NEISS diagnosis codes. Table 6 shows ratios tailored by victim age and sex. Fractures, burns, and open wounds of the head were especially likely to be treated in the ED. Table 7 shows our estimated counts of non-ED cases, along with the weighted ED case counts from NEISS, by nature of injury and body part, for a 21-month period.

Example. For a female victim of a clavicle fracture (diagnosis 810) over age 34, the ratio of non-ED cases to ED cases is 2.3316. For every woman over 34 who is treated for a clavicle fracture in an ED and released, we estimate that 2.3316 others are treated in doctor's offices and clinics.

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[11] Crash victims were excluded because crash injury incidents are not subject to CPSC authority and preliminary analysis suggested the crash victim treatment profile differs from the profile for other injuries.

[12] This percentage was the same in 1987–1991 as in 1992–1996, which confirms that it was reasonable to pool 1987–1996 data.

Admitted Survivors Who By-Pass 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 health care treatment setting or admission to a burn center (or other specialized acute care facility) that does not have an ED.[13]

We used different procedures to estimate ratios for burn victims and other injury victims. The ratio of admitted burn victims without initial ED treatment to victims admitted through the ED was computed from NHDS and NEISS burn admission counts in Miller et al. (1993). These counts suggest roughly 60% of burn admissions go through the ED. Thus, the ratio of non-ED to ED cases is .667 (.4 / .6).

To compute the ratio for other injury victims, we first estimated the number of admissions that bypass the ED. NAMCS indicates when acute care victims treated in doctor's offices and clinics (including walk-in clinics) are transferred to the hospital. NAMCS data for 1993–1996 include only 73 direct non-burn admissions (unweighted).[14] This sample size is too small to support differentiation of non-burn, non-ED admission ratios by diagnosis. The annual number of direct admissions to MIEMMS was obtained from the institution and added to the weighted NAMCS direct admission estimate. The ratio of non-ED admissions to ED admissions was computed by dividing the non-ED count by the NHDS count of total injury admissions minus the non-ED count.

In the 1993–1996 NAMCS data, 330,021 injury victims, not counting burns and late effects, were admitted from clinics and doctors' offices annually. MIEMMS admits about 100 patients a week, 5,200 annually.[15] According to NHDS data, an average of 2,491,142 victims of injuries, other than burns and late effects, were admitted annually through the ED in 1993–1996. Thus the ratio of non-burn injury victims admitted directly to victims admitted through the ED is

$$(330{,}021 + 5{,}200) / [\ (2{,}491{,}142 - (330{,}021 + 5{,}200)\ ] = 0.1555$$

Table 7 shows our estimated case counts for direct admissions, as well as the weighted NEISS counts of cases admitted via the ED, by nature of injury and body part, for a 21-month period.

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

[14] Unfortunately, the ratio reported here cannot readily be updated because NAMCS did not collect discharge destination after 1996.

[15] Personal communication, Pat Dischinger, MIEMMS, April 1997.

Validation of Relative Frequency of ED-Treated Versus Other Non-Admitted Injury

The 1987–1992 NHIS suggests that 48% of non-admitted injury victims (including motor vehicle injury victims) treated in EDs, doctor's offices, or clinics were treated in the ED. That percentage closely matches the estimate of 49% from NCHS provider surveys – NAMCS, which collects data from doctor's offices and clinics, and the NHAMCS ED sample. These NHIS estimates excluded victims who were treated only in ambulatory surgery centers, company clinics, school health clinics, and outpatient clinics.

Because only a small portion of doctor's office and clinic visits are injury-related, NAMCS injury sample sizes often are small, making comparisons by diagnosis tenuous. Even where sample sizes are adequate, the differences between data sets are striking for some diagnoses. Coding practices are the likely cause. For example, no NHAMCS cases use ICD-9 diagnosis code 842, wrist/hand sprain. Also, the NHIS self-reported diagnoses seem to sort sprained knee/lower leg versus sprained ankle/foot differently than the provider reports. Nevertheless, while coding practices prevent the ratios of non-admitted survivors treated by doctors versus EDs from agreeing by ICD-9 diagnosis group, the overall NHIS ratio estimates agree reasonably well with the NAMCS-NHAMCS ratios obtained from providers. That increases our confidence in ICM's overall estimate of non-admitted injury victims not treated in the ED.

Table 6. For Medically Treated, Non-Admitted Injury Survivors: Ratio of Number Treated in Non-ED Settings to Number Treated in the ED, by Victim Diagnosis Group, and Age-Sex Group

	Male			Female		
ICD-9 Group	0-9	10-34	35+	0-9	10-34	35+
800-804,940-941	0.4466	0.4466	0.4466	0.9543	0.9543	0.9543
805-809,820-829	1.2179	1.2179	2.6339	1.2179	1.2179	2.6339
810-811	1.1902	1.1902	2.3316	1.1902	1.1902	2.3316
812-819	1.0779	1.0779	1.1057	1.0779	1.0779	1.1057
830-839,842	1.5069	1.9205	2.5683	1.5069	1.9205	2.5683
840,841,910,918	1.8845	1.8845	2.5683	1.8845	1.8845	2.5683
843,844	1.5069	3.3470	3.9861	1.5069	3.3470	3.9861
845,848,860-869	1.5069	1.9205	2.5683	1.5069	1.9205	2.5683
846,847	1.5069	1.9205	3.9861	1.5069	1.9205	3.9861
850-854,930	1.2656	1.2656	2.5683	1.2656	1.2656	2.5683
870-874	0.5991	0.9498	0.5991	0.9543	0.9543	0.9543
875-880	1.1432	1.1432	1.1432	1.1432	1.1432	1.1432
881-884	0.8375	0.8375	1.1057	0.8375	0.8375	1.1057
890-893	1.1432	1.1432	1.1432	1.1432	1.1432	1.1432
904	1.9205	1.9205	2.5683	1.9205	1.9205	2.5683
911-917,919	3.2521	3.2521	2.5683	3.2521	3.2521	2.5683
920,921,923	1.2656	1.2656	2.7429	1.2656	1.2656	1.7420
922	1.5069	1.9205	2.7429	1.5069	1.9205	1.7420
924	1.5069	1.8036	2.7429	1.5069	1.8036	1.7420
942-949	1.1432	1.1432	1.1432	1.1432	1.1432	1.1432
925-929,931-939, 950-957,959,990	1.5069	1.9205	2.5683	1.5069	1.9205	2.5683
960-989	1.5158	1.5158	1.5158	1.5158	1.5158	1.5158

Source: Decision-tree analysis of 5,359 medically treated non-admitted cases in the 1987-1996 NHIS data. Excludes victims of motor vehicle crashes.

Table 7. Estimated Cases for 1995, by Highest Treatment Level and Nature of Injury or Body Part Injured

NEISS Injury Diagnosis	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted Direct	Hospital-Admitted via ED
41 Ingested Foreign Obj	64,152	40,157	615	3,957
42 Aspirated Foreign Obj	2,794	1,736	47	303
46 Burns, Electrical	7,694	7,418	260	390
47 Burns, Not Specified	2,274	2,218	11	17
48 Burns, Scald	67,712	61,754	5,612	8,418
49 Burns, Chemical	24,855	29,781	353	530
50 Amputation	19,281	19,883	943	6,063
51 Burns, Thermal	142,747	135,261	6,915	10,372
52 Concussions	119,302	78,911	1,487	9,561
53 Contusions, Abrasions	4,461,544	2,312,894	3,636	23,382
54 Crushing	46,106	24,095	85	547
55 Dislocation	329,240	159,930	1,118	7,190
56 Foreign Body	334,633	220,341	547	3,520
57 Fracture	2,185,070	1,571,812	43,192	277,760
58 Hematoma	140,644	88,309	647	4,164
59 Laceration	2,951,741	3,284,952	5,021	32,290
60 Dental Injury	16,878	21,018	28	179
61 Nerve Damage	3,538	1,639	92	589
62 Internal Organ Injury	347,476	233,896	4,440	28,555
63 Puncture	254,832	239,405	580	3,733
64 Strain or Sprain	5,255,015	2,173,540	1,545	9,935
65 Anoxia	59,491	29,315	582	3,745
66 Hemorrhage	6,502	7,606	537	4,454
67 Electric Shock	8,781	4,511	104	669
68 Poisoning	154,748	102,090	1,548	9,952
69 Submersion	4,668	2,911	308	1,980
70 Not Stated	20,419	12,323	533	3,429
71 Other	683,635	378,387	5,222	33,584
72 Avulsion	95,788	78,841	149	955
73 Burns, Radiation	6,122	10,203	34	51
74 Dermat/Conjunctivitis	54,760	36,427	16	105
TOTAL	17,872,439	11,371,565	86,208	489,378

NEISS Body Part	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted Direct	Hospital-Admitted via ED
00 Internal	66,946	41,893	662	4,259
30 Shoulder	791,396	416,082	1,630	9,980
31 Upper Trunk	832,351	392,107	5,582	27,941
32 Elbow	445,256	274,444	1,576	10,022
33 Lower Arm	513,445	398,851	3,034	16,334
34 Wrist	836,088	567,688	2,163	13,852
35 Knee	1,581,592	612,303	1,744	10,992
36 Lower Leg	640,012	360,096	4,376	24,711
37 Ankle	1,767,584	890,893	3,604	22,900
38 Pubic Region	57,112	35,284	517	2,456
75 Head	1,287,914	1,049,562	9,187	58,228
76 Face	1,283,198	1,305,065	3,914	17,960
77 Eyeball	313,496	206,200	643	3,257
79 Lower Trunk	1,623,240	648,241	24,413	154,349
80 Upper Arm	123,568	91,218	1,619	9,498
81 Upper Leg	254,520	129,737	3,794	21,991
82 Hand	912,078	720,738	2,931	8,953
83 Foot	1,002,607	616,939	1,590	7,167
84 25-50% of Body	84,163	45,858	3,936	8,937
85 All Parts of Body	277,760	170,479	4,277	26,158
87 Not Stated	29,498	17,704	484	2,885
88 Mouth	240,381	279,088	401	2,179
89 Neck	304,188	135,141	1,304	7,012
92 Finger	1,977,379	1,586,964	2,172	13,512
93 Toe	475,099	265,792	473	3,039
94 Ear	151,567	113,198	183	805
TOTAL	17,872,439	11,371,565	86,208	489,378

6. MEDICAL COST ESTIMATION

This chapter derives the estimated medical costs per injury by diagnosis. Separate estimates were developed for hospital-admitted victims, victims treated in the ED and released, and victims treated only in doctor's offices, clinics, or other non-ED settings. We were able to tailor the estimates for admitted victims to consumer product injury by victim age and sex.

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.

Two states, Maryland and New York, regulate the relationship between costs and charges for hospital care by department or service.[16] These states have accurate hospital production cost data. Because virtually all hospitals in these states operate on a non-profit basis, the regulations force average payments (societal costs) to equal production costs. The revised ICM incorporates these costs from Maryland and New York, with some adjustment to make them more nationally representative.[17]

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

[16] The most readily available information about fee-for-service health care typically is charges taken from the bill. But charges are unacceptable surrogates for costs for two reasons. First, the charge includes an allowance for bad debt. That means average charges per victim times the number of victims double-counts charity care costs. Second, Medicare requires participating providers to charge everyone the same amount for the same service; Medicare and other health insurers then pay a fraction of the bill according to widely varying negotiated rates or fee schedules. Consequently, medical care bills rarely are paid in full. Because payments typically are only a percentage of charges, providers must charge more than their production costs to break even. Charges, therefore, do not reflect costs as well as payments do.

[17] We believe the two-state data are more accurate than hospital charge data adjusted with medicare cost-to-charge ratios. That approach yields a reasonably good estimate of total hospital costs, but a surprisingly poor estimate of costs by hospital department or service. Injury and illness victims differ in patterns of ancillary service utilization and in case mix. Consequently, most studies of Medicare reimbursement of trauma care find that payments typically cover half of actual trauma care costs (Champion and Mabee 1990, U.S. General Accounting Office 1991).

not closely mirror the overall average, especially for hospital care.[18] The comparisons at the end of Chapter 4 suggest that CHAMPUS payments (including co-pay) are an accurate surrogate for the average patient/payer costs of non-admitted medical care. For non-admitted cases, ICM uses this surrogate.

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. A table 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 body part or nature of injury diagnosis.

Costs for Hospital-Admitted Cases

Hospital-admitted injury survivors usually have the highest severity and costs per nonfatal case. Perhaps as a result, more data are available about these victims than other injury survivors. Given the importance of admitted cases and the availability of data about them, estimating costs for these cases was complex. The overall estimate is built from diagnosis-specific estimates in 7 steps:

1. Estimate length of stay per admission
2. Estimate ratio of professional fees to hospital costs (This step is necessary because hospital cost data exclude most professional fees.)
3. Compute hospital costs and professional fees per admission from length of stay
4. Multiply hospital costs per admission by admissions per admitted victim
5. Add pre-hospital and post-discharge acute care costs
6. Estimate lifetime costs from short-term costs
7. Include health care claims processing costs

Figure 2 shows the flow of the analysis. Steps 1 and 3 each have discrete substeps. Figure 3 summarizes the analysis in equation form.

The estimated costs are based on injury cases that appear likely to be associated with consumer products. They are differentiated by victim sex and age group (0–19, 20–54, 55–69,

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[18] For unsubsidized doctors and hospitals to remain in business, payments must at least cover costs including costs of charity care. Therefore, average payments per patient with payments must include an allowance for bad debt; applying this average to all patients double-counts charity care costs. To the extent non-payment is less frequent for small doctor bills than large hospital bills, payment data from a single payer are more credible cost surrogates for non-admitted than admitted cases.

70 and over).[19] We assessed the possibility of separately estimating medical costs for hospital-admitted children ages 0–9 versus 10–19. We decided against separate estimates because costs per admission generally were quite similar for the two age groups (mostly because they had comparable lengths of hospital stay for comparable diagnoses) and sample sizes were often small when data from the two age groups were not pooled.

This section describes how the costs for hospital-admitted victims were derived and briefly describes the cost patterns. Medical costs per injury victim were estimated for 779 ICD-9-CM diagnosis groups, then mapped to NEISS codes.

As the next sub-section describes, the analysis covered injury victims identified by a traditional diagnostic guideline (an ICD-9 diagnosis code between 800 and 995), as well as victims identified by injury cause code. The latter group of victims often have diagnoses like "pneumonia," "back pain," or "complications of pregnancy" that sometimes result from injury and sometimes result from other causes.

Subsequent subsections explain how each of the seven cost elements was estimated and summarize the estimates. Each subsection concludes by contributing to a running example, which continues in Chapters 7–9 and is reproduced in Appendix A. The example builds a step-by-step cost estimate for a 40-year-old woman's fractured scapula (i.e., shoulder blade, ICD-9 diagnosis 811). This section's example builds a cost estimate for a hospital-admitted victim, while the following section builds a comparable estimate for a non-admitted victim.

Estimates of medical cost components were generated for 779 ICD-9 diagnosis groups. Here, we merely summarize the results.

Identify and Classify Injuries in Hospital Discharge Data. As Chapter 4 states, the NHDS and state hospital discharge data sets used to estimate medical costs for admitted cases all code patient diagnoses with the International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM). Depending on the data set, hospital discharge records may list from 5 to 24 ICD-9 diagnoses per patient. Two steps were taken to prepare these data sets for cost analysis. First, we determined which patients were injured. Next we chose the most appropriate single ICD-9 diagnosis code for each patient, which we called the classifying diagnosis.[20] Once

[19] Limited sample size forced us to use just a few broad age groups.

[20] Classification was more complex because ICD-9 diagnoses often do not match NEISS diagnoses exactly. Furthermore, injury coding is erratic enough that the diagnoses coded for a given patient may vary between coders. The differences are especially severe when payer cost controls lead to better reimbursement for some diagnoses than for others. This problem introduces noise into our estimates.

these steps were completed, we could compute average costs per case by classifying diagnosis, age group, and sex, then as Chapter 10 describes, map them into NEISS diagnosis codes.

To support the mapping, we needed to capture and cost the full range of injuries that might relate to consumer products. In data sets that include injury cause coding, we initially captured all cause-coded cases. The large majority of patients with injury cause codes had diagnoses like fractured leg and arm contusion that obviously described injuries.

When the patient's diagnoses did not include obvious injuries (ones with diagnosis codes between 800 and 994, which the ICD-9 codebook titles Injuries and Poisonings), we had to decide whether the injury cause code appeared in error. From a frequency count, we identified diagnosis codes below 800 that almost always were cause-coded (for example, ICD 310.2, post-traumatic concussion syndrome) and classified them as injuries. The first table in Appendix B lists these diagnoses. We hand-examined the remaining records and either deleted them or identified a diagnosis like dermatitis that sometimes but not always results from injury.[21] This process yielded the second table in Appendix B, which lists diagnoses that sometimes or always resulted from injury. In data sets without cause coding, we developed cost estimates for all cases with diagnoses on these lists. In weighting the diagnosis-specific data into NEISS groupings, we accounted for the relative frequency of injury versus non-injury incidents within these diagnoses.

