

The Impact of a Standard Enforcement Safety Belt Law
on Fatalities and Hospital Charges in Ohio:
An Analysis using 2003 Ohio CODES Data

Center for Injury Research and Policy
Columbus Children's Research Institute

Kristen A. Conner, MPH

Gary A. Smith, MD, DrPH

Huiyun Xiang, MD, MPH, PhD

March 2007

Table of Contents

Executive Summary	3
Introduction.....	4
The Burden of Motor Vehicle Crashes in Ohio	4
The Impact of Safety Belts	4
Medical and Financial Outcomes for Ohio Motor Vehicle Crashes.....	5
Data Sources and Methods.....	6
Data Sources and Limitations	6
Definitions of TBI and SCI.....	6
Medical Costs to Medicaid	7
Calculating TBI Charges to Medicaid	8
Calculating SCI and Other Injury Charges to Medicaid.....	10
SCI	10
Other Injuries	11
Effectiveness of Safety Belts in Preventing Injury	11
Safety Belt Usage Increase Resulting from Standard Enforcement	11
Results.....	12
TBI	13
SCI	13
Other Injuries	13
Direct Medical Costs and Savings to Ohio’s Medicaid Program	14
Medicaid Savings due to Increasing Safety Belt Use	15
Cumulative Savings to Other Payers	15
Refined Effectiveness of Safety Belts.....	17
Limitations of the Study.....	17
Conclusions.....	19
References.....	20

List of Tables

Table 1. Case Definition for Traumatic Brain Injury (TBI)	7
Table 2. Case Definition for Spinal Cord Injury (SCI).....	7
Table 3. Case Definitions for Levels of Spinal Cord Injury Severity.....	7
Table 4. Data Sources for Medical Charges to Medicaid	8
Table 5. Health Care Inflation Rates 2004-2007	9
Table 6. Average Yearly Charges for SCI, by Severity Level (in May 2006 dollars).....	10
Table 7. Effectiveness of Safety Belts in Preventing Moderate-to-Critical Injury for Ohio, 2003	11
Table 8. Demographics of Patients Hospitalized for MVC-Related Injuries in Ohio, 2003.	12
Table 9. Medical Cost Estimates to Medicaid for Unbelted TBI Patients in Ohio in 2003.....	14
Table 10. Medical Cost Estimates to Medicaid for Unbelted SCI Patients in Ohio in 2003	14
Table 11. Estimated 10-Year Savings to Medicaid for Injuries Avoided the 1 st Year after Ohio's Safety Belt Use Rate was at 100%	15
Table 12. Estimated Savings to Medicaid Over 10 Years for Injuries Avoided the 1 st Year after Ohio's Safety Belt Law is Upgraded to Standard Enforcement.....	15
Table 13. Cumulative Medical Charge Savings for 2007-2016 for Payer Sources (in 2007 Dollars)	16
Table 14. Estimated Medical Charges Avoided (in 2003 Dollars) and Fatalities Prevented Over 1 Year if Ohio's Safety Belt Use Rate was at 100% and 92%.	17

List of Figures

Figure 1. Cumulative Savings (in Millions) to All Payers if Ohio's Safety Belt Law is Upgraded to Standard Enforcement in 2007	16
---	----

List of Appendices

Appendix A. Cumulative Savings of Hospital Charges to Medicaid in Ohio	22
Appendix B. Cumulative Savings of Hospital Charges to Other Government Payers (excluding Medicaid) in Ohio	23
Appendix C. Cumulative Savings of Hospital Charges to Commercial Insurance/HMOs in Ohio	24
Appendix D. Cumulative Savings of Hospital Charges to Self-Payers in Ohio	25

Executive Summary

Increasing safety belt use in Ohio would substantially lower deaths, injuries, and medical costs due to motor vehicle crashes in our state. Safety belts are highly effective in preventing death and injury due to motor vehicle crashes. The National Highway Traffic Safety Administration (NHTSA) estimates that three-point safety belts in frontal positions are 45-60% effective in preventing fatalities in frontal collisions and 50-65% effective in preventing moderate-to-critical injuries.

According to a 1995 NHTSA study, states with standard (or primary) enforcement safety belt laws achieved significantly higher belt use than did those with only secondary enforcement laws. In 2006, Ohio's observed safety belt usage rate was 82%. Based on the experiences of other states, it is estimated that by upgrading Ohio's safety belt law to standard enforcement in 2007, the safety belt use rate in Ohio would increase 10 percentage points, from 82% to 92%.

This report analyzes the effect that enactment of a standard enforcement safety belt law in Ohio would have on hospital charges and direct medical costs due to motor vehicle crashes in Ohio, focusing on the impact to the state's Medicaid system. Data for this analysis were obtained from the Ohio Crash Outcome Data Evaluation System (CODES) Program, which was established to gain a better understanding of medical and financial outcomes associated with motor vehicle crashes in Ohio. Under Ohio CODES, individuals in crashes during 2003 were probabilistically linked with hospital emergency department and inpatient treatment information.

If Ohio were to adopt a standard enforcement safety belt law in 2007, the following conservative projections of fatalities prevented and medical cost savings (in 2007 dollars) can be made:

- Injuries prevented within the first year following adoption of standard enforcement would save Medicaid \$15.4 million over 10 years
- Cumulative savings to Medicaid would total \$91.2 million by 2016
- Other government payer sources, excluding Medicaid, would save \$7.0 million
- Commercial insurance and HMOs would save \$54.2 million
- Uninsured individuals paying their own medical bills directly would save \$23.3 million
- At a minimum, 18 fatalities would be prevented

Introduction

The Burden of Motor Vehicle Crashes in Ohio

Motor vehicle crashes are a public health epidemic with tremendous human and financial consequences. In 2004, motor vehicle crashes were the leading cause of death for Ohioans age one to 34 years and the leading cause of death from unintentional injury for ages one to 50.¹

There were 1,326 motor vehicle occupants killed and 131,245 injured on Ohio roadways in 2005.² The total economic cost for all of Ohio's crashes in 2005 is estimated to be \$10.3 billion.³ Cost estimates include such things as costs for medical care, emergency services, rehabilitation, lost productivity, legal services, workplace losses, and insurance administration. This estimate includes both fatal and nonfatal injuries as well as crashes involving property damage only.

