The Cost of Childhood Unintentional Injuries and the Value of Prevention

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Abstract
Cost data are useful in comparing various health problems, assessing risks, setting research priorities, and selecting interventions that most efficiently reduce health burdens. Using analyses of national and state data sets, this article presents data on the frequency, costs, and quality-of-life losses associated with unintentional childhood injuries in 1996. The frequency, severity, potential for death and disability, and costs of unintentional injury make it a leading childhood health problem. Unintentional childhood injuries in 1996 resulted in an estimated $14 billion in lifetime medical spending, $1 billion in other resource costs, and $66 billion in present and future work losses. These injuries imposed quality-of-life losses equivalent to 92,400 child deaths. Since Medicaid and other government sources paid for 39% of the days children spent in hospitals due to unintentional injuries, the government has a financial interest in, and arguably a responsibility for, assuring the safety of disadvantaged children. Federal agencies, however, devote relatively few public dollars to injury prevention research and programming.

Several proven child safety interventions cost less than the medical and other resource costs they save. Thus, governments, managed care companies, and third-party payers could save money by encouraging the routine use of selected child safety measures such as child safety seats, bicycle helmets, and smoke detectors. Yet, these and other proven injury prevention interventions are not universally implemented.

Injury is a common and costly childhood affliction, accounting for approximately 15% of medical spending from ages 1 to 19. Indeed, for children and adolescents 5 to 19 years of age, injury rivals the common cold in frequency. Injuries, however, are much more likely than colds to have lasting effects. In 1996, unintentional injuries—primarily brain, spinal cord, burn, and limb injuries—left an estimated 150,000 or more children and adolescents permanently disabled and often in need of lifetime follow-up care. Another 13,000 children and adolescents were killed by unintentional injuries in the same year (see the article by Grossman in this journal).
Coupled with this high death rate, the frequency, severity, and disabling outcomes of unintentional injuries make them a costly childhood health problem.

Quantifying the costs associated with childhood injuries is important. Cost estimates reduce different outcomes or injuries—deaths, near drownings, broken legs, or even damaged cars—to a common metric. This makes cost data a useful element in gauging the relative size of various problems, assessing risks, setting research priorities, and selecting interventions that most efficiently reduce the burden of injury. For example, injury costs by diagnosis can inform a decision about whether to use a playground-improvement budget to fix swings (estimated to prevent seven broken arms) or to fix slides (estimated to prevent two broken legs). Measuring the benefit of interventions in dollars also helps planners and evaluators estimate the “net cost” of a safety investment (that is, the total cost of the investment minus the benefits accrued). On a broader scale, comparably measured costs of injury and illness can provide insight into the relative magnitude of these problems and can inform resource allocation. Finally, cost data can be used for advocacy purposes, by conveying risk reductions in a way that captures the attention of politicians, the media, and the public. For example, a car seat giveaway program targeting Medicaid recipients may reduce an infant’s risk of death by 1% and save the government $50. While both risk reduction and government savings are important, communicating the benefit in monetary terms may be more informative for policymakers concerned with state or federal budgets.

A widely quoted report, Cost of Injury in the United States: A Report to Congress, estimated medical spending and other costs resulting from childhood injuries, using data from the mid-1980s. This report provided cost-of-injury estimates that helped draw recognition of injury as a major public health threat. It did not differentiate injuries by intent, however, combining unintentional injuries with intentional harm such as child abuse and homicide. The report also grouped costs by only seven causes—burns, drownings, falls, firearms, motor vehicles, poisonings, and other. These groupings fail to distinguish among important subcategories of motor vehicle injuries (that is, occupant, pedestrian, and bicycle) and they do not capture other important injury categories, such as being struck by or against an object, as often occurs in contact sports. With the arrival of the new millennium, these cost estimates are outdated and may no longer portray accurately the burden childhood injuries place on society.

This article defines the costs associated with childhood unintentional injuries and briefly reviews the concepts used in estimating injury costs. It then reports estimates of the lifetime costs of childhood unintentional injuries using more recent, cause-specific, and child-specific data than were previously available. This information allows for a cost comparison between unintentional injuries and other child health problems and it provides a basis for judging whether injury prevention research and
implementation efforts are adequately funded. To address that question more fully, the article closes with a review of cost-effectiveness estimates for selected childhood unintentional injury prevention interventions compared with similar estimates for other child health measures.

Unintentional Injury Costs and Quality-of-Life Losses

Defining Costs
Injuries among children and adolescents impose a financial burden on many segments of society. Parents and health insurers, for example, assume responsibility for a myriad of medically related expenses due to injuries. Parents may be forced to stay home from work to care for an injured child, affecting both the family’s income and the employers’ profit. Children who are disabled from an injury may be unable to work in the future. Deciding which of these costs to include in cost-of-injury estimates is critical, because the decision can influence the estimated monetary burden of injuries by orders of magnitude. As recommended by the Panel on Cost-Effectiveness in Health and Medicine,4 a nonfederal panel convened by the U.S. Public Health Service (PHS), this article adopts a societal perspective that attempts to estimate all costs associated with childhood unintentional injuries—costs to victims, families, government, insurers, and taxpayers. Other perspectives would constrain the analysis to, for example, government expenditures or health care payer expenditures, which include only a subset of total injury costs.

Injury costs can be separated into resource and productivity costs. Resource costs are associated with caring for injury victims and managing the aftermath of injury incidents, and they are dominated by the medical costs of injuries. Productivity costs value wage work and housework that children and adolescents will be unable to do because of their injury, as well as the work that parents or other adults forego to care for injured children. Box 1 describes more fully the cost-of-injury concepts used in this article.

Because injuries sustained during childhood may impact the productivity of both children and their caregivers over time, accounting for losses to both parties is critical. For example, an employed adolescent temporarily disabled from an injury may lose wages in the near term. Likewise, an injury that keeps a child home from school for a few days may require that a parent stay home to act as a caregiver. Since such injuries are relatively frequent among children, total work losses for adult family members caring for injured children also are a major cost. Of course, the most extreme impact on productivity occurs when a child is killed or permanently disabled by an injury. In such instances, a lifetime of work is lost.

Defining Quality-of-Life Losses
This article focuses primarily on resource and productivity costs associated with childhood unintentional injuries. However, these costs do not fully capture the burden of injuries to children. Injuries also affect children and families by reducing their quality of life. Families who lose a child to injury may suffer years of mental anguish. Children who are permanently disabled by injury may experience lifelong pain or suffer permanent loss of motor or cognitive functioning. To capture these less quantifiable consequences of childhood injuries, quality-of-life losses, valued in nonmonetary terms as quality-adjusted life years (QALYs), also are reported (see Box 2). Both monetary costs and quality-of-life measures should be considered when allocating resources, and both should be incorporated into cost-effectiveness analyses that weigh “net costs” against quality-of-life improvements.