Once we selected the injury cases, we chose a classifying diagnosis code for each case. If the first diagnosis listed in the patient's discharge record was a traditional ICD-9 injury diagnosis (ICDs 800–994) or one of the 17 other injury diagnoses listed in the first table of Appendix B, we chose that diagnosis. Depending on the data set, first-listing in the discharge record may imply that the diagnosis was the primary cause for admission (the NHDS rule) or that it was the principal contributor to overall length of stay (the rule in all the state files except Washington, where our file had diagnoses sorted in numerical order).

For 80% of the injury discharges in the state files (except Washington), the first-listed diagnosis was an injury as traditionally defined. For other first-listed diagnoses, we classified the victim by the first listed traditional injury diagnosis or diagnosis from Appendix B, Table B1. If none was listed, we classified by the first diagnosis that we considered might be an injury, as listed in Appendix B, Table B2. For example, if the external cause of injury code was poisoning of unknown intent with solid or liquid, the first diagnosis was ICD 296.2 (single major depressive disorder) and the only secondary diagnosis was ICD 507 (pneumonitis due to solids

[21] A difficult judgment was required when the patient's only injury-related diagnosis was cellulitis and abscess. This diagnosis can result from diabetes, for example, or be a complication of an untreated or improperly treated wound. If the case was cause-coded and contained no illness-related diagnoses, we accepted it as a legitimate complication-of-injury case even though we did not know what body part was injured.

and liquids), we classified the injury as ICD 507. Among all injury cases, 97% ultimately were classified with a traditional injury diagnosis.

Next, we developed a method to classify cases with diagnoses of late-effects-of-injury or complications of injury (e.g., cellulitis and abscess). Such cases conceivably could be first medical encounters for injury or return visits. We analyzed this question using the Missouri hospital, emergency department, and ambulatory surgery center discharge files. Since complication cases treated in January 1994 generally would link to 1993 initial treatment, meaning Missouri did not collect data about them, we excluded January cases. Among the remaining cases, 58% of patients treated in the emergency department and 61% of patients admitted to hospital for late effects of injury or complications of injury sought treatment for injuries that had not been treated previously in the hospital inpatient department, emergency department, or ambulatory surgery center. A few of these patients might have been treated previously in physicians' offices.[22]

Fifty-seven percent (57%) of late-effects-of-injury cases and 79% of injury complications cases were first medical visits. The first-medical-visit patients tried to wait out their injury, only seeking medical treatment when complications arose. Consequently, their treatment was unnecessarily expensive. In NEISS, late-effects victims without prior medical treatment usually would be classified as acute injury victims. Other late-effects cases are readmissions or follow-up treatments.

Finally, we identified which injuries were consumer product-related. We applied the classification criteria CPSC developed in Kessler and Reiff (1995), which uses ICD-9 external-cause-of-injury codes to define consumer product injuries. Three cause categories accounted for most of the injuries excluded from the consumer-product designation: transportation, adverse effects of medical treatment, and intentional injury. For cause codes where Kessler and Reiff included less than 100% of qualifying injuries – injuries with location codes specifying recreation, residential institutions, public buildings, and other specified places – we treated all cases as consumer product injuries. In the pooled 5-state data, 49.8% of cause-coded live injury discharges were identified as potentially related to consumer products.

Estimate Length of Stay. Nationally representative average lengths of stay by diagnosis group came from NHDS. For the same injury diagnosis, average length of stay for victims of consumer product injury may differ from the average for another cause like motor vehicle injury. Since NHDS does not describe injury cause, we used the 5-state pooled hospital discharge data to adjust the NHDS lengths of stay to estimated lengths of stay for consumer product injury. Because victim age and sex may affect the likelihood that an injury was consumer-product

[22] If equal proportions were treated in physicians' offices and EDs, which seems unlikely given that the available data reveal a strong tendency to return to the initial source of treatment, roughly 40% would not have been treated previously.

related as well as affecting length of stay directly (e.g., if older people recover more slowly than youth), we used the 5-state data to adjust the product-injury lengths of stay for age-sex variations. For 63 diagnosis groups, log-linear regressions that estimated length of stay (the dependent variable) as a function of age group, sex, and whether the injury was caused by a consumer product allowed us to tailor the NHDS average length of stay to fit the victim.

Generally, victims under age 20 have below-average lengths of stay. Those over age 54 and especially over age 69 have above-average lengths of stay. The effect of a consumer product etiology versus another etiology on length of stay typically is statistically significant at the 95% confidence level; the direction of the effect varies with the mix of other causes associated with a given diagnosis. Overall, length of stay for consumer product injuries is below the all-injury average.

Example. For scapula fractures, the NHDS length of stay averages 4.2 days. The regression on pooled 5-state data shows the length of stay for consumer product-related scapula fractures of women ages 20–54 is 80% of the average for all scapula fractures. Multiplying 4.2 by 80%, we estimate that the length of stay for our victim would be 3.36 days.

<u>Estimate Ratio of Professional Fees to Hospital Costs</u>. Professional fees include payments to physicians and allied health personnel (e.g., inhalation therapists, physical therapists) whose services are not bundled into the hospital bill. By 3-digit ICD-9 diagnosis, we estimated the ratio of professional payments to hospital payments per admission as annual CHAMPUS professional payments for inpatient care divided by annual CHAMPUS hospital payments.

The ratios vary widely. The average ratio is 30.5% for traditional injury diagnoses (ICDs 800–994), but much higher, 48%, for the broader range of diagnoses including conditions that are often, but not always, the result of injuries. At the low end, professional fees were no more than 7% of hospital payments for post-traumatic concussion syndrome, cerebral lacerations and contusions, trunk crush and fracture, and many burns and poisonings. Conversely, professional fees were at least twice hospital payments for many injury-related complications of pregnancy, carpal fracture, traumatic cataracts, chemical fume inhalation, back or abdominal pain, shoulder dislocation, open wounds of the chest or upper limb, and cranial nerve injury. We multiplied the professional-fee ratios by the hospital cost estimates to estimate total inpatient costs.

Example. For a fractured scapula, CHAMPUS shows the ratio of professional fees to hospital payments is .1814. The total costs incurred during a hospital admission for scapula fracture will be 1.1814 times the hospital's costs. This information will be used in the next step.

<u>Compute Hospital Costs and Professional Fees from Length of Stay</u>. National data were not available on the fixed and variable costs of hospital stays for injury. Furthermore, many health care data sets restricted their fiscal data to charges. Payers typically negotiate the percentage of charges that they will pay to a hospital. The percentages vary widely between

payers and between hospitals. Consequently, provider costs and even payments for service typically bear little relationship to charges.

Hospital inpatient cost information came from Maryland and New York, the only states with cost-control regulatory agencies that require hospitals to maintain fixed, known relationships between costs and charges at the service rather than facility level (meaning accurate costs of trauma care, orthopedic care, neurologic care, etc. are available).[23] Both states collect data on charges and hospital-specific multipliers that can be applied to compute accurate costs of care for individual patients. To estimate national costs, we multiplied the state costs times the ratio of average cost per hospital day in the United States versus the state (Statistical Abstract of the U.S. 1996, table 191). We analyzed 1994–1995 Maryland data and 1994 New York data. The 1995 Maryland costs were converted to 1994 equivalents using the Hospital Room component of the Medical Care Services Consumer Price Index (Statistical Abstract of the U.S. 1996, table 171). As noted in Chapter 4, the adjusted two-state cost data were consistent with payment data from CHAMPUS and DCI.

New York, which has much longer lengths of stay than Maryland (see Table 3), has lower costs per day. A hospital admission has fixed costs (e.g., admission and discharge paperwork) and front-end costs (e.g., emergency department and surgical theater use), plus daily costs. We ran about 700 regressions by ICD-9 diagnosis group to estimate the fixed cost component and the average daily variable cost.[24] The regressions grouped diagnoses in order to obtain large enough samples to analyze.[25] The diagnosis-specific professional-fee-to-hospital-cost ratios had to be applied to the diagnosis-specific hospital costs before grouping. (In our example, the cost of a broken scapula was multiplied times 1.1814.) Thus the regressions predicted hospital cost plus professional fees as a function of length of stay. If the regression intercept was negative (suggesting a diagnosis group had insignificant fixed cost), we used the average hospital cost plus professional fees per day. The regressions analyzed only the 122,605 probable consumer product injury cases in the Maryland and New York files; all other injuries were excluded.

The cost of a hospital admission was computed by multiplying the length of hospital stay by the average variable cost per day of stay, then adding the fixed costs of a stay.

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[23] No other states collect cost data that are reasonably accurate at the diagnosis level.

[24] We used simple, one-independent-variable regressions of the form Total Cost = a + b × Length of Stay. The fixed cost component is a and the variable component is b.

[25] Grouping was impossible for some diagnoses below ICD-9 code 800. The regressions for those below-800 diagnoses are quite tenuous.

Including hospital costs and professional fees, by far the highest costs per day of stay (including the variable costs and average fixed costs per day) were for injury-related complications of pregnancy (caused by a fall, for example). The costs sometimes exceeded $10,000 per day (in 1994 dollars). Many joint injuries – internal derangement, dislocation or cruciate ligament sprains of the knee, carpal fractures, shoulder dislocations, and rotator cuff sprains – cost $3,000 to $4,000 per day. By comparison, the average cost per day for consumer product injury was $1,270. Importantly, the injuries with high daily costs typically required only 2–3 days of hospitalization, less than half the all-injury average.

Example. The regression equation for a hospital-admitted scapula fracture (in 1994 dollars) is:

$$\text{Cost} = \$2{,}038.60 + (\$740.40 \times \text{Length of Stay})$$

In this equation, the dollar amounts are the coefficients estimated by the regression. For the mean length of stay of 3.36 days, the estimated cost is $4,526.

<u>Multiply Hospital Admissions per Victim by Cost per Admission</u>. Hospital discharge data sets typically do not distinguish initial hospital admissions from follow-up admissions. That means only costs per admission are readily computed from these data sets. Data on admissions per victim allowed calculation of costs per victim from costs per admission.

We used 1994 Missouri hospital discharge data to analyze hospital admissions per injury victim by injury diagnosis. Follow-up admissions (readmissions) include admissions to rehabilitation hospitals, follow-up of bad initial outcomes, and planned admissions to complete staged procedures (for example, a leg with a complex fracture may be cleaned, the patient sent home while the swelling subsides, then the leg reconstructed in a follow-up admission). The data were grouped to include at least 30 discharges per diagnosis group. Because the Missouri data contained patients' names and social security numbers, the admission linkage should be quite accurate. To avoid problems with multi-year episodes, we excluded December initial admissions from the analysis.

On average, 9.5% of hospital-admitted injury victims are readmitted. Readmission rates are less than 4% for pregnancy complications, internal injuries, sprains, strains, open wounds, superficial injuries, and poisonings. They exceed 15% for spinal cord injury, pelvis fracture, femur fracture, late effects of injury, and nerve injury.

Example. The average scapula fracture results in 1.072 hospital admissions. Multiplying 1.072 by the $4,526 cost per admission yields total hospital costs of $4,852.

<u>Add Pre-Hospital and Short-Term Post-Discharge Costs</u>. Some costs are incurred before the victim reaches the hospital. Others are incurred after discharge. NMES provided the ratio of inpatient payments to short-term pre-hospital and post-discharge spending (on average, six months after discharge). Pre-hospital spending covers ambulance transport and life-support services. Post-discharge spending pays for physicians, allied health providers, home health care,

prescriptions, and ancillary goods like canes and colostomy bags. As Table 8 shows, payments for these items average 11.8% of inpatient payments. The bulk of the expense covers physician visits and home health care. We multiplied the post-discharge ratio times the inpatient cost estimates to estimate short-term costs. The NMES sample is so small that we could not differentiate this ratio among diagnoses.

Overall, estimated short-term costs average $11,839 per hospital-admitted consumer product injury victim (in 1994 dollars). The estimates average about $600 less for injury victims with ICD-9 diagnosis codes above 800 than for other cause-coded injury victims.

Example. Estimated pre-hospital and short-term post-discharge costs for a fractured scapula are 11.8% of $4,852, or $573. Total short-term care costs equal $5,425 ($4,852 + $573).

<u>Estimate Lifetime Costs from Short-Term Costs</u>. NMES only provides costs for the first six months after hospital discharge. The DCI provided data by diagnosis group on the percentage of lifetime medical payments paid in the first six months after injury. These percentages appear in Pindus et al. (1990, 1991). We divided the short-term costs by the percentage paid in the short term to estimate lifetime costs.

Miller, Pindus et al. (1995) concluded that the DCI did not fully capture lifetime costs for paralyzing spinal cord injuries or for catastrophic injuries resulting in multi-year institutionalization in a nursing home. We added these costs in two steps. First we estimated probabilities of nursing home admission and length of stay if admitted. Second, we estimated cost per year of stay.

For spinal cord injury, we used nursing home, attendant, and other post-discharge costs from the national household survey by Berkowitz et al. (1990). Miller, Pindus, et al. (1995) provide details about this survey and its estimates. For burn victims, Miller, Brigham et al. (1993) estimate the probability of nursing home admission following hospital discharge at 3.8%, computed from California discharge destinations. Stays averaged two years. For anoxia, aspirated foreign object, submersion, and traumatic brain injury cases, we computed nursing home admission probabilities from NHDS data. The probabilities were .115, .151, .018, and .103, respectively. We assumed discharge to nursing home for these injuries implied lifetime skilled nursing care, but a residual average lifespan of 10 years.

Bureau of the Census (1996) reports an annual cost of $84,285 (inflated to 1994 dollars using the CPI–All Items) for custodial care in a public mental retardation facility. Miller et al. (1989) suggest using this cost as a surrogate for ICF cost. They also estimate the average cost of a year in a Skilled Nursing Facility (SNF) is at least double the cost in an ICF. For catastrophic injuries, where SNF care is required, we use twice the ICF cost.

Example. DCI data show short-term costs are 69.11% of the total medical costs of a hospital-admitted fractured scapula. Dividing $5,425 by 69.11%, we estimate total medical costs for a 40-year-old woman admitted with a scapula fractured in a consumer-product incident will be $7,850.

Decompose Burn Costs by Type. NEISS distinguishes among six different categories of burns: scald, thermal, chemical, electrical, and radiation, as well as "not specified." ICD-9-CM diagnoses, however, do not differentiate burns by type, so the hospital costs by diagnosis are the same across all types for a given body part. In order to capture this distinction in the ICM, we returned to the Maryland and New York hospital discharge data and used E-codes to separate burn cases by type. For each body region, we computed the ratio of the average cost per admission for each burn type to the average cost for all burns. Scalds and thermal burns accounted for about 89% of all burn admissions. Hospital costs for thermal burns were higher than for scalds for all body regions except the hand and wrist. Table 9 shows all the ratios by body region and burn type.

Include Claims Processing Costs. The final medical cost factor accounts for the cost of processing medical payments. Claims processing costs are a fraction of medical claims payments, which varies by payer. Published insurance statistics, plus studies of Medicare and Medicaid claims processing costs, provided the payer-specific ratios of claims processing costs to claims payments shown in Table 10. For admitted cases, NHDS shows the distribution of payers, which varies by injury diagnosis. By diagnosis, we computed an average ratio of processing costs to payments. Multiplying these ratios by the medical costs yields the processing cost estimates. Across all cases including self-pay cases, claims processing costs average 5% of the medical care costs for a hospital-admitted injury, with a range from 3% to 10% across diagnoses.

Example. For a fractured scapula, NHDS suggests claims processing costs will average 5.57% of total medical payments. Multiplying 5.57% by $7,850, estimated claims processing costs are $437. Total estimated health care costs for the fracture equal $8,287 ($7,850 + $437).

Summary of Medical Costs per Admission by NEISS Diagnosis Category. Table 11 summarizes lifetime medical cost per survivor of a consumer product injury by place of treatment, age group, and sex. The left panel of the table shows costs by NEISS nature of injury code. Nerve damage and hemorrhage have the highest costs per admitted case. Electric shock, concussion without skull fracture, and ingested foreign object have the lowest costs per admitted case. These conditions all are ones where victims sometimes are admitted briefly for observation. The right panel of Table 11 shows average costs by NEISS body part code. The highest average costs for admitted cases are for injuries to the head, neck, wrist, and upper leg and injuries (generally burns) that affect at least 25% of the body.

Costs for Non-Admitted Cases

ICM uses medical payments per fee-for-service visit or ancillary expense as a proxy for costs for non-admitted victims. This section describes the steps involved in deriving medical spending per medically treated, non-admitted injury survivor and segmenting the cost estimates by medical treatment level. Recall that ICM not only costs the non-admitted ED cases captured by NEISS but uses these cases to estimate and cost non-admitted cases treated only in other settings.

