Alcohol Interventions for Trauma Patients Treated in Emergency Departments and Hospitals

A Cost Benefit Analysis

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Objective: To determine if brief alcohol interventions in trauma centers reduce health care costs.

Summary Background Data: Alcohol-use disorders are the leading cause of injury. Brief interventions in trauma patients reduce subsequent alcohol intake and injury recidivism but have not yet been widely implemented.

Methods: This was a cost-benefit analysis. The study population consisted of injured patients treated in an emergency department or admitted to a hospital. The analysis was restricted to direct injury-related medical costs only so that it would be most meaningful to hospitals, insurers, and government agencies responsible for health care costs. Underlying assumptions used to arrive at future benefits, including costs, injury rates, and intervention effectiveness, were derived from published nationwide databases, epidemiologic, and clinical trial data. Model parameters were examined with 1-way sensitivity analyses, and the cost-benefit ratio was calculated. Monte Carlo analysis was used to determine the strategy-selection confidence intervals.

Results: An estimated 27% of all injured adult patients are candidates for a brief alcohol intervention. The net cost savings of the intervention was $89 per patient screened, or $330 for each patient offered an intervention. The benefit in reduced health expenditures resulted in savings of $3.81 for every $1.00 spent on screening and intervention. This finding was robust to various assumptions regarding probability of accepting an intervention, cost of screening and intervention, and risk of injury recidivism. Monte Carlo simulations found that offering a brief intervention would save health care costs in 91.5% of simulated runs. If interventions were routinely offered to eligible injured adult patients nationwide, the potential net savings could approach $1.82 billion annually.

Conclusions: Screening and brief intervention for alcohol problems in trauma patients is cost-effective and should be routinely implemented.

(*Ann Surg* 2005;241: 541–550)

Alcohol intoxication is the leading risk factor for injury.[1–3] As a result, it offers the most promising and obvious target for injury-prevention programs. Brief alcohol interventions in trauma patients have been shown to reduce subsequent alcohol intake and injury recidivism.[4–8] Given accumulating evidence to support their use, a variety of expert and consensus group panels have concluded that the scientific basis for their routine provision in hospitals and emergency departments has been established, and it is time to move towards national implementation.[7,9–16]

New medical procedures, once confirmed as "best practice," often become virtually mandatory for delivery and insurance coverage. However, this has not been the case for alcohol interventions. Instead, clinicians, hospital administrators, and insurance plans are more likely to require information about cost and benefits before making decisions on implementation or coverage.

Alcohol interventions in trauma patients have not yet been analyzed for cost-benefit. Prior studies have not measured financial outcomes directly because it has been difficult to obtain claims data from this patient population with multiple potential sources of insurance coverage or with no coverage. However, the assignment of dollar values can enable clinicians to make informed choices about competing available treatment options.[17]

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Supported by a grant from the Robert Wood Johnson Foundation: 042424.

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ISSN: 0003-4932/05/24104-0541
DOI: 10.1097/01.sla.0000157133.80396.1c

This study estimates the cost savings associated with routine provision of brief alcohol interventions to trauma patients treated in hospitals and emergency departments. We chose to restrict this analysis to direct medical costs so that it would be most meaningful to hospitals, insurers, and government agencies responsible for health care costs.

METHODS

Determination of Eligible Subjects

We estimated the proportion of injured patients who would be candidates for a brief alcohol intervention. Patients were considered eligible if they were treated in an emergency department or admitted to a hospital after sustaining an injury, were 18 years of age or older, and had either a blood alcohol level ≥100 mg/dL or a positive result on a standard brief alcohol disorder screening questionnaire. Patients with a major concurrent psychiatric illness or severe disability precluding participation in a brief intervention were excluded.

We performed a literature search to identify studies reporting alcohol intoxication (blood alcohol concentration: BAC) or problem drinking as defined by a positive result on a standard screening questionnaire (CAGE, Michigan Alcohol Screening Test, or Alcohol Use Disorders Identification Test) in injured adults treated in emergency departments (Table 1). The screen positive rate varied, depending on the proportion of all patients screened and the methods used to classify a screen as positive. These differences prevented formal meta-analysis. To arrive at a prevalence estimate, the proportion from each study was weighted by the study sample size.[18] The range was used to conduct a sensitivity analysis.