Of the \$10.3 billion in total economic costs for Ohio in 2005, \$1.6 billion (15.5%) were related to medical services.³ Although, commercial insurers pay the majority of these medical costs, a substantial burden also falls on public sources such as Medicaid, Medicare, and the Worker's Compensation system.

Nationally, the economic cost of motor vehicle crashes reached \$230.6 billion in 2000. Medical expenses accounted for \$32.6 billion (14%) of these costs. Public funds paid for approximately 9% of all costs, or \$21 billion. Analyses have found that the failure of a large portion of the driving population to wear a safety belt cost society more than \$26 billion in preventable injury-related costs in 2000.⁴

Crashes pose a significant burden on government services. Local and state governments respond to motor vehicle crashes, and the severity of a crash determines the numbers, types and time commitment of responders at the crash site. Total cost for a crash escalates as clean up occurs, reconstruction and analysis of the crash are performed, and litigation against the government entities responsible for the roadway is fought. Ultimately, the tax payer bill can skyrocket when crash victims are unable to pay for their medical care or become reliant on government programs after serious injury renders them unable to adequately provide for themselves and their families. Furthermore, the public feels the impact of motor vehicle crashes through higher insurance premiums and medical costs.

The Impact of Safety Belts

Safety belts are highly effective in preventing death and injury due to motor vehicle crashes. According to the National Highway Traffic Safety Administration (NHTSA), in frontal collisions, three-point safety belts in frontal positions are 45-60% effective in preventing fatalities and 50-65% effective in preventing moderate-to-critical injuries.⁴ In 2005 in Ohio, 55% of motor vehicle occupants who died in a crash and 31% of crash survivors with

incapacitating injuries were not wearing a safety belt.² These figures exclude pedestrians and others involved in motor vehicle crashes for whom safety belt use does not apply.

Ohio's observed safety belt usage rate for 2005 was 79%.⁵ This rate was 3 percentage points below the national rate of 82%. Although safety belt use in Ohio is on the rise (82% in 2006), substantial progress can be made in reducing the number of deaths and injuries that result from crashes by strengthening safety belt laws and dramatically increasing safety belt usage statewide.⁵

In order to gain a better understanding of the medical and financial outcomes of motor vehicle crashes statewide, a Crash Outcome Data Evaluation System (CODES) program, funded by NHTSA, was implemented in Ohio by the Ohio Department of Public Safety in 2004. Under the CODES program, individuals involved in Ohio crashes during 2003 were probabilistically linked with hospital emergency department (ED) and inpatient treatment information. The linked data are referred to in this report as the 2003 CODES dataset. The Ohio CODES program represents a collaborative effort between the Ohio Department of Public Safety (ODPS), the Ohio Hospital Association (OHA), the Ohio Department of Health (ODH) and the Center for Injury Research and Policy (CIRP) at Columbus Children's Research Institute.

Medical and Financial Outcomes for Ohio Motor Vehicle Crashes

This report will focus on both hospital charges and direct medical costs associated with crashes that occur in Ohio. The impact crashes have on the state Medicaid program is also examined. Information on hospital patients treated and released from emergency departments and inpatient care is collected by the OHA. No personal identifiers are collected by the OHA; therefore, its database is linked with the ODPS motor vehicle crash database using software based on statistical theory known as probabilistic linkage.⁶

Hospital patient data contain total charges that were *billed* for the patient's initial hospital stay following a motor vehicle crash. In the 2003 CODES dataset, there were 90,797 linked crash and hospital records with hospital charges totaling \$252.9 million. These charges reflect charges incurred, not actual charges paid, and include such things as room and board, lab and radiology services, and other ancillary charges.

For most people injured in crashes, there are relatively few costs beyond the initial hospital stay. However, certain types of serious injuries commonly result in post-discharge costs, including for rehabilitation, home nursing services, and medical and pain management. This study focuses on two such injuries, traumatic brain injury (TBI) and spinal cord injury (SCI) for which data are available about post-discharge costs.

Motor vehicle crashes are the leading cause of TBI. The National Institute of Neurological Disorders and Stroke reports that half of all TBIs nationally are due to transportation incidents.⁷ According to the Brain Injury Association of Ohio, nearly 50% of TBIs in Ohio result from motor vehicle crashes.⁸

This report places special emphasis on costs to Ohio's Medicaid system; however, estimates of the costs to commercial insurers and other government payer sources were also calculated. Due to the lack of available information on the percentage of injured persons whose post-discharge costs would be paid by commercial insurers and other government sources, only the initial hospital charges were considered for these payers. As a result, the medical charges associated with motor vehicle-related hospitalizations for these non-Medicaid payers are underestimates.

In addition, an estimate of medical cost savings resulting from the adoption of a standard enforcement safety belt law in Ohio was calculated. The cost savings for a standard enforcement law were estimated over a 10-year period (from 2007 to 2016). A 10-year time period was selected to illustrate that medical charges resulting from motor vehicle crashes continue to accumulate over time.

Data Sources and Methods

Data Sources and Limitations

The primary data source for this analysis was the 2003 CODES linked dataset. Variables in this dataset include the external cause of injury code (or E-code, which was used to classify motor vehicle crash-related discharges), diagnosis codes (used to classify TBI and SCI injuries), total hospital charges, expected sources of payment, safety belt use, seating position, and others.

For this report, only motor vehicle occupants who were hospitalized as a result of a motor vehicle crash were considered, i.e., E-codes of E810-E819 (.0, .1, .8, .9). In order to accurately apply NHTSA-reported safety belt effectiveness rates, the analysis was further limited to occupants of a passenger car or light truck (including SUVs, minivans, and other passenger vans), who were older than 4 years of age, with a motorist safety equipment code of lap belt only, lap/shoulder belt, child safety seat or unknown. The resulting dataset included 51,960 linked crash and hospital records with charges totaling \$108.8 million (n=51,313).

