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Cost-Effectiveness of Traffic Safety Interventions in the United States

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Executive Summary

OBJECTIVE: In order to demonstrate the results of all available studies on cost-effectiveness and traffic safety, and report them in a comparable format, we conducted a comprehensive review of the literature on the subject.

Knowledge of cost-effective (CE) traffic safety programs that result in reduced motor vehicle crashes and fatalities is essential to city planners, managers, and police.

METHOD: Using a systematic approach to literature review, the relevant literature has been identified through the use of electronic databases, hand searching of journals, scanning reference lists, and consultation with corresponding authors and experts. Target populations were drivers, passengers and pedestrians in urban and rural roads. Studies on passenger vehicles, busses, and light trucks are included in this review. Studies were included with outcome measure such as cost per year of life saved (LYS), and cost per quality-adjusted life-year saved (QALY), or enough data on cost and benefit to estimate these measures. We followed the recommendations of the Panel on Cost Effectiveness in Health and Medicine (PCEHM) in our recalculations. Interventions are categorized based on the Haddon matrix.

RESULTS: We found that despite the specific framework recommended by the PCEHM, the methods used to derive CE measures vary considerably among studies. The CE for these interventions vary enormously, from those that cost more than $1 million per QALY saved i.e. lap/shoulder belts in rear-center occupant; to those that save money i.e. mandatory use of daytime running lights, painting lines on roads, and compulsory helmet use in motorcyclists. Cost saving interventions are compared according to the major components of crash causation as demonstrated in the Haddon matrix.

CONCLUSION: The design of cost benefit evaluations in road safety needs to be improved so that more comparable evidence can be obtained. Literature reviews on CE should be updated regularly to ensure relevance. Many life saving traffic safety programs are cost saving and many are more CE than other interventions to prevent cancer, heart disease, and other causes of morbidity and mortality. Investment in traffic safety measures can have a greater impact on population health than investment in other chronic diseases.

Introduction

Motor vehicle crashes are the leading cause of mortality and morbidity in the United States. In 2000, an estimated 6,394,000 police reported traffic crashes killed 41,821 people and injured 3,189,000 (1). Injuries from vehicle crashes result in an estimated 500,000 hospitalizations and 4 million emergency departments visits annually (2).

Injuries from motor vehicle crashes kill more children and young adults than any other single cause in the United States (2). They kill an average of six and injure 797 children every day. One fourth of pedal cyclists killed in motor vehicle crashes were under age 15 (3)**.** Fourteen percent of all drivers involved in fatal crashes were between ages 15 and 20. Compared to the fatality rate for drivers between the ages 25-69, the fatality rate for teenage drivers is about four times higher, and for older drivers it is nine times higher. Data from the year 2000 suggest increases in alcohol-related and motorcycle fatalities over 1999 of 4.2% and 15% respectively (4).

Fortunately motor vehicle related deaths and serious injuries have declined sharply. The overall fatality rate from motor vehicle crashes in the year 2000 remained at its historic low of 1.6 per 100 million vehicle miles traveled (1), with a 12% decrease in motor- vehicle-related injuries among children age five to 15 years (4).

From an economic perspective, motor vehicle crashes place a great burden on the society. The total economic cost of motor vehicle crashes in the United States during 1994 was estimated to be more than $150.5 billion. Over 85% of this cost was due to lifetime loss of productivity, and 11% was due to medical costs (5).

When resources are limited, selection of traffic safety policies requires enough knowledge about the relative costs and benefits of potential interventions, so that planners will invest in a way to maximize health improvement. Some interventions are well known in terms of their benefits; they have saved thousands of lives; (e.g. automobile safety belt use, child restraints, minimum drinking age law, and motorcycle helmet use). However, economic evaluations are necessary to justify the cost of existing or proposed safety interventions versus their effectiveness.

In this paper, we present a summary of available literature on the cost effectiveness of traffic safety interventions in the United States, published between 1980 and 2001. The paper summarizes two original studies and three review articles that reviewed the cost effectiveness of more than 100 traffic safety programs and reported them in terms of cost per life year saved (LYS) and/or cost per quality adjusted life year (QALY) saved (6-10). Interventions reviewed in the articles included prevention of any kind of motor vehicle crashes or related injury. To facilitate comparison of the cost-effectiveness of the various interventions, we used Haddon Matrix (11) to demonstrate effect of cost saving programs on major components of crash causation (vehicle, human, and environment).