Eligible patients would have to agree to counseling. Consent rates for studies enrolling patients in brief intervention trials were used to estimate acceptance rates, as no data exist on acceptance rates when offered as a routine component of trauma care.[4,5,7,8,19–24] The mean consent rate, representing 9116 subjects, was 76% (range 57 to 94%). This is a conservative estimate as patients are more likely to consent to routine care than to participation in a study.

Cost-Benefit Analysis

Screening Costs

We determined the cost of screening all eligible adults with a BAC and a brief alcohol-disorder screening questionnaire. The direct cost of a BAC was valued at $15 based upon the current Medicare allowable fee schedule in 2000. Screening expenses also included the cost of paper materials ($1). Average screening costs were $16/patient (Table 2).

Costs of Brief Alcohol Intervention

The cost of the brief intervention included direct costs representing professional expenses and materials. Typically, brief interventions are administered over a 20- to 30-minute period.[7,25] Professional costs were determined by multiplying the national average hourly wage for a psychologist by an estimated 1.4 hours of work time per intervention, which included 30 minutes for the intervention, and the remainder for follow-up and documentation. Sensitivity analysis was conducted to include salary ranges for social workers to physicians ($15.09 to $61.43 per hour).[26] The estimated cost of the intervention is $38 per patient (Table 2).

TABLE 1. Prevalence of Alcohol Use in Injured Patients Treated in US Emergency Departments

Author	Population	Measurement	Prevalence*	BAC ≥100 mg/dL	N
Wechsler, et al, 1969[58]	ED	Breath analysis	23%	12%	2989
Cherpitel, 1988[59]	ED in 4 hospitals	Breath analysis	15%	8%	1528
Cherpitel, 1989a[60]	ED, hospital	Breath analysis	23%	15%	555
Teplin et al, 1989[61]	ED	Blood test	NA	10%	179
Rivara et al, 1989[62]	ED, level 1 hospital	Blood test	38%	NA	316
Cherpitel, 1992[63]	ER admissions	Breath analysis	13%	6%	1004
Cherpitel, 1993[64]	3 HMO EDs, 1 county hospital ED, 3 community hospital EDs	Breath analysis	9%	3%	1478
Cherpitel, 1994[65]	EDs in 1 county hospital, 3 community hospitals, and 3 HMO hospitals	Breath analysis	9%	3%	1548
Cherpitel, 1994b[66]	4 EDs	Breath analysis	9%	4%	1494
Average (weighted by sample size)			16%	7.4%	
Range			9–38%	3–15%	

ED indicates emergency department; BAC, blood alcohol concentration.
*Positive for any blood alcohol.

TABLE 2. Determination of Model Variables

Variable	Baseline Value (US$ 2000)	Range	Source
Number of adults (≥18 y) treated for injuries in US EDs, 2000	20,507,601	18,407,275 to 22,607,928	NCIPC[28]
Proportion of injured ED patients who required hospitalization	6.00%	4.61%-7.38%	NCIPC[28]
Proportion of injured patients with psychiatric illness prohibiting intervention	2.4%	2.4%	Gentilello[7]
Prevalence of intoxicated injured adult patients treated in ED (blood alcohol concentration ≥100 mg/dL)	7.4%	3%-12%	See Table 1
Prevalence of nonintoxicated trauma patients with a positive substance abuse screening questionnaire	19.6%	11.7%-45.8%	See references[2,38,39]
Consent rate to participate in a brief intervention trial	76%	57%-94%	See references[4,5,7,8,19–24]
Annual proportion of injured adult patients with intoxication or alcohol problems readmitted to an ED for trauma	28%	5%-50%	See Table 3
Relative risk for readmission in injured patients with alcohol dependency compared to injured patients without dependency	2.2	1.4–3.5	Rivara[27]
Economic annual discount rate	3%	0%-5%	Weinstein et al, 1996[32]
Costs of screening for alcohol use			
Cost of blood alcohol test	$15	$15	Medicare reimbursement
Cost of materials (paper, photocopy)	$1	$0-$1	Estimated cost of 5 copies at $0.20/copy
Cost of brief alcohol intervention			
Provider time (30-min intervention plus administrative time)	84 min	30–120 min	HMC brief intervention program
Provider hourly salary	$27.20 (psychologist)	$15.09-$61.43	Hourly salary range: social worker; psychologist; physician, BLS[26]
Health care costs			
Cost of ED visit for injury	$440	$149-$1250	MarketScan[44]
Cost of hospitalization	$16,852	$4,691-$49,672	MarketScan[44]
Effectiveness of brief intervention in the context of acute injury at reducing subsequent health care use			
Effectiveness of intervention in reducing annual ED injury recidivism (hazard ratio)	0.53	0.26–1.07	Gentilello[7]
Effectiveness of intervention in reducing annual injury recidivism requiring hospitalization (hazard ratio)	0.52	0.21–1.29	Gentilello[7]