Estimating Costs and Quality-of-Life Losses
The next section reports findings from an analysis that estimated the present and future costs of childhood unintentional injuries that occurred during 1996. Injuries were included that affected children ages 0 to 19 and resulted in a physician office visit, an emergency department visit, a hospitalization, or a death. Cost-of-injury estimates were computed by multiplying the number of injury victims in 1996—stratified by age, diagnosis, severity, and cause—by the corresponding costs per victim (in 1996 dollars). Data for these estimates were abstracted from the literature and 11 data sets described in Table 1. Table 2 summarizes the
estimated frequency, by severity and age, of the childhood unintentional injuries. This article, however, focuses on injury costs and quality-of-life losses. Total injury costs are reported, as are costs stratified by cause, age, severity, and cost category. Estimated QALY losses were computed in a similar manner and are reported following the cost-of-injury findings. The methods used to estimate injury frequency, costs, and quality-of-life losses are described more fully in the Appendix at the end of this article.

Childhood Unintentional Injury Costs

The estimated lifetime resource and productivity costs of unintentional injuries that occurred during 1996 to U.S. children ages 0 to 19 equal $81 billion (see Table 3). This estimate summarizes the costs for 22.2 million children—3 in every 10 children—who suffered unintentional injuries serious enough to require medical treatment or cause at least half a day of restricted activity. Of these children, more than 13,000 died and 292,000 were hospitalized because of their injuries. The overwhelming majority of injured children, however, did not sustain injuries severe enough to require a hospital admission.

The bulk of the financial burden associated with childhood unintentional injuries results from work losses experienced by injured children and their caregivers. Present and future productivity losses accounted for more than 80% ($66.5 billion) of the total lifetime childhood injury costs.
The Cost of Childhood Unintentional Injuries and the Value of Prevention

Costs by Injury Severity

The most severe childhood injuries—those that result in death—disproportionately contribute to lifetime injury costs. Fatal injuries accounted for less than 1% of all childhood injuries in 1996, but they accounted for more than 17% of injury-related costs. By contrast, the least severe injuries—nonfatal injuries where the child was not hospitalized—accounted for nearly 99% of all childhood injuries, yet they were associated with 58% of the estimated lifetime costs (see Table 3). Thus, although the very rare injury fatalities contributed disproportionately to the financial burden of childhood injuries, the most common and least severe injuries still accounted for more than half of the total injury costs.

The severity of childhood injuries also affects the relative contribution of medical costs, versus productivity losses, to total injury costs. When a child suffers a nonfatal injury, for example, caregiver work losses typically cost much more than medical treatment. Nonetheless, hospital care is expensive, and medical costs account for a larger proportion of total injury costs among hospitalized (27%) than nonhospitalized (21%) injured children. For children killed from an injury, the overwhelming cost (96%) is the future work that these children will never do. Medical costs account for less than 1% of the total injury costs for these victims.

Costs by Age of Child

As children grow, their motor skills and cognitive skills develop and their environment changes. Therefore, their injury risks shift. Critical developmental milestones that affect injury risk may include starting to crawl, walk, attend school, ride a bicycle, drink alcohol, and drive a car, as well as developing an ability to recognize and make decisions about dangerous situations. Thus, injury rates, causes, and severity vary with age.
### Summary of Data Sources Used for Cost-of-Injury Analysis

<table>
<thead>
<tr>
<th>Name and Source</th>
<th>Population Covered</th>
<th>Years of Data Used</th>
<th>Data Elements Used</th>
<th>Other Relevant Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAMPUS Civilian Health and Medical Program of the Uniformed Services (U.S. Department of Defense)</td>
<td>Annual summary of health care claims for about 2 million military dependents and retirees</td>
<td>1992–94</td>
<td>• Ratio of professional fees to hospital payments • Payments per nonadmitted case</td>
<td>• Longitudinal for one year • Few males ages 18 to 45 • Few people over age 65</td>
</tr>
<tr>
<td>Medstat, Inc. claims data (leased proprietary data)</td>
<td>Proprietary health care claims data on employer-insured families</td>
<td>1987–89</td>
<td>Ratio of medical costs over time for child versus adult injury victims with comparable diagnoses</td>
<td>Longitudinal data on children and adults under age 65</td>
</tr>
<tr>
<td>NAMCS National Ambulatory Medical Care Survey (National Center for Health Statistics [NCHS])</td>
<td>Sample of doctor's office and clinic visits</td>
<td>1995–96</td>
<td>Cause distribution (for incidence estimates)</td>
<td>—</td>
</tr>
<tr>
<td>NCCI Detailed claims database (National Council on Compensation Insurance)</td>
<td>Sample of workers' compensation lost-work claims</td>
<td>1979–87 1992–96</td>
<td>• Percentage of medical payments in first year • Disability probabilities</td>
<td>• Longitudinal data • Workdays lost to qualify varies by state</td>
</tr>
<tr>
<td>NHAMCS National Hospital Ambulatory Medical Care Survey (NCHS)</td>
<td>Sample of hospital emergency department visits</td>
<td>1992–96</td>
<td>Cause distribution (for incidence estimates)</td>
<td>Initial visits are hard to distinguish</td>
</tr>
<tr>
<td>NHDS National Hospital Discharge Survey (NCHS)</td>
<td>Annual sample of hospital discharges</td>
<td>1996</td>
<td>• Hospital admissions by age and cause • Length of stay • Percentage discharged to nursing home • Payer distribution</td>
<td>Only 63% cause coded</td>
</tr>
<tr>
<td>NHIS National Health Interview Survey (NCHS)</td>
<td>Household interview survey</td>
<td>1987–96</td>
<td>• Nonadmitted injury cases • Work-loss probabilities</td>
<td>• Self-reported diagnoses • Data covers the two weeks prior to interview</td>
</tr>
</tbody>
</table>
Adolescents, and to a lesser extent young children ages zero to four, experience higher rates of unintentional injuries that are fatal or require hospitalization compared with children ages 5 to 14 (see Table 2). Similarly, injury costs are higher among adolescents than other children. The total lifetime resource and productivity costs of unintentional injuries that occurred in 1996 are estimated to be $28 billion among teenagers 15 to 19 years of age. Among school-age and younger children, costs are considerably less ($19 billion among 0- to 4-year-olds, $20 billion among 5- to 9-year-olds, and $14 billion among 10- to 14-year-olds). Adolescents ages 15 to 19 also have higher lifetime costs per child due to unintentional injury ($1,500) compared with younger children or adults (see Figure 1).

The higher total injury costs among adolescents reflect the greater absolute number of serious and fatal injuries that occur in this age group and the types of injuries sustained. Approximately 6,900 youths ages 15 to 19 died from unintentional injuries that occurred in 1996—more than the number of deaths from unintentional injuries in all other age groups combined (6,400 deaths). The higher number of adolescent fatalities translates into higher total injury costs in this age group, since teenagers who are killed lose a lifetime of future work. The causes of injuries sustained by adolescents also tend to result in the most costly injuries per victim. For example, as shown in Table 4, firearm injuries are one of the most costly causes of unintentional childhood injury per victim, and such injuries, although rare, occur much more frequently among adolescents than children in any other age group (data not shown). These troubling statistics related to adolescent injury costs should not be a surprise. Adolescence is a time of learning and a time of testing, so teenagers are prone to engage in dangerous activities that can prove costly.

**Costs by Cause of Injury**

Five primary causes of unintentional injury account for almost 80% of total lifetime costs among children ages 0 to 19. As shown in Table 5, these causes include falls, motor vehicle crashes on public roads (includes occupant, pedestrian, or bicyclist injuries), being struck by or against an object or person, vehicle crashes not on public roads, and cutting or piercing. These five causes of unintentional injuries contribute substantially to overall injury costs because the combination of their frequency in the population and the average cost per victim is exceedingly high.

