

The Cost of Head Trauma in Olmsted County, Minnesota, 1970–74

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Abstract: A study of the total cost of head injury in Olmsted County, Minnesota, with the costs projected to the United States population, revealed that the annual cost for head trauma in the US can be estimated at approximately \$12.5 billion using a 6 per cent

discount rate. The nonmedical costs accounted for more than 92 per cent (\$11.5 billion) of the total cost, while direct medical costs amounted to \$1.0 billion. (*Am J Public Health* 1984; 74:710–712.)

Introduction

About 75 million Americans are injured every year and, in 1977, 150,000 died of injury.¹ In 1982, there were about 165,000 deaths due to trauma.² Head injuries are the cause of a substantial percentage of trauma-related mortality and morbidity. Knowledge of the direct and indirect costs related to head injury may contribute to the implementation of appropriate programs of prevention.

Materials and Methods

From a previously identified group of Olmsted County, Minnesota, patients³ who suffered head trauma during the years 1935 through 1974, we selected a subset of those seen during the last five years of that study. Patients were followed for a minimum of five years. Costs are expressed in terms of 1982 dollars and projected to the 1980 Olmsted County^a and United States populations.

In this study the actual cost data were available from the respective business office sources and individual patient interviews; thus, for the most part, costs obtained were not estimated, as is often necessary in other studies.^{4–12}

The records linkage system at the Mayo Clinic includes all medical, surgical, and pathologic diagnoses given to residents of Olmsted County, Minnesota, by physicians at the Clinic and other medical facilities serving that population. The minimal clinical criterion of eligibility for inclusion in the previous study³ was the existence of at least one of the following: loss of consciousness because of head injury, posttraumatic amnesia, or evidence of skull fracture.

Subjects were subclassified by severity:

- *fatal*—patients who died within 28 days of the head injury;
- *severe*—patients with intracranial hematoma, brain contusion, loss of consciousness longer than 24 hours, or posttraumatic amnesia of more than 24 hours, or a combination of these;
- *moderate*—patients with either unconsciousness or posttraumatic amnesia of 30 minutes to 24 hours, or skull fracture, or both; and
- *mild*—patients with loss of consciousness or posttraumatic amnesia of less than 30 minutes without skull fracture.

^aDemographic data of Olmsted County are available on request.

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A sample of cases stratified by age, sex, and severity was selected.^b Cost data were sought on all fatal and severe cases. Mild and moderate cases were sampled with the goal of studying 20 per cent of the mild and 50 per cent of the moderate cases. Appropriate adjustments were made in the sampling percentages in projecting results to the county population.

Thirteen patients had more than one incident of head trauma during the five-year period, and these were included as separate events. Using established methods,^{12–16} we obtained cost data^c for both the immediate and the five-year periods after the head injury.

Direct costs were based on charges for medical goods and services actually used. Indirect costs represent economic products, goods, and services not produced because of the impairment.

For hospital costs, the hospital stay ended when the patient was transferred from the hospital service responsible for the care of the head trauma or dismissed from the hospital, whichever occurred first. Only the direct and indirect costs related to head trauma were included.

Direct cost data were available from hospital or clinic records on all 281 nonfatal cases. For the indirect cost data, 208 patients cooperated for an interview, 32 refused participation, 19 could not be contacted, and 14 had died. Average indirect costs appropriate to sex, age, and trauma severity were substituted in nonfatal cases for which indirect costs could not be obtained.

Direct costs included hospital care (hospital room, private duty nurse, operating room, emergency room, medical/surgical supplies, intravenous therapy, hospital pharmacy); x-ray; laboratories; special diagnostic tests; special services, treatment, appliances; physicians and professionals; and others.^d

For determining direct costs other than those abstracted from hospital and clinic records, the patients, guardians, or relatives were interviewed. Indirect costs were also delineated during the interview. When needed, permission was obtained for verification of expense items. Patients were asked to recall transportation costs, the amount of time expended by others, and cost of physician visits. The patients were questioned regarding time away from their occupations, as well as changes in work category, as a

^bTable of sampling percentages is available on request to authors.