Safety belt use and seating position were imputed for those cases where the variable was unknown. Cost savings were only calculated for those individuals who were not belted.

Definitions of TBI and SCI

Credible data exist about the long-term medical charges associated with traumatic brain and spinal cord injuries. The Centers for Disease Control and Prevention (CDC) has developed case definitions for TBI and SCI based on the World Health Organization's International Classification of Diseases, Ninth Revision (ICD-9) systems (Tables 1 and 2). The case definitions used in this report are based on those published in CDC's *Central Nervous System Injury Surveillance Data Submission Standards – 2002*.^{9,10,11}

Table 1. Case Definition for Traumatic Brain Injury (TBI)

ICD-9 code(s)	Description
800.0-801.9	Fracture of the vault or base of the skull
803.0-804.9	Other and unqualified and multiple fractures of the skull
850.0-854.1	Intracranial injury, including concussion, contusion, laceration, and hemorrhage
950.1-950.3	Injury to the optic chiasm, optic pathways, and visual cortex
959.01	Head injury, unspecified

Table 2. Case Definition for Spinal Cord Injury (SCI)

ICD-9 code(s)	Description
806.0-806.9	Fracture of the vertebral column with spinal cord injury
952.0-952.9	Spinal cord injury without evidence of spinal bone injury

Table 3 outlines the case definitions for the four levels of injury severity used in this report to determine medical charges associated with SCI. These definitions were obtained from the National Spinal Cord Injury Statistical Center (NSCISC).¹²

Table 3. Case Definitions for Levels of Spinal Cord Injury Severity

Injury severity	Definition	ICD-9 codes
High quadriplegia	Injury to C1-C4	806.00-806.04, 806.10-806.14, 952.00-952.04
Low quadriplegia	Injury to C5-C7	806.05-806.09, 806.15-806.19, 952.05-952.09
Paraplegia	Injury to T1-S5	806(.2-.7), 952(.1-.4)
Incomplete motor function at any level	--	806.8, 806.9, 952.8, 952.9

Medical Costs to Medicaid

Hospital charges data include coding for a primary source of payment, such as Medicaid or commercial insurance, as well as a secondary payment source. The primary payer source was used to determine who would pay the first-year medical costs. Patient records with Medicaid as the primary payer source were selected for the analysis of medical costs to Medicaid.

The model used to estimate medical costs to Medicaid is based partially on methodologies used in Virginia, Kentucky and Minnesota.^{13,14,15} Three categories of injury (TBI, SCI, other) and two time frames (first-year costs, including initial hospital charges and first-year post-discharge costs; and additional-year costs) were employed in this model.

To more accurately calculate charges to Medicaid for TBI patients, unbelted Ohio crash survivors who sustained a TBI were divided into two categories: 1) patients who received inpatient care, and 2) patients who were treated within the emergency department only.

Table 4. Data Sources for Medical Charges to Medicaid

Type of Injury	First Year		Additional year charges
	Initial hospital charges	Post-discharge charges	
TBI patients discharged from Inpatient care	2003 CODES dataset	Craig Hospital	Chaudhary and Preusser
TBI patients discharged from ED services	2003 CODES dataset	--	--
SCI patients	NSCISC	NSCISC	NSCISC
Other injury patients	2003 CODES dataset	--	--

Calculating TBI Charges to Medicaid

Initial hospital charges were calculated from the Ohio 2003 CODES dataset. To estimate post-discharge first-year costs for TBI patients, information from two sources was applied. Craig Hospital, a specialty rehabilitation and research facility dedicated to patients with traumatic brain or spinal cord injury, estimates that a TBI patient discharged from inpatient care has an average post-discharge first-year cost of approximately \$40,000.^{16,17} Additional-year costs are derived from a study released by the Preusser Research Group that calculated average additional-year costs for TBI patients as \$26,871 per year per patient.¹⁴

Using these definitions and assumptions, first-year and long-term medical charges for Ohio motor vehicle crash survivors with TBI over the 10-year period from 2007 to 2016 were calculated as follows:

Inpatient Care

$$CTBI_s = H_{TBI} + a * N_{TBI}$$

where: $CTBI_s$ = TBI charges to Medicaid in the first year following injury
 H_{TBI} = the initial hospital charges to Medicaid for TBI patients
 N_{TBI} = the number of unbelted TBI patients on Medicaid who survived hospitalization
 a = the first-year post-discharge medical charges (estimated at \$40,000 per patient)

Emergency Department Care Only

$$CTBI_s = H_{TBI}$$

where: $CTBI_s$ = TBI charges to Medicaid in the first year following injury
 H_{TBI} = the initial hospital charges to Medicaid for TBI patients

Only initial hospital charges were used to calculate first-year costs for patients treated in the emergency department only. There was insufficient evidence to accurately project the number of these patients who would be in need of follow-up care or the amount those services would cost.

According to Craig Hospital, the percentage of TBI patients on Medicaid will double in the year following injury.¹⁶ Using this projection, the cost savings for each additional year after injury was calculated for inpatients only as follows:

$$CTBI_L = (2 * N_{TBI} * b)$$

where: $CTBI_L$ = TBI charges to Medicaid in each additional year following injury

N_{TBI} = the number of unbelted TBI patients on Medicaid who survived hospitalization

b = the additional-year post-discharge medical charges (estimated at \$26,871 per patient)

Initial hospital charge data are from 2003 and additional-year cost estimates are based on studies using pre-2002 cost data with adjustments for inflation. Health care inflation rates for 2004-2007 were obtained from R-C Healthcare Management and used to adjust our cost estimates (Table 5).¹⁸

Table 5. Health Care Inflation Rates 2004-2007

Year	Inflation Rate	Calculation Type
2004	4.6%	Historical
2005	4.5%	Historical
2006	4.6%	Projected
2007	4.5%	Projected

Source: R-C Healthcare Management

Calculating SCI and Other Injury Charges to Medicaid

SCI

NSCISC reports that average SCI charges per patient range from \$218,504 to \$741,425 in the first year and from \$15,313 to \$132,807 in each subsequent year, depending on injury severity (Table 6).