The relative importance of frequency versus cost per case, however, varies by type.
of injury. For example, although individual falls are not unreasonably costly ($4,200 per victim as shown in Table 4), estimates from this analysis found that falls are the leading cause of injury hospitalization among children (data not shown). It is primarily because of their frequency in the population that falls cause the most costly childhood unintentional injuries overall. In contrast, although motor vehicle crashes that injure children occur much less frequently than falls, the resulting injuries are often severe and costly. It is primarily the severity of such injuries that make motor vehicle traffic crashes the second leading contributor to total unintentional injury costs among children.

The relative importance of various injury causes to total injury costs is different when cost per victim is estimated rather than total cost (see Table 4). Drowning or submersion, for example, causes the most expensive injuries, at $21,000 per victim. Motor vehicle-pedestrian ($20,500), motor vehicle-pedalcycle ($17,600), and unintentional firearm ($17,400) cause the next most costly injuries per victim. Although high-cost injuries occur less frequently than many unintentional injury causes among children and adolescents, the severity of the injuries and the long-term disability and deaths that often result make them extremely expensive when they do occur.

Finally, the importance of the five most costly unintentional injury causes is fairly consistent across the child age categories, although their relative importance differs (see Table 5). For example, through age 14, falls are the most costly cause of unintentional injury. Among 15- to 19-year-olds, however, motor vehicle crashes displace falls as the most costly cause of injury. Also, some causes only show up as leading contributors for one age group. For example, burns are among the five leading causes of injury costs only for infants and young children ages 0 to 4, while drowning or submersion makes the list only for children ages 10 to 14 (where it edges out cutting and piercing injuries, which are the fifth leading contributors for other age groups).

**Quality-of-Life Losses**

Unintentional injuries among children impose more than monetary costs on society. Such injuries also reduce the quality of life for injured children and their families. Children injured in 1996 lost the equivalent of 2.7 million years of life, a loss comparable to 92,400 child deaths. Nearly half of QALYs lost were associated with nonfatal injuries that did not require hospitalization (see Table 3). The losses for these injuries result from short-term and long-term disabilities that arise when complications develop or a nonfatal injury...
like a facial laceration or arm fracture scars a child or permanently restricts range of motion. Injury fatalities, however, contributed disproportionately to quality-of-life losses—nearly 16% of QALYs lost resulted from injury deaths, but only 1% of all childhood injuries in 1996 resulted in death.

Similar to the patterns observed for injury frequency and costs across age groups, total estimated QALY losses were highest among adolescents ages 15 to 19 (978,000 QALYs, a loss comparable to 34,800 child deaths) and lowest among children ages 10 to 14 (463,000 QALYs, a loss comparable to 16,500 child deaths). The number of children in these age groups is similar. The differences in QALY losses result from the same injury frequency and severity differences that cause higher resource and productivity loss costs among teenagers.

Five primary injury causes account for 81% of the QALY losses due to unintentional injury among children ages 0 to 19. Four of the five leading causes contributing to resource and productivity costs and QALY losses are identical (see Table 6). These include falls, motor vehicle crashes on public roads (includes occupant, pedestrian, and bicycle injuries), being struck by or against an object or person, and vehicle crashes not on public roads. Some differences in the leading causes of costs versus QALY losses also emerge within specific age groups. For example, among five- to nine-year-olds, injuries caused by being caught in or between something—such as fingers caught in doors—are among the top contributors to QALY losses. Such injuries often result in fingertip amputations, which can be disabling. They reduce quality of life but they are not expensive to treat. Children who suffer these injuries typically are not even hospitalized.

**Table 2**

<table>
<thead>
<tr>
<th>Number of Unintentional Injury Victims Ages 0 to 19 by the Severity of Their Injury, United States, 1996</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Severity</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fatality</td>
</tr>
<tr>
<td>Hospitalized survivors</td>
</tr>
<tr>
<td>Nonhospitalized survivors</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Note: Includes 219 deaths later in childhood due to injuries in 1996. The article by Grossman in this journal issue excludes these deaths.


Summary of Cost and Quality-of-Life Losses

Unintentional injuries to U.S. children ages 0 to 19 that occurred in 1996 imposed $81 billion in lifetime resource and productivity costs and swept away 2.6 million quality-adjusted years of life. The losses per child averaged $1,060 and were highest among adolescents. Five injury causes accounted for nearly 80% of lifetime resource and productivity costs. These were falls, motor vehicle crashes on public roads, other motor vehicle or pedalcycle crashes, victims struck by or against something, and cutting or piercing. The first four of these causes, along with poisonings, also accounted for more than 80% of QALYs lost to injury. When the total injury costs for all children were compared with the average cost per injury victim, however, a different pattern emerged. Some causes that often lead to lethal or serious injury—such

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as unintentional firearm injury and drowning or submersion—had the highest costs per victim. Because these causes are relatively infrequent, however, they did not contribute substantially to total injury costs.

**The Implications of Injury Costs for Investing in Safety Behaviors and Practices**

The first part of this article examined the lifetime costs and quality-of-life losses associated with childhood unintentional injuries that occurred during 1996. The following sections explore the implications of these costs for decisions about policy investments in safety behaviors and practices. Specifically, the sections examine how the medical costs and lost productivity of childhood unintentional injuries compare with the costs of other child health problems, with emphasis on a payer’s perspective. This analysis points to the government as a major player in childhood injury prevention and control. It also raises the question of whether the level of government funding for injury prevention research makes sense relative to the overall size of the problem and the costs incurred. In part, funding priorities depend on whether strategies for preventing childhood injuries are cost effective relative to strategies aimed at preventing other major child health problems.

**Comparing Costs and Sources of Payment for Childhood Injury and Illness**

The estimated medical costs of childhood injuries are comparable to the costs associated with low birth weight, an important health problem afflicting children in the United States. On a prevalence basis (as defined in Box 1), roughly 13% of all medical spending on children ages 1 to 19 during 1996 was used to treat unintentional injuries; these injuries accounted for 11% of hospital admissions, 39% of nonadmitted emergency department visits, and 9% of physician office visits for this age group. Analyses performed for this article suggest that prevalence-based medical spending on unintentional injury during 1996 totaled $13 billion for children ages 0 to 19. By comparison, the estimated prevalence-based medical spending on low birth weight during 1996 was $9 billion to $10 billion for children from birth through age 14. Thus, unintentional injuries to children impose a health care burden relatively...
similar in magnitude to another major child health problem—low birth weight.

In terms of lost productivity, unintentional injuries are more costly than child illnesses. In 1996, 43% of all deaths and related future work-loss costs among children and adolescents ages 1 to 19 were the result of unintentional injury, while only 35% resulted from illness (with the remaining 22% resulting from intentional injury). Thus, fatal unintentional injuries caused greater work-related productivity losses than all fatal childhood illnesses combined.

Given the tremendous financial burden of childhood injuries, in terms of both medical and future productivity costs, investing in effective injury prevention makes sense. Who should invest in prevention, however, largely depends on who pays the costs associated with childhood injuries. The remainder of this section examines separately the payment sources for injury-related medical costs versus lost productivity costs.