Methods

We conducted a comprehensive search for cost-effectiveness analyses from 1980 through 2001. We searched electronic databases -including MEDLINE, EMBASE, MELVYL CATALOG, PSYCHINFO, and WEB OF SCIENCE- for the following keywords alone or in combination: motor vehicle, injury, fatalities, automobile, driving, transport, traffic safety, safety, visibility, injury prevention, cost, and cost-effectiveness. Our search also included any major subject heading related to traffic. The Transportation Research Information Services (TRIS) database and National Highway Traffic Safety Administration (NHTSA) website were also searched. In addition, we examined the bibliographies of some of the review articles and contacted their authors and other experts in the field.

From a total of 26 studies reviewed, 5 studies met the following selection criteria for this review: 1) contained information on traffic safety interventions in the United States, 2) included a cost-effectiveness analyses (CEA) for the intervention, 3) estimated health outcome of the intervention in terms of years of life saved (LYS), or quality adjusted life year saved (QALY), and 4) provided enough information to evaluate the components of the cost-effectiveness ratio.

Traffic safety interventions were defined as any intervention before, during or after the crash that targeted the vehicle (passenger vehicles, busses, and light trucks), human (drivers, passengers and pedestrians), or environment (e.g. urban and rural roads in the United States) and that resulted in injury and fatality prevention or reduction.

To make the estimates of different studies comparable, we followed the recommendations of the Panel on Cost Effectiveness in Health and Medicine (PCEHM)(12, 13) in our review, and re-calculated the cost estimates.

Studies varied on their discount rates and base years for estimating the cost-effectiveness (CE) ratio. We converted all the cost estimates to 1998 dollars, using Consumer Price Index (14). In the CEA, future costs are discounted to present values; which reflects difference in value people assign to resources and health outcomes in the present vs. the future. A wide variety of discount rates were used in the various studies reviewed. PCEHM suggested using both 3% and 5% discount rates in future CEAs for the next few years, as well as including sensitivity analysis using the ranges of 0% to 7% discount rate, and revising the rate periodically to reflect economic changes (13). However, the panel recommended the use of 3% discount rate, thus, we re-calculated the results at this rate where it was necessary.

For this purpose we estimated the remaining life span of a 35-year-old adult killed in an accident to be 42 years (15). Using the discount table for the present value of $1.0 (16), we calculated the present value of $1.0 after 42 years with 0%-7% discount rate. We converted the CE ratio for a given intervention with x% discount rate to the CE ratio with 3% as follows:

(CE ratio with x% discount rate) * (present value of $1.0 after 42 years with x% discount rate / present value of $1.0 after 42 years with 3% discount rate)

Cost- saving interventions are the ones that save lives, and their benefit savings are greater than cost of the intervention. These interventions have a CE ratio of less than $0 per LYS or per QALY.

Results

In this review we found great variations in the methodology used in the CEA on traffic safety. Due to space limitation we selected a sample of the studies to demonstrate the sources for heterogeneity, which are presented in Table 1. Quality assessment of the reviewed studies is beyond the scope of this report.

Tengs, et al in a CEA of five hundred lifesaving interventions (9) reported incremental cost per life saved, which is: (discounted net cost of life-saving intervention – discounted net cost of baseline intervention) / (discounted lives with life-saving intervention- discounted lives with baseline intervention). They excluded indirect costs, used net costs and effectiveness, which were evaluated from societal perspective, and discounted them at a rate of 5%.

In the CEA of airbags by Graham, et al. (7) and another study looking at injury prevention and control by Miller, et al. (8) the method is mentioned to be consistent with the recommendations of the PCEHM. However, the former study discounted the estimates at a rate of 3% and the later at 2.5%.

Miller et al. (8) and Tengs et al. (9) used LYS for estimating health benefits. Miller et al. also calculated QALYs, as well as three other papers (Graham 1997, 1998, Redelmeir 1999). Other kinds of benefit estimated in reviewed studies included fatality reduction, lives saved, hospitalization reduction, accidents or injuries prevented, and equivalent fatality.

