

Texas Traumatic Brain Injury (TBI) Hospitalizations, 2004-2007

Created by: Ryan Beal, MPH
Crystal Beasley, MS
John Villanacci, Ph.D., NREMT-I

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EXECUTIVE SUMMARY

From 2004-2007 there were 74,122 reported traumatic brain injury (TBI) related hospitalizations in Texas. Rates of TBI hospitalization were highest for males and for older adults. Falls and motor vehicle traffic were responsible for the highest frequencies and rates of TBI hospitalization. Older adults had the highest rates due to falls. Adults 18-44 years of age had the highest rates due to motor vehicle traffic, struck by/against, and firearms. Among children, infants less than one year had the highest rate due to falls, and children 1-4 years had the highest rate due to drowning/ near drowning.

The average length of stay in the hospital due to TBI was 8.2 days. The highest average lengths of stay in the hospital were due to TBI related to motor vehicle traffic (8.7 days) and firearms (9.2 days). The 45-64 years age group had the highest average length of stay at 9.6 days. Total hospital charges for all TBI related hospitalizations were \$3,832,000,000. Cases for which Medicare and Medicaid were the primary payer source accounted for \$1,040,000,000 in hospital charges; Medicare was the largest primary payment source. TBI hospitalizations due to motor vehicle traffic and falls accounted for \$2,195,000,000 in hospital charges.

The following recommendations were proposed to reduce hospitalizations due to TBI:

- Reduce TBI-related injuries due to falls in the elderly by implementing a state-wide falls prevention program aimed at older adults;
- Reduce TBI-related injuries due to motor vehicle collisions by improving education and training for the youngest drivers;
- Reduce TBI related injuries in young children by providing parents with information on common causes of TBI in young children;
- Improve the ability to obtain the epidemiologic data needed to better understand the causes of TBI-related injuries.

INTRODUCTION

Texas Health and Safety Code, Sec. 92.001, defines traumatic brain injury (TBI) as “an acquired injury to the brain, including brain injuries caused by anoxia due to near drowning.” The term does not include brain dysfunction caused by congenital or degenerative disorders or birth trauma (1). From 2004 to 2007, approximately 18,500 Texas residents diagnosed with a TBI were discharged from Texas hospitals each year; approximately 440,000 Texans (2% of the population) live with a disability from TBI (2). TBI can result in a wide range of symptoms including changes to thinking, sensation, language, and emotion and can result in conditions such as epilepsy, Alzheimer’s disease, and Parkinson’s disease (3).

To better characterize the impact of TBI in Texas and to identify groups most likely to be hospitalized for brain injury, we examined TBI hospitalizations using Texas hospital discharge data for the years 2004-2007.

Objectives:

This report focuses on the following questions:

1. How many Texans were reported as discharged from Texas hospitals for TBI from 2004-2007?
2. What are the demographic distributions of TBI cases?
3. What were the causes of TBI hospitalizations?
4. What was the length of stay?
5. What was the hospital discharge status?
6. Who were the primary payers for hospital charges?
7. What hospital charges were associated with TBI?
8. What measures can be taken to reduce the burden on TBI related hospitalizations in Texas?

METHODS

The Texas Health Care Information Collection (THCIC), housed within the Center for Health Statistics at the Texas Department of State Health Services, collects information related to hospital discharge data from state licensed hospitals. The data presented in this document are derived from these datasets to describe TBI hospitalization for the years 2004-2007, and were identified by ICD-9CM (International Classification of Diseases 9th Revision, Clinical Modification) diagnosis codes. The following ICD-9CM codes were used to define a case (4):

- 800.00--801.99 fracture of vault or base of skull
- 803.00--804.99 other and unqualified skull fractures;
multiple fractures involving skull or face with
other bones
- 850.00--854.19 concussion; cerebral laceration and
contusion; subarachnoid, subdural, and
extradural hemorrhage, following injury other;
and unspecified intracranial hemorrhage
following injury; Intracranial injury of other and
unspecified nature
- 950.1--950.3 injury to optic nerve and pathways where one
or more of the following injuries occurred: optic
nerve injury, injury to optic chiasm, injury to
optic pathways, injury to visual cortex
- 959.01, and 995.55 unspecified head injury; shaken infant
syndrome
- 994.1 drowning and nonfatal submersions

To be identified as a TBI case, one of the above ICD-9CM codes must be included in the principal diagnosis field, or in any of the 24 subsequent diagnosis fields. The data were further limited to Texas residents.