Payment Sources for Medical Costs
The largest share of the medical costs of injuries are paid by private insurers and Medicaid (the government program for low-income children and families). Private insurers paid for 43% of the days children spent in hospitals due to unintentional injury, while government sources, primarily Medicaid, paid for another 39%, according to the 1996 National Hospital Discharge Survey (NHDS). For other childhood illnesses, government sources paid for nearly half (49%) of hospital days, while private insurers paid for 40%. One reason for the lesser reliance on government funding for injury hospitalizations is the presence of property-casualty insurance (auto, home, and workers’ compensation), which NHDS states is the payer for at least 5% of the injury costs but none of the illness costs. Also, costly low birth weight and related perinatal problems are concentrated in the Medicaid population, and health care responsibility for children with permanently disabling and costly chronic illnesses gravitates toward government.

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Figure 1

Lifetime Costs per Child Resulting from Unintentional Injuries in 1996 by Age Group

Source: Calculations by authors from data and methods presented in this article.
Table 4

<table>
<thead>
<tr>
<th>Cause</th>
<th>Per Victim</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resource and Productivity Cost</td>
<td>QALY Loss</td>
</tr>
<tr>
<td>Bites and Stings</td>
<td>$2,300</td>
<td>0.016</td>
</tr>
<tr>
<td>Burn/Anoxia</td>
<td>$4,500</td>
<td>0.112</td>
</tr>
<tr>
<td>Caught in/Between Objects</td>
<td>$1,900</td>
<td>0.105</td>
</tr>
<tr>
<td>Cut/Pierce</td>
<td>$2,200</td>
<td>0.039</td>
</tr>
<tr>
<td>Drowning/Submersion</td>
<td>$21,000</td>
<td>0.374</td>
</tr>
<tr>
<td>Fall</td>
<td>$4,200</td>
<td>0.130</td>
</tr>
<tr>
<td>Firearm</td>
<td>$17,400</td>
<td>1.055</td>
</tr>
<tr>
<td>Motor Vehicle Traffic Occupant</td>
<td>$9,300</td>
<td>0.314</td>
</tr>
<tr>
<td>Motor Vehicle Traffic Pedalcycle</td>
<td>$17,600</td>
<td>0.626</td>
</tr>
<tr>
<td>Motor Vehicle Traffic Pedestrian</td>
<td>$20,500</td>
<td>0.721</td>
</tr>
<tr>
<td>Natural Environment</td>
<td>$3,000</td>
<td>0.226</td>
</tr>
<tr>
<td>Other Pedalcycle</td>
<td>$4,900</td>
<td>0.142</td>
</tr>
<tr>
<td>Other Pedestrian-Vehicle</td>
<td>$2,300</td>
<td>0.124</td>
</tr>
<tr>
<td>Other Vehicle</td>
<td>$12,800</td>
<td>0.511</td>
</tr>
<tr>
<td>Overexertion</td>
<td>$1,600</td>
<td>0.044</td>
</tr>
<tr>
<td>Poisoning</td>
<td>$300</td>
<td>0.046</td>
</tr>
<tr>
<td>Struck By/Against</td>
<td>$3,400</td>
<td>0.082</td>
</tr>
<tr>
<td>Suffocation and Choking</td>
<td>$11,000</td>
<td>0.412</td>
</tr>
<tr>
<td>Other Known Cause</td>
<td>$3,700</td>
<td>0.137</td>
</tr>
<tr>
<td>Unknown</td>
<td>$1,900</td>
<td>0.104</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$3,600</strong></td>
<td><strong>0.119</strong></td>
</tr>
</tbody>
</table>

Note: Percentages may not total 100% due to rounding.

Source: Calculations by authors from data and methods presented in this article.
### Table 5

<table>
<thead>
<tr>
<th>Priority</th>
<th>Ranking</th>
<th>Ages in Years</th>
<th>0 to 4</th>
<th>5 to 9</th>
<th>10 to 14</th>
<th>15 to 19</th>
<th>Total (0 to 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fall</td>
<td>Fall</td>
<td>Motor Vehicle Traffic a</td>
<td>Fall</td>
<td>$7,230</td>
<td>$6,010</td>
<td>$3,930</td>
</tr>
<tr>
<td>2</td>
<td>Struck By/ Against</td>
<td>Other Vehicle b</td>
<td>Motor Vehicle Traffic a</td>
<td>Fall</td>
<td>Struck By/ Against</td>
<td>Struck By/ Against</td>
<td>Struck By/ Against</td>
</tr>
<tr>
<td>3</td>
<td>Motor Vehicle Traffic a</td>
<td>Motor Vehicle Traffic a</td>
<td>Struck By/ Against</td>
<td>Struck By/ Against</td>
<td>Struck By/ Against</td>
<td>Struck By/ Against</td>
<td>$2,550</td>
</tr>
<tr>
<td>4</td>
<td>Burn/Anoxia</td>
<td>Struck By/ Against</td>
<td>Other Vehicle b</td>
<td>Other Vehicle b</td>
<td>Other Vehicle b</td>
<td>Other Vehicle b</td>
<td>$1,120</td>
</tr>
<tr>
<td>5</td>
<td>Cut/Pierce</td>
<td>Cut/Pierce</td>
<td>Drowning/ submersion</td>
<td>Cut/Pierce</td>
<td>Cut/Pierce</td>
<td>Cut/Pierce</td>
<td>$770</td>
</tr>
</tbody>
</table>

| Percentage | 79% | 81% | 85% | 84% | 79% |

a Motor vehicle traffic includes child occupant, pedestrian, and bicyclist injuries in crashes on public roads.
b Other vehicle includes motorized vehicle crashes not on public roadways (for example, in driveways, train-pedestrian incidents) and pedalcycle crashes.
c Among injuries with known causes, the percentage of total costs that result from the five leading causes of injury.

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**Payment Sources for Lost Productivity**

Work-loss costs fall heavily on victims and their families, with modest contributions from property-casualty insurance and public welfare programs, including Supplemental Security Income (SSI) and food stamps. Presumably, property-casualty insurance (workers’ compensation or auto insurance) partially covers work-loss costs for the 5% of child injury victims whose medical costs it pays. Almost all other work-loss costs associated with child injury deaths and disabilities are borne by children and their families. The financial burden of short-term work losses by parents of injured children falls on parents and their employers. The work-loss costs for permanently and totally disabling childhood injuries (an estimated 12,000 victims per year) are split in unknown proportions between victims, insurers, and public welfare programs.¹¹

Low-income families may not be able to afford safety measures (for example, child safety seats, bicycle helmets, etc.) that protect their children against injuries and related financial and functional losses. Therefore, without government and charitable intervention, children from low-income families may be at greater risk for injuries because they cannot afford safety measures.¹² Safety funding decisions for this population, thus, need to consider not just who bears the injury costs, but also government’s role in providing low-income children a fair start on life.

http://www.futureofchildren.org
Are Current Federal Funding Patterns for Health Care Research Sensible?