^cMost of the cost data were obtained from the Mayo Clinic and affiliated hospitals (Rochester Methodist Hospital and St. Mary's Hospital) and from patient interview data. Cost data were obtained from a few outside medical facilities and physicians for residents injured or cared for outside Olmsted County. Direct cost data were obtained by a nurse abstractor who reviewed actual cost data from clinic or hospital records with the patients or significant other persons. Additional information about interviewing procedures is available on request to authors.

^dDetails on all categories are available on request to authors.

TABLE 1—Annual Costs for Head Trauma in Olmsted County, Minnesota* in 1982 Dollars

	Severity of head trauma				Total
	Mild	Moderate	Severe	Fatal	
Direct Costs					
1. Hospital	36,851	28,616	63,661	15,547	144,675
2. X-ray	21,308	11,078	7,076	1,773	41,235
3. Laboratories	7,111	5,543	8,446	4,392	25,492
4. Special diagnostics	5,498	5,215	7,082	1,823	19,618
5. Special services	2,152	2,138	17,212	5,446	26,948
6. Physicians/Professionals	25,450	20,387	32,036	8,839	86,712
7. Other direct	8,212	8,646	43,343	0	60,201
8. Total direct	106,582	81,623	178,856	37,820	404,881
Indirect Costs					
9. Loss of income by patient	43,256	11,717	54,857	0	109,830
10. Loss of income by other person	14,417	34,621	67,743	0	116,781
11. Interest on funeral expenses		<not applicable>		142,602	142,602
12. Total indirect	57,673	46,338	122,600	142,602	369,213
Present value based on					
13. 6% Discount rate				4,151,810	4,151,810
14. 10% Discount rate		<not applicable>		2,781,027	2,781,027
Totals					
15. Direct + Indirect	164,255	127,961	301,456	180,422	774,094
16. Direct + Indirect + (13)				4,332,232	4,925,904
17. Direct + Indirect + (14)		<same as 15>		2,961,449	3,555,121

*Assumes population composition as existed in 1980.

consequence of their head trauma. If the patient was a housewife, she was queried about loss of housewife's services and resultant household costs, and a value for this loss was calculated.^{e17,18}

For the fatal cases, the present value for expected future earnings was calculated using standard techniques with two discount rates, 6 per cent and 10 per cent. Present values were calculated specific to sex and age at death,¹⁰ with earnings beginning at age 18 years. Deaths between ages 18 and 24 years are hence the most costly.

Funeral expenses, obtained by averaging funeral costs from three funeral parlors in Rochester, Minnesota, were estimated at \$2,725 in terms of 1972 dollars. The only funeral-related cost assessed to the fatal head trauma cases was that of the loss of interest on these monies expended prematurely, computed over the age- and sex-specific years of expected remaining life for each fatal case, using a real interest rate of 2 per cent.^f

Transfer payments such as workmen's compensation, sick pay, disability payments, insurance payments, and legal settlements were not included in our estimates. Transfer payment costs associated with head injury, projected to the US population in terms of 1982 dollars, were approximately \$620 million.

Three price indices from the Bureau of Labor Statistics were used in projecting costs in terms of 1982 dollars.⁸ For direct costs, the medical services price index was used. For projecting indirect costs (excluding present values) in 1982

dollars, the "all items" consumer price index was used. For present values of the fatal cases, the average gross hourly earnings (total private, non-agricultural) were utilized.

To estimate total costs for the entire country, we first computed total costs for Olmsted County. To determine these costs, we obtained the average cost per person for each of the 32 categories formed, by considering the four severity levels of head trauma (mild, moderate, severe, fatal), sex, and the four age groupings (0-4, 5-14, 15-24, 25+). These average costs were then multiplied by the appropriate severity and sex- and age-specific incidence rates (per 100,000).⁸ Multiplying these intermediate results by the number of persons in either Olmsted County in 1980 or the total US sex- and age-specific population subgroups (in units of 100,000)⁸ yielded total costs for these subgroups for Olmsted County and for the total US, respectively.

