The Medical Costs of Gunshot Injuries in the United States

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I N 1997, GUNSHOTS CAUSED 31 636 fatal injuries and approximately 100 000 nonfatal injuries in the United States.[1,2] In addition to the enormous human toll of gun violence, the cost of treating these injuries imposes a financial burden on society. While measuring medical costs is not as straightforward as counting the number of victims, valid cost estimates are important for at least 2 reasons. First, such estimates are relevant to evaluating gun violence–reduction programs. Second, reliable estimates for the financial burden that gun violence imposes on the medical care system may help guide reimbursement policies.

We present new estimates for the aggregate medical costs of gunshot injuries in the United States. Compiling such estimates requires a variety of data sets and a number of assumptions. The result is necessarily imperfect, but our estimates improve on previous published estimates in several ways. We used the most up-to-date and comprehensive sources available, including some that have not been used for this purpose before. In particular, our sample of hospitalized gunshot injuries is more current and more than twice as large as that used in previous studies,[3-5] and our sample of cases treated in the emergency department (ED) is a vast improvement over the sample used in a previous estimate (800 cases vs 11 cases).[4,5] We paid particular attention to the small pro-

portion of serious gunshot injuries that account for a disproportionate share of lifetime medical costs by developing new estimates for gunshot-related spinal cord injuries using data from the National Spinal Cord Injury Statistical Center (NSCISC).[6] We focused as much as possible on medical costs rather than payments or charges.[7] Finally, how these costs are distributed may be at least as important as their overall magnitude for informing policy makers. Our study presents what we believe are the first nationally representative estimates for the sources of payment for medical costs that are specific to gunshot injuries.

METHODS

In our approach, the national medical cost for each category of gunshot inju-

ries is calculated as the product of 2 estimated magnitudes, the number of gunshot cases and the average cost per case in that category. As a rule, we were able to quantify the uncertainty about the number of cases, but had no way to quantify the uncertainty about the average cost. The primary sources of uncertainty with the average-cost estimates stem from questions about data representativeness rather than sampling variability. As a result, we present 95% confidence intervals (CIs) for

Context The cost of treating gunshot injuries imposes a financial burden on society. Estimates of such costs are relevant to evaluation of gun violence reduction programs and may help guide reimbursement policies.

Objectives To develop reliable US estimates of the medical costs of treating gunshot injuries and to present national estimates for the sources of payment for treating these injuries.

Design and Setting Cost analysis using E-coded discharge data from hospitals in Maryland for 1994-1995 and New York for 1994 and from emergency departments in South Carolina for 1997. Other sources of data included the National Electronic Injury Surveillance System for 1994 incidence of nonfatal gun injuries, the National Spinal Cord Injury Statistical Center database for 1988-1992 estimates of lifetime medical costs of gun injuries, and the 1994 Vital Statistics census for incidence of fatal gun injuries.

Main Outcome Measures Estimated national acute-care and follow-up treatment costs and payment sources for gunshot injuries.

Results At a mean medical cost per injury of about $17 000, the 134 445 (95% confidence interval [CI], 109 465-159 425) gunshot injuries in the United States in 1994 produced $2.3 billion (95% CI, $2.1 billion–$2.5 billion) in lifetime medical costs (in 1994 dollars, using a 3% real discount rate), of which $1.1 billion (49%) was paid by US taxpayers. Gunshot injuries due to assaults accounted for 74% of total costs.

Conclusions Gunshot injury costs represent a substantial burden to the medical care system. Nearly half this cost is borne by US taxpayers.

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the number of gunshot cases but not for average cost per case.

TABLE 1 outlines the key data sources that we used to estimate medical costs. Because the available data sources are focused on different levels of treatment, we organized our estimates according to the highest level of medical treatment the patient received—hospitalized, ED only, and "other." This last category includes untreated cases, both fatal and nonfatal, and nonfatal cases treated in physicians' offices. Our estimates start with average acute-care costs: we used data from New York and Maryland for hospitalized cases and from South Carolina for ED-only cases. Lifetime follow-up costs were calculated using a number of national data sources. The lifetime cost per case of each sort was then multiplied by the estimate for the number of gunshot cases of that sort.