ED indicates emergency department; NCIPC, National Center for Injury Control and Prevention, Centers for Disease Control and Prevention; HMC, Harborview Medical Center, Seattle, WA; NIAAA, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health; BLS, Bureau of Labor Statistics.

Emergency Department Visits and Hospitalization Rates for Problem Drinkers

To estimate the baseline proportion of screen-positive patients who will sustain an injury requiring emergency department treatment in a given year, we performed a literature review (Table 3). The proportion of patients treated for an injury in the emergency department from each study was weighted by the study sample size.[18] The range of the reported fraction of alcohol-using patients was used to conduct the model sensitivity analysis. The relative risk for readmission in injured patients with an intoxicating BAC or positive screening questionnaire compared with injured patients without these characteristics was estimated to be 2.2 (range 1.4 to 3.5).[27] We assumed that the proportion who

TABLE 3. Proportion of Intoxicated or Injured Problem Drinkers With Subsequent Injury Requiring an Emergency Department Visit Within 1 Year

Author	Study Site	Proportion of Patients Revisiting Emergency Departments Within 1 y	N	Number of ED Visits
Fleming, 1999[21]	Primary care	35%	382	132
Gentilello, 1999[7]	ED, trauma center	10%	396	38
Freeborn, 2000[22]	Primary care	9%	254	23
Blose, 1991[41]	Primary care	23%	3729	858
Cryer, 1999[67]	Primary care	42%	2253	935
Davidson, 1997[68]	ED, trauma center	50%	150	75
Schermer, 2001[69]	ED	5%	180	9
Total (range)		28% (5%-50%)	6962	1937

ED indicates emergency department.

required admission to the hospital was equivalent to national estimates in which 6% of injured emergency department patients required hospitalization.[28]

Intervention Effectiveness

We conducted a literature search to identify studies reporting brief alcohol interventions for patients treated in the context of an acute injury for which subsequent utilization of health care resources was an outcome. Multiple reviews have reported that brief interventions are effective in reducing alcohol consumption, problems related to consumption, and injury.[6,19,29,30] Three studies conducted in the acute-injury context reported substantial decreases in reinjury rates.[4,7,8] However, only 1 reported the effect on injury-related emergency department utilization, thus fulfilling the search criteria. This was a randomized controlled trial in which patients who were admitted to a hospital and screened positive were offered a brief intervention.[7] The authors reported a 47% reduction in subsequent injuries requiring either emergency department or hospital admission (hazard ratio 0.53, 95% CI 0.26–1.07) and a 48% reduction in injuries requiring hospital admission over 3 years of follow-up (hazard ratio 0.52, 95% CI 0.21–1.29). These confidence intervals were used for sensitivity analysis.