DATA PARAMETERS

1. Cause and Intent of Injury:
 - a. "Underlying Cause of Injury" (Informally known as "E-Codes") is coded using International Classification of Diseases 9th Revision, Clinical Modification (ICD-9CM).
 - b. Cause of injury by intent matrix was created based on the recommended framework of E-Code groupings provided by the Centers for Disease Control and Prevention (CDC).

2. Age:
 - a. Due to considerations regarding confidentiality, TTHCIC determined that patients diagnosed with HIV or drug/alcohol use be categorized using a broad age range scheme in hospital discharge datasets.
 - b. Age groupings including HIV & drug/alcohol use patients are categorized as follows: 0-17 years, 18-44 years, 45-64 years, 65-74 years, and 75+ years.

3. Due to considerations regarding confidentiality, TTHCIC determined that the field `sex_code`, indicating gender, be suppressed for patients diagnosed with HIV or drug/alcohol use in the hospital discharge datasets.

4. Population data used to calculate rates were provided by the Texas Office of the State Demographer. Rates are per 100,000 persons.

5. For more information regarding Texas Hospital Discharge Data, visit:
<http://www.dshs.state.tx.us/thcic/>

ANALYSIS

Texans Discharged from Texas Hospitals, 2004-2007

From 2004 through 2007 there were 74,122 reported hospitalizations involving cases of TBI. Table 1 lists the frequencies and percents of the types of TBI injuries in our case group. The top 5 types of TBI represent 87.8% of all TBI hospitalizations, with the largest proportion, 25.8%, occurring among the “Subarachnoid, subdural, and extradural hemorrhage following injury” group, followed by “Fracture of base of skull” (22.6%), and “Concussion” (18.2%).

Table 1: TBI Hospitalization by Type of TBI, 2004-2007

Type of TBI	Frequency	Percent
Subarachnoid, subdural, and extradural hemorrhage following injury	19,146	25.8%
Fracture of base of skull	16,724	22.6%
Concussion	13,490	18.2%
Cerebral laceration and contusion	8,436	11.4%
Head injury, unspecified	7,267	9.8%
Other and unspecified intracranial hemorrhage following injury	3,081	4.2%
Intracranial injury of other and unspecified nature	2,795	3.8%
Multiple fractures involving skull or face with other bones	2,068	2.8%
drowning and nonfatal submersion	923	1.2%
Shaken infant syndrome	191	0.3%
Injury to optic nerve and pathways	1	<0.1%
Total	74,122	100.0%

Demographic Distribution of TBI Cases

Table 2 describes the distribution of cases by age and sex. The age group with the highest rate of TBI hospitalization is the 75+ group (394.1/100,000 persons); 7.6 times greater than the age group with the lowest rate, 0-17 years (51.7/100,000 persons). Males were reported at a higher percentage (51.0%) and rate (81.5/100,000 persons) compared to females; 35.0% and 55.8/100,000 persons, respectively. The male to female rate ratio was greatest for the 18-44 years age category (Rate Ratio[RR]=2.53) and decreased with each increasing age category (75+ years: RR=1.08).

Table 2: TBI Hospitalization by Age and Sex, 2004-2007

Age Category (years)	Sex			Total	Percent	Male:Female Rate Ratio
	Female	Male	Missing			
0-17	4,604 (37.3)	8,090 (62.7)	366	13,060 (51.7)	17.6%	1.68
18-44	4,867 (26.6)	12,990 (67.3)	5,876	23,733 (63.1)	32.0%	2.53
45-64	4,107 (38.7)	7,083 (68.8)	3,117	14,307 (68.5)	19.3%	1.78
65-74	2,895 (108.6)	3,144 (136.7)	543	6,582 (132.6)	8.9%	1.26
75+	9,463 (370.7)	6,500 (401.5)	477	16,440 (394.1)	22.2%	1.08
Total	25,936 (55.8)	37,807 (81.5)	10,379	74,122 (79.8)	100.0%	1.46
Percent	35.0%	51.0%	14.0%	100.0%		