In terms of discounting, most of the articles were not clear about the discount rate or whether the estimated rates are discounted at all. In a report prepared for National Highway Traffic Safety Administration (17) estimates were reported using discount rates from 2% to 10%.

Table 2 is a summary of cost saving interventions reported in four studies, which matched our selection criteria. Interventions presented in this table have a cost effectiveness ratio of less than $0 per LYS or per QALY. In this table we identify causal component of the accidents relative to each intervention, according to Haddon Matrix (1). Changes in vehicle design both for crash avoidance i.e. daytime running lights; as well as for occupant protection i.e. driver automatic belts are listed in the first column. Law enforcement and education programs fall into the second category, which is change in driver or human behavior. The third column shows CE highway design improvements in order to reduce deaths or injuries in case vehicle and human safety factors fail. Detailed description of each intervention, the CE ratio, and their source is presented in Table 3. As shown in Table 3, CE ratio for identified traffic safety interventions has a wide range, varying between less than $0 to more than $8 million per LYS for side door strength standard in light trucks to minimize back seat intrusion, or $450,000 per QALY for shoulder belts in rear seat of passenger vehicles. Many of the interventions listed in Table 3 will save lives and prevent injuries at cost of less than $50,000 per LYS.

Discussion

In this paper we presented the results of available studies in cost-effectiveness and traffic safety in the United States that matched our selection criteria. In addition, we briefly reviewed sources of heterogeneity in the cost-effectiveness studies.

According to PCEHM, in the cost effectiveness ratio the changes in resource use associated with an intervention goes in the numerator (in monetary terms) and the net improvement in health (a non-monetary measure) goes in the denominator. The costs in the numerator reflect the incremental (marginal) resource expenditure or savings, and the health outcomes in the denominator are measured in terms of QALYs (2). The heterogeneity of methods used to conduct CEA interferes with the ability of decision makers to make appropriate comparisons of CE ratios across programs in order to allocate resources. Following a set of recommendations for the practice of CEA as a reference would allow broad comparisons among interventions. In our review of the available literature on the CEA of traffic safety interventions, there were few studies published after 1996 (date PCEHM recommendation was published) that referred to the recommendations of PCEHM in their methodology (3-6). For the studies published before 1996, we relied greatly on Tengs review paper (7), which provided enough information in the methodology, and described CE formulas along with some examples of the calculations in the appendices. They reported CE ratios in terms of cost per LYS using a 5% discount rate.

We summarized a number of cost-saving interventions as the first priority for decision makers. The Haddon Matrix (1) was developed as an approach to motor vehicle occupant injury, and has become a model for the prevention of many types of injuries among children and adult. Haddon developed a conceptual matrix model of vehicle injury prevention that focused on the host (driver), the agent (motor vehicle), and the environment (highway design) at three different temporal phases of the crash: before, during, and, after. Injury prevention efforts can be directed to modify any of the three major causal components. However, since the opportunities to prevent morbidity and mortality due to crashes could be present at one or more of the three different time intervals, we did not stratify the interventions by the time line.

Occupant restraint systems (seat belts and child seats) are among the cost-saving interventions, both at the level of vehicle design and human behavior. Legislative action on automobile occupant protection started at July 1984, with the goal of seat belt use promotion. Forty-nine states and the District of Colombia have seat belt use laws in effect at this time (8). In 32 of the states with belt use law in 2000, secondary enforcement law, which allows police officers to write a citation only after a vehicle is stopped for other reason, is specified. Primary enforcement law enforcement, which is a cost saving program and reduces fatality, is allowed in only seventeen states and District of Columbia. That is, only in those states police officers are permitted to stop a vehicle for the belt law violation and write citation. Fortunately, mandatory usage law for the other occupant protective device, child restraint, was implemented in all 50 states and the District of Columbia since 1985 (8).

All states have passed child passenger protection laws, but they vary largely in age and size requirements and penalties for noncompliance. In addition, child seats are misused by 80% of users (20). Considering highly effectiveness of this cost-saving countermeasure in preventing head and brain injuries (3), proper use of age-appropriate child seats and booster seats should be encouraged.