Costs of Emergency Visits and Hospitalization

The costs of emergency department visits and hospital admissions were derived from the 1998 MarketScan database of commercial claims (MedStat Group, Inc., Ann Arbor, MI). This database reflects reimbursed payments by commercial insurance carriers and Medicare supplemental reimbursement. Injury episodes were identified by *ICD9-CM* codes. The cost of an emergency department visit for treatment of an injury and the cost of a hospital admission for injury reflected the average reimbursement. We conducted sensitivity analyses using the 25th-percentile cost reimbursement amount as the lower limit and the average cost reimbursement plus 1 standard deviation as the upper limit (Table 2). All cost data were converted into year 2000 US dollars using the Consumer Price Index for wage data, and the Consumer Price Index for Medical Care for medical expenditures.[31]

To reflect the opportunity cost of future investment returns for financial or physical resources used in the present, a discount rate of 3% was employed for all future costs. Rates varying between 0% and 5% were tested in a sensitivity analysis.[32]

Estimation of Cost Savings From Reduced Trauma Recidivism

The average length of stay for a hospital injury admission was estimated to be 5.1 days.[33] We have not included costs for postdischarge medical care required by more severely injured patients, nor have we assigned a cost to individuals who died.

Decision Analysis

A decision-analysis model was used to determine whether the cost-benefit analysis favored the adoption of brief alcohol interventions by comparing 2 scenarios (Fig. 1). In the first, all eligible injured patients would be screened and would incur screening costs. Patients who screen positive would be asked to consent to a brief intervention, and accrue intervention costs. In the second scenario, injured patients would not be screened or offered an intervention. The decision tree compares the costs of screening and intervention to the potential cost savings from reduced trauma recidivism.

The model was constructed based on Figure 1. It incorporated an imbedded Markov model allowing for transitions between the defined states of "well," "injured requiring emergency department care," and "injured requiring hospital admission" in a yearly cycle. We assumed that transition probabilities and the costs of being in each state were time independent. A 1-year period was used, and the model was run for 3 periods of observation, emulating the intervention