Cases were classified in several ways, including (1) injury outcome (fatal or nonfatal); (2) the highest level of medical treatment received (hospitalized, ED only, or other); (3) victim's sex and age; and (4) diagnosis and external cause-of-injury codes from the *International Classification of Diseases, Ninth Revision* (*ICD*-9). The *ICD-9* diagnosis codes allowed us to distinguish cases according to body part injured. The *ICD-9* external cause-of-injury codes (E codes)

identify the injury intent (self-inflicted, unintentional, assault), whether the injury was caused by a firearm, and, if so, the gun type (handgun, shotgun, rifle). Our incidence estimates were calculated separately for each of our disaggregated injury groups. Total national costs were thus defined as the sum across injury groups of average costs times incidence. One advantage of our method is that it allows us to more confidently project national costs because this procedure controls for the possibility that the gunshot case mix in the 3 states used to estimate acute-care costs may not be nationally representative.

In all of our calculations, we followed the recommendation of the Panel on Cost-Effectiveness in Health and Medicine, convened by the US Public Health Service in 1993, and converted lifetime costs into a present value using a 3% discount rate.[8] Unless otherwise noted, we converted all medical costs into 1994 prices using the Consumer Price Index for Medical Care.[9] We chose 1994 as our reference year because most of our medical cost data come from this period.

Incidence

We calculated the incidence of fatal gunshot injuries that occurred in the United States in 1994 from the 1994 Vi-

tal Statistics census of deaths.[10] The 1994 Vital Statistics multiple-cause-of-death file includes *ICD-9* diagnosis codes and E codes, the victim's sex and age at death, and whether the victim died as a hospital inpatient, an ED patient (which under our definition includes dead-on-arrival cases and those for whom hospitalization status was unknown), or outside of the ED or hospital (such as dead at the scene).

Estimates for the number of nonfatal gunshot injuries come from the National Electronic Injury Surveillance System (NEISS), a national probability sample of hospital EDs.[2] Case studies suggest that NEISS coders record 92% to 97% of gunshot injuries treated in sampled EDs.[11,12] While NEISS uses a system different than the *ICD-9* to provide injury characteristics, we have developed a system that matches NEISS injury codes with *ICD-9* diagnosis and E codes. We adjusted the NEISS estimates for the fact that some gunshot victims receive emergency medical treatment outside of hospital EDs (authors' unpublished data, 1999).

The detailed injury and victim data available from the Vital Statistics and NEISS allow us to estimate the national incidence of fatal and nonfatal gunshot injuries within each of the disaggregated injury groups described above.

Table 1. Data Sources for Estimating the Medical Costs of Treating Gunshot Injuries*

Highest Level of Treatment or Outcome	Incidence†	Acute Care Costs†	Physician Fees	Follow-up Medical Costs	Payment Source†
ED only	1994 NEISS	1997 South Carolina ED discharge data	1992-1994 CHAMPUS‡	1987 NMES§ and 1979-1987 DCI‡	1992-1996 NHAMCS and 1997 South Carolina ED
Hospitalization	1994 NEISS	1994-1995 Maryland and 1994 New York hospital discharge data	1992-1994 CHAMPUS‡	1987 NMES§ and 1979-1987 DCI‡	1994 HCUP and 1996 NHDS hospital discharge data
Serious disability (spinal cord injuries)	1994 NEISS and 1988-1992 NSCISC	1988-1992 NSCISC	1988-1992 NSCISC†	1988-1992 NSCISC†	1988-1992 NSCISC
Death	Vital statistics	1994-1995 Maryland and 1994 New York hospital discharge data	1992-1994 CHAMPUS‡	. . .	1994 HCUP, 1997 South Carolina ED, and 1993 NMFS

*ED indicates emergency department; NEISS, National Electronic Injury Surveillance System; CHAMPUS, Civilian Health and Medical Program of the Uniformed Services; NMES, National Medical Expenditure Survey; DCI, National Council on Compensation Insurance's Detailed Claims Information; NHAMCS, National Hospital Ambulatory Medical Care Survey; HCUP, Agency for Health Care Policy and Research's Healthcare Cost and Utilization Project; NHDS, National Hospital Discharge Survey; NSCISC, National Spinal Cord Injury Statistical Center; ellipses, not applicable; and NMFS, National Mortality Followback Survey.
†Data set identifies gunshot injuries using either *International Classification of Diseases, Ninth Revision* (*ICD-9*) E codes or other injury identification system.
‡Data set does not provide E codes or other information to distinguish between gunshot injuries and nongun injuries within the same *ICD-9* injury diagnosis code.
§Data set includes too few injuries to calculate separate estimates disaggregated by *ICD-9* injury diagnosis code. Instead, the ratio of follow-up medical costs during the first 6 months to acute care treatment costs for all injuries was estimated, regardless of weapon type or body part injured.