Medical cost estimation for non-admitted cases was severely constrained by data availability. CHAMPUS provides costs for a rich range of diagnoses but does not differentiate costs of ED care from care in other non-admitted settings. NMES differentiates costs by treatment setting but contains so few cases that costs only can be stated separately for very broad diagnosis groups like dislocations or superficial injuries. The challenge was to use the two data sets to arrive at diagnosis-level cost estimates by highest level where treated.

The bottom section of Figure 3 summarizes the analysis in equation form. The overall estimate is built from diagnosis-specific data in six steps:

1. Estimate short-term medical payments per visit
2. Break out estimated payments per visit for non-admitted ED versus non-ED cases
3. Multiply payments per visit by visits per case
4. Add ambulance, prescription, and ancillary payments
5. Estimate lifetime costs from short-term costs
6. Include claims processing costs

Like the previous section, this section describes each step. It also develops costs for a non-admitted scapula fracture, which serves as a continuing example in Chapters 6–9.

Estimate Short-Term Medical Payments per Visit. Short-term medical payments per non-admitted medical visit by ICD-9 diagnosis came from CHAMPUS. As Chapter 5 stated, CHAMPUS data are not disaggregated by age or sex.

Example. For a scapula injury, CHAMPUS reports payments per non-admitted medical visit average $184 (in 1995 dollars).

Break Out Estimated Payments per Visit for ED versus Non-ED Cases. Guided by NMES data on costs per non-admitted visit by diagnosis group and highest level where treated (non-admitted ED versus non-ED) and by NHIS data on relative numbers of non-admitted ED versus non-ED cases, we split the CHAMPUS provider payments into estimated payments per visit by highest level where treated. Cases treated both in the ED and a non-hospital setting were classified as ED cases.

Example. For scapula fractures originating in the ED, including follow-up visits to other treatment settings, payments per visit average $130. Payments per visit for cases originating in doctor's offices or walk-in clinics average $335. (This pattern is atypical. For most non-admitted injuries, the costs per visit are higher for cases originating in the ED.)

Multiply Costs per Visit by Visits per Case. The costs per visit were multiplied times NMES visits per case for the relevant treatment setting and diagnosis group.

Example. ED-treated scapula fractures average 3.68 visits per case; doctor's office cases average 2.02 visits. That means ED-treated cases have average CHAMPUS-based costs of $478 (3.68 × $130) and doctor's office cases have average costs of $677 (2.02 × $335).

Add Ambulance, Prescription, and Ancillary Care Costs. CHAMPUS cost reports exclude payments for ambulance transport, prescriptions, and ancillary care. We added NMES data on these costs by highest level where treated (non-admitted ED or other) and diagnosis group.

NMES describes utilization for an average of six months after injury. Thus, the CHAMPUS/NMES estimates represent the short-term costs of medical care by diagnosis and highest level where treated.

Short-term costs per ED case are typically about one-third higher than costs of doctor's office/clinic treatment for comparable diagnoses. The costs for cases treated in the ED and released range from $157 for lead poisoning to $7,951 for liver injury. Other high-cost diagnoses include heart, lung, and other internal organ injuries, and traumatic amputation of the arm (a rare diagnosis in the non-admitted population).

Short-term costs per doctor's office or clinic case range from $55 for some poisonings to $3,789 for traumatic amputation of the leg. Other high-cost diagnoses include traumatic amputation of the arm, knee dislocation, liver injury, and neck/trunk fractures. Traumatic amputations and such, however, rarely are treated outside of hospital emergency or inpatient departments.

Example. Ambulance, prescription, and ancillary costs average $11 for ED-treated scapula/clavicle cases, yielding short-term costs of $489 per case ($478 + $11). Doctor's offices cases in the NMES data incurred no costs in these categories, so the short-term cost averages $677.

Estimate Lifetime Costs From Short-Term Costs. To estimate lifetime costs from the short-term costs, we divided the short-term costs by the DCI percentage of costs incurred after the acute care phase. Pindus et al. (1992) provides those percentages for non-admitted victims by diagnosis.

Example. DCI data show short-term costs are 85.29% of the total medical costs of a non-admitted fractured scapula. Dividing $489 by 85.29%, we estimate medical costs for a fractured scapula victim who is treated in the ED and released total $573. Similarly, costs average $793 for a victim treated only in a doctor's office or clinic.

Include Claims Processing Costs. To estimate claims processing costs for non-admitted NEISS cases, we multiplied the NHAMCS distributions of payers for non-admitted, non-motor-vehicle, ED-treated injury survivors times the claims processing cost percentages in Table 10. This procedure yielded an estimated average injury claims processing expense of 6.74% for injury survivors treated in the ED and released. A similar analysis of NAMCS data yielded an injury claims processing expense of 7.28% for non-admitted injury survivors treated only in non-ED settings. Multiplying the appropriate percentage times estimated lifetime medical costs (excluding nursing home costs) yields estimated claims processing costs.

Example. For an ED-treated-and-released fractured scapula, NHAMCS suggests claims processing costs will average 6.74% of total medical payments. Multiplying 6.74% by $573, estimated claims processing costs are $39. Total estimated health care costs for the fracture equal $612 ($573 + $39). NAMCS suggests claims processing costs for the fracture treated in the doctor's office will average 7.28% or $58. Total costs equal $851 ($793 + $58).

Summary of Medical Costs per Case by NEISS Diagnosis Category. Table 11 summarizes lifetime medical cost per non-admitted survivor of a consumer product injury by place of treatment. Medical costs are higher for non-admitted victims treated in the ED than just a doctor's office or clinic with the following exceptions: by nature, fractures, dislocations, nerve injuries, and internal injuries; by body part, shoulder and head injuries. In terms of NEISS nature of injury codes, amputations, dislocations, fractures, dental injuries, internal injuries and electric shock are most costly. Dermatitis, hematoma, and selected burns are least costly. Treatment of head, neck, and trunk injuries is most costly. Eye, hand, foot, and toe injuries are least costly to treat.

Figure 2. Steps to Build Medical Costs for Hospital-Admitted Cases

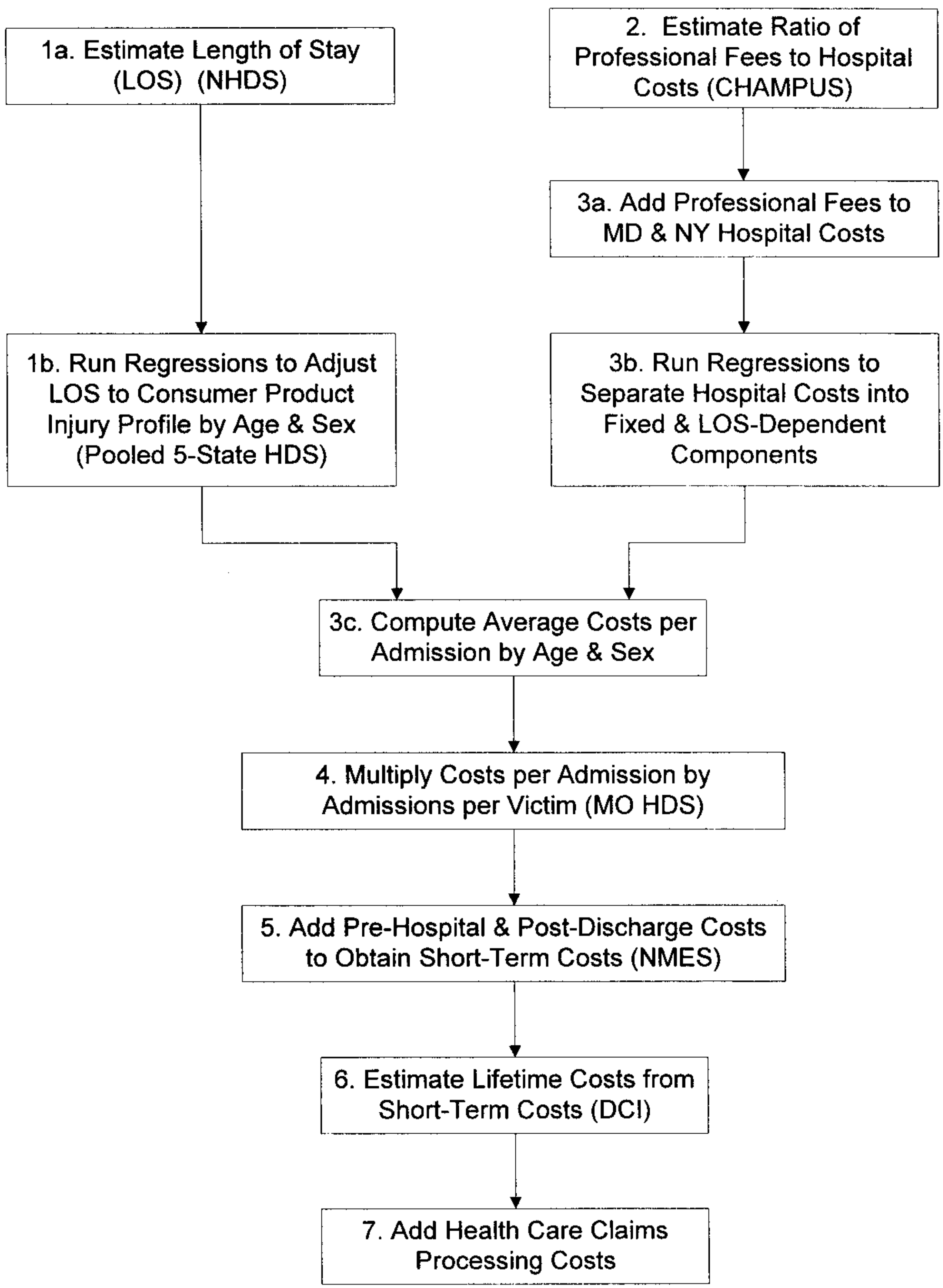

Figure 3. Injury Cost Model Medical Cost Equations

HOSPITAL-ADMITTED

Denote the medical cost per admitted case with diagnosis i as MH_i.

$$\mathbf{MH_i} = \{(1 + c_i) \times [(1 + a) \times (1 + e_i) \times H_i] / s_i\} + N_i$$

where,

- c_i = health insurance claims processing cost factor
- a = short-term ancillary and post-discharge medical cost factor (follow-up physician visits, prescriptions, medical equipment, physical therapy, home health, etc.)
- e_i = readmission factor
- H_i = total cost of hospital visit, including professional fees
- s_i = share of medical costs incurred in short term (used to include lifetime follow-up costs)
- N_i = nursing home cost for catastrophic injuries

In this equation, i denotes either data specific to diagnosis i or to a diagnosis group that includes diagnosis i. H_i is a computed variable.

$$H_i = C_{f,i} + (d_i \times C_{v,i})$$

where,

- $C_{f,i}$ = fixed cost of hospital visit (including professional fees)
- $C_{v,i}$ = variable cost of hospital visit (including professional fees)
- d_i = length of stay in hospital (by sex and age group)

NON-ADMITTED

Denote the medical cost per non-admitted case with diagnosis i as $MN_{i,t}$, where t is an index variable indicating whether the case was treated in the ED (e) or only treated in other non-admitted settings (d).

$$\mathbf{MN_{i,t}} = (1 + c_i) \times [(M_{i,t} \times v_{i,t}) + A_{i,t}] / s_i$$

where,

- c_i = health insurance claims processing cost factor
- $M_{i,t}$ = medical payments per visit (t = e, d)
- $v_{i,t}$ = acute care visits per case (t = e, d)
- $A_{i,t}$ = other ancillary medical costs
- s_i = share of medical costs incurred in short term (used to include lifetime follow-up costs)

Table 8. Ambulance, Prescription, Ancillary, and Medical Follow-Up Expenses for Hospital-Admitted Injuries, and Their Relation to Inpatient Expenses

	Mean Cost	Number of Uses	Mean Uses per Case	Mean Cost per Case
Ambulance	$ 177	104	0.26	$ 46
Prescription	83	202	0.51	42
Other Medical	210	72	0.18	38
Home Health Care	2,863	41	0.10	296
Emergency Dept	248	55	0.14	34
Outpatient Dept	336	23	0.06	19
Doctor/Clinic	69	2194	5.53	381
Total Ancillary				**$857**
Hospital Inpatient	$7,258	397	1.00	$7,258
Ratio Ancillary/Inpatient				0.118

Source: 1987 National Medical Expenditure Survey
Note: Mean cost per case was computed before rounding.

Table 9. Ratio of Average Total Hospital Costs for Burn Type to Average Total Hospital Costs for All Burn Types, by Body Region

	Burn Type				
Body Region	Chemical	Electrical	Scald	Thermal	Other
Head/neck	0.72203		0.70236	1.32677	0.42485
Trunk	0.65696		0.79673	1.38024	1.02339
Arm	0.40137		0.77317	1.27274	1.10324
Hand/wrist	0.52262	0.35550	1.26586	1.07505	0.87233
Leg	0.50249		0.98162	1.11524	0.78190
Multiple	0.28106		0.73961	1.39820	0.84463
Average	0.42246		0.87283	1.27033	0.63414

Source: Maryland 1994–95 and New York 1995 hospital discharge data.

Table 10. Health Care Claims Processing Expenses As a Percentage of Claims Costs, by Payer

Private/Commercial Insurance	8.4%
Worker's Compensation	13.0%
Medicare	3.2%
Medicaid	6.6%
Other Government Payment	6.6%
Self-Pay	0.0%
Not Stated	0.0%
No Charge	0.0%
Other	12.5%

Source: Miller (1993).

Table 11. Lifetime Medical Costs per Survivor of Consumer-Product Injury, by Place of Treatment and Nature of Injury or Body Part Injured, Including Health Insurance Claims Processing Costs (in 1995 dollars)

NEISS Injury Diagnosis	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted
41 Ingested Foreign Object	331	500	6315
42 Aspirated Foreign Object	610	890	247256
46 Burns, electrical	353	520	12315
47 Burns, not specified	406	652	27840
48 Burns, scald	437	720	26403
49 Burns, chemical	291	505	14026
50 Amputation	1134	2497	13201
51 Burns, thermal	372	578	40943
52 Concussions	588	1473	5362
53 Contusions, Abrasions	321	593	16199
54 Crushing	588	651	22112
55 Dislocation	1588	1055	19556
56 Foreign Body	358	697	9626
57 Fracture	1410	1137	19756
58 Hematoma	354	458	11967
59 Laceration	476	897	13346
60 Dental Injury	1155	1798	11730
61 Nerve Damage	5232	4118	479780
62 Internal Organ Injury	4303	2085	161620
63 Puncture	289	718	11104
64 Strain or Sprain	354	500	14086
65 Anoxia	412	536	185179
66 Hemorrhage	558	1625	22366
67 Electric Shock	399	519	3442
68 Poisoning	241	729	8669
69 Submersion	412	536	33047
70 Not Stated	954	1534	25794
71 Other	913	1478	26186
72 Avulsion	336	796	11461
73 Burns, radiation	284	474	16654
74 Dermatitis, Conjunctivitis	123	225	15574
AVERAGE	634	825	29584

NEISS Body Part	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted
00 Internal	340	514	22066
30 Shoulder	768	693	22000
31 Upper Trunk	1250	1289	16617
32 Elbow	522	780	12131
33 Lower Arm	683	1091	13970
34 Wrist	466	696	44710
35 Knee	545	628	16957
36 Lower Leg	570	744	19823
37 Ankle	511	732	13401
38 Pubic Region	511	979	14398
75 Head	1534	1163	81572
76 Face	503	845	14381
77 Eyeball	225	497	22317
79 Lower Trunk	705	1115	19812
80 Upper Arm	789	951	19841
81 Upper Leg	419	692	28874
82 Hand	394	572	12185
83 Foot	335	559	19003
84 25-50% of Body	453	785	44155
85 All Parts of Body	404	837	49404
87 Not Stated	788	1393	13293
88 Mouth	806	1391	39534
89 Neck	655	1112	39534
92 Finger	405	712	10472
93 Toe	275	496	9631
94 Ear	494	856	13651
TOTAL	620	825	29141

7. WORK LOSS ESTIMATION

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

- Short-term work losses of victims (VS) are the losses resulting from the victim's physical inability to work while recovering from an injury.

- Long-term work losses 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 experience and training.

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 4 summarizes the formulas used in the calculations.

Short-Term Work Losses of Victims (VS)

The value of short-term work loss equals 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,[26] whether hospital-admitted or non-admitted.

Probability of Short-Term Work Loss (Wage and Household). All hospital-admitted injuries obviously cause some wage and/or household work loss. We used 1987–1992 NHIS data to estimate the probability of losing work for medically treated, non-admitted injury victims. To achieve adequate sample size, we grouped ICD-9 diagnoses for analysis. For each of 26 diagnosis groupings, we estimated regression-based probabilities that injury of an employed person would result in at least one lost day of wage work.[27] The estimation procedure tailored the work-loss probabilities to consumer product injury by excluding motor vehicle cases and 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.