Table 6. Average Yearly Charges for SCI, by Severity Level (in May 2006 dollars)

Injury Severity	First Year	Each Subsequent Year
High Quadriplegia	\$741,425	\$132,807
Low Quadriplegia	\$478,782	\$54,400
Paraplegia	\$270,913	\$27,568
Incomplete Motor Function at Any Level	\$218,504	\$15,313

Source: National Spinal Cord Injury Statistical Center (NSCISC)

The estimates of first-year charges noted above include the initial hospital charges; as a result, the hospital charges from the 2003 CODES dataset were not used in the calculations. First-year and additional-year charges to Medicaid for SCI patients in Ohio were calculated as follows:

First Year

$$CSCI_S = \sum (b_i * N_{(SCI)i})$$

where: $CSCI_S$ = SCI charges to Medicaid in the first year following injury

$N_{(SCI)i}$ = the number of unbelted SCI patients in each severity level

b_i = the average expenses in the first year at each severity level (Table 6)

Additional Years

According to Craig Hospital, 25.4% of all persons who experience a spinal cord injury will become Medicaid patients.^{16,17}

$$CSCI_L = \sum (e_i * 25.4\% * T_{(SCI)i})$$

where: $CSCI_L$ = SCI charges to Medicaid in each additional year following injury

$T_{(SCI)i}$ = the number of unbelted SCI patients in each severity level who survived hospitalization

e_i = the average expenses in each subsequent year for each severity level (Table 7)

Calculations for SCI were adjusted for inflation using the rates presented in Table 5. SCI charges estimates derived from NSCISC were in 2006 dollar figures so adjustments were only made for 2007.

Other Injuries

For unbelted vehicle occupants who did not have a diagnosis of TBI or SCI, cost projections were restricted to initial hospital charges and are referred to in this report as “Other.” There are no available research data to project post-discharge medical costs for these injuries. Calculations for Other injuries were adjusted for inflation using rates presented in Table 5.

Effectiveness of Safety Belts in Preventing Injury

According to NHTSA, the estimated effectiveness of safety belts in preventing moderate-to-critical or fatal injury varies depending on the type of vehicle (passenger car versus light truck), the type of safety belt used (lap only, lap/shoulder, child safety seat) and the occupant’s position in the vehicle (front versus rear seat).^{4,19} The 2003 Ohio CODES dataset was used to determine the number of occupants with each combination of vehicle type, belt type and seating position. These numbers were used to calculate a weighted average effectiveness of safety belts in preventing injury for Ohio, as follows:

Table 7. Effectiveness of Safety Belts in Preventing Moderate-to-Critical Injury for Ohio, 2003.

Vehicle Type	Seating Position	Lap Belt Only		Lap/Shoulder Belt		Child Safety Seat	
		Effectiveness	# hosp. in OH	Effectiveness	# hosp. in OH	Effectiveness	# hosp. in OH
Passenger Car	Front	30%	224	50%	29,266	59%	3
	Rear	37%	365	49%	1,359	59%	29
Light Truck	Front	55%	153	65%	11,918	59%	1
	Rear	68%	174	78%	655	59%	13
Total		-	916	-	43,198	-	46

$$\text{Effectiveness} = (224*30\% + 365*37\% + \dots + 13*59\%) / (916 + 43,198 + 46) = \mathbf{54.32\%}$$

Safety Belt Usage Increase Resulting from Standard Enforcement

According to NHTSA, the typical safety belt usage increase for states that have enacted standard enforcement legislation is 10-15 percentage points.⁴ In this report, it was assumed that Ohio would experience an increase of 10 percentage points. This would increase the state’s observed usage rate from the 2006 level of 82% to 92%.

Results

We analyzed 51,960 motor vehicle occupants hospitalized in 2003 in Ohio as a result of crashes. The demographics of these occupants are presented in the following table:

Table 8. Demographics of Patients Hospitalized for MVC-Related Injuries in Ohio, 2003.

Characteristic	No. (%) of injured patients (N=51,960)
Gender	
Male	21,959 (42.3%)
Female	30,001 (57.7%)
Age	
5-7 years	595 (1.2%)
8-15 years	2,610 (5.0%)
16-24 years	16,826 (32.4%)
25-69 years	29,283 (56.4%)
70+ years	2,645 (5.1%)
Type of insurance	
Medicaid	5,612 (9.9%)
Other federal	2,306 (4.4%)
Commercial	14,313 (27.6%)
HMO	12,844 (24.7%)
Workers' compensation	821 (1.6%)
Self pay	15,145 (29.2%)
Other	1,343 (2.6%)
Unknown	27 (0.1%)
Safety belt use	
No	6,113 (11.8%)
Yes	45,847 (88.2%)
Safety belt type	
No safety belt	6,113 (11.8%)
Lap belt only	956 (1.8%)
Lap & shoulder belt	44,845 (86.3%)
Child safety seat	46 (0.1%)

Of the 51,960 occupants, 6,113 (11.8%) were unbelted. The total hospital charges for these unbelted occupants was \$29.2 million (n=6,031), which represented 27% of total charges for all patients. Self pay was the leading source of payment for Ohio motor vehicle occupants in 2003, accounting for 29.2% of hospital charges, followed closely by commercial insurance (27.6%) and HMOs (24.7%). Government payer sources, including Medicaid and Workers' Compensation, were the primary payers for more than \$22 million in hospital charges, representing 21% of total charges to motor vehicle occupants. The average hospital charge billed to a government payer source was 36% greater than to a non-government source.