Costs for Hospitalized Victims

With slight variations, the lifetime cost per hospitalized gunshot survivor was computed using the formulas in equations 1 and 2:

(1) *Short-term* = (*Hospital Costs*) × (1+ *Fee Ratio*) × (*Readmission*) × (1+ *Postdischarge*); and (2) *LC* = (*Short-term*) × (*Long-term*) × (1 + *Claims*).

In the equations, *Short-term* indicates costs during the first 6 months following the injury; *Hospital Costs*, hospital costs for initial hospitalization; *Fee Ratio*, ratio of inpatient professional fees to hospital costs; *Readmission*, average number of hospital admissions per gunshot injury; *Postdischarge*, ratio of costs in the first 6 months after discharge to acute inpatient care costs; *LC*, lifetime medical cost per gunshot survivor; *Long-term*, ratio of total lifetime costs to *Short-term*; and *Claims*, ratio of claims administration costs to total lifetime medical costs. Hospital costs for gunshot injuries are based on a census of hospital discharges in Maryland in 1994-1995 (2852 cases) and New York in 1994 (3835 cases). Around 7% of victims in each state were deceased at discharge. We focused on hospital discharge data from Maryland and New York because these states require that hospitals provide E codes for all injury-related hospital discharges. More importantly, regulatory agencies in these states ascertained costs of care by hospital service, and, as a result, the charges reported in these hospital-discharge data sets can be converted to reasonably accurate estimates of actual hospital costs.

The ratio of professional fees to hospital costs (*Fee Ratio*) was calculated at the diagnosis-code level using the 1992-1994 Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) data, which are based on payments (including co-payment) in an insured population of 2 million military dependents and non-Medicare retirees.[13] While CHAMPUS is the best available data source for estimating professional fees, the lack of E codes meant that we had to calculate professional fee ratios by diagnosis regardless of whether the injury was by gunshot or other means.

The ratio of ancillary and follow-up costs in the first 6 months to all acute inpatient care costs (*Postdischarge*) was calculated from the 1987 National Medical Expenditure Survey (NMES).[4,5] These follow-up costs include emergency transport, prescriptions, medical supplies (such as crutches), home health care, and follow-up physician visits (but not follow-up hospitalizations). Because NMES contains only 397 total hospital-admitted injuries, we could not produce estimates for *Postdischarge* that are specific to individual *ICD-9* diagnosis or E codes. Instead, we used NMES data to estimate that *Postdischarge* is equal to 11.8% for all injuries, regardless of the body part injured or method of injury.

Some gunshot victims will have repeat hospitalizations in the short term that are not captured by *Postdischarge*. To adjust for this, we used Missouri hospital-discharge data from 1994 that include individual patient identification numbers to estimate the average number of hospital admissions for each gunshot victim during the first year following the injury (*Readmission*). We multiplied the Maryland and New York estimates of costs per admission by our Missouri estimate of total first-year hospital admissions per victim to obtain an estimate of hospital costs per gunshot injury case.

Except for catastrophic spinal cord injuries and traumatic brain injuries, we estimated long-term follow-up medical costs by calculating for each *ICD-9* diagnosis code the fraction of lifetime medical payments for treating an injury that is incurred during the first 6 months and then converting it to a ratio (*Long-term*). Our estimate for *Long-term* comes from the National Council on Compensation Insurance's Detailed Claims Information (DCI) data set, which provides a sample of 452 000 injury cases (including 138 000 hospitalized cases) that occurred from 1979 through 1987.[13] The advantage of the DCI data set is that it is one of the few sources of lifetime medical costs. The disadvantages of the DCI are that it provides information only at the diagnosis level and not at the E-code level, only includes injuries that occur at work, is somewhat dated, and in some states excludes injuries that involve fewer than 3 to 9 days of work loss.

As an example of how these components combine to form average costs per case, consider an unintentional gunshot injury to the abdomen with initial hospitalization costs (*Hospital Costs*) equal to $10 000 and professional payments equal to 30% of the hospitalization costs (*Fee Ratio* = 0.3). Suppose that on average patients with such injuries are hospitalized 1.1 times during the first year (*Readmission* = 1.1), that other follow-up costs during the first 6 months equal 70% of hospitalization costs (*Postdischarge* = 0.7), and that the DCI data suggest that lifetime medical costs for injuries within this *ICD-9* diagnosis code are twice the total costs incurred during the first 6 months (*Long-term* = 2.0). Lifetime costs then equal ($10 000 × 1.3 × 1.1 × 1.7 × 2.0) = $48 620.