As with illness, government plays a major role in funding childhood injury prevention and control efforts. Evidence reported in other articles in this journal issue indicate that effective prevention strategies exist for many causes of childhood injury, including motor vehicle crashes, bicycle injuries, and residential fires (see the articles by DiGuiseppi and Roberts, by Klassen and colleagues, by Schieber, Gilchrist, and Sleet, and by Malloonee in this journal issue). Furthermore, as discussed in the next section of this article, cost-effectiveness estimates indicate that injury prevention strategies of proven effectiveness often are a good investment worthy of wider implementation. Taken together, these findings—that effective and cost-effective injury prevention strategies exist—suggest that government funding priorities should be commensurate with the prevalence and cost of childhood unintentional injuries relative to other child health problems.

To gain insight into the federal government’s allocation of resources for injury prevention versus prevention of major illnesses, recent estimates of total federal civilian injury prevention and treatment research spending levels (fiscal year 1995–96) were compared with National Institutes of Health (NIH) research budgets for two other leading health problems—vascular disease (heart attack and stroke) and cancer. Prevalence-based estimates of medical spending for all ages in 1996 and published estimates of years of potential life lost also

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Table 6

<table>
<thead>
<tr>
<th>Priority Ranking</th>
<th>Ages in Years</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>0 to 4</td>
</tr>
<tr>
<td>1</td>
<td>Fall</td>
</tr>
<tr>
<td></td>
<td>216,800</td>
</tr>
<tr>
<td>2</td>
<td>Motor Vehicle Traffic a</td>
</tr>
<tr>
<td></td>
<td>52,800</td>
</tr>
<tr>
<td>3</td>
<td>Struck By/ Against</td>
</tr>
<tr>
<td></td>
<td>44,400</td>
</tr>
<tr>
<td>4</td>
<td>Burn/Anoxia</td>
</tr>
<tr>
<td></td>
<td>31,700</td>
</tr>
<tr>
<td>5</td>
<td>Other Vehicle b</td>
</tr>
<tr>
<td></td>
<td>25,200</td>
</tr>
</tbody>
</table>

Percentage: 73% 90% 85% 83% 81%

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Notes:
- Motor vehicle traffic includes child occupant, pedestrian, and pedalcyclist injuries in crashes on public roads.
- Other vehicle includes motorized vehicle crashes not on public roadways (for example, in driveways, train-pedestrian incidents) and pedalcycle crashes.
- Among injuries with known causes, the percentage of total costs that result from the five leading causes of injury.

Source: Calculations by authors from data and methods presented in this article.
were compared for these three health problems. Unfortunately, research spending on children could not be separated from government estimates, so estimates for all ages combined are reported here. Prevention versus treatment research spending also could not be separated in this analysis.

Federal spending for research on injuries, vascular disease, and cancer contrasted sharply with the relative burdens of these health problems, measured by medical spending and years of potential life lost. As shown in Figure 2, although injury, vascular disease, and cancer accounted for similar proportions of medical spending (12%, 14%, and 9% respectively), research funding in these areas varied substantially (2.4%, 5.9%, and 10.5% respectively). Estimated research spending on vascular disease ($900 million) was approximately 2.4 times higher than estimated research spending on injuries ($370 million), and spending on cancer research ($1.6 billion) was more than four times higher than injury research spending. Thus, relative to problem size, research spending on injuries is much lower than research spending on vascular disease or cancer.

The estimated injury research spending data used in this analysis was compiled by a federal agency, but it should be interpreted...
cautiously since injury research funding is diffused across many federal agencies, which makes it difficult to identify. Yet, although it is difficult to assess current funding levels for injury prevention, increased funding is warranted. Unfortunately, the trend is not in this direction. Alarmingly, based on the fiscal year 2000 federal budget, it is likely that the Preventive Health Services Block Grant—which has supported many state injury prevention programs as well as chronic disease prevention—will be reduced in future years. Moreover, some policymakers are arguing that the remaining funds should be targeted for chronic disease only. The return on investment for injury prevention strategies shown in the cost-effectiveness analyses reported in this article should be carefully weighed by these decision makers.

### How Cost Effective Are Childhood Injury Prevention Strategies?

Estimating the cost effectiveness of injury prevention strategies relative to the cost effectiveness of efforts aimed at mitigating other child health problems is useful to inform decisions about the allocation of scarce resources. For example, the costs and outcomes of one intervention (such as child safety seat use) can be compared with the costs and outcomes of another intervention (such as immunizations) when the outcomes measured are the same. In health-related studies, the outcome considered most frequently is good health measured in QALYs. With cost-effectiveness estimates, decision makers may decide to invest, for example, only in interventions that save a specified number of QALYs for a given cost. Alternatively, they may decide to invest in one intervention over another because it has a more favorable cost-effectiveness ratio (that is, cost per QALY is lower).

This section summarizes the cost effectiveness of seven childhood injury prevention measures that published studies have demonstrated to be effective (see Table 7). These seven measures were selected because they primarily focus on unintentional childhood injuries, cover a range of risks and approaches, have reasonably strong evidence for effectiveness, and were analyzed using uniform methods for estimating injury costs and cost effectiveness. The cost effectiveness of these injury prevention strategies is compared with published cost-effectiveness estimates for measures that have been widely used to prevent other important neonatal and childhood problems, including neonatal intensive care, phenylketonuria screening, and measles/mumps/rubella immunization. The data presented here suggest that many childhood injury prevention strategies have similar cost-effectiveness ratios compared with other well-accepted strategies to prevent childhood illnesses. Yet, implementation of childhood injury prevention strategies is not widespread.

### The Cost Effectiveness of Selected Child Safety Measures

Table 7 lists the seven child safety measures examined and the cost per QALY saved from society’s perspective. Each safety measure, the evidence for its effectiveness, and cost-effectiveness estimates based on previous analyses are summarized below.

- **Child Safety Seats.** A national study of outcomes in crashes where two infants or toddlers were restrained differently provided effectiveness estimates for analyzing the cost effectiveness of child safety seats. The study estimated that, based on actual use, child safety seats were 54% effective against child occupant fatalities and 52% effective against nonfatal injuries. These data were combined with retail purchase price data for a no-frills convertible seat that can be used for infants and toddlers, with a 20% allowance added to cover parent education about need and installation. Applying these estimates, child safety seats yielded net cost savings. This finding holds even if one adds the cost of passing child seat laws and the time spent by parents buying and learning to use a seat. These estimates ignore child discomfort costs and offsetting benefits from reduced driver distraction when a toddler is not free to roam in the vehicle.
The Cost of Childhood Unintentional Injuries and the Value of Prevention

Zero Alcohol Tolerance Laws.

Every state has passed zero alcohol tolerance laws making it illegal for adolescents under age 21 to drive with a blood alcohol level of 0.02% or greater. Two multistate studies estimated that these laws reduced alcohol-related crashes among young drivers by 20%. The primary cost of these laws is the freedom that youths lose to drink illegally and then drive; police enforcement and sanctioning impose much smaller costs. Accounting for these costs, zero tolerance laws yielded net cost savings.

Graduated Licensing with Midnight Driving Curfews.

A broader approach to reducing the costs of automobile crashes by young drivers is graduated licensing, discussed by Schieber, Gilchrist, and Sleet in this journal issue. The cost effectiveness of graduated licensing programs that impose a midnight driving curfew until the driver turns 19 years of age or drives for at least six consecutive months without a crash or moving violation has been estimated. Drawing on evidence from three programs, researchers estimated that crashes involving novice drivers decline by 5% with these programs in place. The largest cost of this intervention is lost mobility for young drivers (loss of the ability to legally drive independently between midnight and 5:00 a.m., plus loss of the ability to drive legally when a license is revoked or suspended for curfew violation). Enforcement and sanctioning impose further costs. Nonetheless, taking these costs into account, the graduated licensing model yielded net cost savings.