Results

Table 1 shows that the total annual direct costs in terms of 1982 dollars, \$404,881, in Olmsted County are approximately equal to the total annual indirect costs^h of \$369,213 (excluding present value for fatal cases). Hospital costs accounted for 36% of direct costs. Direct costs were greatest for the severe head trauma group, although severe head injury amounted to only 6.3 per cent of the total cases. For the fatal cases, the present-value costs^h (resulting from loss of earnings) for Olmsted County at a 6 per cent discount rate were \$4.2 million and at a 10 per cent discount rate were \$2.8 million annually; these far exceeded the total direct and

^eAdditional details on methods are available on request to authors.

^fThe real rate of interest is estimated by subtracting the inflation rate from the market rate of interest. The market interest rate used in the calculation was the Moody's Aaa corporate securities rate and the inflation rate used was the consumer price index.¹⁹ The 2 per cent real interest rate represents the average real interest rate for 1929 through 1974.

⁸Table available on request to authors.

^hAlthough we realize that present-value costs are indirect costs, for the purpose of this study, we chose to tabulate them separately and have used the term "indirect" to exclude present value for fatal cases. Patients who died within 28 days are included in the fatal group and incur not only direct but also indirect costs.

indirect costs of all cases, which amounted to \$774,094. The total costs for Olmsted County were either \$4.9 million or \$3.6 million annually, depending on whether the discount rate of 6 per cent or 10 per cent, respectively, was used.

On the assumption that the incidence and cost of head trauma are the same in the US as in Olmsted County, the total annual cost projection for head trauma for the nation was high—\$9.0 billion at 10 per cent and \$12.5 billion at 6 per cent discount rate.

Discussion

We believe our regional cost projections to the nation represent a conservative estimate since medical costs in the Olmsted County (including Rochester, Minnesota) area, as well as in the metropolitan St. Paul-Minneapolis area, are equal to or lower than the national averages.

Patients with head trauma as defined in this study invariably would have been brought to a medical facility or would have sought medical care in any of the regions of the US with about the same frequency. We realize that the rates for seeking medical attention by persons with head injury without loss of consciousness or without amnesia (for example, those with lacerations and bruises of the scalp, not included in our study) could vary in different geographic areas of the US. If patients with lacerations and bruises of the scalp, who often require emergency room care, were included, the cost of head trauma would have been even greater. Projecting costs which included lesser head injuries would be more precarious in light of the varying rates at which people might seek medical attention for such injuries.

In 1980, Anderson and McLaurin reported on the National Head and Spinal Injury Survey conducted for the National Institute of Neurological and Communicative Disorders and Stroke.²⁰ Their study differed from ours in sampling techniques of US hospitals, in the definition of head injury, case selection, response rates for hospitals and participating patients, and in estimates of cases of head trauma in the nation. Therefore, it serves no useful purpose to compare their finding of the \$2.76 billion for indirect costs (including present value), in terms of 1980 dollars, for head injury with our findings. However, direct costs should be more readily comparable, and their value of \$1.14 billion is about 14 per cent¹ higher than our figure of \$1.00 billion.

In our study, automobile injury was the leading cause of mild head injury (32 per cent), followed in frequency by falls (20 per cent), recreational trauma (14 per cent), bicycles (14 per cent), and motorcycles (9 per cent).³ In the group with moderate head injury, falls were the largest category (36 per cent), followed by automobile injuries (21 per cent) and recreational trauma (17 per cent). In the group with severe injury, automobile injury accounted for 47 per cent and falls for 17 per cent. In the fatal group, the leading cause was automobile injury (51 per cent), followed by gunshot wounds (26 per cent) and falls (12 per cent).³

Approximately 49 per cent of the total cost of head trauma, using the 6 per cent discount rate for present-value calculations, was associated with automobile injuries. It

¹The percentage would have been greater than 14 per cent if their 1980 dollars were expressed in 1982 dollars.

would seem plausible from the standpoint of potential economic benefit that the automobile and its occupants should be the primary target of preventive measures. Furthermore, it is clear that the present-value costs associated with the cases of fatal head trauma contribute disproportionately to the total cost (Table 1), representing 84 per cent of the total cost if the 6 per cent discount rate is used and 78 per cent if the 10 per cent discount rate is used. Thus, preventive measures focused on the causes of fatal head trauma would have great potential benefit.

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