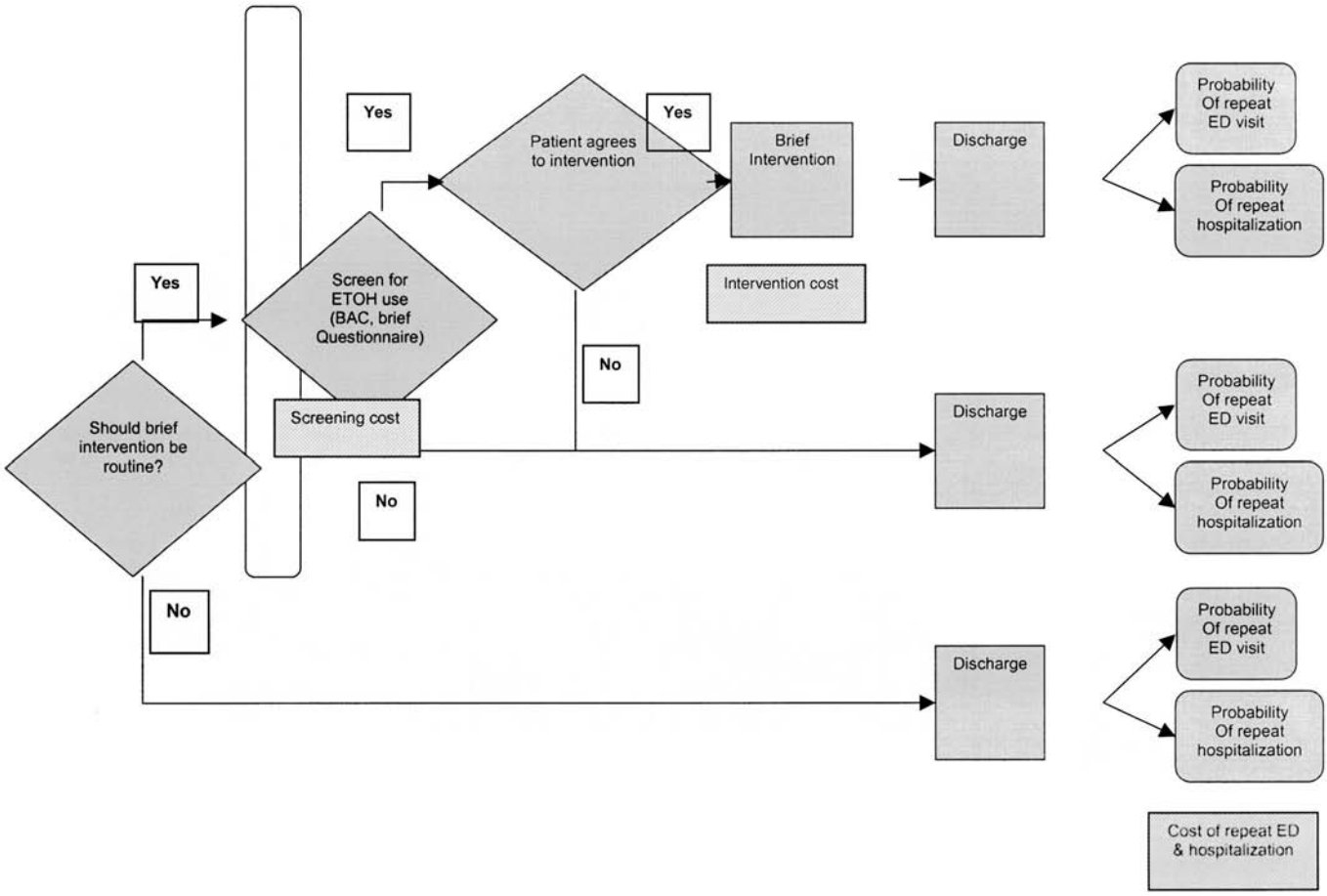

FIGURE 1. Flow diagram illustrating potential outcomes related to screening and intervention strategies.

study in which injury recidivism was reduced over the course of 3 years.[7] The costs of being in each state accrued during each cycle. The analysis was performed using Data 4.0 (TreeAge Software, Inc., Williamstown, MA).

Sensitivity testing was performed for the critical variables to explore their impact on cost savings using the confidence intervals or ranges derived as discussed above (Fig. 2). A graph of these univariate sensitivity analyses called a "tornado plot" was generated to compare the relative influence of model variables on final cost estimates. Sensitivity analysis was done using Monte Carlo analyses in which key parameters were varied simultaneously, performed with Data™ 4.0 (TreeAge Software, Inc., Williamstown, MA).[37] Distributions were sampled 50,000 times for the final analysis (Fig. 3). Probability density functions for parameters were chosen to approximately match the high and low ranges found in the published studies cited and in our own data. Emergency department costs and hospitalization costs were modeled using a γ distribution.[38] Parameters measuring intervention effectiveness at reducing ED and hospital recidivism were modeled with a log normal distribution.[38] Other probabilities were transformed using a method described by Doubilet et al.[37]

RESULTS

In 2000, there were an estimated 20.5 million adult injuries requiring emergency department care.[28] The weighted average of studies in Table 1 indicates that approximately 7.4% (range 3% to 12%) were intoxicated. An additional 19.6% of these patients screen positive on an alcohol screening questionnaire even when not intoxicated (range 11.7% to 45.8%).[2,39,40]

Approximately 94% of injured adults treated in the emergency department are discharged, and 6% are admitted to the hospital.[28] The probability that an injured patient has a concurrent, serious psychiatric illness was 2.4%.[7] In total, 27% of injured adult patients treated in the emergency department screen positive and could be candidates for an intervention (5.5 million visits/y).

The proportion of problem drinkers who will return to the emergency department for treatment of a new injury within 1 year was estimated to be 28% (range 5% to 50%;