The calculation is slightly different for traumatic brain injuries, for which we made some additional adjustment for lifetime custodial-care costs that are unlikely to be fully captured by the *Long-term* factor. The Bureau of the Census[14] reports an annual cost of $84 285 (inflated from 1993 to 1994 dollars using the consumer price index–all items) for custodial care in a public facility for individuals with mental retardation. We followed previous studies[15] in assuming that traumatic brain injury care in an intensive care facility costs twice the Census Bureau's custodial-care figure.

We produced separate estimates for the lifetime medical costs for spinal cord injuries because these relatively rare catastrophic cases account for a disproportionately large share of the overall costs of treating gun injuries. We estimated lifetime medical charges using data from the NSCISC on 820 gunshot-related spinal cord injuries treated between 1988 and 1992 in 24 model spinal cord injury treatment centers.[6] We

converted estimates for inpatient hospital charges into costs using Medicare cost-to-charge ratios for the spinal cord injury hospitals.

Finally, we controlled for the possibility that Maryland and New York medical prices may not be nationally representative by deflating our cost estimates using the Health Care Financing Administration's Hospital Wage Index values for October 1, 1994.[16] This hospital wage index should closely approximate overall variation in medical costs in light of a recent case study suggesting that 80% of total hospital operating expenses come from employee costs.[17] We also multiplied lifetime medical costs by 1.03 or 1.04 (depending on the patient's primary payment source) to reflect claims administration costs.[4,5]

Costs for ED-Only Injuries

We estimated medical charges for gunshot survivors admitted to the ED but not admitted to the hospital by means of a census of ED discharges from South Carolina for 1997. The South Carolina data set provides information on 796 ED-only gunshot injuries and includes those who were dead on arrival at the ED. While these data are not from our reference year (1994) and have charge rather than cost data, they are the best available data on this subject. We estimated follow-up medical costs using the ancillary and follow-up factors described in equation 1.

Costs for Non-ED Cases

No data set provides reliable information on nonfatal gunshot injuries each year in which the victim does not seek medical treatment at the ED or hospital. Since these cases are likely to account for only a very small share of total costs, we ignored them. For fatal non-ED gunshot injuries (the victim dies on the spot) we assumed that the medical costs equal the cost of emergency transport to the medical examiner, equal to $175,[5] plus the costs of the medical examiner's or coroner's examination, equal to $443.[18]

Sources of Payment

The primary hospital discharge data set used to calculate these estimates is the

Table 2. Medical Costs per Case for Hospitalized Patients With Nonfatal and Fatal Gunshot Injuries: Hospital Discharge Data for Maryland, 1994-1995, and New York, 1994*

Injury Intent	No.	Acute Care Costs, $	Hospital Readmissions, $	6-Month Ancillary and Follow-up Costs, $†	Post–6-Month Follow-up Costs, $‡	Claims Administration Costs, $§	Total Lifetime Cost, $‖
Nonfatal Injuries							
Maryland 1994-1995							
All gunshot injuries	2394	14 757	593	1814	17 350	1999	36 685
Unintentional	516	11 897	505	1465	10 807	1452	26 127
Self-inflicted	50	29 619	916	3608	10 561	2855	47 558
Assault	1470	15 756	640	1937	20 853	2289	41 755
Intent unknown	357	12 684	484	1556	13 335	1474	29 533
New York 1994							
All gunshot injuries	3334	14 497	537	1776	15 693	1917	34 420
Unintentional	600	13 083	501	1605	20 533	2203	37 926
Self-inflicted	69	31 316	676	3780	38 878	5277	79 927
Assault	2503	14 616	550	1792	14 041	1772	32 771
Intent unknown	163	10 817	389	1324	13 508	1678	27 716
Fatal Injuries							
Maryland 1994-1995							
All gunshot injuries	200	11 397		1294		501	13 191
Unintentional	21	9087		1021		495	10 603
Self-inflicted	37	8893		998		354	10 245
Assault	107	13 325		1522		563	15 410
Intent unknown	35	9947		1070		466	11 033
New York 1994							
All gunshot injuries	258	10 950		1241		614	12 806
Unintentional	29	13 781		1576		868	16 225
Self-inflicted	26	7862		877		291	9030
Assault	188	11 327		1281		630	13 197
Intent unknown	15	6506		716		483	7706

*Figures reported in 1994 dollars. Lifetime medical costs calculated using a 3% real discount rate.
†Estimate is an average across all injuries of follow-up costs during first 6 months, calculated from the 1987 National Medical Expenditure Survey data.
‡Follow-up costs beyond the first 6 months are estimated at the diagnosis-code level from the National Council on Compensation Insurance Detailed Claim Information worker's compensation data.
§Claims administration costs calculated separately by the patient's expected payer. Estimated ratios for injuries are 0.03 (all gunshots), 0.04 (unintentional), 0.03 (self-inflicted), and 0.03 (assaults).
‖Note that total cost column may not equal sum of other columns; total costs are calculated by first multiplying the lifetime cost factors for each case and then calculating the average of this product, which may not equal the product of the averages.