All states and District of Columbia have 21-year old minimum drinking age law at present, however, during the year 2000, one alcohol related fatality occurred every 32 minutes (1). This reflects the need for more forceful implementation of existing drunk driving programs and laws.

Driver and passenger airbags have been installed in all new passenger cars since 1998 and light trucks since 1999 in addition to manual lap/shoulder belts (19). Cost-effectiveness of airbags, however, has a range of $9,000 to 70,000 per QALY in different studies, depending on their type and the baseline intervention. In spite of the relative high CE ratio of the airbags, they are required in new model cars because in combination with lap/shoulder belts they are the most effective safety devices available today for passenger vehicle occupants (19).

More safety activities at the time focused on decreasing the risk of a crash by focusing on driver behavior and federal standards for motor vehicle design and safety equipment. Too little attention had been paid to changing highway design to decrease the chance of a crash.

Many common public health measures have relatively high CE ratios, comparing to traffic safety programs presented in this paper. For example annual colorectal cancer screening for persons older than 65, will cost $35,000 per life year saved (21). High blood cholesterol periodic screening with dietary treatment only, has a CE ratio of $20,000 per LYS, while drug treatment of asymptomatic middle-aged men, will have an estimated $50,000-90,000 per LYS (21). One optimistic estimate for CE ratio of annual mammography and breast exam for women 40-49 years old is $50,000 per LYS. These comparisons may help policy makers to set priority in allocating funds and resources for traffic safety (9).

There are many safety programs for which cost evaluation is not available, or the components of the cost estimate are not clear enough to be included and compared in this review. The outcome measures in some others are not a health outcome. Exclusion of these interventions might have biased our study results towards underestimating the value of some particular areas.

The design of cost benefit evaluations in road safety needs to be improved so that more comparable evidence can be obtained. Literature reviews on CE should be updated regularly to ensure relevance. Many life saving traffic safety programs are cost saving and many are more CE than other interventions to prevent cancer, heart disease, and other causes of morbidity and mortality. Greater investment in traffic safety measures can have a greater impact on population health than investment in measures to reduce chronic diseases.

Table 1. Variation in Cost Estimates, Benefit Estimates, and Discounting in Traffic Safety Studies Between 1980 and 2001

Sources of Heterogeneity	Example
Cost Estimates	
Incremental cost[1]	(9)
Net Cost[2]	(6-8)
Comprehensive cost[3]	(22)
Direct economic cost without benefit	(23, 24)
Comprehensive and monetary benefits[4]	(25)
Cost from consumer perspective only	(26)
Benefit Estimates	
Fatality reduction	(27) (28)
Lives saved per year Fatality/Hospitalization reduction	(17)
Accidents/ fatalities/ injuries prevented	(24)
Equivalent fatality[5]	(22)
Quality adjusted life years	(6-8)
Life year saved	(8, 9)
Discounting	
Not clear	(26)
Different rates (%2-%10)	(17)

[1] Incremental cost = Discounted net cost of intervention – Discounted net cost of baseline
[2] Net cost = Intervention cost – Direct cost saving
[3] Willingness-to-pay minus its after-tax earnings and household production losses
[4] Monetary benefits include medical, productivity, and legal benefits. Cost of the program not mentioned.
[5] Equivalent fatality is defined as the sum of fatalities and nonfatal injuries prevented converted to fatality

Table 2. First Priority

Cost Saving Traffic Safety Interventions by Crash Component [1]

Vehicle design	Driver/Human	Road Design
Install windshield with adhesive bonding	Driver improvement schools for bad drivers	Federal Road safety programs 1996-1990
Terminate sale of three-wheeled All Terrain Vehicles	Provisional licensing, midnight curfew	Painting lines on roads
Daytime running lights	0.08% Driver blood alcohol limit	Post-mounted reflectors
Safety belts in front seat (50% use)	Sobriety checkpoints	Flashing beacons
Driver automatic belts in cars	SIP law [2] enforcement	Bridge-end guardrail
Lap/shoulder belts (50% use) vs. no restraints	Zero tolerance of alcohol-drivers <21 years of age	
Front Passenger lap/shoulder belts (50% use) vs. no restraints	Alcohol testing ignition interlock	
	ALR [3]	
	Enforcement of primary belt law	
	Child safety seat	
	Children's bicycle helmet	
	Motorcycle helmet	
	Mandatory motorcycle helmet law	