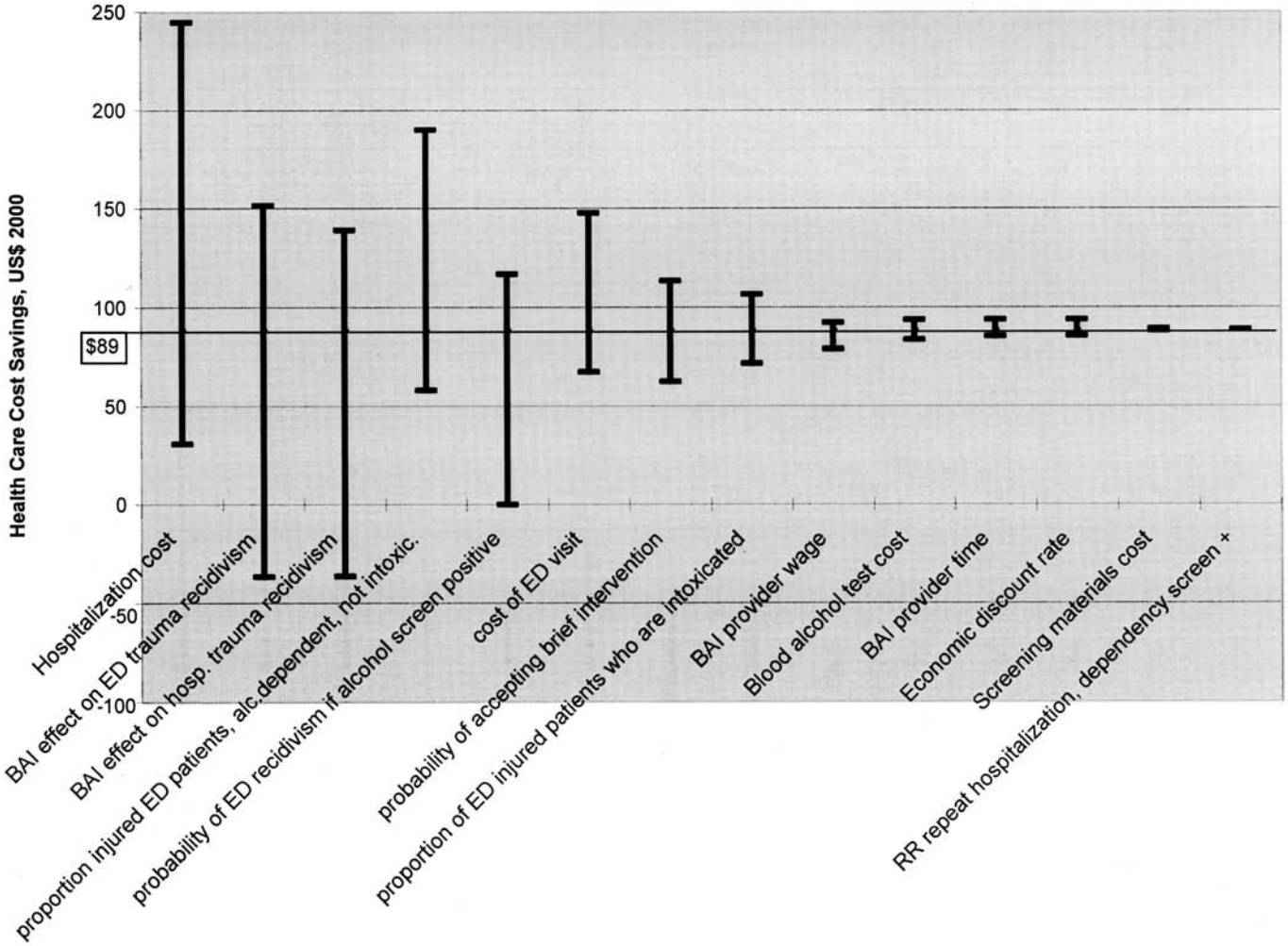

FIGURE 2. Sensitivity analysis demonstrating potential cost savings associated with variations in a number of primary variables. Screening and brief intervention is associated with cost savings when the bar is above zero. The estimated mean cost savings is $89 in US dollars (year 2000). BAI, brief alcohol intervention; ED, emergency department; RR, relative risk.

Table 3). It was assumed that the proportion who will require admission to the hospital was 6.0%, reflecting the national admission rate for injured adults treated in emergency departments (Table 2).

Cost Analysis of Universal Screening and a Brief Alcohol Intervention Policy

Using the above base-case parameter values, the analysis found that routine screening and intervention would save costs and is the preferred option (Table 4). If the brief intervention is offered, the expected cost of screening, intervention, and subsequent emergency department visits and hospital admissions over the next 3 years was $600 per patient. In the scenario where screening and intervention are not offered, the expected cost of subsequent emergency department visits and hospital admissions was $689 per patient over 3 years, resulting in an estimated cost savings of $89 per injured patient screened, or $330 for each patient offered a brief intervention. The brief intervention resulted in $3.81 in health care costs saved for every $1.00 spent on screening and intervention.