Agency for Health Care Policy and Research's Healthcare Cost and Utilization Project (HCUP) for 1994,[19] which includes an E-coded sample of discharges from California, Connecticut, Massachusetts, Maryland, New Jersey, New York, Washington, and Wisconsin. (We did not use the HCUP discharge data to estimate costs themselves because only the Maryland and New York data provide information on costs rather than charges). For nonfatal cases we also used the 226 gunshot cases from the National Hospital Discharge Survey (NHDS) for 1996,[20] a nationally representative sample of discharges from 500 hospitals with 63% of cases E coded. For fatal hospitalized injuries, we replicated the HCUP estimates using the National Mortality Followback Survey (NMFS),[21] a nationally representative sample of US decedents in 1993 that includes 2764 gunshot victims.

Estimated payment sources for ED-only cases come from the 1997 ED discharge data from South Carolina. We also estimated the distribution of primary payers for ED-only cases using pooled data from the 1992-1996 National Hospital Ambulatory Medical Care Survey (NHAMCS).[22] The NHAMCS provides information on primary payment source, but not on total costs or charges. The 5 years of pooled NHAMCS data contain 129 gunshot cases.

RESULTS

Costs per Case: Hospitalized Injuries

The average costs for acute-care treatment ($14 757 vs $14 497) and total lifetime costs ($36 685 vs $34 420) of persons hospitalized with nonfatal gunshot injuries in Maryland and New York are remarkably similar, as seen in TABLE 2. In both Maryland and New York, nonfatal self-inflicted gunshot injuries have higher lifetime costs than unintentional injuries or assaults.

As is shown in Table 2, the medical costs of fatal gunshot injuries in which the individual was hospitalized $12 691 in Maryland and $12 191 in New York, calculated as the sum of acute care costs and 6-month ancillary and follow-up costs are, on average, less than half those for nonfatal cases. The difference between fatal and nonfatal hospitalized gunshot injury cases highlights the magnitude of follow-up treatment costs. For the nonfatal gunshot injury cases shown in Table 2, the majority of medical treatment costs come after the patient has been discharged from the hospital (54% of costs in Maryland and 58% in New York).

Costs Per Case: ED-Only Injuries

As seen in TABLE 3, the lifetime charges associated with ED-only gunshot injuries in South Carolina average $1321 for nonfatal cases and $2394 for fatal cases.

Sources of Payment

TABLE 4 presents information on the primary expected payment source for gunshot injuries by severity of the injury. Government programs are the primary payers for 40% to 50% of hospitalized gunshot injury cases. For hospital-admitted survivors, the average of the 1994 HCUP and 1996 NHDS estimates suggest that government is the primary payer in 44% of cases. Government is the primary payer in a smaller number of less-expensive injuries—only 7% for fatal cases from the South Carolina ED data and averaging 18% for nonfatal cases between the South Carolina ED data and the 1992-1996 NHAMCS data. On the other hand, government is the primary payer for a greater share of costs of more expensive gunshot injuries. For example, the NSCISC data suggest that government programs are the primary payers of acute-care costs for 62.5% of spinal cord injuries due to gunshots and 88.6% of spinal injury cases after initial hospitalization.

Private insurance is the primary payer for 18% of hospitalized and ED-only cases. Costs that are classified as "self pay" may increase charges for other pa-

Table 3. Medical Costs per Case for Emergency Department (ED)-Only Gunshot Cases: 1997 South Carolina ED Data *

Injury Intent	Cases, No.	ED Charges, $	6-Month Follow-up Physician or Clinic Visits, $†	6-Month Ancillary and Follow-up Costs, $†	Post–6-Month Follow-up Costs, $‡	Claims Administration Costs, $§	Total Lifetime Costs, $‖
			Nonfatal Injuries				
All gunshot injuries	796	914	199	34	133	39	1321
Unintentional	351	874	188	32	93	39	1227
Self-inflicted	22	1896	217	33	256	60	2461
Assault	342	923	206	36	122	33	1320
Intent unknown	89	786	218	31	329	56	1420
			Fatal Injuries				
All gunshot injuries	41	1956	0	357	0	81	2394