[1] Cost-effectiveness ratio < $0 per life year saved, or per quality-adjusted life saved
[2] Enforcing laws against serving intoxicated patrons of bars and restaurants
[3] Administrative license revocation for drunk driving

Table 3. Cost-effectiveness Ratio for Traffic Safety Interventions in Terms of Cost per Life-Year Saved or Cost per Quality Adjusted Life-Years Saved (1998 Dollars)

Source	Intervention	Compared to	CE Ratio $/LYS	CE Ratio $/QALY
	Vehicle Design			
(6)	Daytime running lights	Nighttime lights only	<0	<0
(9)	Install windshield with adhesive bonding	Rubber gaskets	<0	
(8)	Federal vehicle safety programs during 1966-1990			25,000
(8)	Vehicle side-impact protection			51,000
(9)	Dual master cylinder braking system in cars		10,773	
(9)	Automobile dummy acceleration tests	Side door strength test	52,209	
(9)	Collapsible steering columns in cars	Traditional steering columns	55,523	
(9)	Side structure improvements in cars to reduce door intrusion upon crash		91,157	
(9)	Front disk brakes in cars	Drum brakes in cars	198,889	
	Airbags			
(8)	Driver airbag with 60% belt use			9,140
(8)	Passenger airbag with 60% belt use			64,998
(7)	Seat belt/driver side air bag	Seat belt only		27,056
(7)	Seat belt/dual air bag system	Seat belt only		68,766
(9)	Airbag/manual lap belts in cars	Manual lap belts only	5,552	
(9)	Airbag/lap belts in cars	Lap/shoulder belts	14,088	
(9)	Driver airbag/manual lap belt in cars	Manual lap/shoulder belt	34,806	
(9)	Driver and passenger airbags/manual lap belts	Airbag for driver only and belts	50,551	
(9)	Driver and passenger airbags/manual lap belts	Manual lap belts only	51,380	
(9)	Air bags in cars	Manual lap belts	99,445	
(6)	Driver's frontal airbags	Manual belts (50% use)	102,372	25,593
(6)	Front passenger's frontal airbag	Driver-only airbags	227,139	65,049
	Occupant Restraint Systems			
(8)	Safety belts in front seat (50% use)			<0
(8)	Buying a child safety seat (allowing for misuse and nonuse)			<0
(6)	Lap/shoulder belts (50% use)	No restraints	<0	<0

Table 3. Cost-effectiveness Ratio for Traffic Safety Interventions in Terms of Cost per Life-Year Saved or Cost per Quality Adjusted Life-Years Saved (1998 Dollars)

Source	Intervention	Compared to	CE Ratio $/LYS	CE Ratio $/QALY
(6)	Front Passenger lap/shoulder belts (50% use)	No restraints	<0	<0
(9)	Driver automatic belts in cars	Driver manual belt	<0	
(9)	Driver and passenger automatic shoulder belt/knee pads in cars	Manual belts	1,078	
(9)	Driver and passenger automatic shoulder/manual lap belts in cars	Manual laps	4,475	
(9)	Driver and passenger automatic belts in car	Manual belts	26,518	
(6)	Child seats in children<4	No child seat	35,191	
(9)	Child restraint system in cars		60,495	
(9)	Rear outboard lap/shoulder belts in all cars	In 96% of cars	61,324	
(9)	Rear outboard and center lap/shoulder belts in all cars	Outboard only	298,335	
(6)	Lap/shoulder belts (9%use) in rear seat occupant	Lap belts	447,880	170,621
(8)	Shoulder belts in rear seat			408,109
	Bicycle/Pedestrian			
(8)	Children's bicycle helmet			< 0
(9)	Pedestrian and bicycle visibility enhancement programs		60,495	
	Motorcycle			
(8)	Wearing a motorcycle helmet			< 0
(6)	Compulsory helmet use in motorcyclists	Voluntary helmet use	<0	<0
(8)	Motorcycle helmet mandatory use law			29,779
(9)	Require front and rear lights to be on when motorcycle is in motion		912	
(9)	Federal mandatory motorcycle helmet laws	State determined policies	1,657	
	Restraining Regulations			
(8)	Primary belt law allowing police to cite unbelted occupant, with enforcement checkpoints			< 0
(9)	Mandatory seat belt use law		57	
(9)	Mandatory seat belt use law and child restraint law		81	
	Rules of the Road			
(8)	Provisional licensing of youth with a midnight curfew			<0