In the regressions, NHIS work-loss probabilities by diagnosis group did not differ significantly for non-admitted injuries by highest level where treated (emergency departments versus other 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 12 shows the mean work-loss probabilities for medically treated, non-admitted injury survivors. They range from 61% for back sprain, and 50% for trunk fractures, lower limb fractures, and knee/leg sprains to less than 10% for foreign bodies.

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 only for the two weeks preceding the

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[26] 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.

[27] We ran logistic regressions on 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 (region of the country, level of urbanization, and whether the locality was oversampled for blacks). Where appropriate, we also included dummy variables for body region injured and/or nature of injury. We evaluated the regression equations at the mean values for the stratifiers and with the occupational variable set to 0 to remove the influence of occupational injuries.

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 1993 BLS Annual Survey of Occupational Illness and Injury data. We had to work around two limitations of this data set. First, the survey only collects days lost during the calendar year. That means the data understate losses for *open cases* – injuries that occur near the end of the calendar year and those that result in especially lengthy work losses. To estimate mean work-loss duration by diagnosis, age group, and sex, we inferred the duration of these open cases. A second problem with the survey is that it 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 NHTSA 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 Annual Survey 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.[28] 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.

The BLS survey data do not provide a basis for differentiating work-loss duration by admission status. To make this differentiation, the ICM uses information collected in 1982–1985 by the National Highway Traffic Safety Administration's National Accident Sampling System (NASS) for a nationally representative sample of highway crash victims. Analyzing the NASS

[28] 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.

data on victims who lost work reveals that work loss duration is 3.0 times as long for hospital-admitted victims as for non-admitted victims. This ratio holds when the injuries are grouped by severity (rated on a 5-point threat-to-life scale) or by body region. Because the NASS ratio is robust with respect to severity, we are confident of its applicability to consumer product injuries, despite their tendency to be less severe than highway injuries. We used the NASS ratio to segment the mean work loss estimates by admission status.

To estimate the duration of wage work loss by admission status[29], we start with the BLS-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):

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

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 = $q + [(1 - q) \times p]$

Applying the NASS ratio of work loss duration for hospital-admitted versus non-admitted victims, $T^*_h = 3 \times T^*_n$. Substituting for T^*_h in the equation above and solving for T^*_n:

$$T^* = \{[(3 \times q) + (1 - q) \times p] \times T^*_n\} / r$$
$$T^*_n = (r \times T^*) / \{(3 \times q) + [(1 - q) \times p]\}$$

Tables 12 and 13 show the mean values of p and T*, respectively, by diagnosis group. We estimate q using NHDS counts of hospital-admitted survivors and NHIS counts of medically treated, non-admitted survivors.

A caveat about the BLS 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 13 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

[29] Although the revised ICM specifies work losses for each relevant combination of diagnosis group, sex, and age group, the discussion omits the corresponding subscripts in the interest of simplification.

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 in Table 14 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 nature of injury diagnosis.[30] 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 in Table 14 summarizes the same work-loss data by NEISS body part. Knee, ankle, lower trunk/back, and neck injury victims have the highest probabilities of work loss from non-admitted injuries; ear and internal injury victims have 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 BLS annual survey data (summarized in Tables 13 and 14) reveals 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

$.0365 + (.9635 \times .367) = .390$

Estimated mean duration of work loss per non-admitted victim age 35–54 with work loss (T^*_n) is

$(.390 \times 65.5 \text{ days}) / [(3 \times .0365) + (.9635 \times .367)] = 55.2 \text{ days}$

The average work loss duration for admitted cases (T^*_h) is 3 times as long, or 165.5 days.

<u>Duration of Short-Term Household Work Loss</u>. 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 procedure in Miller (1993) and Miller, Cohen, and Wiersema (1994). The procedure has two steps. First, lost wage-work days are multiplied by 365/243, since people do household work

[30] Detailed estimates by NEISS nature of injury and body part diagnosis are in the separately bound appendices.

daily, 365 days a year, but typically do wage work on only 243 days a year.[31] Second, the product is multiplied by 0.9, because Waller et al. (1990) and Marquis (1992) find people cannot do housework on 90% of the days when injury would have 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 223.7 days of household work loss (165.5 × .9 × 365/243) if hospital-admitted (T'_h) and 74.6 days of household work loss (55.2 × .9 × 365/243) if non-admitted (T'_n).

Value per Day of Work Lost. The duration models assess work loss in days. Wage data, however, typically are collected on an hourly basis. To cost a day of work loss, therefore, requires information on hours worked per day.

Conventionally, a day of wage work is valued as eight hours of work. The number of hours in a day of lost housework is less obvious. After evaluating available alternatives, Douglass et al. (1990) recommend using a regression model from Peskin (1984) to estimate the hours of household services performed per day by sex and age group. The model takes account of household demographic structure (e.g., marital status, family size, age of youngest child, parental education, and employment status). We applied the regression model to 1993–1994 Census Bureau data. Peskin developed her model for a data set of working-age people. Therefore, we used another source, the 1985 Panel Study of Income Dynamics, to estimate household work losses per day for the elderly (Miller and Jensen 1997).

Conceptually, the value of an hour of wage work equals the hourly wage rate plus fringe benefits. An hour of household work was valued using a method called the specialist cost approach (see Douglass et al. 1990 for a review). This approach starts by cataloguing the average hours per day the person spends on different categories of household tasks (for example, cooking, cleaning, child care, financial management, repairs and maintenance, and gardening). The time spent is valued at the average hourly wage of specialists in the relevant fields (a cook, a house-cleaner, a day care worker, a bookkeeper, etc.). We were able to differentiate the mix of tasks performed by sex, but not by age, because the sample size was small. Standard criticisms of this approach are that (1) a professional might perform the tasks at a different pace, (2) people may view portions of some tasks as leisure rather than work (e.g., gardening, child care), and (3) child supervision goes on as a background task 24 hours daily; the specialist cost approach only values child-care hours when this care is the primary activity.

We valued wage work losses with BLS data on average annual earnings by age group and sex in 1992 (based on a 2,080-hour work year) multiplied times probabilities of being in the

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

labor force and employed by age group and sex. We valued the household production losses with BLS data on wages by occupation in 1993. Fringe benefits are valued at 21.9% of wages according to data about wages and supplements in the National Income Accounts (Clinton 1997). Wages were converted to 1995 dollars with the Employment Cost Index (Clinton 1997).

Example. The estimated cost of short-term work loss for a 40-year-old woman with a hospital-admitted shoulder fracture will be $17,215 (165.5 days × $104.02/day) in wage work plus $7,469 (223.7 days × $33.39/day) in household work. For a non-admitted case of the same type of injury, her estimated work loss cost would be $2,107 (36.7% probability of work loss × 55.2 days × $104.02/day) in wage work and $914 (36.7% probability of work loss × 74.6 days × $33.39/day) in household work.

Long-Term Work Losses by Victims (VL)

When injury results in permanent (or "long-term") disability, the victim will lose work annually until death. The expected value of long-term work loss 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 1979–1988 DCI data about permanent disability **among Workers' Compensation lost-workday claimants**. Averaged across DCI states, workers must lose at least four days of work to become claimants. For non-admitted cases, the DCI probabilities were multiplied by 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 BLS annual survey 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), ingested foreign objects, dermatitis, and conjunctivitis. We used the disability probabilities for internal organ injuries for poisoning and ingested foreign objects. We conservatively assumed dermatitis and conjunctivitis never resulted in permanent disability.

A recent head injury study found that children are significantly less likely to suffer long-term disability from a head injury than adults (Becker et al. 2000). The DCI data, which cover only subjects of working age, could not capture this phenomenon. Therefore, the long-term disability cost of certain diagnoses involving the head (concussion, fracture, internal organ injury, and puncture) was adjusted downwards by 60% for children.

Total permanent disability results in 100% earnings loss. The percentage of impairment for partial permanent disability 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%. Applying these percentages by diagnosis to the 1995-1996 NEISS data results in an average impairment percentage of 13.1% – a bit lower than the DCI average, but not surprising, since consumer product injuries tend to be somewhat less severe than the workplace injuries on which DCI is based. We assume an equal loss in lifetime household production. For the four admitted diagnoses that involved permanent custodial care (traumatic brain injury, asphyxiation, aspirated foreign object, and submersion), we assumed the total permanent disability probabilities at least equaled the institutionalization probabilities.

The accepted way to value lifetime work is to multiply the average sex-specific value of work at a given age by the probability of surviving to that age. The future work is discounted to present value (the amount that would have to be invested today to pay someone to do this work in the future). We used NPSRI's proprietary linked FORTRAN and LOTUS modeling system to compute the present value of lifetime wage and household work losses. The system includes a standard age-earnings model as described in Rice et al. (1989) and Miller et al. (1996).

The NPSRI model inputs include 1992-1993 probabilities of survival, earnings if employed, 20-year average probabilities of labor force participation and employment given participation, and annual household production (365 times the daily household production estimates by age group and sex used in estimating short-term wage loss, as described above). The 20-year averages are superior to a single year of data because they adjust out the effects of the business cycle.[32] All values, including the estimated value of lifetime work, are broken down by sex and by age group (in 5-year increments, up to 85 and over). The revised ICM computes lifetime earnings losses at a 2.5% real discount rate.

Table 15 shows the present value of lifetime wage work and household work by age group and sex. (For reference, Table 15 also shows the **annual** value of household work.) 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.

[32] They do, however, ignore any temporal trends independent of the business cycle.

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 $d_{p,n} = .0000 \times .367 \times .778 = .0000$ and $d_{t,h} = .0233 \times .367 \times .778 = .00665$. A victim with partial permanent disability suffers an average 13.45% loss of earning capacity. From Table 15, the present value of expected lifetime work (K) for a 40-year-old female is $662,851 in 1994 dollars, or $680,026 inflated to 1995 dollars. The value of expected long-term work loss for an admitted injury (VL_h) is

$$\begin{aligned} VL_h &= K \times [d_{t,h} + (i \times d_{p,h})] \\ &= \$680{,}026 \times [(.0125 + (.1345 \times .2382)] = \$30{,}287 \end{aligned}$$

For a non-admitted injury, the losses would amount to

$$\begin{aligned} VL_n &= K \times [d_{t,n} + (i \times d_{p,n})] \\ &= \$680{,}026 \times [(.0000 + (.1345 \times .00665)] = \$608 \end{aligned}$$

Total Cost of Victim Work Loss

Table 16 summarizes the total expected cost of victims' work losses, including both short-term and long-term losses of both wage work and household work, averaged across all demographic groups. The left 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 submersion victims, followed by victims of amputations, anoxia, and nerve damage. The lowest costs are for poisoning, dermatitis, and conjunctivitis survivors.[33]

The right portion of Table 16 presents the value of expected total victim work losses by body part injured. Extremity injuries generally cause the greatest work losses among admitted victims, with toe injuries serious enough to require hospital admission imposing especially large losses. Upper extremity injury victims experience the largest average work loss per non-admitted case.

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[33] The costs for these diagnosis categories are low, in part, because we were unable to estimate their associated permanent disability probabilities very well.

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 is $98. This loss is the average across weekdays and weekends and across labor force participants and non-participants. It includes $76 in lost wages and fringe benefits and $22 in lost household production. It equates to roughly $6 per waking hour.

To represent the time people lose while transporting and visiting injury victims, we used the time-loss estimates in the original injury cost model. 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 $12 per case (2 hours × $6/hour). Visitor time costs for admitted cases are $18 per bed day (3 hours × $6/hour).

In addition to visitor and transportation costs, caregiver costs are associated with bed days at home. The model estimates caregiver costs for children 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, 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). By diagnosis and admission status, 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. This caregiver time plus the child's school-work losses are valued, somewhat arbitrarily, at the $98 average value of a lost work day.

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 $163 ($12 + $18 × 8.4). For a non-admitted case, family cost includes only transportation time at $12.

Employer Costs (EM)

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. Nevertheless, it may warrant further study.

Employers incur a variety of costs resulting from non-occupational injuries to employees. The original model did not separate these costs. This section discusses how the revised ICM estimates these costs.

Employers lose productivity whenever an employee works at less than usual capacity or is diverted to less demanding tasks (Miller 1997a). Uninjured co-workers also may lose productivity (Miller and Rossman 1990, NHTSA 1984). 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 1997a). 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 (1997a). 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).[34]

Miller and Galbraith 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 1995 dollars gives us $134.19. 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: $C_1 = 83 \times M = \$11{,}138$
- Employed, *not* permanently disabled, hospital-admitted: $C_2 = 10 \times M = \$1{,}342$
- Employed, temporary work loss, non-admitted: $C_3 = 3 \times M = \$403$
- Employed, no work loss, non-admitted: $C_4 = 0.25 \times M = \$34$
- Not employed: $C_5 = 2 \times M = \$268$

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).

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[34] 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.

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.

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

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

$EM_h = (.1868 \times \$11,138) + (.5582 \times \$1,342) + (.255 \times \$268) = \$2,898$

$EM_n = (.00495 \times \$11,138) + (.2685 \times \$403) + (.4716 \times \$34) + (.255 \times \$268) = \$248$

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:

$$WL = VS + VL + FF + EM$$

$$WL_h = \$24,684 + \$30,287 + \$142 + \$2,898 = \$58,011 \quad \text{(if admitted)}$$

$$WL_n = \$3,021 + \$608 + \$12 + \$243 = \$3,884 \quad \text{(if non-admitted)}$$

As Figure 5 shows, victim losses dominate total work-loss costs. Visitor work losses contribute negligibly to the total – less than 0.4%.

Figure 4. Injury Cost Model Work Loss Equations

Work loss includes the following four major components (VS, VL, FF, and EM):

- **(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 (wage work) 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

$T^*_n = (r \times T^*) / \{(3 \times q) + [(1 - q) \times p]\}$

$T^*_h = 3 \times T^*_n$

$T'_n = 0.9 \times (365/243) \times T^*_n$

$T'_h = 0.9 \times (365/243) \times T^*_h$

Estimation of victim long-term loss:

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

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:

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

where,

W = initial transportation/waiting time = 2 hours
v = value of time = \$6 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,

$$\mathbf{FF} = \$12 + (\$18 \times B)$$

Estimation of employer costs from victim work loss:

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

$$\mathbf{EM_n} = e \times [(d_n \times C_{pd}) + ((p - d_n) \times C_{td,n}) + (1 - p) \times C_{nd}] + (1 - e) \times C_{cg}$$
(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 = \$11,138
$C_{td,h}$ = cost of temporary disability = \$1,342
$C_{td,n}$ = cost of temporary disability = \$403
C_{nd} = cost if no work loss = \$34
C_{cg} = cost for caregiver work loss effect = \$268

Table 12. Unweighted Count of Workers Suffering Medically Treated, Non-Admitted Injuries and Weighted Probability Their Injuries Caused Work Loss, by ICD Diagnosis Group

ICD-9 Code	Raw 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 13. Estimated Mean Days of Work Lost per Person Losing Work, by BLS Diagnosis Group

Diagnosis Group	Estimated Mean Days	Estimated Median
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 Annual Survey of Occupational Illness and Injury, with durations estimated for cases that still were open when the survey was completed.

Table 14. Average Days of Work Lost Per Lost-Work Injury and Probability Non-Admitted Injury Victims Will Lose Work, by Body Part Injured or Nature of Injury

NEISS Nature of Injury	Days of Lost Work Males	Days of Lost Work Females	Probability of 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
AVERAGE	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
AVERAGE	21.2	21.2	0.34

Source: Estimated from 1993 BLS Annual Survey and 1987–1992 NHIS data.

Table 15. Present Value of Lifetime Wage Work (Including Fringe Benefits) and Household Work, and Value of Household Work in the Current Year, by Age Group and Sex (1994 dollars)

Age	Annual Household Production		Lifetime Household Production*		Lifetime Earnings*		Lifetime Total*	
	Male	Female	Male	Female	Male	Female	Male	Female
<1	0	0	107,493	233,701	872,188	500,961	979,681	734,662
1-4	0	0	115,560	250,733	914,380	524,135	1,029,940	774,868
5-9	0	0	129,389	280,651	978,824	560,903	1,108,213	841,554
10-14	0	0	146,587	317,833	1,055,105	604,384	1,201,692	922,217
15-19	4,659	10,218	156,619	338,643	1,124,615	638,882	1,281,234	977,525
20-24	4,612	9,123	153,344	331,234	1,163,049	644,351	1,316,393	975,585
25-29	4,708	10,780	149,803	323,096	1,155,011	617,688	1,304,814	940,784
30-34	5,106	12,125	144,838	305,850	1,094,159	563,975	1,238,997	869,825
35-39	5,422	12,492	137,589	281,464	991,427	493,540	1,129,016	775,004
40-44	5,539	11,881	128,446	254,376	852,410	408,475	980,856	662,851
45-49	5,596	11,206	118,030	227,767	685,607	314,080	803,637	541,847
50-54	5,714	11,728	106,530	199,765	501,826	217,988	608,356	417,753
55-59	6,182	12,473	93,382	166,070	326,251	132,671	419,633	298,741
60-64	6,985	13,845	76,816	123,790	186,139	66,965	262,955	190,755
65-69	6,735	7,808	57,190	84,562	101,053	28,311	158,243	112,873
70-74	5,567	6,983	38,673	62,430	53,484	11,415	92,157	73,845
75-79	4,281	6,075	23,985	42,675	22,850	3,705	46,835	46,380
80-84	3,229	5,333	12,996	24,906	10,895	1,480	23,891	26,386
>84	2,060	3,848	4,744	9,297	3,489	469	8,233	9,766

*Calculated using 2.5% real discount rate.