TBI

There were 5,364 vehicle occupants diagnosed with TBI as a result of a motor vehicle crash in 2003, with initial hospital charges totaling \$35,454,688 (n=5,283). Of the 5,364 TBI patients, 1,366 (25.4%) were not wearing a safety belt. Total hospital charges for the unbelted cases were \$13,527,621 (n=1,340), representing 38% of total charges for all TBI patients. Seventy-five (1.4%) of the TBI patients died. Of these, 45 (60%) were not wearing a safety belt.

Of the 5,364 vehicle occupants diagnosed with TBI, Medicaid was the primary source of payment for 585 (10.9%). Of these 585 cases, 39 were missing a discharge status code and were excluded from further analysis. Of the remaining 546 cases, 180 (33.0%) patients were unbelted (71 inpatients and 109 patients who received emergency department services only). The initial hospital charges for the 71 inpatients totaled \$1,950,450. Three inpatients died, leaving 68 inpatients who would potentially have post-discharge costs. Initial hospital charges for the 109 ED patients totaled \$228,650. Three ED patients did not survive the initial hospitalization.

SCI

There were 69 vehicle occupants diagnosed with SCI as a result of a motor vehicle crash in 2003. The total initial hospital charges were \$2,129,687 (n=68). Of the 69 total, 20 (29.2%) occupants were not wearing a safety belt. Initial hospital charges for the unbelted occupants totaled \$1,193,364 (n=20), representing 56% of total charges for all SCI patients. Two (3.0%) of the SCI patients died. Of these, one was not wearing a safety belt.

Of the 69 vehicle occupants diagnosed with motor vehicle crash-related SCI in 2003, Medicaid was the primary source of payment for 7 (9.8%). Of these 7 cases, 3 (47.1%) persons were unbelted (all inpatients). The initial hospital charges for the unbelted occupants totaled \$90,288. All 3 of these patients survived and would potentially have post-discharge costs.

Other Injuries

There were 46,544 vehicle occupants diagnosed with injuries other than TBI or SCI as a result of a motor vehicle crash in 2003. The initial hospital charges totaled \$72,081,397 (n=45,978). Of the 46,544 total occupants, 4,732 (10.2%) were not wearing a safety belt. Initial hospital charges for the unbelted occupants totaled \$14,842,190 (n=4,676), representing 20.6% of total charges for all patients with Other injuries. Fifty-two (0.1%) of the Other injury patients died. Of these, 26 (50.0%) persons were not wearing a safety belt.

Of the 46,544 vehicle occupants diagnosed with injuries other than TBI or SCI, Medicaid was the primary source of payment for 4,573 (9.8%). Of these 4,573 cases, 121 were missing a discharge status codes and were excluded from further analysis. Of the remaining 4,447 cases, 677 (15.2%) persons were not wearing a safety belt (60 inpatients and 617 patients who received emergency department services). Initial hospital charges for the 60 unbelted inpatients totaled \$1,504,153. Fifty-nine inpatients survived the initial hospitalization and would potentially have

post-discharge costs. Initial hospital charges for the 617 unbelted ED patients totaled \$758,481. One ED patient died, while 616 ED patients survived the initial hospitalization.

Direct Medical Costs and Savings to Ohio's Medicaid Program

The direct medical cost estimates to Medicaid for unbelted TBI patients are presented in Table 9.

Table 9. Medical Cost Estimates to Medicaid for Unbelted TBI Patients in Ohio in 2003

Type of Injury	N	First Year			Each additional year cost	Sum 10 Years
		Initial hospital charges	# survived	Post-discharge costs		
TBI - Inpatient	71	\$1,950,449	68	\$2,720,000	\$3,654,456	\$37,560,553
TBI – ED	109	\$228,650	106	--	--	\$228,650

Over 10 years, it is estimated that medical costs for unbelted occupants sustaining a motor vehicle crash-related TBI would total \$37,789,203 (in 2003 dollars). Adjusting for health care inflation rates, this figure rises to \$45,150,615 (in 2007 dollars).

The direct medical cost estimates to Medicaid for unbelted SCI patients are presented in Table 10.

Table 10. Medical Cost Estimates to Medicaid for Unbelted SCI Patients in Ohio in 2003

Type of injury	N (Medicaid)	First year	# unbelted SCI patients (all payers)	* 25.4%	Each additional year	Over 9 years	Sum 10 years
High quad	--	--	3	0.76	\$101,198	\$910,782	\$910,782
Low quad	1	\$478,782	5	1.27	\$69,088	\$621,792	\$1,100,574
Paraplegia	--	--	6	1.52	\$42,013	\$378,117	\$378,117
Incomplete motor function	2	\$437,008	4	1.02	\$15,558	\$140,022	\$577,030
TOTAL		\$915,790	18		\$227,857		\$2,966,503

First-year charges for unbelted occupants sustaining a motor vehicle crash-related SCI would total \$915,790; over 10 years, charges total \$2,966,503. Adjusted for inflation, the 10-year estimate rises to \$3,099,995 (in 2007 dollars).

Initial hospital charges for unbelted occupants sustaining other (non-TBI and non-SCI) injuries as a result of motor vehicle crashes totaled \$2,262,634. Adjusting for health care inflation, this total becomes \$2,703,399 (in 2007 dollars).

By adding together the 10-year estimates for each injury category, we arrive at a total charge to Medicaid over 10 years for unbelted motor vehicle occupants injured in 2003 of **\$50,954,009** (in 2007 dollars).

Medicaid Savings due to Increasing Safety Belt Use

To calculate an estimate of savings to Medicaid by increasing safety belt use, the total estimated Medicaid charges for all unbelted injured motor vehicle occupants was multiplied by the weighted average effectiveness rate of 54.32% calculated for Ohio (Table 11).