*Figures reported in 1994 dollars. Sample includes both fatal and nonfatal injuries.
†Estimate is an average across all injuries of follow-up costs during first 6 months, calculated from the 1987 National Medical Expenditure Survey data.
‡Follow-up costs beyond the first 6 months are estimated at the diagnosis-code level from the National Council on Compensation Insurance Detailed Claim Information (DCI) worker's compensation data. The percentage of total medical costs incurred during the first 6 months was estimated from the DCI data for each diagnosis code, and then 1 minus this proportion was multiplied by the sum of the ED charges and other medical costs incurred during the first 6 months. Estimates for the proportion of medical costs incurred during the first 6 months after the injury are 0.92 (all gunshot wounds), 0.93 (unintentional), 0.90 (self-inflicted), and 0.91 (assault).
§Claims administration costs are calculated separately by the patient's expected payer. Estimated ratios for injuries are 0.03 (all gunshots), 0.04 (unintentional), 0.03 (self-inflicted), and 0.03 (assaults).
‖Note that the total cost column may not equal sum of other columns; total costs are calculated by first multiplying together the lifetime cost factors for each case and then calculating average of this product, which may not equal the product of the averages.

tients because some of these victims will never pay their medical bills. These payer distributions are roughly similar for assault, unintentional, and self-inflicted injuries (authors' unpublished data, 1999).

While these estimates show the distribution of primary payers for gunshot cases, the bottom half of Table 4

Table 4. Payment Sources for Gunshot Injuries by Level of Treatment and Nature of Injury*

	ED Only		Admitted Survivors		Disabled Survivors—Spinal Cord Injuries, 1988-1992 (N = 820)		Fatal Cases		
	NHAMCS 1992-1996 (N = 129)	South Carolina 1997 (N = 796)	HCUP 1994 (N = 4404)	NHDS 1996 (N = 226)	Acute Care	5 Years Postdischarge	Hospitalized 1994 (N = 370)	ED Only 1997 (N = 41)	All 1993 (N = 2764)
Primary payer									
Private/company insurance	18.8	25.6	21.9	22.1	30.0	11.5	18.7	34.1	24.7
Medicaid	17.2	8.9	35.5	29.1	55.1	54.2	32.2	2.1	11.2
Worker's compensation	2.3	0.9	1.5	2.0	2.1	4.2	0.6	0.0	1.1
Medicare	1.5	4.2	2.0	2.2	2.0	28.1	5.7	4.9	11.3
Other government	0.0	1.0	9.5	5.9	3.3	2.1	6.4	0.0	5.3
No payer (indigent)	0.8	0.8	0.1	1.6	6.0	0.0	0.0	0.0	23.5
Self-pay	52.7	56.8	26.9	27.4	1.3	0.0	33.1	53.7	21.3
Other	6.5	1.9	2.6	9.7	0.7	0.0	3.4	4.9	1.4
All sources of payment									
Private/company insurance	NA	NA	NA	NA	31.7	17.7	NA	NA	37.6
Medicaid					61.0	64.6			13.4
Worker's compensation					2.4	4.2			3.0
Medicare					2.5	32.3			16.0
Other government					7.8	5.2			8.3
No payer (indigent)					6.1	0.0			22.8
Self-pay					1.3	0.0			47.3
Other					1.2	1.0			2.2

*All data are presented as percentages. ED indicates emergency department; NHAMCS, National Hospital Ambulatory Medical Care Survey; HCUP, Agency for Health Care Policy and Research's Healthcare Cost and Utilization Project; NHDS, National Hospital Discharge Survey; and NA, not available. Spinal cord injury estimates come from model system data from the National Spinal Cord Injury Statistical Center database; acute care data are available for 820 patients with injuries between 1986 and 1992, for whom 5-year follow-up data are available for 96 cases (see "Method"). Distributions for all sources of payment (where available) may sum to more than 100 since some patients have multiple sources of payment. Hospitalized fatal case estimates come from the 8-state 1994 HCUP-3 hospital discharge data set.