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

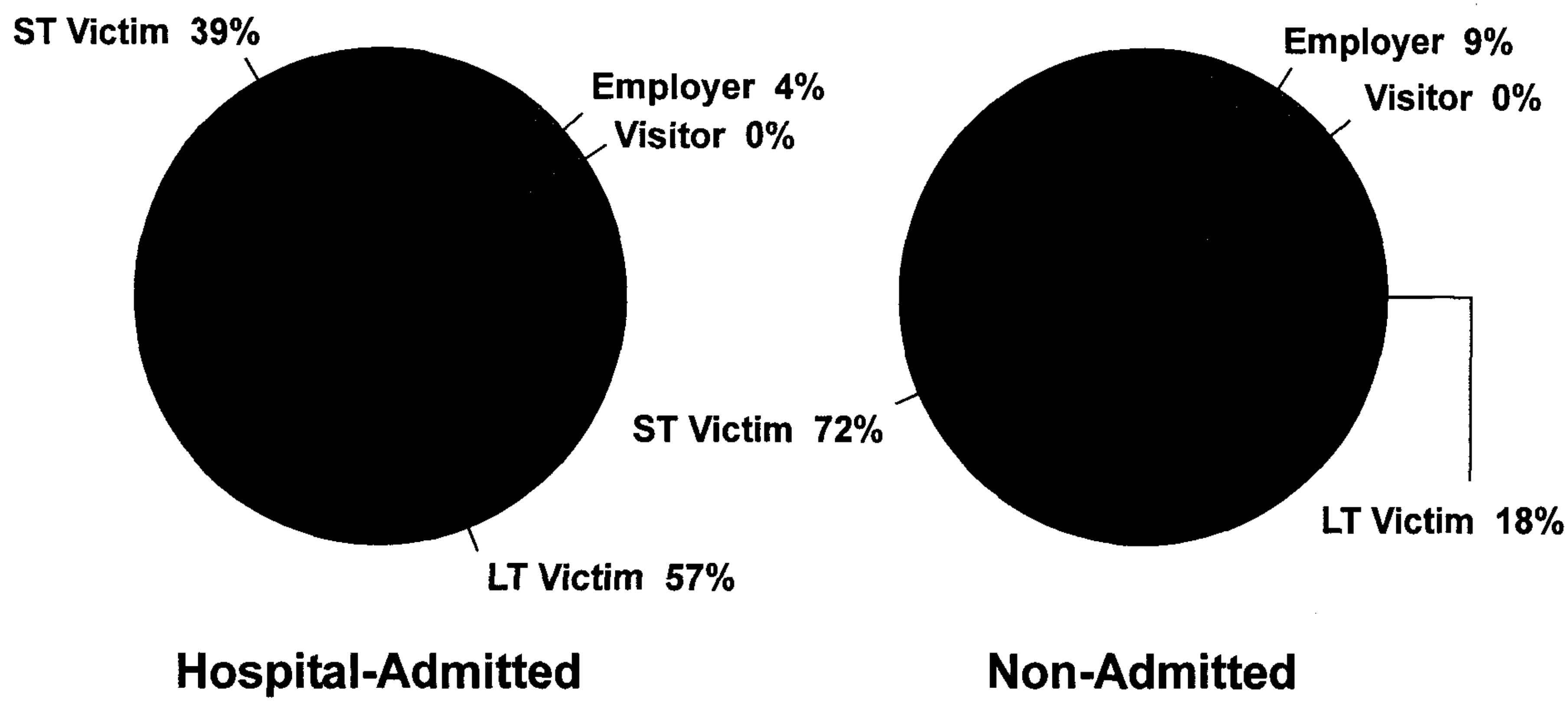
Table 16. Total of Short-Term and Long-Term Victim Work-Loss* Costs per Consumer-Product Injury Survivor by Victim's Admission Status and Nature of Injury or Body Part Injured (in 1995 dollars)

NEISS Injury Diagnosis	Non-Admitted	Hospital-Admitted
41 Ingested Foreign Object	363	16,160
42 Aspirated Foreign Object	281	12,273
46 Burns, electrical	2,703	33,165
47 Burns, not specified	1,910	23,674
48 Burns, scald	941	24,593
49 Burns, chemical	722	18,660
50 Amputation	27,272	146,711
51 Burns, thermal	1,145	22,971
52 Concussions	1,217	22,277
53 Contusions, Abrasions	456	12,025
54 Crushing	1,894	32,719
55 Dislocation	2,449	41,203
56 Foreign Body	205	30,880
57 Fracture	2,935	26,817
58 Hematoma	597	15,439
59 Laceration	391	24,780
60 Dental Injury	1,731	10,973
61 Nerve Damage	2,766	59,111
62 Internal Organ Injury	1,898	37,898
63 Puncture	331	56,932
64 Strain or Sprain	1,565	22,808
65 Anoxia	224	175,176
66 Hemorrhage	840	20,276
67 Electric Shock	460	67,387
68 Poisoning	636	18,991
69 Submersion	177	225,261
70 Not Stated	1,580	39,215
71 Other	1,334	23,341
72 Avulsion	1,122	44,356
73 Burns, radiation	1,297	10,957
74 Dermatitis, Conjunctivitis	433	4,487
AVERAGE	1,149	29,619

NEISS Body Part	Non-Admitted	Hospital-Admitted
00 Internal	360	15,906
30 Shoulder	1,908	25,777
31 Upper Trunk	1,407	19,042
32 Elbow	1,128	43,681
33 Lower Arm	2,032	51,704
34 Wrist	1,418	56,387
35 Knee	1,553	31,403
36 Lower Leg	1,469	43,681
37 Ankle	1,184	40,215
38 Pubic Region	1,059	31,290
75 Head	735	28,712
76 Face	408	17,778
77 Eyeball	423	59,657
79 Lower Trunk	1,918	12,340
80 Upper Arm	1,806	29,698
81 Upper Leg	945	18,697
82 Hand	785	35,292
83 Foot	1,229	34,144
84 25-50% of Body	767	37,164
85 All Parts of Body	605	59,215
87 Not Stated	1,415	19,487
88 Mouth	739	19,816
89 Neck	2,166	47,150
92 Finger	1,053	79,906
93 Toe	1,155	89,154
94 Ear	979	39,078
AVERAGE	1,193	29,619

* Including work loss by caregivers of injured children.

Figure 5. Work Losses for a Fractured Shoulder by Admission Status



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 still is 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 1997). Because these losses are both large and difficult to measure, the revised 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 applies the QALY approach 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) establish 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.[35] Lopez, Dexter, and Reinert (1995), Cohen (1988), Miller, Cohen, and Rossman (1993), Miller, Cohen, and Wiersema (1996), Bovbjerg, Sloan, and Blumstein (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) estimates pain and suffering for physical assaults from jury verdict regressions, then compares 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 vary fairly significantly in some cases; averaged across diagnoses, however, the mean estimates for physical assaults from the two methods differ 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 data base 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).[36] All cases involving consumer products were collected – even if the product's manufacturer was not subject to litigation. As shown in Table 17, we sampled 1,986 JVR cases that matched the above criteria. Of these cases, 828 involved a specified consumer product. The

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[35] 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.

[36] 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 equations 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.

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 consumer product-related injuries, the largest category of products involved bicycles (173),[37] hand tools (83), elevators (62), mopeds (46),[38] ladders (42), furniture (39), lawn mowers (33), beverage containers (32), and all-terrain vehicles (ATVs) (28). Other product categories contained 10 or fewer cases.[39]

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 data set, 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 data set.[40] Injuries to individuals ages 65 or over represent 8.4% of injured consumers identified by age in the JVR data set, compared to about 9.3% in the NEISS data. About 56.8% of the injuries occurred to individuals who were known to be employed at the time of injury. Minors represented about 28.3%,[41] 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).

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[37] Although 173 cases involved bicycles, 111 of these cases also involved moving motor vehicles. The regression includes a zero-one variable that identifies the automobile-related victims.

[38] Although 46 injuries involved mopeds, all but three cases also involved motor vehicles.

[39] The original JVR data set 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.

[40] It is possible that the reason for the lower percentage of children in our sample is due to the exclusion of many premises liability cases noted in a prior footnote. We tested this to see if there was a higher percentage of children in premises liability than consumer product liability cases, and found just the opposite. Premises liability cases actually had fewer children than consumer product liability cases.

[41] 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.

Table 18 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 18 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.[42] 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 18 is higher than the mean jury award. However, the mean jury award is based on 1,154 cases. When we restrict the 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).[43]

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.[44]

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

[43] 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 average jury award is $619,747 and the median award is $108,767. The mean pain and suffering award (including those with zero awards) is $562,742, while the median pain and suffering award is $75,188.

[44] 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

Table 19 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 pool injuries ($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),[45] 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 ($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),[46] and mopeds ($54,000).

In addition to those listed in Table 19, 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.

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account for contributory negligence. To do so would dramatically and incorrectly decrease the pain and suffering estimates in many cases.

[45] 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).

[46] 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).

The natural logarithm of pain and suffering was estimated using a log-linear regression model.[47] Table 20 reports the regression results.[48] In addition to the demographic, product-specific, and injury-specific variables, Table 20 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 and automobile-related liability from product liability.[49] 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.[50]

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[47] Pain and suffering estimates from regressions on the full sample of awards 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 the regressions that excluded these cases.

[48] 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.

[49] 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 19 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.

[50] 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 20 regression.

Table 20 can be used to estimate pain and suffering for any type of injury sustained as a result of a consumer-product-related incident. Table 21 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.[51]

Table 22 summarizes mean pain and suffering costs by level of treatment and separately by NEISS nature of injury or NEISS body part. The losses are largest for admitted survivors, generally followed by non-admitted ED victims. Nerve damage, which is dominated by spinal cord injury, imposes the most pain and suffering of any injury type. Internal injuries and amputations also impose very large losses. By body part, head injuries, whole-body injuries (typically severe burns), and the rare admitted toe injury (generally a potentially crippling crush or multiple traumatic amputation) impose the most pain and suffering. Pain and suffering is lowest for non-admitted doctor's office or clinic cases of dermatitis, contusions, abrasions, foreign bodies, and hematomas, and for non-admitted, ED-treated dermatitis cases.

Example. Pain and suffering was estimated with the regression equation in Table 20 and the estimated costs of a fractured shoulder for a woman ages 35–54 from earlier chapters. The equation was evaluated at the mean employment rate for women in their early 40s, 74.5%. 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. 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 victims who were not. We then multiplied the estimates by the probabilities of disability and no disability,

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In Table 20, we group past and future losses. Preliminary regressions that separated these losses yielded similar results.

[51] 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.

respectively, and summed them to get the revised ICM's pain and suffering estimates.[52] These pain and suffering calculations were performed separately for admitted, non-admitted ED, and other non-admitted cases.

Estimated pain and suffering costs are $60,057 for the hospital-admitted case without permanent disability and $124,356 for the permanently disabling case. With the 25.07% permanent disability probability for an admitted shoulder fracture, the mean value of pain and suffering is $76,176 ($58,540 × .7493 + $124,356 × .2507). Similar computations yield pain and suffering estimates of $17,740 for the victim treated in the ED and released, and $18,233 for the victim treated only at a doctor's office or clinic. By comparison, estimated medical and victim work-loss costs total $70,433 for the admitted case, $4,198 for the case treated in the ED and released, and $4,416 for the case treated only at a doctor's office or clinic. Thus, 52% of estimated costs for the hospital-admitted victim and 81% of costs for the non-admitted victims are pain and suffering. These values are consistent with the typical 65–85% range for pain and suffering costs as a percentage of total victim costs (Miller, Perth 1997).

Quality-Adjusted Life Years

A quality-adjusted life year (QALY) represents a year in perfect health. QALY losses show the percentage loss in health associated with a health state. The concept of valuing health effects in QALYs was popularized by Fanshel and Bush (1970). It forms the basis for cost-utility analysis. Patrick and Erickson (1993), Miller, Pindus et al. (1995), Miller (1997b), and Gold et al. (1996) review many of the QALY scales.

QALY measurement was considered in the original ICM but never implemented. Subsequently, the National Highway Traffic Safety Administration created functional capacity indices that were applied to a broad range of injury diagnoses (Hirsch et al. 1983). Luchter (1987), for example, used these indices to compute the years of life and functioning lost to highway crash injuries. Numerous peer-reviewed injury cost studies are based on QALYs related to those in the ICM sensitivity analysis – notably, Miller, Luchter, and Brinkman (1989), Miller et al. (1991), Miller (1993), Miller, Douglass, and Pindus (1994), Miller and Blincoe (1994), Miller, Pindus et al. (1995), and Miller and Galbraith (1995). These studies built QALY estimates from the functional capacity loss ratings, then monetized them. Miller, Pindus et al. (1995) details the computations.

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[52] 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.

First, a six-dimensional Injury Impairment Scale (IIS) was developed for rating the functional capacity losses that typically result from an injury (Hirsch et al. 1983). The scale assessed impacts on mobility, cognitive, bending and grasping, 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.

Second, physicians rated the typical functional capacity losses of a survivor for each survivable injury diagnosis with a threat-to-life severity of 2 or more (Hirsch et al. 1983).[53] They estimated the expected number of weeks of functional loss at each level during the year after injury (e.g., 15 weeks at mobility level 3) and the probable levels of impairment in years 2–5 and thereafter. Third, estimates derived from the work-loss impacts of the injuries were added for some previously unrated diagnoses (Carsten 1986) and for victims with the lowest threat-to-life severity score on the most commonly used severity scoring system, the Abbreviated Injury Scale (AAAM 1985). Fourth, data on a seventh dimension – the probability of permanent partial or total work-related disability – were estimated from DCI data (following the procedures described in the chapter on work loss and more fully in Miller, Pindus et al. 1995 and Pindus et al. 1991) and added for each injury.

Fifth, the seven dimensions of functional capacity loss (in a given time period) were converted into a single measure of lost utility (an economic measure of something's value) by applying published population survey estimates of the utility losses associated with different functional losses. This step uses opinion polling of the general population to convert the physician's estimates of the impacts of injury on physical functioning into QALY losses. For example, the physicians might estimate a hip fracture will leave the victim able to walk normally but unable to run or climb stairs. The opinion poll might ask people how much this restriction reduces their quality of life along a scale where 100% is normal ability to walk, run, and climb stairs and 0% is confinement to bed. Ratings not only were needed within dimensions, but across dimensions (e.g, the loss associated with severe disfigurement versus loss of sight in both eyes).

The utility loss estimates primarily came from Torrance (1982) (which is presented more simply in Drummond, Stoddart, and Torrance 1987). This study relies on time-tradeoff, a survey method that is a popular way to combine loss ratings by dimension into a single QALY measure. Some experts praise this technique; others question it (Gold et al. 1996). Miller, Calhoun, and Arthur (1989) find the available direct survey estimates of utility losses for specific health

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[53] Threat-to-life severity was rated on a generally accepted scale, the Abbreviated-Injury-Scale or AIS (AAAM 1985).

conditions (e.g., people's ratings of how much quality of life a blind person loses) compare reasonably well with ratings from Torrance's scale. Additional values and checks on Torrance's values came from rating efforts by Kaplan (1982), Green and Brown (1978), and Carsten (1986), as well as Kind, Rosser, and William's (1982) analysis of the non-economic component of British jury awards, which reportedly follow "an informal schedule". This step yielded an estimate of the quality-adjusted life years (QALYs) lost.

Several QALY rating scales have been developed since the analysis in Miller et al. (1991) and Miller, Pindus et al. (1995) was completed. Most notable are EuroQol (Williams 1995) and two impairment scales that Torrance has calibrated with two rating approaches (Torrance et al. 1992, Gold et al. 1996). Torrance's two new sets of ratings are somewhat inconsistent with one another; for virtually every functional loss category and severity level, however, at least one of the two new ratings appears to be consistent with the values used to convert IIS ratings to utility losses.