Table 11. Estimated 10-Year Savings to Medicaid for Injuries Avoided the 1st Year after Ohio's Safety Belt Use Rate was at 100%

Total charges to Medicaid for 2003 unbelted vehicle occupants	\$50,954,009
Weighted average safety belt effectiveness rate	54.32%
Estimated savings if 100% safety belt use rate	\$27,678,217

The savings estimate in Table 11 assumes 100% safety belt use after adoption of a standard enforcement safety belt law. Based on the experience of other states, it is estimated that Ohio's safety belt use rate would rise 10 percentage points, from 82% to 92%, if Ohio's current safety belt law was upgraded to standard enforcement. Table 12 presents the projected total cost savings to Medicaid over 10 years if the safety belt use rate in Ohio increased to 92%. To calculate cost savings at 92%, the expected percentage point increase of 10 was divided by the current non-belted use rate of 18 percentage points, and then multiplied by the total estimated cost savings at 100% belt use.

Table 12. Estimated Savings to Medicaid Over 10 Years for Injuries Avoided the 1st Year after Ohio's Safety Belt Law is Upgraded to Standard Enforcement

Estimated savings if 100% safety belt use rate	\$27,678,217
Expected belt use rate with standard enforcement law	92%
Projected cost savings with standard enforcement law	\$15,376,787

The total direct medical cost savings to Medicaid over 10 years for hospitalizations that occur in 2007 alone would be nearly **\$15.4 million**.

Cumulative costs savings to Medicaid for a 10-year period, assuming passage of a standard enforcement safety belt law in 2007, are presented in Appendix A. By 2016, cumulative savings to Medicaid would be more than **\$91.2 million**.

Cumulative Savings to Other Payers

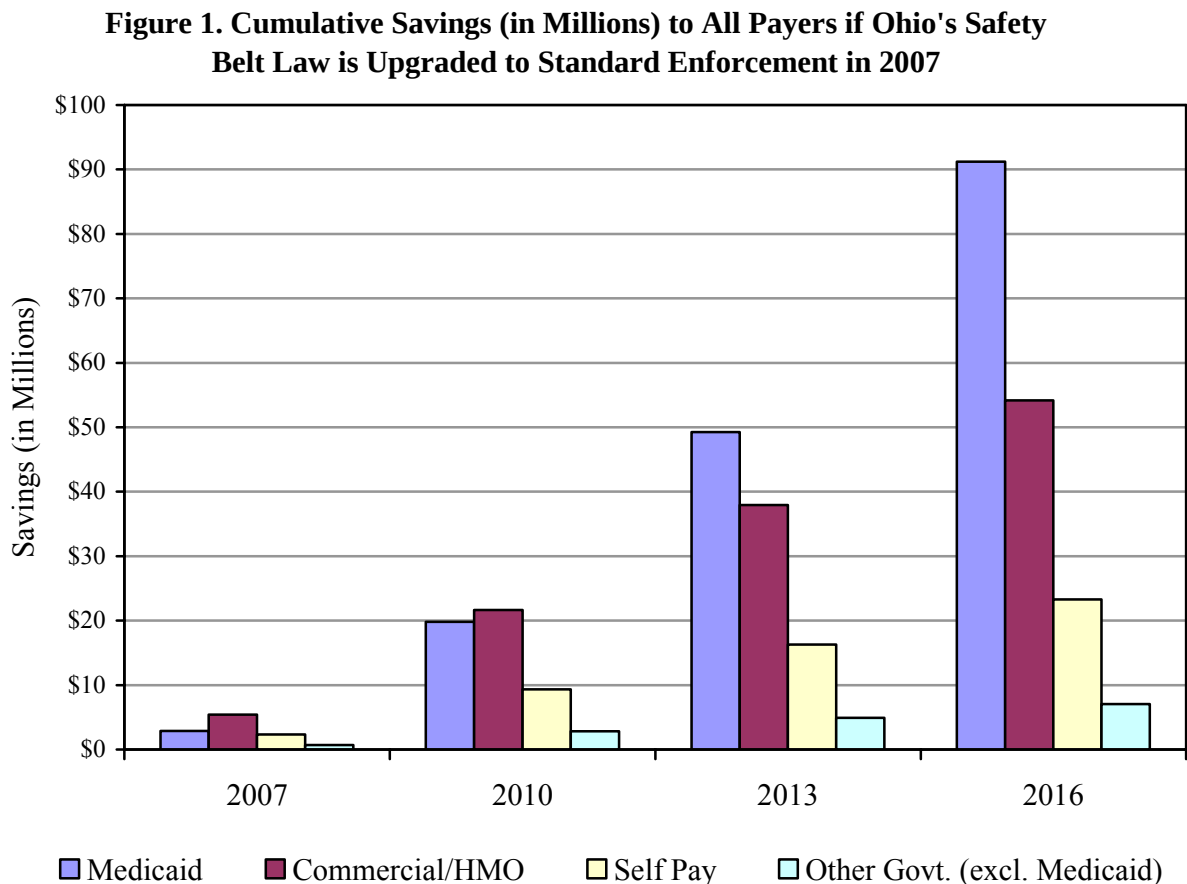
Other payer sources, such as commercial insurance, will also benefit from adoption of a standard enforcement safety belt law. Using a simplified version of the methods used for Medicaid, cumulative savings were calculated for other major sources of payment (Appendices B, C, and D). The results are presented in Table 13. These estimates only account for charges related to the initial hospitalization because information is not available to determine the number of injured

occupants for whom these payers would bear the post-discharge and long-term medical costs. Therefore, these are conservative estimates of the actual savings.

Table 13. Cumulative Medical Charge Savings for 2007-2016 for Payer Sources (in 2007 Dollars)

Payer	Savings in 2011 (millions)	Savings in 2016 (millions)
Self pay	\$11.65	\$23.30
Commercial/HMO	\$27.08	\$54.15
Other government (excluding Medicaid)	\$3.51	\$7.03

If Ohio upgraded its safety belt law to standard enforcement in 2007, the cumulative savings of hospital charges to all government payer sources is projected to be **\$98.2 million by 2016 (in 2007 dollars)**. The cumulative savings to all payers are illustrated in Figure 1.