Bicycle Helmet Use.

The cost effectiveness of a bicycle safety helmet purchased at a retail cost of $25, as well as the cost effectiveness of a bulk distribution program that delivered helmets at half this price, have been analyzed. The estimated effectiveness of bicycle helmets taken from case-control studies showed that, even when misuse was considered, helmets prevented 68% to 85% of nonfatal head and scalp injuries and 65% of upper and middle face injuries. Ignoring children’s discomfort and inconvenience costs and the time spent shopping for a helmet, the study estimated that bicycle helmets offered net cost savings if at least half of children who ride a bicycle wear a helmet, helmet use offers a net cost savings.

Table 7

<table>
<thead>
<tr>
<th>Injury Prevention Measure*</th>
<th>Cost per QALYa</th>
</tr>
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<tbody>
<tr>
<td>Child Safety Seatb</td>
<td>&lt;$0**</td>
</tr>
<tr>
<td>Zero Tolerance of Alcohol, Drivers under Age 21c</td>
<td>&lt;$0</td>
</tr>
<tr>
<td>Provisional Licensing, Midnight Curfewc</td>
<td>&lt;$0</td>
</tr>
<tr>
<td>Bicycle Helmet, Ages 5 to 15d</td>
<td>&lt;$0**</td>
</tr>
<tr>
<td>Smoke Detectore</td>
<td>&lt;$0</td>
</tr>
<tr>
<td>Childproof Cigarette Lighterf</td>
<td>$4,000</td>
</tr>
<tr>
<td>Poison Control Centerg</td>
<td>&lt;$0</td>
</tr>
</tbody>
</table>

a. All estimates were computed at a 3% discount rate and are compared with the absence of the intervention. The cost per QALY saved was computed by dividing the QALYs saved per unit by the net cost of the unit (which equals the unit cost minus the reduced medical care, property damage, insurance claims administration, and other direct costs). When these direct cost savings exceeded the cost of the safety measure, the cost per QALY saved is <$0.

** Ignores discomfort and inconvenience costs.
savings, even accounting for time spent shopping. This may be a realistic usage goal, based on helmet use estimates following the enactment of legislation in Georgia, where 90% of parents reported that their children who owned a helmet wore it on their most recent ride, with reported helmet use stable across family income levels.33

- Smoke Detectors. The cost effectiveness of battery-operated smoke detectors has been analyzed20 using National Bureau of Standards engineering estimates that smoke detectors are 45% effective against deaths and 30% effective against nonfatal injuries.34 The cost-effectiveness estimates reported here further assume that smoke detectors are 10% effective against property damage. Smoke detectors are not strictly child safety devices; they also benefit children by saving their parents and grandparents. The cost-effectiveness analysis accounted for time and money spent buying, installing, and maintaining an average of 1.6 smoke detectors per home. Using these estimates, smoke detectors offer net cost savings.20

- Child-Safe Cigarette Lighters. In 1993, the U.S. Consumer Product Safety Commission (CPSC) required that all cigarette lighters have a dual-action catch that children ages zero to five cannot readily operate.21 The CPSC used engineering and experimental research to estimate the effectiveness as approximately a 70% reduction in fires started by children ages zero to five playing with lighters. This change in product design cost $.15 per cigarette lighter. The regulation costs $3,000 to $4,000 per QALY saved.21

- Poison Control Centers. Poison control centers, professionally staffed sources of free telephone advice about how to respond to and prevent potentially toxic exposures, have been shown to reduce the unnecessary use of health care services.22 Studies from two jurisdictions where services became unavailable estimated that the centers appropriately reduced medical visits for poisoning by more than 37%.35,36 The cost per poison control center telephone call came from a national summary of center financial reports.37 Using these estimates, poison control center calls yield net cost savings.22 An analysis of the robustness of this finding in regards to changes in the estimated effectiveness found that poison control centers offer net cost savings as long as the estimated reduction in medical visits is at least 7%.22

Comparison with the Cost Effectiveness of Other Child Health Risks
To further interpret the cost-effectiveness analyses of childhood injury prevention efforts, similar estimates of cost per QALY saved for seven other neonatal and child health risks were examined (see Table 8). These examples were selected because the
The cost-effectiveness studies were of good quality, used or could be converted to a 3% discount rate, and represented diverse approaches to child risk reduction.\textsuperscript{38–41} Many of these estimates—including cereal fortification with folic acid, selected newborn vaccinations, and newborn screening for phenylketonuria—offered net cost savings. Efforts to reduce cigarette sales to minors cost $1,000 per QALY saved. Hepatitis B vaccination of newborns and neonatal intensive care were less cost effective. The cost estimates in these studies all focused on the costs of delivering health care, food supplements, or health education. They ignored time spent by parents and child discomfort and inconvenience. Thus, the costs are accounted for less completely than in many of the safety studies, so comparisons of cost-effectiveness estimates should be made with caution.

### Summary of Cost-Effectiveness Estimates

This section summarized the cost-effectiveness of seven childhood unintentional injury prevention interventions, and it compared these estimates with the cost effectiveness of other widely accepted interventions aimed at improving the health of infants and children. Six of the injury prevention interventions offered net cost savings; one measure cost $4,000 per QALY saved. Two recent reviews of cost-effectiveness analyses in health and safety conclude that net cost savings are “fairly rare,” so childhood injury prevention efforts score well.\textsuperscript{38,41}

The cost effectiveness of childhood unintentional injury prevention strategies reviewed here also compares favorably with the cost effectiveness of several widely implemented childhood illness prevention measures. These findings should be interpreted cautiously, however, since the studies are not completely comparable, especially in their methods for estimating QALY savings. They should, however, be reasonably robust since the injury studies generally account for costs more comprehensively than do the illness studies.

Despite some uncertainty about the cost-effectiveness estimates reported here, these findings suggest that society may profit from implementing many child safety measures, and more widespread use of them may be warranted. Third-party payers—such as managed care organizations, other health insurers, and auto insurers—may save money by advocating for, subsidizing, or paying to promote routine use of some

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Table 8

<table>
<thead>
<tr>
<th>Child Health Measure*</th>
<th>Cost per QALY\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis B Vaccination of Newborns\textsuperscript{38}</td>
<td>$26,000–$55,000</td>
</tr>
<tr>
<td>Restriction of Cigarette Sales to Minors\textsuperscript{38}</td>
<td>$1,000</td>
</tr>
<tr>
<td>Cereal Fortification with Folic Acid to Improve Pregnancy Outcomes\textsuperscript{39}</td>
<td>&lt;$0</td>
</tr>
<tr>
<td>Neonatal Intensive Care, Weight 500 to 999 Grams\textsuperscript{40}</td>
<td>$23,000</td>
</tr>
<tr>
<td>Neonatal Intensive Care, Weight 1,000 to 1,499 Grams\textsuperscript{40}</td>
<td>$13,000</td>
</tr>
<tr>
<td>Phenylketonuria Screening of Newborns\textsuperscript{41}</td>
<td>&lt;$0</td>
</tr>
<tr>
<td>Measles/Mumps/Rubella Immunization\textsuperscript{41}</td>
<td>&lt;$0</td>
</tr>
</tbody>
</table>

\textsuperscript{a} All estimates were computed at a 3% discount rate and are compared to the absence of the intervention.