Where possible, ICM offers QALY loss estimates that can be used as an alternative to the jury verdict estimates. Pindus et al. (1991) mapped the QALY loss ratings by time after injury that Miller, Pindus et al. (1995) fully detail and document into NEISS diagnosis categories. These loss estimates originate with the IIS. To add the losses related to permanent disability[54], we use the formula

$$QALY_t = 1 - (1 - IISimp_t) \times (1 - .33 \times (ptotperm + pptperm \times \%imp))$$

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)

$IISimp_t$ is the 6-dimensional IIS-based QALY loss in time period t, which generally ranges from 0 to 1 (but is 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)

.33 is the QALY weighting factor for loss of ability to work, from Drummond, Stoddart, and Torrance (1987)

ptotperm is the probability of total permanent disability

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[54] The QALY estimates deliberately exclude short-term work loss to the extent possible. Therefore, the short-term work loss costs can be added to the QALYs without double-counting. When QALYs are monetized, the dollar value used is adjusted to avoid double-counting the monetary value of the work loss resulting from permanent disability.

pptperm is the probability of partial permanent disability

%imp is the average percentage of earning power lost to partial permanent disability

As in Miller, Pindus et al. (1995), total QALYs lost are computed (at a 2.5% real discount rate) as

$$QALY_{tot} = QALY_1 + 3.762 \times QALY_{2\text{-}5} + (PVyrs - 4.762) \times QALY_{6\text{-}99}$$

where:

3.762 is the sum of the present values, at a 2.5% annual discount rate, of years 2 through 5, i.e. $(1/1.025) + (1/1.025)^2 + (1/1.025)^3 + (1/1.025)^4$

PVyrs is the present value of the victim's expected lifespan according to a standard life table, discounted at a 2.5% discount rate

Example. Continuing with the fractured shoulder example from earlier chapters, exclusive of the permanent disability factor, Pindus et al. (1991) estimate the QALY losses for an admitted case are 3.23% of annual utility in year 1 and 0.06% thereafter. Recall that the hospital-admitted fractured shoulder victim has a 1.25% probability of total permanent disability and a 23.82% probability of partial permanent disability. Adding permanent disability, the losses are 4.65% in year 1:

$$1 - (1 - .0323) \times [1 - .33 \times (.0125 + .2382 \times .1345)] = .0465$$

and 1.53% per year thereafter:

$$1 - (1 - .0006) \times [1 - .33 \times (.0125 + .2382 \times .1345)] = .0153$$

The present value of average future lifespan for a woman age 40 is 24.22 years. Therefore, lifetime losses for the hospital-admitted shoulder fracture are 0.402 quality-adjusted life years:

$$.0465 \times 1 \text{ year} + .0153 \times 23.22 \text{ years} = .402 \text{ years}$$

The permanent disability probabilities for a non-admitted victim are 0.00% and 2.33%. The QALY losses for the non-admitted fracture are 2.09% in year 1 and nothing thereafter without the permanent disability factor. With the permanent disability factor, they are 2.19% in year 1:

$$1 - (1 - .0209) \times [1 - .33 \times (.0000 + .0233 \times .1345)] = .0219$$

and 0.103% per year thereafter:

$$1 - (1 - .0000) \times [1 - .33 \times (.0000 + .0233 \times .1345)] = .00103$$

Lifetime losses are 0.046 QALYs:

$$.0219 \times 1 \text{ year} + .00103 \times 23.22 \text{ years} = .046 \text{ years}$$

To put these losses in context, the admitted case costs 1.7% of lifetime utility (.402 / 24.22) and the non-admitted case costs 0.2% (.046 / 24.22).

Comparability of the QALY Estimates and Jury Award Estimates. We compared the pain and suffering estimates from the non-monetized QALY approach to the independent estimates from the jury awards approach. This comparison attempts to cross-validate the pain and suffering estimates from the two approaches. To compare, we redid the regression analysis shown in Table 20, substituting QALYs lost for past losses and the injury variables. Thus, the present value of future QALYs lost (stated as a fraction of the person's lifetime QALYs) replaces the variables used earlier to describe the injury. The coefficient on QALYs is highly significant (with t-values between 6.0 and 10.0) and positive. The strong significance of the QALY variable implies that the independent QALY and jury award estimates are reasonably consistent, which increases our confidence in their validity.

Table 17. Distribution of Product Injuries in Jury Awards, Settlements, and Mediation

Product	Number	Percent
Bicycle /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	1158	58.3%
Total	**1986**	**100%**

* All but three moped cases involved motor vehicles.

Table 18. Summary of Past and Future Losses and Awards (Jury Awards and Settlements)

	Cases	Mean	Median	Minimum	Maximum
Settlements					
Monetary Settlement	781	$ 320,705	$ 28,305	$ -	$ 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	1154	$ 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: Settlements are cases that settled out of court, while jury awards involve cases that ultimately went to trial.

NOTE: The rows are independent of each other – different but overlapping sets of cases appears in each row.

Table 19. Summary of Past Medical Loss and Jury Awards by Type of Product, For Jury Award Cases and Jury Award Cases with Separately Stated Medical Loss

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

Table 20. Regression Predicting Pain and Suffering from Jury Verdicts

Variable	Coefficient	Test Statistic	P(Insignificance)	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	.048
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	.059
Burn	.746	2.881	.004	.0571
Laceration/Puncture	-.262	-1.216	.224	.076
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 21. Predicted Pain and Suffering for Some Illustrative Hypothetical Injuries

Injury Type	Medical & Work Loss	Pain & Suffering
Minor Contus/Abras Only	-	$ 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 22. Pain and Suffering Cost per Survivor of Consumer-Product Injury by Nature of Injury or Body Part Injured (in 1995 dollars)

NEISS Injury Diagnosis	Non-Admitted: Doctor or Clinic	Non-Admitted: Emergency Department	Hospital-Admitted
41 Ingested Foreign Object	5,941	6,768	34,727
42 Aspirated Foreign Object	7,486	8,514	144,332
46 Burns, electrical	25,188	25,930	124,771
47 Burns, not specified	19,929	22,085	127,216
48 Burns, scald	18,094	20,247	135,230
49 Burns, chemical	15,343	17,260	119,680
50 Amputation	77,364	91,510	337,065
51 Burns, thermal	17,423	19,185	134,224
52 Concussions	21,058	27,477	90,620
53 Contusions, Abrasions	2,260	2,612	13,187
54 Crushing	14,881	14,887	77,729
55 Dislocation	20,952	19,033	83,077
56 Foreign Body	1,895	2,452	14,560
57 Fracture	17,883	16,210	71,763
58 Hematoma	2,420	2,485	12,990
59 Laceration	5,716	7,134	36,664
60 Dental Injury	6,159	7,168	21,393
61 Nerve Damage	67,191	58,945	824,884
62 Internal Organ Injury	59,273	44,681	390,195
63 Puncture	4,622	6,282	44,286
64 Strain or Sprain	7,762	7,607	36,141
65 Anoxia	6,176	6,742	157,702
66 Hemorrhage	2,469	4,036	17,914
67 Electric Shock	7,440	7,849	54,492
68 Poisoning	6,460	8,542	34,133
69 Submersion	5,929	6,571	107,645
70 Not Stated	7,681	8,541	71,342
71 Other	7,382	8,126	61,189
72 Avulsion	17,860	23,629	100,671
73 Burns, radiation	20,505	22,501	109,094
74 Dermatitis, Conjunctivitis	2,003	2,098	12,537
AVERAGE	8,671	9,085	92,943

NEISS Body Part	Non-Admitted: Doctor or Clinic	Non-Admitted: Emergency Department	Hospital-Admitted
00 Internal	5,993	6,828	41,892
30 Shoulder	11,582	11,118	61,922
31 Upper Trunk	12,003	11,092	65,293
32 Elbow	6,754	8,034	64,068
33 Lower Arm	9,230	11,286	72,615
34 Wrist	8,062	9,850	91,689
35 Knee	7,666	7,340	56,416
36 Lower Leg	8,584	9,273	81,631
37 Ankle	7,317	8,047	70,507
38 Pubic Region	5,050	6,141	46,891
75 Head	20,881	16,277	210,171
76 Face	4,711	6,463	44,484
77 Eyeball	3,029	5,153	46,738
79 Lower Trunk	10,126	10,103	64,649
80 Upper Arm	9,883	11,145	63,920
81 Upper Leg	6,248	7,304	72,878
82 Hand	6,453	7,581	71,741
83 Foot	6,791	7,311	76,426
84 25-50% of Body	4,977	6,464	154,211
85 All Parts of Body	6,288	7,883	68,507
87 Not Stated	5,235	5,916	31,346
88 Mouth	6,377	8,259	36,357
89 Neck	10,613	10,811	96,906
92 Finger	6,795	8,425	137,187
93 Toe	7,174	7,728	175,524
94 Ear	3,542	5,340	41,711
AVERAGE	8,671	9,085	88,457

9. PRODUCT LIABILITY COSTS

This chapter describes product liability costs, which include two related cost factors: (1) the costs of product liability insurance ("insurance") and (2) legal costs associated with product liability, such as litigation in which plaintiffs claim damages resulting from product defects ("legal"). Costs borne by insurers to defend against product liability litigation are included under insurance costs, not legal costs.

Product Liability Insurance Administrative Costs

Like the original model, the revised ICM includes the costs of administering the product liability insurance system. These costs include costs of defending the insured manufacturer or seller, the costs of claims investigation and payment, and general underwriting and administrative expenses. The product liability insurance administration component of ICM includes only administrative costs; to avoid double-counting, it excludes the medical, work loss, and pain and suffering compensation paid to injury victims and their families.

The original model also included the costs associated with product liability insurance brokerage and commissions. In 1991–1995, these costs averaged 11.1% of premiums paid, $250 million annually (A.M. Best 1996). Although these fixed sales costs are legitimate costs of consumer product injury in the aggregate, they are not marginal costs that decline when injuries are averted and are excluded from the revised ICM.

Product liability insurance premiums totaled $2.34 billion in 1994 and $2.16 billion in 1995 (Insurance Information Institute 1996). In 1991–1995, product liability claims processing costs averaged 30.4% of premiums; general underwriting and administrative expenses averaged 16.4% (A.M. Best 1996). Thus, claims investigation and payment processing costs totaled $684 million and general underwriting expenses totaled $369 million. These costs are spread across a base of roughly $446 billion in what this chapter calls victim-related costs – the sum of all wage, medical, and pain and suffering costs related to fatal[55] and non-fatal consumer product injury. They equate to 0.24% of the victim-related costs. Multiplying that percentage times the victim-related costs for a given product-related injury yields its estimated product liability insurance administrative costs. These administrative costs average $35 per product-related injury victim (averaged across the 29.9 million victims that the ICM estimates were medically treated in 1995).

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[55] For this calculation, we add $42.8 billion for fatalities - 21,400 annual consumer fatalities valued at $2 million per life. The $2 million value is our estimate, based on a review of awards for consumer product injury deaths, of the average wrongful death award.

Legal Costs

To model legal costs, we first estimate the number of product liability lawsuits filed annually and the average legal and court costs per lawsuit. From this information, we estimate a percentage multiplier on victim-related costs in the same way we derived the liability insurance administrative cost multiplier. Note that legal costs include fees, often proportions of awards, paid by plaintiffs to lawyers as compensation for their services. Beyond this, awards are merely transfers of responsibility for paying injury costs from plaintiffs to defendants. They are not included in the ICM because it counts costs, not who pays them.

Number of Liability Lawsuits. Smith et al. (1995) report 572,041 tort liability lawsuits were filed during 1993 in 29 reporting states. We calculate that these states have 3.3 tort liability lawsuits per thousand population. Assuming this rate holds for the remaining 21 states, we estimate 827,144 tort liability lawsuits are filed annually. In the nation's 75 most populous counties 3.38% of tort liability lawsuits were product liability lawsuits (Smith et al. 1995). Multiplying that percentage by the number of tort liability lawsuits yields an estimate of 27,957 product liability lawsuits filed annually.

Cost per Lawsuit. A lawsuit involves three categories of costs besides the defense attorney costs covered as part of insurance claims payment expenses: court and claiming expenses, plaintiff attorney fees, and time spent by plaintiffs, defendants, and witnesses. A major study by Kakalik and Pace (1986) estimates the average costs for these components in a tort case other than a motor vehicle crash is $25,365 (inflated to 1995 dollars with the Consumer Price Index – All Items). This estimate includes $2,383 in court and claiming expenses, $12,938 in plaintiff attorney fees, and time valued at $10,044.

Legal Costs Multiplier. Annual product liability litigation costs exclusive of defense costs counted in insurance claims processing are an estimated $689.6 million or 0.15% of the $446 billion in victim-related costs.[56] The costs average $23 per consumer product injury victim.

Total Costs

With the legal and liability costs now included, our estimates of consumer product injury costs are complete. Table 23 shows the average total cost per nonfatal case – the sum of medical, work loss, pain and suffering, and legal and liability costs – by NEISS nature of injury and body part. Nerve damage and amputation are the most costly injury diagnoses, overall. Hospitalized cases of aspirated objects, anoxia, and submersion also have high average costs because of the permanent brain damage that can result. The head is the most expensive body part to injure.

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[56] This estimate excludes $328.6 million in defense legal expenses ($12,087 per case), which are treated as liability insurance claims payment expenses.

Table 23. Average Total Cost per Nonfatal Consumer-Product Injury by Nature of Injury or Body Part Injured (1995 dollars)

NEISS Injury Diagnosis	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted
41 Ingested Foreign Object	6,927	7,930	57,947
42 Aspirated Foreign Object	8,678	9,985	406,112
46 Burns, Electrical	28,692	29,491	172,108
47 Burns, Not Specified	22,657	24,994	181,035
48 Burns, Scald	19,810	22,257	188,084
49 Burns, Chemical	16,747	18,769	154,317
50 *Amputation*	105,756	123,420	502,217
51 Burns, Thermal	19,285	21,269	200,479
52 Concussions	23,211	30,556	119,803
53 Contusions, Abrasions	3,295	3,910	42,592
54 Crushing	17,718	17,736	135,198
55 Dislocation	25,365	22,880	146,207
56 Foreign Body	2,681	3,593	56,674
57 Fracture	22,608	20,648	120,142
58 Hematoma	3,652	3,779	41,557
59 Laceration	6,843	8,686	76,583
60 Dental Injury	9,326	11,018	45,917
61 Nerve Damage	75,731	66,356	1,372,164
62 *Internal Organ Injury*	65,896	49,282	593,260
63 Puncture	5,468	7,580	114,341
64 Strain or Sprain	10,037	9,827	74,799
65 Anoxia	7,037	7,730	521,868
66 Hemorrhage	4,117	6,789	62,044
67 Electric Shock	8,548	9,065	127,743
68 Poisoning	7,641	10,221	62,534
69 Submersion	6,815	7,586	368,168
70 Not Stated	10,523	11,930	138,345
71 Other	9,976	11,121	112,578
72 Avulsion	19,489	26,022	158,525
73 Burns, Radiation	22,573	24,540	139,034
74 Dermatitis, Conjunctivitis	2,802	2,945	38,661
AVERAGE	10,824	11,328	149,142

NEISS Body Part	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted
00 Internal	6,987	8,001	80,708
30 Shoulder	14,580	13,996	111,479
31 Upper Trunk	15,004	14,013	102,682
32 Elbow	8,655	10,296	121,568
33 Lower Arm	12,186	14,811	140,271
34 Wrist	10,115	12,426	195,116
35 Knee	10,116	9,655	106,968
36 Lower Leg	10,939	11,768	147,661
37 Ankle	9,285	10,314	126,890
38 Pubic Region	6,904	8,469	94,096
75 Head	23,528	18,480	322,843
76 Face	5,890	8,020	78,010
77 Eyeball	3,910	6,328	130,787
79 Lower Trunk	13,143	13,276	98,224
80 Upper Arm	12,725	14,335	115,060
81 Upper Leg	7,916	9,185	122,320
82 Hand	7,886	9,206	121,484
83 Foot	8,697	9,288	131,835
84 25-50% of Body	6,463	8,292	238,220
85 All Parts of Body	7,566	9,631	178,903
87 Not Stated	7,708	9,012	65,446
88 Mouth	8,194	10,708	69,064
89 Neck	13,856	14,209	185,878
92 Finger	8,492	10,487	230,923
93 Toe	8,921	9,612	277,938
94 Ear	5,095	7,678	96,281
AVERAGE	10,824	11,328	149,142

10. MAPPING INTO NEISS DIAGNOSIS CODES

The Injury Cost Model operates by merging cost estimates onto individual NEISS cases. The merge is by body part, nature of injury code, 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 data sets in the cost computations – NHDS, NHIS, NMES, CHAMPUS, and state hospital discharge data sets – code injuries using the Ninth Edition of the International Classification of Diseases (ICD-9; DHHS 1994). ICD-9 is not limited to injury-related morbidity or mortality. It is organized around nature of injury or illness codes. ICD-9 codes a nature category in three digits. The Clinical Modification, ICD-9-CM, provides greater coding detail by adding two more digits. In contrast to NEISS, ICD 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 Open Wound category groups three NEISS categories: Avulsion, Laceration, and Puncture.

Because most of our medical data sources use ICD-9-CM, our estimates largely were built by ICD diagnosis. To put the estimates in the ICM, we had to map them from ICD-9-CM to NEISS diagnoses. 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 and NEISS used hundreds of codes cloaked in medical jargon.