Refined Effectiveness of Safety Belts

A second analysis was performed in which the varying safety belt effectiveness rates, based on seating position, belt type and vehicle type, were applied. Using these rates, we were able to estimate charges avoided and fatalities prevented had all unbelted occupants who sustained a fatal injury instead chosen to wear their safety belt (Table 14).

Table 14. Estimated Medical Charges Avoided for All Payers (in 2003 Dollars) and Fatalities Prevented Over 1 Year if Ohio's Safety Belt Use Rate was at 100% and 92%.

Vehicle Type	Seating Position and Belt Type Available	Total # Killed & Hospital Treated	Total Acute Care Charges	NHTSA Effectiveness Rate	Estimated Charges Saved if 100% Belted	Estimated Lives Saved if 100% Belted
Passenger Car	Front, Lap/Shoulder	41	\$1,132,987	45%	\$509,844	18
	Front, Lap only	0	--	35%	--	0
	Rear, Lap/Shoulder	4	\$90,081	44%	\$39,635	1
	Rear, Lap only	2	\$38,137	32%	\$12,204	0
Light Truck	Front, Lap/Shoulder	23	\$496,646	60%	\$297,987	14
	Front, Lap only	0	--	50%	--	0
	Rear, Lap/Shoulder	0	--	73%	--	0
	Rear, Lap only	0	--	63%	--	0
Total Charges Saved and Fatalities Prevented at 100% Safety Belt Usage					\$859,670	33
Total Charges Saved and Fatalities Prevented at 92% Safety Belt Usage					\$477,594	18

Many motor vehicle crash victims die at the scene and do not incur hospitalization charges and thus, do not appear in the linked database. According to NHTSA's Fatality Analysis Reporting System (FARS), there were 1,274 fatalities as a result of motor vehicle crashes in Ohio in 2003.²⁰ Therefore, the estimates of fatalities prevented and hospital charges saved presented in Table 14 can be considered underestimates. At the very least, **18** fatalities could be prevented in 2007 alone, with a financial savings of nearly **\$500,000** to all payer sources.

Limitations of the Study

There are limitations of this study. The estimates of medical costs savings and lives saved are underestimates for several reasons. First, the calculations only included cases where crash and hospital data could be linked. We were unable to ascertain costs associated with injuries treated in a non-hospital setting (e.g., doctor's office, urgent care center). In addition, only motor vehicle occupants older than 4 years of age, who were riding in a passenger car or light truck were included. Also, as mentioned previously, the costs associated with those motor vehicle crash victims who die at the scene are not included.

Another limitation is our reliance on estimates of long-term costs from sources outside of Ohio. Due to the lack of Ohio-specific data on long-term costs, it was necessary to use estimates derived from other sources. Third, it is possible that by wearing a safety belt, a motor vehicle occupant may suffer a serious injury instead of a fatality, and we were unable to determine the medical charges incurred by these individuals.

Conclusions

It is clear that increasing safety belt use in Ohio will significantly lower medical costs to both government and non-government payer sources. According to a 1995 NHTSA study, *Safety Belt Use Laws: An Evaluation of Primary Enforcement and Other Provisions*, states with standard (primary) enforcement safety belt laws achieved significantly higher belt use than those with only secondary enforcement laws.²¹ Upgrading Ohio's safety belt law to standard enforcement would be the most effective and efficient means of increasing safety belt use in Ohio. Using the 2003 Ohio CODES linked dataset, the following conservative projections of fatalities prevented and medical costs savings can be made:

- Injuries prevented within the first year following adoption of standard enforcement would save Medicaid \$15.4 million over 10 years.
- Cumulative savings to Medicaid would total \$91.2 million by 2016.
- Other government payer sources, excluding Medicaid, would save \$7.0 million
- Commercial insurance and HMOs would save \$54.2 million
- Uninsured individuals paying their own medical bills directly would save \$23.3 million
- At a minimum, 18 fatalities would be prevented

References

- 1 Centers for Disease Control and Prevention. WISQARS. Accessed February 13, 2007 at <http://www.cdc.gov/ncipc/wisqars/>.
- 2 Ohio Department of Public Safety. *Ohio Traffic Crash Facts 2005*. April 1, 2006.
- 3 National Highway Traffic Safety Administration. NHTSA-MVS Software. Washington, DC: National Highway Traffic Safety Administration. Accessed February 15, 2007. Available at <http://www.nhtsa.dot.gov/people/crash/MVS/>.
- 4 Blincoe, LJ, Seay, A, Zaloshnja, E, Miller, T, Romano, E, Luchter, S, Spicer, R. *The Economic Impact of Motor Vehicle Crashes 2000*. National Highway Traffic Safety Administration Technical Report, DOT HS 809 446. Washington, DC. May 2002.
- 5 Seufert, RL, Kubilius, KA, Newton, TD, Walton, AJ. *2006 Observational Survey of Safety Belt Use in Ohio*. Prepared for the Ohio Department of Public Safety, Governor's Highway Safety Office; Applied Research Center, Miami University Middletown.
- 6 CODES 2000 software. Strategic Matching, Inc. Morrisonville, NY.
- 7 National Institute of Neurological Disorders and Stroke. *Traumatic Brain Injury: Hope Through Research*. Accessed February 13, 2007 at http://www.ninds.nih.gov/disorders/tbi/detail_tbi.htm#56473218.
- 8 Brain Injury Association of Ohio. Accessed February 13, 2007 at <http://www.biaoh.org/abtstatistics.html>.
- 9 Practice Management Information Corporation. *International Classification of Diseases, 9th Edition (Clinical Modification – 5th Edition)*. Los Angeles, CA: Practice Management Information Corporation, 1998.
- 10 World Health Organization. *International Classification of Diseases and Related Health Problems – 10th Revision*. Geneva, Switzerland: World Health Organization, 1992.
- 11 Marr, A, Coronado, V, editors. *Central Nervous System Injury Surveillance Data Submission Standards – 2002*. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2004.
- 12 National Spinal Cord Injury Statistical Center. Accessed February 13, 2007 at <http://www.spinalcord.uab.edu/show.asp?durki=21446>.
- 13 Chaudhary, NK, Preusser, DF. *Impact of a Primary Seat Belt Law on Virginia's State Medicaid Expenses*. Trumbull, CT: Preusser Research Group, Inc., January 2004.