Table 5. Annual Medical Costs of Gunshot Injuries in the United States*

	All Gunshot Injuries	Assault†	Unintentional†	Self-Inflicted†
Incidence of gunshots, United States, 1994‡				
Total (95% CI)	134 445 (109 465-159 425)	91 273 (66 772-115 774)	17 458 (13 973-20 943)	25 714 (22 319-29 109)
Nonfatal, incidence (95% CI)	95 860 (70 880-120 840)	73 096 (48 595-97 598)	16 084 (12 599-19 570)	6679 (3284-10 074)
Hospital-admitted	55 441 (33 041-77 842)	42 715 (20 711-64 719)	6802 (4267-9337)	5924 (2582-9266)
Emergency department only	40 419 (29 362-51 475)	30 381 (19 604-41 159)	9282 (6889-11 675)	755 (160-1350)
Fatal, incidence§	38 585	18 177	1374	19 035
Hospital-admitted	4264	2431	281	1552
Emergency department only	10 296	6942	488	2868
Dead on scene	24 025	8804	605	14 615
Total lifetime medical costs for annual gunshots injuries, $ (95% CI)	2.3 billion (2.1-2.5)	1.7 billion (1.5-1.9)	0.4 billion (0.4-0.4)	0.2 billion (0.09-0.3)
Costs by payer, %				
Government	49	55	48	42
Private insurance	18	20	20	34
Victim	19	20	23	22
Other	14	5	9	2

*All costs are presented in 1994 dollars. CI indicates confidence interval. Incidence of nonfatal gunshot injuries estimated from the 1994 National Electronic Injury Surveillance System. Costs are calculated using National Spinal Cord Injury Statistical Center–based estimates for lifetime medical treatment costs of gunshot-related spinal cord injuries. Share of lifetime medical costs paid by different sources comes from multiplying total medical cost estimates by payer distribution estimates as shown in Table 4 (including payer distributions calculated separately by injury intent category, not shown).
†Cases for which injury intent is unknown are assumed to have the same distribution across intent categories as gunshot cases for which intent is known.
‡Incidence estimates exclude nonfatal gunshot injuries for which the victim does not receive medical treatment, or is treated in a physician's office and released.
§Incidence of fatal gunshot injuries comes from Vital Statistics census of all deaths and is a population total rather than an estimate.

suggests that primary payers are responsible for the large majority of total costs, at least for serious injuries. Data from the NSCISC and NMFS suggest that the distribution of all sources of payment is quite similar to the distribution of primary payers. Presumably, the same pattern holds for less-serious injuries.

Lifetime Costs of Treating 1994 Injuries

We estimated that there were a total of 134 445 gunshot injuries in the United States in 1994 (95% CI, 109 465-159 425), as shown in the first row of **TABLE 5**. The estimates for nonfatal gunshot injuries come from the 1994 NEISS data and, as noted above, exclude gunshot injury patients who do not seek professional medical treatment. Of the 95 860 nonfatal gunshot cases (95% CI, 70 880-120 840), most occurred as the result of an assault. Our figure for the number of fatal gunshot injuries, 38 585, comes from the Vital Statistics census of deaths. For both fatal and nonfatal cases, we assume the same distribution across intent categories (unintentional, self-inflicted, and assaults) for cases in which intent is unknown as for cases in which intent is known.

We estimated that gunshot injuries in the United States in 1994 will cost $2.3 billion in lifetime medical costs (95% CI, $2.1 billion-$2.5 billion) or, on average, about $17 000 per injury ($2.3 billion per 134 445 injuries). Of these costs, 74% are accounted for by injury due to assaults.

Government programs pay about half of the total lifetime costs of treating gunshot injuries, with private insurance and victims covering another fifth each. Our estimates for the payment sources for gunshot injuries, shown in the bottom row of Table 5, were calculated by a weighted average of the fraction of each component of the total costs of gunshot injuries paid for by government, private insurance, victims, and other sources.

COMMENT

Our study suggests that the lifetime costs of treating all US gunshot injuries in 1994 was $2.3 billion. Of these costs, we estimated that $1.1 billion was paid by government. Our data leave some uncertainty about who pays for the $0.4 billion that the records indicate is to be paid by the victims themselves, although data from several Massachusetts hospitals suggest that self-pay cases are nearly 6 times as likely as

others to become bad debts and ultimately be covered by other sources.[23]

In **TABLE 6**, our results are compared with those found in previous research. We focus on hospitalized gunshot survivors because these are the injuries examined in most previous studies and because our estimates suggest that these cases account for 85% of the total lifetime medical costs of treating all gunshot injuries. As seen in Table 6, previous estimates for the acute-care costs for hospitalized gunshot injury survivors range from $11 023 to $21 324 (all in 1994 dollars). Part of the discrepancy between our results and those in previous studies is that we estimated costs while 5[25-29] of the 9 previous studies estimate charges. Furthermore, most studies were limited to data from trauma centers rather than all hospitals. In any event, our estimates for acute-care treatment costs fall in the middle of the range of previous research.