* See related endnotes at the end of this article.
safety measures, such as child safety seats and smoke detectors. The potential cost savings may be particularly great for low-income families on Medicaid, since these parents often cannot afford the safety devices purchased by wealthier parents. Finally, many other injury prevention measures merit careful evaluation and, if effective, cost-effectiveness analyses. These include readily grasped, small-diameter handrails without sharp edges; window guards; pool fencing ordinances; learn-to-swim programs (which potentially could increase risk); restrictions on child gun access; childproof cabinet latches; plastic plug covers for electric outlets; rounded corners on furniture; and home safety inspections. Particularly for safety measures that are expensive, widespread adoption should await these cost-effectiveness analyses.

Conclusions

In 1996, unintentional injuries were the most prevalent and expensive health risk faced by children and adolescents ages 1 to 19. Childhood unintentional injuries that occurred in 1996 resulted in $14 billion in lifetime medical spending, $1 billion in other resource costs, and $66 billion in present and future work losses. These injuries imposed quality-of-life losses equivalent to 92,400 child deaths. The most costly risks were falls, motor vehicle crashes, and incidents in which children were unintentionally struck by or against an object. Despite their relatively small numbers, deaths and hospitalized injuries accounted for half of the injury costs.

Most unintentional injuries are, in theory, preventable, and proven strategies exist to reduce the injury toll. Moreover, the costs of preventing injuries are often less than the costs of treatment. This suggests that managed care companies, state Medicaid agencies, and other third-party payers could save money by subsidizing or promoting routine use of selected child safety measures such as child safety seats. Tax dollars could be saved by providing child safety seats and bicycle helmets to infants and children enrolled in Medicaid. Insurance bills could be reduced by equipping homes with working smoke detectors. Yet, these and other proven injury prevention interventions often are not widely implemented. When personal freedom clashes with child safety, Americans strongly value their freedom. Furthermore, unintentional injury is under-appreciated as a major child health problem. Federal agencies fund disproportionately little research on injury prevention measures and devote relatively few public dollars to injury prevention programming.

Children pay the price for the nation’s underinvestment in injury prevention; many die unnecessarily, and others suffer from long-term disabilities. This article suggests that, with funding and will, the nation can prevent these devastating injuries. Until this
happens, unintentional childhood injuries will remain a costly national tragedy.

The research reported in this article was supported by a grant from the National Highway Traffic Safety Administration (grant number DTHN22-97-8-55072); a Children’s Safety Network contract from the Health Resources and Services Administration, U.S. Department of Health and Human Services (contract number MCJ-240-98-0006); and a grant from The David and Lucile Packard Foundation. Participating in the International Collaborative Effort on Injury Statistics—sponsored by the National Center for Health Statistics with funding from the National Institute of Child Health and Human Development, National Institutes of Health—also contributed critically to this research.

Appendix

Methods of Estimating Childhood Unintentional Injury Costs and Quality-of-Life Losses

Throughout most of this article, cost estimates refer to incidence-based costs—the lifetime costs associated with childhood unintentional injuries that occurred during 1996 (see Box 1). Prevalence-based costs—the costs associated with childhood unintentional injuries accrued in 1996, regardless of when the injury occurred—are discussed only in reference to spending on injury versus illness. This appendix focuses on the estimation of incidence-based costs.

The Theory behind Estimating Future Costs

The incidence-based costs reported estimate the present value of all expected costs over the child’s expected life span. For costs that will occur in future years, the “present value” is estimated, defined as the amount one would have to invest today in order to pay these costs when they come due. The present value of future costs depends on how many years in the future the costs are borne and on the “discount rate.” The discount rate applied to future costs to estimate their present value is independent of inflation. This article uses the 3% discount rate recommended by the Panel on Cost-Effectiveness in Health and Medicine.1


Estimating the costs and quality-of-life losses associated with childhood unintentional injuries required separately estimating the frequency of injuries (stratified by severity, diagnosis, cause, and age), the present and future costs (resource and productivity) of the injuries, and the quality-adjusted life years (QALYs) lost due to injury. Table 2 presents the injury frequency data used in this analysis.

The subsections below summarize the data sources and limitations of the methods used to estimate each component of injury frequency, cost, and quality-of-life losses in this analysis. Detailed technical notes on the methods and results tables by cause and age group are available from the authors.

Estimating Injury Occurrence

Injury Frequency, Severity, and Diagnoses

The frequency, severity, and diagnoses for childhood injury were estimated primarily from three federal sources: the 1996 U.S. Vital Statistics census for injury deaths; the 1996 National Hospital Discharge Survey (NHDS) for hospitalized injury survivors; and 1987–1996 National Health Interview Surveys (NHIS) for other injury survivors. Poisonings handled over the telephone by poison control centers were estimated from Toxic Exposure Surveillance System data collected in 1992.2
Appendix (continued)

These data sets provide nationally representative estimates, but they have methodological limitations that may lead to undercounting or overcounting injuries. For example, the NHDS does not clearly distinguish initial hospitalizations from transfers and follow-up hospitalizations, so some injuries may have been counted more than once, even though an attempt was made to remove transfers and follow-ups from the analyses. Because of small survey responses, many years of NHIS data were pooled to obtain the distribution of diagnoses for nonhospitalized survivors by age group, and this distribution was assumed to be stable over time. This assumption may not be accurate, however, because managed care probably has reduced the likelihood of hospital admission differentially across diagnoses. The NHIS survey also is limited because it relies on victim rather than medical descriptions of injury, and it does not include homeless or institutionalized populations.

Injury Intent and Causes

The unintentional injury cause distributions used in this analysis are nationally representative, classified by external cause of injury codes, and cover all medically treated injuries (see Table 2). Intent and cause were modeled with intent/cause-coded data from 1996 U.S. Vital Statistics, 1996 NHDS, pooled 1992–1996 National Hospital Ambulatory Medical Care Surveys (NHAMCS), pooled 1995–1996 National Ambulatory Medical Care Surveys (NAMCS), and pooled hospital discharge data from six states. For injuries with differing severity or place of treatment, these data sets either provided national intent/cause distributions or enabled those distributions to be estimated from national data sets describing injury incidence by age group and diagnosis. The vital statistics mortality census included external cause of injury codes, as did 63% of 1996 NHDS injury cases. The causes for NHDS cases without external cause of injury codes were inferred from external cause coded cases for the same diagnosis group and age group, which introduces some unknown level of inaccuracy.

Similarly, for nonhospitalized injury survivors, available national data on the distribution of intent/cause by diagnosis and age group were applied to pooled, nationally representative 1987–1996 NHIS data on nonhospitalized injury frequency to estimate intent and causes. The cause distributions by diagnosis group and by age group, however, were taken from available external cause coded federal provider surveys—the 1995–1996 NAMCS and the 1992–1996 NHAMCS. The NAMCS and NHAMCS are limited in that they do not cover all ambulatory care; they count visits rather than injury victims; they fail to distinguish some follow-up visits from initial visits; and sample sizes are small. As a result, causes for 10.4% of childhood injury cases, almost entirely cases treated only in physician offices, were unable to be estimated.