14 Kentucky Transportation Center, College of Engineering. *Economic Costs of Low Safety Belt Usage in Motor Vehicle Crashes in Kentucky*. Lexington, KY, October 2005.

15 Minnesota Department of Public Safety, Office of Traffic Safety. *Estimating Minnesota Hospital Charge Savings with the Adoption of a Standard Enforcement Seat Belt Law*. March 13, 2006.

16 Craig Hospital. Service Utilization, Cost, and Payor Source for Individuals with Traumatic Brain Injury in the Year Following Initial Inpatient Rehabilitation. Accessed January 5, 2007 at http://www.craighospital.org/TBI/DOC_costs.asp.

17 Mayer, NH, Pelensky, J, Whyte, J, Fidler-Sheppard, R. Characterization and correlates of medical and rehabilitation charges for traumatic brain injury during acute rehabilitation hospitalization. *Archives of Physical Medicine and Rehabilitation*. 2003;84:242-8.

18 R-C Healthcare Management. Hospital Inflation. 4th Quarter 2006 Year-to-Year Percent Increase. Accessed January 26, 2007 at http://www.rcmgmt.com/data/files/Hospital_Inflation_2006_4th_Quarter.pdf.

19 Durbin, DR, Elliott, MR, Winston, FK. Belt-positioning booster seats and reduction in risk of injury among children in vehicle crashes. *JAMA*. 2003;289(14):2835-40.

20 National Highway Traffic Safety Administration. Fatality Analysis Reporting System (FARS). Accessed on March 29, 2007 at www-fars.nhtsa.dot.gov.

21 National Highway Traffic Safety Administration. *Safety Belt Use Laws: Evaluation of Primary Enforcement and Other Provisions*. DOT-HS-808-324. October 1995.

Appendix A
Cumulative Savings of Hospital Charges to Medicaid in Ohio

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2003	\$2,870,541	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269
2004		\$2,870,541	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269
2005			\$2,870,541	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269
2006				\$2,870,541	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269
2007					\$2,870,541	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269
2008						\$2,870,541	\$1,389,269	\$1,389,269	\$1,389,269	\$1,389,269
2009							\$2,870,541	\$1,389,269	\$1,389,269	\$1,389,269
2010								\$2,870,541	\$1,389,269	\$1,389,269
2011									\$2,870,541	\$1,389,269
2012										\$2,870,541
Total saved per year	\$2,870,541	\$4,259,810	\$5,649,079	\$7,038,348	\$8,427,617	\$9,816,886	\$11,206,155	\$12,595,424	\$13,984,693	\$15,373,962
Saved cumulative	\$2,870,541	\$7,130,351	\$12,779,430	\$19,817,778	\$28,245,395	\$38,062,281	\$49,268,436	\$61,863,860	\$75,848,553	\$91,222,515

Appendix B
Cumulative Savings of Hospital Charges to Other Government Payers (excluding Medicaid) in Ohio*

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2003	\$702,683									
2004		\$702,683								
2005			\$702,683							
2006				\$702,683						
2007					\$702,683					
2008						\$702,683				
2009							\$702,683			
2010								\$702,683		
2011									\$702,683	
2012										\$702,683
Total saved per year	\$702,683	\$702,683	\$702,683	\$702,683	\$702,683	\$702,683	\$702,683	\$702,683	\$702,683	\$702,683
Saved cumulative	\$702,683	\$1,405,366	\$2,108,049	\$2,810,732	\$3,513,415	\$4,216,098	\$4,918,781	\$5,621,464	\$6,324,147	\$7,026,830

* = savings include only hospital charges related to the initial hospitalization

Appendix C
Cumulative Savings of Hospital Charges to Commercial Insurance/HMOs in Ohio*

Year	2007 Year 1	2008 Year 2	2009 Year 3	2010 Year 4	2011 Year 5	2012 Year 6	2013 Year 7	2014 Year 8	2015 Year 9	2016 Year 10
2003	\$5,415,102									
2004		\$5,415,102								
2005			\$5,415,102							
2006				\$5,415,102						
2007					\$5,415,102					
2008						\$5,415,102				
2009							\$5,415,102			
2010								\$5,415,102		
2011									\$5,415,102	
2012										\$5,415,102
Total saved per year	\$5,415,102	\$5,415,102	\$5,415,102	\$5,415,102	\$5,415,102	\$5,415,102	\$5,415,102	\$5,415,102	\$5,415,102	\$5,415,102
Saved cumulative	\$5,415,102	\$10,830,204	\$16,245,306	\$21,660,408	\$27,075,510	\$32,490,612	\$37,905,714	\$43,320,816	\$48,735,918	\$54,151,020

* = savings include only hospital charges related to the initial hospitalization

Appendix D
Cumulative Savings of Hospital Charges to Self-Payers in Ohio*

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2003	\$2,330,118									
2004		\$2,330,118								
2005			\$2,330,118							
2006				\$2,330,118						
2007					\$2,330,118					
2008						\$2,330,118				
2009							\$2,330,118			
2010								\$2,330,118		
2011									\$2,330,118	
2012										\$2,330,118
Total saved per year	\$2,330,118	\$2,330,118	\$2,330,118	\$2,330,118	\$2,330,118	\$2,330,118	\$2,330,118	\$2,330,118	\$2,330,118	\$2,330,118
Saved cumulative	\$2,330,118	\$4,660,236	\$6,990,354	\$9,320,472	\$11,650,590	\$13,980,708	\$16,310,826	\$18,640,944	\$20,971,062	\$23,301,180

* = savings include only hospital charges related to the initial hospitalization