As seen in Table 6, only 2 previous studies[3-5] estimated the lifetime costs of medical treatment. Our preferred estimate of $35 367 per nonfatal hospitalized gunshot injury is approximately 14% higher than 1 estimate of $30 969,

Table 6. Comparison of Estimates for Average Costs per Hospitalized Gunshot Survivor*

Source, y	Data Source (No.)	Costs for Acute Care Treatment, $	Lifetime Medical Costs, $
Current study, 1999			
Maryland hospital discharge data, 1994-1995	Maryland, 1994-1995 (2394)	14 757	36 685
New York hospital discharge data, 1994	New York, 1994 (3334)	14 497	34 420
Pooled Maryland and New York	Maryland, 1994-1995, and New York, 1994 (5728)	14 605	35 367
Previous state or national studies			
Miller and Cohen,[5] 1997	Maryland, 4/1993-3/1994 (1181)	11 023	30 969†‡
Max and Rice,[3] 1993	Maryland, 1985 (NA)	12 305	15 602§
Vassar and Kizer,[25] 1996	California, 1991 (9562)	21 324‖	NA
Trauma center studies			
Dischinger et al,[26] 1992	Maryland, 1988 (566)	20 113‖	
Kizer et al,[24] 1995	Davis, Calif, 1990-1992 (750)	13 028	
Martin et al,[27] 1988	San Francisco, Calif, 1984 (131)	11 157‖	
Morabito,[28] 1989	Oakland, Calif, 1987-1988 (215)	14 220‖	NA
Mock et al,[29] 1994	Seattle, Wash, 1992 (1116)	13 834‖	
Webster et al,[30] 1992	Washington, DC, 1988 (385)	16 465	
Wintemute and Wright,[31] 1992	Davis, Calif, 1984-1985 (250)	19 541‖	

*Adapted from Miller and Cohen,[5] Table 2. All cost estimates presented in 1994 constant dollars. NA indicates not available.
†The costs of mental health treatment are excluded from Miller and Cohen's[5] estimate to make the definition of *lifetime medical treatment* comparable to that used in the present study.
‡Calculated using a 2.5% real discount rate.
‖Calculated using a 6% discount rate.
§Charges rather than costs.

and 2.3 times the estimate of $15 602[3] (all in 1994 prices). These differences are probably accounted for by variations in the data sources used for estimating medical costs and our different treatment of the small minority of catastrophic cases that account for a large share of total costs.

Taken together, the estimates presented in this study substantially improve the quality of information on the medical costs of gunshot injuries in the United States. Nevertheless, these findings are subject to several qualifications stemming from limitations of the available data. Our estimates for the national costs of hospital treatment come from data from only 2 states. Unfortunately, no other states both require hospitals to E code discharge records and provide information that can identify actual medical costs. Our estimates for follow-up medical costs come from NMES and DCI data that do not allow us to specifically identify costs for gunshots distinct from other types of injuries. The DCI data are further restricted to workplace injuries. Finally, our E-coded ED-discharge data from South Carolina provide information on charges, not costs.

Our study's most important potential limitation concerns the lifetime medical costs for treating gunshot injuries resulting in permanent disability, which account for a large share of total medical costs. While we developed separate estimates for 1 type of catastrophic case that may result from gunshots—spinal cord injuries—there are other types of costly disabilities that may also be caused by gunshot injuries. We estimated the lifetime medical costs for these other injuries using somewhat dated NMES and DCI data that did not allow us to distinguish gunshot injuries from other injuries within the same *ICD-9* diagnosis code. Our estimates will understate the actual lifetime costs of treating gunshot injuries if gunshots are more likely than other injuries with the same diagnosis to result in long-term disability. Our attempts to develop separate lifetime-cost estimates for other types of disabilities were hampered by limited charge, payment, or cost information for long-term care from available data sources. Improving surveillance and cost data for gunshot injuries resulting in long-term disability is the highest priority in any effort to further refine the estimates presented here.

The estimated medical costs of treating the gunshot injuries received during 1994 in the United States was $2.3 billion. The average medical cost of a gunshot injury was approximately $17 000, of which 49% was borne by taxpayers, 18% by private insurance, and 33% by other sources. While medical costs are a relatively small component of the total burden imposed on society by gun violence,[3-5] they represent a substantial cost to the medical care system.

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