ICD-NEISS Mapping

Chapter 6 and Appendix B describe the range of ICD-9 codes mapped into NEISS codes. We built two maps from ICD-9-CM to NEISS - one from 5-digit ICD-9 codes, and another from 3-digit ICD-9 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 ICDs, notably late effects of injury (ICD 905-909), a single ICD group may map to many NEISS codes. For example, late effects of tendon injuries (ICD 905.8) maps to 72 different NEISS groups.

A cost estimate for a given NEISS code was computed as the weighted average of the costs for the various ICD diagnosis groups mapped to the NEISS code. For the 5-digit mapping applied to hospital-admitted cases, each ICD group was weighted by its case count in the pooled five-state (CA, MD, NY, VT, WA) data set of admitted consumer product injuries. In the 3-digit mapping applied to non-admitted cases, NHIS case counts further segmented in proportion to CHAMPUS case counts within ICD groupings were used as weights. When a given ICD group was mapped to multiple NEISS codes, its weight was divided evenly among the codes it was mapped to.

Example. Sprains and strains of shoulder and upper arm (ICD 840) was split into two ICD groups at an earlier stage – rotator cuff (capsule) sprain and strain (ICD 840.4), with 4,755 hospital-admitted cases, and all others (ICDs 840.0-840.3, 840.5-840.9), with 692 admitted cases. The rotator cuff diagnosis is mapped to NEISS code 6430 (64 = strain or sprain, 30 = shoulder). The other diagnosis group is mapped to both 6430 and 6480 (80 = upper arm). The 692 cases in the other group are divided evenly between the two NEISS codes, giving each a weight of 346 cases. The cost for an admitted survivor with diagnosis 6480 equals the average cost for the corresponding ICD group. The medical cost, in 1994 dollars, for NEISS diagnosis 6430 for admitted males ages 20–54 is:

$$[(4{,}755 \times \$8{,}649) + (346 \times \$8{,}616)] \,/\, (4{,}755 + 346) = \$8{,}647$$

11. CONCLUSION

Strengths of the ICM Estimates

The Revised Injury Cost Model (ICM) improves on the original model in a number of significant ways. For example, incidence estimates for non-ED medically treated injuries are now linked to injury groupings and the age of the injury victim, unlike in the original model, and may therefore differ substantially from the original model's estimates depending on the types of injuries involved. Generally, more severe injuries are treated in non-ED settings less often than minor injuries (for example, three-fourths of sprained ankles are treated in non-ED settings, but fewer than half of dislocations are treated in non-ED settings). Also, the original model did not estimate the injury victims admitted directly to hospitals from doctors' offices or directly to burn centers or other trauma facilities.

The ICM also greatly simplifies the reporting of costs, if not their estimation. Costs have been grouped into four easy-to-understand categories: medical costs, work loss, pain and suffering, and product liability costs. All four cost groupings are more comprehensive in the ICM than in the original model. Professional fees, ancillary costs, and long-term costs are captured better in the medical cost estimates of the ICM. Work loss estimates of the ICM now include permanent disability resulting from non-admitted injuries. Since the regression equations to estimate pain and suffering include medical costs and lost work as independent variables, the pain and suffering estimates will reflect the more comprehensive estimates of these costs. Also, all four cost groupings are far more up-to-date than the original model, since they are based on data that reflect the enormous changes in medical technology and practice, the work force, and the legal landscape that have occurred over the last 20 years.

ICM estimates the cost of all 29.9 million medically treated, nonfatal consumer product injuries at $405 billion for 1995, with medical costs accounting for 9 percent of the costs, lost work for 13 percent, and pain and suffering for 78 percent. The comparable cost estimate from the original model would be less than half of the ICM estimate.

The ICM estimates costs for both the emergency department (ED) injuries estimated by CPSC's NEISS and non-ED injuries treated in doctor's offices, walk-in clinics, and other settings. ED-treated injuries account for 40 percent of total injuries, but 50 percent of total costs. Costs for ED-treated injuries were, on average, 52 percent greater than those treated in other settings. This difference is explained by the relatively high proportion of ED-treated injuries admitted to the hospital (4.2 percent) versus those treated initially in doctors' offices and other non-ED settings (less than 0.5 percent) and 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 - for example, medical costs for amputation of the arm above the elbow (ICD 887.2, 887.3) - we were unable to accumulate enough data points to be assured of statistical reliability, despite our best efforts to combine injury and victim categories. As a result, certain estimates may be problematic. These instances are relatively rare and the effects on any analysis are likely to be limited by the mapping process, which tends to spread the impact of cost estimates over several NEISS codes. Furthermore, the injury categories with these problems also tend to occur infrequently in the NEISS injuries - for example, NEISS has no hospitalized cases of amputations of the elbow (5032) or upper arm (5080); thus their impact on any analysis is likely to be highly diluted.

Since the ICM injury costs are based on NEISS 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 costs for those cases should be regarded with caution.

Further Research

This revision of the Injury Cost Model addresses many of the limitations of the original model, but several potential areas of benefit analysis could not be fully addressed. Addressing them may require long-term follow-up of NEISS cases. For example, some evidence suggests that head injuries, even apparently minor ones, can cause long-term cognitive deficits or behavioral problems that may significantly affect the quality of life for the head injury victim and his or her family. Following head injury cases supplied by the NEISS system could help determine whether the ICM adequately reflects these injury sequelae. Follow-up of NEISS cases may also provide valuable information on 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.

Nursing home costs were not fully developed in the ICM because of resource constraints; costs for nursing homes can be developed from existing databases. Nursing home costs are likely to be a minor factor for all but the most severe consumer product injuries.

For lack of data, this study has not estimated permanent disability probabilities for poisonings (essentially setting them to 0). The only poisoning disability data we were able to locate was an all-exposure average for occupational exposures. The mix of toxins seems likely to differ greatly between occupational and consumer product incidents. The best source for information on disability caused by consumer-product poisonings probably is follow-up on a sample of NEISS poisoning cases, possibly as part of in-depth investigations involving specific products.

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. The Commission 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. It preceded a variety of medical care cost containment efforts. Since then, measures of lost quality of life have become more accepted and medical costs have shifted treatment regimens. 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.

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APPENDIX A: Example of Cost Calculations

This appendix recapitulates the running example used in Chapters 6–9. The example builds a step-by-step cost estimate for a 40-year-old woman's fractured scapula (i.e., shoulder blade, ICD-9 diagnosis 811).

Medical Costs for Hospital-Admitted Cases

Length of stay. For scapula fractures, the NHDS length of stay averages 4.2 days. The regression on pooled 5-state data shows the length of stay for consumer product-related scapula fractures of women ages 20–54 is 80% of the average for all scapula fractures. Multiplying 4.2 by 80%, we estimate the length of stay for our victim to be 3.36 days.

Ratio of professional fees to hospital costs. For a fractured scapula, CHAMPUS shows the ratio of professional fees to hospital payments is .1814. The costs incurred during a hospital admission for scapula fracture will be 1.1814 times the hospital's costs. This factor will be applied to the total hospital charge for each scapula-fracture case in the Maryland and New York hospital discharge data sets.

Average cost of hospital admission. The estimated regression equation for a hospital-admitted scapula fracture (in 1994 dollars) is:

Cost = \$2,038.60 + (\$740.40 × Length of Stay)

In this equation, the dollar amounts are the coefficients estimated by the regression. Given the mean length of stay of 3.36 days for a woman 20–54 years old, the estimated cost is \$4,526.

Readmissions. The average scapula fracture results in 1.072 hospital admissions. Multiplying 1.072 by the \$4,526 cost per admission yields total hospital costs of \$4,852.

Additional short-term costs. Estimated pre-hospital and short-term post-discharge costs for a hospitalized injury are 11.8% of \$4,852, or \$573. Total short-term care costs equal \$5,425 (\$4,852 + \$573). (These costs include ambulance transportation, follow-up care, prescriptions, and ancillary goods.)

Lifetime medical costs. DCI data show short-term costs are 69.11% of the total medical costs of a hospital-admitted fractured scapula. Dividing \$5,425 by 69.11%, we estimate total medical costs for a 40-year-old woman admitted with a scapula fractured in a consumer-product incident will be \$7,850.

Claims processing costs. For a fractured scapula, NHDS suggests claims processing costs will average 5.57% of total medical payments. Multiplying 5.57% by \$7,850, estimated claims processing costs are \$437. Total estimated health care costs for the fracture equal \$8,287 (\$7,850 + \$437).

Medical Costs for Non-Admitted Cases

Average cost per visit. For a scapula injury, CHAMPUS reports payments per non-admitted medical visit average $184 (in 1995 dollars).

Separating costs for ED and Non-ED Cases. For scapula fractures originating in the ED, payments per visit, including follow-up visits to other treatment settings, average $130. Payments per visit for cases originating in doctor's offices or walk-in clinics average $335. (This pattern is atypical. For most non-admitted injuries, the costs per visit are higher for cases originating in the ED.)

Average costs per case. ED-treated scapula fractures average 3.68 visits per case; doctor's office cases average 2.02 visits. That means ED-treated cases have average CHAMPUS-based costs of $478 (3.68 × $130) and doctor's office cases have average costs of $677 (2.02 × $335).

Additional short-term costs. Ambulance, prescription, and ancillary costs average $11 for ED-treated scapula/clavicle cases, yielding short-term costs of $489 per case ($478 + $11). Doctor's offices cases in the NMES data incurred no costs in these categories, so the short-term cost averages $677.

Lifetime medical costs. DCI data show short-term costs are 85.29% of the total medical costs of a non-admitted fractured scapula. Dividing $489 by 85.29%, we estimate medical costs for a fractured scapula victim who is treated in the ED and released total $573. Similarly, costs average $793 for a victim treated only in a doctor's office or clinic.

Claims processing costs. For an ED-treated-and-released fractured scapula, NHAMCS suggests claims processing costs will average 6.74% of total medical payments. Multiplying 6.74% by $573, estimated claims processing costs are $39. Total estimated health care costs for the fracture equal $612 ($573 + $39). NAMCS suggests claims processing costs for the fracture treated in the doctor's office will average 7.28% or $58. Total costs equal $851 ($793 + $58).

Short-Term Work Loss Costs

Probability of short-term work loss. For all hospital-admitted cases, the probability of losing work is 100%. For non-admitted cases, the probability of losing work after fracturing a shoulder is 36.7%, according to results of regression analysis of the NHIS data.

Duration of short-term wage work loss. Our analysis of the BLS annual survey data (summarized in Tables 13 and 14) reveals 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 for a woman age 35–54 is 65.5 days.

Of medically treated shoulder fractures, 3.65% are hospital-admitted. 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 is

$.0365 + [(1 - .0365) \times .367] = .390$

Estimated mean duration of work loss per non-admitted victim age 35–54 with work loss (T^*_n, as defined on page 68) is

$(.390 \times 65.5 \text{ days}) / [(3 \times .0365) + (.9635 \times .367)] = 55.2 \text{ days}$

The average work loss duration for admitted cases is 3 times as long, or 165.5 days.

Duration of short-term household work loss. If the woman's fractured shoulder results in work loss, it is expected to cause 223.7 days of household work loss (165.5 × .9 × 365/243) if hospital-admitted and 74.6 days of household work loss (55.2 × .9 × 365/243) if non-admitted.

Cost of short-term work loss. The estimated cost of short-term work loss for a 40-year-old woman with a hospital-admitted shoulder fracture will be $17,215 (165.5 days × $104.02/day) in wage work plus $7,469 (223.7 days × $33.39/day) in household work. For a non-admitted case of the same injury, her estimated work loss cost would be $2,107 (36.7% probability of work loss × 55.2 days × $104.02/day) in wage work and $914 (36.7% probability of work loss × 74.6 days × $33.39/day) in household work.

Other Work-Loss Costs

Permanent disability. 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 $d_{p,n} = .000 \times .367 \times .778 = .000$ and $d_{t,h} = .0233 \times .367 \times .778 = .00665$. A partially permanently disabled shoulder-injury victim suffers an average 13.45% loss of earning capacity. From Table 15, the present value of expected lifetime work for a 40-year-old female is $662,851 in 1994 dollars, or $680,026 inflated to 1995 dollars. The value of expected long-term work loss for an admitted injury is $680,026 × [(.0125 + (.1345 × .2382)] = $30,287. For a non-admitted injury, the losses amount to $680,026 × [(.0000 + (.1345 × .00665)] = $608.

Work loss of family and friends. 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 $163 ($12 + $18 × 8.4). For a non-admitted case, family cost includes only transportation time at $12.

Employer costs. The cost of an injury to employers depends on the victim's employment status, admission status, whether the victim loses work, and whether the victim is permanently disabled. The costs of the various scenarios, explained on page 65, will be used below without further explanation. For a 40-year-old female, the probability of being employed is 74.5%, and the probability of not being employed is 25.5%. If she fractures her shoulder, she has a 100% probability of losing work if hospital-admitted and 36.7% if non-admitted. Using the probabilities of permanent partial and permanent total disability that we estimated under victim long-term disability, the probability of permanent disability is 25.07% (23.82% + 1.25%) for a hospital-admitted injury and 0.665% (0.665% + 0.00%) for a non-admitted injury.

For a hospital-admitted injury, three scenarios are possible: employed victim permanently disabled ($11,138), employed victim not permanently disabled ($1,342), and unemployed victim ($268). The expected employer cost of a 40-year-old woman's hospital-admitted shoulder fracture is the sum of these three values times their respective probabilities:

$$\{.745 \times [(.2507 \times \$11{,}138) + ((1 - .2507) \times \$1{,}342)]\} + (.255 \times \$268) = \$2{,}898$$

For a non-admitted injury, there are four scenarios: employed victim permanently disabled ($11,138), employed victim with temporary work loss ($403), employed victim with no work loss ($34), and unemployed victim ($268). The expected employer cost of a 40-year-old woman's non-admitted shoulder fracture is the sum of these four values times their respective probabilities:

$$\{.745 \times [(.00665 \times \$11{,}138) + ((.367 - .00665) \times \$403) + ((1 - .367) \times \$34)]\} + (.255 \times \$268) = \$248$$

Total cost of work loss. Total work loss is the sum of its four components: short-term work loss, long-term work loss, work loss of family/friends, and employer costs. For the 40-year old female shoulder injury victim, this loss is:

$24,684 + $30,287 + $142 + $2,898 = $58,011 (if admitted)
$3,021 + $608 + $12 + $243 = $3,884 (if non-admitted)

Pain and Suffering Costs

Jury verdict approach. Pain and suffering was estimated with the regression equation in Table 20 and the estimated costs of a fractured shoulder for a woman of age 35–54. The equation was evaluated at the mean employment rate for women in their early 40s, 74.5%. 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. 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 victims who were not. We then multiplied these two estimates by the probabilities of disability and no disability, respectively, and summed them to get the revised ICM's pain and suffering estimates.[57] These pain and suffering calculations were performed separately for admitted, non-admitted ED, and other non-admitted cases.

Estimated pain and suffering costs are $60,057 for the hospital-admitted case without permanent disability and $124,356 for the permanently disabling case. With the 25.07% permanent disability probability for an admitted shoulder fracture, the mean value of pain and suffering is $76,176 ($60,057 × .7493 + $124,356 × .2507). Similar computations yield pain and suffering estimates of $17,740 for the victim treated in the ED and released, and $18,233 for the victim treated only at a doctor's office or clinic.

<u>QALY approach</u>. Exclusive of the permanent disability factor, Pindus et al. (1991) estimate the QALY losses for an admitted case are 3.23% of annual utility in year 1 and 0.06% thereafter. Recall that the hospital-admitted fractured shoulder victim has a 1.25% probability of total permanent disability and a 23.82% probability of partial permanent disability, and in the latter case will suffer a 13.45% reduction in earning capacity. Adding permanent disability, the losses are 4.65% in the first year:

$$1 - (1 - .0323) \times [1 - .33 \times (.0125 + .2382 \times .1345)] = .0465$$

and 1.53% thereafter:

$$1 - (1 - .0006) \times [1 - .33 \times (.0125 + .2382 \times .1345)] = .0153$$

(These calculations use the formula on pp. 84–85.) The present value of average future lifespan for a woman age 40 is 24.22 years. Therefore, lifetime losses for the hospital-admitted shoulder fracture are 0.402 quality-adjusted life years:

$$.0465 \times 1 \text{ year} + .0153 \times 23.22 \text{ years} = .402 \text{ years}$$

The permanent disability probabilities for a non-admitted victim are 0.00% and 2.33%. The QALY losses for the non-admitted fracture are 2.09% in the first year and nothing thereafter without the permanent disability factor. With permanent disability, they are 2.19% in the first year:

$$1 - (1 - .0209) \times [1 - .33 \times (.0000 + .0233 \times .1345)] = .0219$$

and 0.103% thereafter:

$$1 - (1 - .0000) \times [1 - .33 \times (.0000 + .0233 \times .1345)] = .00103$$

with the permanent disability factor. Lifetime losses are 0.046 QALYs:

$$.0219 \times 1 \text{ year} + .00103 \times 23.22 \text{ years} = .046 \text{ years}$$

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[57] 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.