Table 3. Cost-effectiveness Ratio for Traffic Safety Interventions in Terms of Cost per Life-Year Saved or Cost per Quality Adjusted Life-Years Saved (1998 Dollars)

Source	Intervention	Compared to	CE Ratio $/LYS	CE Ratio $/QALY
(8)	Retain 55 mph speed limit on rural interstates			17,647
(8)	Change youth driving curfew from midnight to 10 pm			33,088
(10)	Regulation restricting cellular telephone usage while driving	No regulation		304,680
(9)	National 55 mph speed limit on highways and interstates	State and local 55 mph speed limit on highways and interstates	5,469	
(9)	Full enforcement of national 55 mph speed limit	50% Enforcement	13,260	
(9)	National 55 mph speed limit on highways	State and local 55 mph speed limit on highways	48,894	
(9)	National 55 mph speed limit	State and local 55 mph speed limit	73,755	
(6)	55 mph speed limit	65 mph limit	234,604	87,443
(9)	National 55 mph speed limit on rural interstates	State and local 55 mph speed limit on rural interstates	422,640	
	Safety Programs/ Interventions			
(8)	Federal driver and pedestrian safety program investments during 1966-1990			<0
(9)	Selective traffic enforcement programs at high-risk times and locations		4,309	
(9)	Require employers to ensure employees' motor vehicle safety		20,717	
	Light Trucks/Design			
(9)	Terminate sale of three-wheeled All Terrain Vehicles			
(9)	Ceiling of 0-6000 lb light trucks withstand forces of 1.5 x vehicle's weight		10,773	
(9)	Ceiling of 0-10,000 lb light trucks withstand forces of 1.5 x vehicle's weight		11,602	
(9)	Ceiling of 0-8,500 lb light trucks withstand forces of 1.5 x vehicle's weight		64,639	
(9)	Ceiling of 0-10,000 lb light trucks withstand 5000 lb of force		140,880	
(9)	Side door strength standard in light tricks to minimize front seat intrusion		157,455	
(6)	Strengthened side door beams in light trucks	Status quo occupants	170,621	56,518
(9)	Ceiling of 0-6,000 lb light trucks withstand 5000 lb of force		911,576	
(9)	Side door strength standard in light trucks to minimize back seat intrusion		8,287,057	

Table 3. Cost-effectiveness Ratio for Traffic Safety Interventions in Terms of Cost per Life-Year Saved or Cost per Quality Adjusted Life-Years Saved (1998 Dollars)

Source	Intervention	Compared to	CE Ratio	
			$/LYS	$/QALY
	Light Trucks/Restraint System			
(8)	Wearing an all-terrain vehicle helmet			
(9)	Driver and passenger non-motorized automatic belts in light trucks	Manual belts	11,602	
(9)	Push-button release and emergency locking retractors on truck and bus seat belts		11,602	
(9)	Promote voluntary helmet use while riding All-Terrain Vehicles		36,463	
(9)	Driver and passenger motorized automatic belts in light trucks	Manual belts	41,435	
(9)	Driver airbag in light trucks	Manual lap/shoulder belt	46,408	
(9)	Driver and passenger airbags in light trucks	Manual lap/shoulder belt	55,523	
	Road design and upgrading			
(8)	Road safety investments during 1966-1990 that used Federal Highway Administration funds			<0
(8)	Center, edge, and lane lines painted on roads			<0
(8)	Transition guardrail at bridge ends with = 1 crash every 3 year			<0
(8)	Post-mounted reflectors on horizontal curves with = 1 crash every 3 year			<0
(8)	Flashing beacons on horizontal lanes of rural two-lane roads with = 1 crash every 3 year			<0
(8)	Concrete median barrier on undivided primary roads with medians of 1-12 ft			48,529
(8)	Flatten crest vertical curves with = 1 crash every 3 year			195,222
(8)	Concrete median barrier on undivided primary roads with medians of 13-30 ft			265,437
(9)	Grooved pavement on highways		24,032	
(9)	Decrease utility pole density to 20 poles per mile on rural roads	40 Poles per mile	25,690	
(9)	Channelized turning lanes at highway intersections		32,319	
(9)	Flashing lights at rail-highway crossings		34,806	
(9)	Flashing lights and gates at rail-highway crossings		37,292	
(9)	Widen existing bridges on highway		67,954	