Sensitivity analyses were used to determine when it was optimal to offer the intervention. The most critical variables included the costs of hospitalization, the hazard ratios for trauma recidivism following a brief intervention, and the probability of a subsequent injury resulting in emergency department care. The hazard ratio for having a subsequent injury requiring emergency department treatment was allowed to vary between 0.26 and 1.07.[7] The hazard ratio for hospital readmission was allowed to vary between 0.21 and 1.29.[7] One-way and 2-way sensitivity testing for the most critical model variables of brief intervention effectiveness showed that under most assumptions, it is preferable to offer

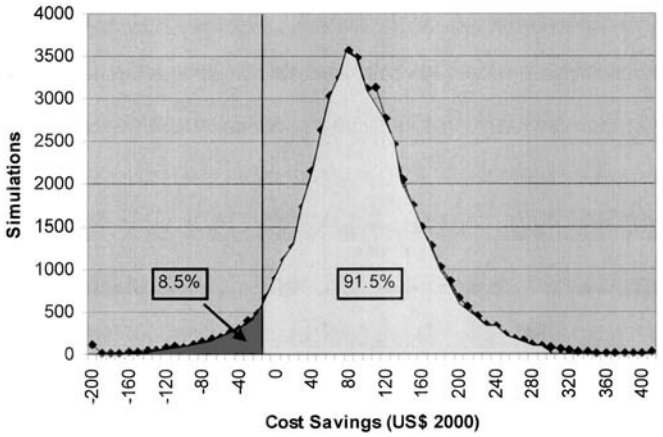

FIGURE 3. Histogram demonstrating likelihood of cost savings where variables are allowed to range simultaneously. In 91.5% of simulations, screening and intervention were associated with cost savings.

the intervention because its costs are very low compared with the costs of repeat hospital care (Fig. 2). The model was relatively invariant to the probability of accepting a brief intervention, the cost of a brief intervention, and the cost of alcohol screening, as these costs were small compared with the potential savings in medical costs.

We used Monte Carlo analysis in which each parameter was allowed to vary, using a distribution centered around the baseline value to account for the uncertainty in estimating each parameter. The results indicated that a brief alcohol intervention would result in a reduction of health care expenditures in 91.5% of the simulations (Fig. 3). In 95% of the simulations, the intervention was either cost saving or cost less than $24 per patient screened. Given that the benefits of reducing alcohol use greatly exceed the reduction in health care costs alone, the brief alcohol intervention is an inexpensive and likely cost-savings therapy for injured patients.

DISCUSSION

This study indicates that routine alcohol screening and intervention in trauma patients results in net dollar savings through the effect of the intervention on reducing subsequent health care costs. Current recommendations to provide brief interventions to trauma patients are based on a number of factors. They capitalize on a "teachable moment," wherein the health care worker can moderate the conceptual link between drinking and its consequences at a time when the consequences are obvious. Patients with alcohol problems may not seek alcohol treatment but often receive treatment of medical conditions related to their drinking. Injuries are the most common condition for which patients with alcohol problems seek medical attention.[42] Alcohol interventions in trauma centers may also provide an opportunity to initiate care before problems progress to a more severe stage, requiring more costly and intensive treatment and medical services.[42] Alcohol also plays such a major role in causing injuries that injury-prevention programs are unlikely to be successful if hazardous drinking is not addressed. This study now adds a strong financial argument to the above reasons for implementing routine alcohol screening and intervention programs in trauma centers.

Before considering the implications of this research, the potential limitations should be understood. Multiple studies have reported that brief interventions conducted in emergency departments or trauma centers reduce the rate of injury

TABLE 4. Cost-Savings Analysis of Brief Alcohol Intervention Policy ($US 2000)

	Screening and Brief Intervention			
	Patient Ineligible for Intervention (73%)	Patients Eligible for Intervention (27%)		No Screening and Brief Intervention
		Intervention Accepted (20.5%)	Intervention Refused (6.5%)	
Screening costs	$16	$16	$16	$0
Intervention costs	$0	$38	$0	$0
Health care costs of ED and hospital recidivism over next 3 y	$521	$600	$1145	$689
Total costs per adult trauma patient	$536	$653	$1161	$689
Weighted average costs		$600		$689
Cost savings per patient screened		$89		$0
Cost savings per intervention		$330		$0
Cost savings per dollar spent	$3.81		$0	
Potential annual savings	$1.82 billion		$0	