APPENDIX B: Additional Injury Diagnoses

TABLE B1. 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 B2. 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 *	Pneumoconioses
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 C: Updating the ICM's Inflators

All data needed for updating the inflators used in the ICM can be found in the *Economic Report of the President*, published annually by the U.S. Government Printing Office, usually in February.

The medical inflator is computed from 1) medical care expenditures, the final column in TABLE B–14.—*Personal consumption expenditures, 1959–99*, and 2) U.S. population, the final column in TABLE B–29.—*Total and per capita disposable personal income and personal consumption expenditures in current and real dollars, 1959–99*. (The table numbers may change slightly from one year to the next. The table numbers shown are for 2000. In 1999, these tables were numbered 16 and 31, respectively.) The former figure is divided by the latter to obtain our inflator, medical expenditures per capita. Table C1 shows both of the input series and the resulting inflator series.

For inflating work loss and pain and suffering costs, the ICM uses the total private total compensation index, the first column in TABLE B–46.—*Employment cost index, private industry, 1980–99*. The CPI–All Items was used to inflate some series to 1995 dollars for use in the ICM when neither the medical nor the compensation index seemed appropriate, but these calculations all took place at preliminary stages. The CPI is not used in annual updates of the ICM's inflators. For reference, the CPI-All Items is the first column in TABLE B–58.—*Consumer price indexes for major expenditure classes, 1958-99*. Both the compensation index and the CPI are shown in Table 1 in Chapter 3.

Preliminary figures for the most recent year are sometimes given in the *Economic Report of the President*, but these should not be used, as they are subject to substantial revision. As of the date of publication of this report, the 1998 inflators were in use.

The medical and compensation inflators appear in two places in the program, CPSCTOTL.SAS, which creates the final look-up tables - once in the DATA step for non-admitted cases, and again in the DATA step for hospital-admitted cases. The inflators must be changed in both places when they are to be updated.

Table C1. Computation of Medical Cost Inflator

	Medical Care Expenditures *(billions)*	Population *(thousands)*	Medical Care Expenditures per Capita
1980	$181.2	227,726	$ 796
1981	$213.0	230,008	$ 926
1982	$239.3	232,218	$1,030
1983	$267.9	234,332	$1,143
1984	$294.6	236,394	$1,246
1985	$322.5	238,506	$1,352
1986	$346.8	240,682	$1,441
1987	$381.8	242,842	$1,572
1988	$429.9	245,061	$1,754
1989	$479.2	247,387	$1,937
1990	$540.6	249,981	$2,163
1991	$591.0	252,677	$2,339
1992	$652.6	255,403	$2,555
1993	$700.6	258,107	$2,714
1994	$737.3	260,616	$2,829
1995	$780.7	263,073	$2,968
1996	$814.4	265,504	$3,067
1997	$850.2	268,046	$3,172
1998	$894.3	270,595	$3,305
1999*	$941.3	273,161	$3,446

*Preliminary.

APPENDIX D: Tracing the Impacts of Hypothetical Data Changes

In the two following examples, hypothetical data changes are introduced, and their impacts are traced through the rest of the ICM.

Example #1. For a hospital-admitted four-year-old male victim of a concussion (ICD-9 850, NEISS 52 75), the average length of stay is reduced from 2.83 days to 2.50 days.

A change in the average length of a hospital stay will affect **medical** costs directly, and **pain and suffering** and **legal/liability** costs indirectly. The only **work loss** costs affected are costs to family and friends.

In the ICM, the base length of stay estimates come from NHDS 1987–1992, by ICD-9 diagnosis group. Average length of stay (AvgLoS) varies across the five concussion diagnosis groups (DXG in the table below), but the overall average is 2.83. The five-state (CA, MD, NY, VT, WA) hospital discharge dataset is used to estimate regression-based adjustments to length of stay for the age and sex of the victim and whether the injury was consumer-product-related. (The latter adjustment relies on E-codes for identification of consumer product injuries, and thus could not be estimated from NHDS, which was not E-coded.) For concussion, as for most diagnoses, all three of these factors - male, under 20, and consumer product - affect length of stay negatively. Combined, they reduce the average length of stay to 1.93 (shown below in the EstLoS column, but not actually stored as a variable in any dataset of the ICM). (These methods are described on pp. 40-41 of this report.)

For each diagnosis group, the estimated cost of a hospital *visit* (YngMal) is calculated as FIXCOST + (EstLoS × DAYCOST). (FIXCOST and DAYCOST come from regressions on Maryland and New York hospital costs. This method is described on pp. 41-43 of this report.) YngMal is factored up by (1 + READMRAT) to get the estimated hospital treatment cost per *case* (YngMalC), which is multiplied by AVGADM to get the claims administration cost, YngMalA.

All of these costs are then averaged across the five detailed diagnosis groups, using the five-state case counts (COUNT) as weights, and the results appear under diagnosis 850 in MEDICAL\HOSP\NEISCOST.SD2.[58] The total hospital cost (YngMalC+YngMalA=$3,100.97), is then divided by the share of costs that occur in the first six months (PCT6MO2=0.74819), to get the lifetime medical cost (YngMal=$4,144.62). The nonadministrative portion of this cost (YngMalNA=$3,885) is found by subtracting the long-term claims administration cost (YngMalA/PCT6MO2=$259) from YngMal. These costs are then mapped from ICD-9 (diagnosis 850) to NEISS (diagnosis 52 75).

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[58]The file extension .SD2 is associated with SAS datasets. The other file extension that appears in this appendix, .SAS, is associated with SAS programs.

dxq	Count	AvgLoS	FixCost	DayCost	YngMal	ReadmRat	YngMalC	AvgAdm	YngMalA	EstLoS
850.0	2191	2.6404	999.60	634.97	2141.48	0.05813	2533.68	0.0617	156.34	1.79832
850.1	2415	2.6293	1683.32	484.97	2551.79	0.03922	2965.18	0.0701	207.80	1.79078
850.2-4	87	7.5049	3211.99	728.16	6933.99	0.04231	8081.26	0.0858	693.00	5.11152
850.5	565	3.5493	218.62	1113.46	2910.27	0.10058	3581.41	0.0653	233.91	2.41738
850.9	691	2.9591	747.30	679.97	2117.71	0.13327	2683.48	0.0635	170.48	2.01540
850	**5949**	**2.8303**			**2448.39**		**2906.88**		**194.09**	**1.92772**

To initiate the proposed decrease in length of stay, we reduced the length of stay for all five concussion diagnosis groups by 11.67%, across the board. The weighted average length of stay fell from 2.83 days to 2.50 days. The calculations of the above table were repeated with the reduced lengths of stay. The results:

- Average adjusted length of stay (AVGLOS) fell from 1.93 days to 1.70.
- Average hospital cost (YngMal) fell from $2,448 to $2,303.
- Average short-term medical cost (excluding claims processing costs) (YngMalC) fell from $2,907 to $2,733.
- Average claims processing (YngMalA) cost fell from $259 to $244.
- Average lifetime medical costs (excluding claims processing costs) (YngMalNA in the dataset MEDICAL\HOSP\NEISCOST.SD2) fell from $3,885 to $3,653.
- Average total medical cost (YngMal in the dataset MEDICAL\HOSP\NEISCOST.SD2) fell from $4,145 to $3,897.

When medical cost excluding claims administration cost (YngMalNA) drops from $3,885 to $3,653, the estimated average pain and suffering cost also drops. The programs PAINSUFF\HOSP.SAS and PAINSUFF\HOSPPERM.SAS are run, substituting the new YngMalNA for the old. The latter program estimates pain and suffering costs for permanently disabled victims, while the former program covers non-disabled victims. In HOSP, the pain and suffering cost (Mal04HOP) drops from $62,105.02 to $61,302.71, while in HOSPPERM, the pain and suffering cost (Mal04HPP) drops from $388,386 to $388,244.

The work loss of family and friends of a hospital-admitted patient also depends directly on the length of the hospital stay (see p. 63). There is a fixed cost of $12 for transport to the hospital, plus an additional $18 for each bed day. It is assumed that a patient's total bed days are twice the length of the average hospital stay for the diagnosis. Therefore, a decrease in average length of stay from 2.83 days to 2.50 days reduces the estimated work loss of family and friends from $113.88 to $102.00. This change has no impact on pain and suffering costs, which depend on *victim* work loss, but not on work loss of family and friends.

All of the medical, work loss, and pain and suffering costs enter the final calculations in TOTAL\CPSCTOTL.SAS (including calculation of the legal/liability costs). Similar calculations are carried through to the end in the next example.

Example #2. For a non-admitted 40-year-old female victim of a shoulder fracture (NEISS 57 30), the estimated probability of permanent partial disability, given at least four days of work loss, is raised from .0233 to .0350.

A change in the probability of disability directly affects **work loss** costs and indirectly affects **pain and suffering** and **legal/liability** costs, which depend on work loss. **Medical** costs are unaffected. Within the work loss category, a change in disability probability will affect long-term work loss and costs to the victim's employer, but *not* short-term work loss or costs to the victim's family.

The initial part of the long-term work loss calculations take place in the program LTWLNONH.SAS, which CPSC does not have. The main calculation is identical to the non-admitted part of the example on pp. 59-61 of this report. Note that, in this example, the probability of permanent complete disability (called COMPPCT in the program) is 0, and the probability of permanent partial disability (PARTPCT) is .0233. Since these probabilities are based on cases with at least four days of work loss, they are multiplied by the probability that a non-admitted case results in work loss (PCTWKLOS=.367) and the probability that such work loss lasts at least four days (PCT4DAY×PCTNONH4/PCTNONHW=.778). This program creates two SAS datasets that feed into programs further down the run stream:

- LTDANONH.SD2 contains long-term work-loss costs averaged across *all* non-admitted cases, including Fem44NCD (disability cost for non-admitted females 40-44 years old). This dataset feeds into the program NONPAIN\NONH.SAS, which collects medical and work-loss cost estimates before feeding them into TOTAL\CPSCTOTL.SAS.

- LTDVNONH.SD2 contains average long-term work-loss costs *for cases with permanent disability*. The dataset includes the variable LTDFem44 (long-term disability cost for non-admitted females 40-44). This dataset is used by PAINSUFF\NEDPERM.SAS and PAINSUFF\EDPERM.SAS, programs that calculate pain and suffering costs for patients with permanent disability treated in clinics/doctor's offices and EDs, respectively.

The numeric results of the increased probability of permanent partial disability are summarized in the following table:

Program	Variable	Actual Value	Hypoth Value
LTWLNONH.SAS	PartPct	0.0233	0.035
	CompPct	0	0
LTDANONH.SAS	Fem44NCD	769.80	1,154.70
LTDVNONH.SAS	LTDFem44	115,604.43	115,604.43
NEDPERM.SAS	Fem44DPP	105,629.44	105,629.44
EDPERM.SAS	Fem44EPP	105,537.84	105,537.84
NONHPAIN.SAS	Fem44DCP	18,310.24	18,602.91
	Fem44ECP	17,817.97	18,111.99

Note that Fem44NCD increases in proportion to the increase in PARTPCT, but LTDFem44 does not change at all. This results from the fact that COMPPCT is 0. Because *all* permanent disabilities resulting from this injury (non-admitted shoulder fracture) are partial, rather than complete, the higher probability of partial disability does not change the balance between partial and complete disability - 100% of disabilities are still partial. Therefore, the average cost of long-term work loss from a permanent disability, LTDFem44, does not change. As a result, the average pain and suffering costs associated with shoulder fractures, Fem44DPP and Fem44EPP, also remain the same. However, the average pain and suffering of *all* shoulder fracture victims (as opposed to the pain and suffering of *permanently disabled* shoulder fracture victims) increases somewhat because of the greater probability of disability, as we see in Fem44DCP and Fem44ECP (the average pain and suffering figures for females age 40-44 who are treated, respectively, in a doctor's office/clinic or in an ED).

The other type of cost affected by the change in disability probability is the cost to the victim's employer. This calculation occurs in NONPAIN\NONH.SAS, and it is similar to the calculations in the example on p. 65 of this report, where it appears as $248. It can be found as the variable FEM44NOE in the output dataset from NONPAIN\NONH.SAS, with a value of $247.53. Increasing the raw disability probability from .0233 to .035 raised the adjusted probability from .00666 to.00999 and FEM44NOE to $274.16.

The long-term work loss, employer costs, and pain and suffering all feed into the final program, TOTAL\CPSCTOTL.SAS, whose function is to inflate costs from 1995 to 1997 dollars and add everything up. It calculated the legal/liability costs, DOCLIAB and EMDLIAB, by multiplying the subtotal by a fixed ratio.

Variable	Actual Value	Hypoth Value	
nonhwdis	820.84	1,231.25	long-term work loss
nonhwrkv	4,040.54	4,450.95	victim work loss
nonhwemp	263.94	292.34	employer cost
nonhwrkt	**4,317.28**	**4,756.08**	**total work loss cost**
docpain	19,524.18	19,836.25	doctor/clinic pain
emdpain	18,999.28	19,312.78	ED pain
docsub	24,682.97	24,995.04	doc/clinic subtotal
docliab	80.97	81.99	doc/clinic legl/liab
doctotl	**24,763.94**	**25,077.04**	**doctor/clinic total**
emdsub	23,925.35	24,238.85	ED subtotal
emdliab	78.48	79.51	ED legal/liability
emdtotl	**24,003.83**	**24,318.37**	**ED total**

APPENDIX E: Estimated Medical Costs of Fatalities

Medical costs of unintentional fatalities were estimated by E-code and age group, according to the formula:

$$ftmedcst = pos \times dos + poa \times doa + ped \times ded + phosp \times dhosp + phome \times dhome + pnurs \times dnurs$$

where dos, doa, ded, dhosp, dhome, and dnurs denote the costs associated with six different places of death (on-scene, on-arrival, emergency department, hospital [admitted], home, and nursing home, respectively); and pos, poa, ped, phosp, phome, and pnurs denote relative shares of deaths that occurred at each place by E-code and age group.

Place-of-death shares for each E-code/age group were estimated from US Vital Statistics 1994, after deleting all cases with unknown place of death (2,410 out of 147,482 cases, or 1.63%). Vital Statistical identifies two other places of death, besides the six considered – "hospital – status unknown" and "other." "Hospital – status unknown" (0.4% of cases) was collapsed into "hospital (admitted)." "Other" (30% of cases) was collapsed into "dead-on-the-scene." This assumption seemed reasonable because 86% of "other" deaths were associated with traffic accidents.

Medical cost for the six places of death was estimated by summing the following components:

dos = coroner + funeral;
doa = coroner + funeral + transport + ed;
ded = coroner + funeral + transport + ed;
dhosp = coroner + funeral + transport + hospital;
dhome = coroner + funeral + transport;
dnurs = coroner + funeral + transport + hospital + nursing home;

The coroner and funeral components represent the difference in present value of burial and coroner costs in 1996 versus at the end of the victim's expected life span (from Miller, Pindus et al. 1995 and NHTSA 1983, respectively). Except for deaths at the scene, we added costs of emergency transport from 1987 NMES data. It was assumed that victims who died at home were not first treated at a medical facility. For deaths on arrival or in the emergency department, we added average charges for fatalities in the emergency department by external cause grouping from 1997 South Carolina emergency department discharge data, adjusted to US prices using the ACCRA medical care cost index (Bureau of the Census 1998). Deaths in hospital were costed using the same methods as other hospital admissions, but with no post-discharge costs. We assumed deaths in nursing home were preceded by hospital admissions of average cost and involved a one-month skilled nursing facility stay (double the cost of an intermediate care facility according to Bureau of the Census (1998), as discussed on p. 43 of this report).

Table E1. Fatal Unintentional Injuries: Medical Cost by Cause and Age (*1996 dollars*)

Cause	0-19	20-44	45-64	65+
Bite/Sting	8,531	13,330	9,887	16,787
Caught in/between Objects	8,515	5,976	6,810	13,423
Cut/Pierce	22,780	7,314	5,361	4,996
Drowning/Submersion	7,349	5,921	4,450	3,517
Fall	9,639	12,283	17,808	20,714
Burn/Anoxia	8,830	15,930	24,893	26,075
Firearm	7,172	5,954	4,510	3,331
Motor Vehicle	8,512	13,638	19,631	15,390
Pedestrian - MV Traffic	8,510	13,636	19,626	15,386
Pedalcycle - MV Traffic	8,505	13,628	19,598	15,287
Pedalcycle - Other	8,504	13,626	19,593	15,260
Other Vehicles	7,186	8,641	8,535	12,077
Machinery	8,504	12,624	3,955	4,032
Natural/Environmental	8,510	13,633	19,614	15,388
Overexertion	8,517	13,619	9,859	9,715
Poisoning	9,773	6,476	6,875	12,643
Struck by/against	9,754	9,364	8,584	9,269
Suffocation/Choking	6,524	6,725	6,054	18,683
Other	8,504	13,623	19,591	15,368
Unknown	9,296	12,403	19,301	25,006