Table 3. Cost-effectiveness Ratio for Traffic Safety Interventions in Terms of Cost per Life-Year Saved or Cost per Quality Adjusted Life-Years Saved (1998 Dollars)

Source	Intervention	Compared to	CE Ratio $/LYS	CE Ratio $/QALY
(9)	Widen shoulders on rural two-lane roads to 5 feet	2 feet	99,445	
(9)	Breakaway utility poles on rural highways	Existing utility poles	124,305	
(9)	Widen lanes on rural roads to 11 feet	9 Feet	124,305	
(9)	Relocate utility poles to 15 feet from edge of highway	Utility poles at 8 feet from edge of highway	348,056	
	Education			
(9)	Driver improvement schools for bad drivers	Suspending/ revoking license	<0	
(8)	Miami's child pedestrian safety education program			2,647
(9)	Media campaign to increase voluntary use of seat belts		257	
(9)	Public pedestrian safety information campaign		414	
(9)	Improve traffic safety information for children grades K-12		588	
(9)	Improve basic driver training		16,575	
(9)	Alcohol safety programs for drunk drivers		17,403	
(9)	Multimedia retraining courses for injury-prone drivers		19,060	
(9)	Improve educational curriculum for beginning drivers		69,611	
(9)	First aid training for drivers		149,167	
(9)	Improve pedestrian education programs for school bus passengers grades K-6		232,037	
	Warning letters sent to problem drivers		596,668	
	Education/Motorcycle			
(9)	Motorcycle rider education program		4,724	
(9)	Improve motorcycle testing and licensing system		7,210	
	Drunk driving interventions			
(8)	0.08% Maximum legal driver blood alcohol level			<0
(8)	Sobriety checkpoints			<0
(8)	Enforcing laws against serving intoxicated patrons of bars and restaurants (SIP law)			<0
(8)	Administrative license revocation with probationary licensing for travel to work			<0

Table 3. Cost-effectiveness Ratio for Traffic Safety Interventions in Terms of Cost per Life-Year Saved or Cost per Quality Adjusted Life-Years Saved (1998 Dollars)

Source	Intervention	Compared to	CE Ratio	
			$/LYS	$/QALY
(8)	Administrative license revocation, probationary licensing, and a per se law stating that properly administered blood alcohol tests indicate impairment			<0
(8)	Equipping cars of drivers convicted of drunk driving with alcohol-testing ignition interlocks			<0
(8)	Zero tolerance of alcohol for drivers <21			<0
	School bus safety			
(9)	Seat back height of 24" in school buses	Height of 20"	124,305	
(9)	Crossing control arms for school buses		339,769	
(9)	Signal arms on school buses		356,344	
(9)	External loud speakers on school buses		488,936	
(9)	Mechanical sensors for school buses		994,446	
(9)	Seat belt for passengers in school buses		2,320,376	
	Staff school buses with adult monitors		4,060,658	
	Vehicle inspection			
(9)	Random motor vehicle inspection		1,243	
(9)	Compulsory annual motor inspection		16,575	
(9)	Periodic motor vehicle inspection		17,403	
(9)	Periodic inspection for motor vehicle sample focusing on critical components		323,195	
	Emergency vehicle response			
(9)	Defibrillators in emergency vehicles for resuscitation after cardiac arrest		32	
(9)	Defibrillators in emergency vehicles staffed with paramedics	EMTs	323	
(9)	Defibrillators in ambulances for resuscitation after cardiac arrest		381	
(9)	Advanced life support paramedical equipped vehicle		4,475	
(9)	Advanced resuscitative care for cardiac arrest	Basic emergency services	22,375	
(9)	Combined emergency medical services for coordinated rapid response		99,445	

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