SBI indicates screening and brief intervention; ED, emergency department.

recidivism.[4,7,9] However, due to differences in method of reporting, costs could not be analyzed, and therefore, they were not included in this paper. For example, Monti et al[8] reported a greater than 50% reduction in reinjury rate in intervention compared with control group patients but did not report the percentage of patients who subsequently required injury-related emergency department or trauma-center care. Another study analyzed 84 different injury prevention methods and found that brief interventions for heavy drinkers were ranked towards the top in benefit-cost ratio, but outcomes other than injury recidivism were included in the analysis.[43]

We therefore based our model sensitivity range on a randomized study that reported the impact of trauma-center interventions on the annual rate of emergency department injury-related visits.[7] Despite this limitation, as shown in Figure 2, only under extremely negative assumptions regarding the intervention effect on injury recidivism rates would the net cost savings drop to zero. And, taken together, multiple recent studies support the notion that injury-related hospital visits are reduced following a brief intervention.

Another potential limitation of the study is that the results depend on the estimates used for costs of hospitalization. We used data from MarketScan, which represents a spectrum of trauma patients across Medicaid, Medicare, and private insurers.[44] It has been widely used in other cost-effectiveness and cost-benefit studies.[45–51] However, we did not include the costs of follow-up care. Data from the Medical Expenditure Panel Survey suggest that the average non-admitted injured patient treated in the emergency department generates $832 in medical expenditures when follow-up care is included, which exceeds the $440 cost used in this study for the ED visit alone.[52] Medical expenditures for follow-up care and rehabilitation services for patients who are admitted are likely to be even higher.

We also chose to provide cost-benefit information that is primarily relevant to clinicians, hospital administrators, insurance carriers, and governmental agencies that are responsible for health care costs and insurance legislation. Therefore, this study only examined the impact of interventions on direct medical costs. Many cost-benefit analyses include costs related to mental health services, property damage, lost productivity, crime, and intangible losses such as pain, suffering, and reduced quality of life. From a societal perspective, these costs are likely to be large, resulting in a much greater savings than $3.81 for each dollar spent.

Despite these limitations, we believe that this study has important implications for trauma care in the United States. Unlike the majority of medical treatments that cost money to improve health care, offering brief interventions to injured patients saves money by reducing subsequent injuries requiring emergency department treatment or hospital admission. There are 20.5 million emergency department visits and 1 million hospitalizations of adults in the United States annually for trauma, and approximately 5.5 million of these individuals are candidates for an alcohol intervention. If a brief intervention were offered to every eligible injured person in the United States, the resulting savings from health care costs alone would be approximately $1.82 billion annually (20.5 million adult trauma patients × $89 health care cost savings per patient screened). To put this number in perspective, it is more than twice the aggregate charges, or total national bill in year 2000, for all forms of cholecystitis (both acute and chronic).[53]

Implementation of screening and intervention programs in trauma centers will require changes in health care financing. Since 1947, most states have allowed insurance companies to deny payment on a claim in which an individual was injured and alcohol use was documented.[54] This has been found to be a deterrent to alcohol screening in hospitals and emergency departments.[55] The National Association of Insurance Commissioners recently passed a model law that disallows such denials. The National Conference of Insurance Legislators has recommended that states adopt this model. Such changes, however, must be adopted by each state legislature. Several states have recently done so.[56,57]

Excessive alcohol use is the single most important risk factor for injury and is by far the most promising yet underutilized target for injury prevention programs. The economic value of brief alcohol interventions supports the development of a policy of routine trauma-center screening and the provision of brief interventions to those who screen positive. Current insurance statutes resulting in financial penalties for patients and providers may prevent the implementation of such programs, resulting in greater health care costs.

ACKNOWLEDGMENTS

This study was funded by a grant from the Robert Wood Johnson Foundation. The views expressed herein are our own and do not necessarily reflect those of the foundation.

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