Estimating Injury Costs

Injury costs were divided into resource costs (medical and other) and productivity costs (costs of work losses).

Resource Costs

Medical costs were estimated using the methods employed in building the U.S. Consumer Product Safety Commission’s (CPSC) injury cost model, except the methods were tailored to children. These methods have been documented elsewhere.3 Briefly, costs of initial treatment were extracted from nationally representative or
The Cost of Childhood Unintentional Injuries and the Value of Prevention

Appendix (continued)

statewide data sets. By diagnosis, medical follow-up, rehabilitation, and long-term costs computed from national data on the percentage of medical costs associated with initial treatment were added. Due to data unavailability, these percentages were less current than the costs for initial treatment, although they were tailored to children. The primary data sources used to compute medical costs included: NHDS, hospital discharge data from Maryland and New York, payment summaries from the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS), longitudinal MEDSTAT health care claims data, and longitudinal Detailed Claims Information data from the National Council on Compensation Insurance. Data for other resource costs—including police, fire department, and travel delay costs—were available from previous research. Conceptually, these costs should not vary by victim age.

Productivity Costs

Productivity cost estimates also paralleled the CPSC injury cost model where those estimates were tailored to children. For nonfatal injuries, the work loss cost is the sum of the lifetime loss due to permanent disability (averaged across permanently disabling and nondisabling cases), plus the loss due to temporary disability. For fatal injuries, the work-loss cost is the present value of expected lifetime earnings, fringe benefits, and household work. The primary data sets used to estimate the extent of productivity losses included the 1987–1996 NHIS, the 1993 Survey of Occupational Injury and Illness of the U.S. Bureau of Labor Statistics, and the Detailed Claims Information database from the National Council on Compensation Insurance.

Data Limitations

While primarily large, nationally representative data sets were used to estimate injury costs, data had limitations that may have biased the cost estimates. For example, although hospitalization cost estimates used in this analysis are age-specific, other data are not. Specifically, the permanent disability cost estimates associated with productivity losses account for the longer life span of children but are not child-specific in other respects. The work-loss cost estimates in this analysis have other drawbacks as well. Because women and minorities are paid less than white males for comparable work, productivity costs undervalue their lives. For example, using a 3% discount rate, at age seven the present value of lifetime wage and household work loss resulting from the death of a girl is $788,000, compared with $1,003,000 for the death of a boy. Because children’s earnings are in the future, their present value also is less than the present value of earnings losses of young adults, even though more years of future work are lost. Some of the minor cost contributors in this analysis, notably coroner costs, also have limitations, because data used to estimate them are 10 to 20 years old. Inflating these old estimates to current dollars may introduce some inaccuracy, but they contribute too little to total costs to justify the expense of collecting new estimates. Finally, the cause-estimating process for nonfatal injuries required several assumptions and failed to associate causes with almost 10% of the costs (virtually all for nonfatal injuries treated only in doctor offices). Thus, many of the cost estimates presented in this analysis may be underestimates.

Estimating Lost Quality-of-Life

Quality-of-life losses were estimated as the sum of years of potential life lost to fatal injury plus the QALY losses resulting from nonfatal injury. For each death or
paralyzing injury that shortens the life span, the years of life lost were estimated from a life expectancy table. For QALY losses associated with temporary or permanent disability, estimates by injury diagnosis and victim age were taken from a previous study. These estimates combined physician ratings of the impact of injuries over time on a person’s ability to think, see, walk, and so forth, and on pain, with diagnosis-specific National Council on Compensation Insurance data on the probability that an injury would permanently reduce earning capacity or prevent the victim from working and on the percentage earnings reduction. The rating scales used were not tailored to children, although the physicians were asked to rate probable impairment levels and durations separately for children. The estimated impairment impacts were translated into QALY losses using survey data that weighed the relative importance that respondents placed on different dimensions of impact. Most of these weights were specific to a child and adolescent population.

1. This estimate comes from the analyses reported in this article.
7. Costs were estimated from National Health Interview Survey and National Hospital Discharge Survey (NHDS) data, Maryland and New York hospital data on cost per day, and Civilian Health and Medical Program of the Uniformed Services cost data. This prevalence-based estimate is consistent with the most current published estimate, which analyzed 1987 National Medical Expenditure Survey data. See Miller, T.R., Lestina, D.C., and Galbraith, M.S. Patterns of childhood medical spending. Archives of Pediatrics and Adolescent Medicine (1995) 149: 369–73. Visit counts are from the NHDS with intent modeled where missing, the National Hospital Ambulatory Medical Care Survey, and the National Ambulatory Medical Care Survey.


11. See note no. 3, Rice and MacKenzie, chapter 3.


13. The injury estimates are from a database maintained by the National Center for Injury Prevention and Control (Inventory of federally funded research in injury prevention and control, 1995. Atlanta, GA: Centers for Disease Control, 1997), which includes both intentional and unintentional injuries. The estimates for other causes come from the National Institutes of Health (NIH) budget and exclude spending by the Agency for Health Care Policy and Research. Both estimates exclude spending by the Departments of Defense and Veterans Affairs. These estimates may not have captured all research on occupational injuries, possibly underestimating injury research funding. Activities comparable to some of the activities included under NIH research spending on cancer would not have been labeled as research in the injury estimate, possibly overstating cancer research funding.

14. See note no. 2, Bureau of the Census, table 144.


16. Cost effectiveness is measured as the net cost per quality-adjusted life year (QALY) of good health produced or saved. To compute cost effectiveness, the costs of implementing a prevention measure and the direct costs and QALYs it is expected to save are estimated. Subtracting the direct cost savings from the costs of implementing the intervention yields the net cost. If the net cost is less than zero, the measure produces "net cost savings." If this is not the case, dividing the net cost by the QALYs saved produces a cost per QALY saved. The cost-effectiveness analyses provide results relative to the preintervention situation.


21. U.S. Consumer Product Safety Commission (CPSC). Safety standard for cigarette lighters, 58 Fed. Reg. 131 (July 12, 1993) 16 C.F.R. pt. 1210. In this study, the burn injury costs were replaced with more recent CPSC burn injury costs, which match the injury costs used in the other six studies.


23. Six of the seven estimates come from previously published benefit-cost analyses that used a 2.5% discount rate and similar injury costs to one another. The seventh is from a regulatory analysis of dual-catch cigarette lighters. For this article, all seven estimates were recomputed using a 3% discount rate. Supplementing the published information with unpublished details, the cost per QALY saved for each study was computed.


40. Boyle, M.H., Torrance, G.W., Sinclair, J.C., and Horwood, S.P. Economic evaluation of neonatal intensive care of very low birth weight infants. *New England Journal of Medicine* (1983) 308:1330–37. Estimated cost per QALY saved of neonatal intensive care was at a 5% discount rate. The estimate in Table 8 was recomputed at a 3% discount rate and omitted expected earnings gains (an indirect cost) from the calculation of net costs to avoid double counting. This estimate unavoidably reflects 1978 treatment capabilities, so it may not measure current cost effectiveness very accurately.