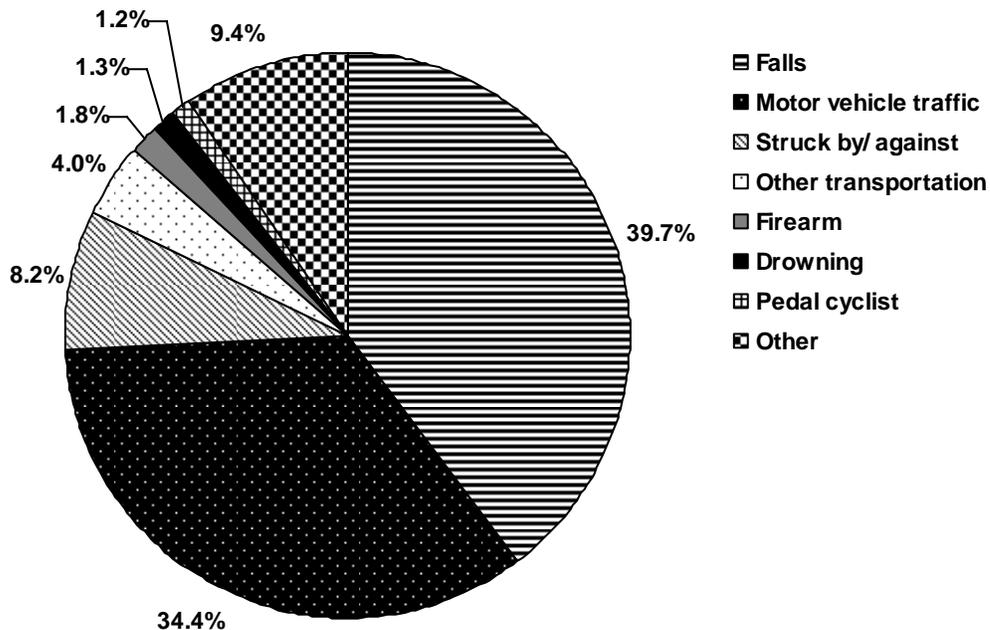
*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents in applicable age and gender groups for years 2004-2007.

**To protect patient confidentiality, sex is blank if ICD-9-CM code indicates drug or alcohol use or an HIV diagnosis

Causes of TBI Hospitalization

Figure 2 shows the percent of TBI hospitalization by cause. The leading causes are falls (39.7%), motor vehicle traffic (34.4%), struck by/against (8.2%), other transportation (4.0%: includes instances of railway, bicycle, animal-drawn, watercraft, air/space, and non-traffic related injuries), firearms (1.8%), drowning/near drowning (1.3%), and pedal cyclist (1.2%). Other causes including cut/pierce, natural/environmental, poisoning, suffocation, fire/burn, and overexertion represent the remaining 9.4% of identified cases.

Figure 1: Percent of TBI Hospitalization by Cause, 2004-2007



Rate of TBI Hospitalization by Sex

The rates by sex for the top 5 causes of TBI hospitalization are described in Table 3. The highest rate of TBI hospitalization (24.9/100,000 persons) was due to falls, with falls and motor vehicle traffic comprising 74.1% of all TBI cases. Females had higher rates of TBI hospitalizations for falls than males; however, males had higher rates of TBI hospitalization for motor vehicle traffic compared to females. Males also had higher rates than females in the categories struck by/against (4.3 times as high as females), and firearms (5 times as high). Further analysis of specific ICD-9CM codes within the category struck by/against revealed that males were more than 8 times as likely to be hospitalized for TBI resulting from assault (unarmed fight or brawl, assault & striking by blunt or thrown object).

The sex field was suppressed (See Data Parameters section) for 14.4% of all TBI cases. Suppression was higher than average for struck by/against (22%), firearms (18.7%), and motor vehicle traffic (17.0%), indicating a possible increased association with alcohol and/or drug use in these cause categories.

Table 3: Rate* of TBI Hospitalization by Sex, 2004-2007

Cause of injury	Female rate	Male rate	Overall rate
Falls	22.8	22.0	24.9
Motor vehicle traffic	12.9	22.8	21.5
***Struck by/ against	1.5	6.5	5.1
**Other transportation	1.4	3.0	2.5
Firearms	0.3	1.5	1.1

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents in applicable gender groups for years 2004-2007.

**Other transportation includes instances of railway, bicycle, animal-drawn, watercraft, air/space, and non-traffic related injuries.

*** struck by/against includes: unarmed fight or brawl or using blunt object, legal intervention, struck and injured unintentionally by falling or stationary objects or persons, including TBI originating from participation in sports.

TBI Hospitalization by Age Group

Table 4 describes the rates of hospitalization by age group for the top five causes of TBI injury. Among specific causes of TBI hospitalization, the highest rates were related to falls and occurred in the two oldest age groups, 65-74 years and 75+ years (57.1%) [Figure 2]. Rates for fall related TBI decreased from 0-17 years (11.8/100,000 persons) to 18-44 years (7.4/100,000 persons) followed by marked rate increases from 45-64 years (19.8/100,000 persons) to 65-74 years (64.7/100,000 persons), and from 65-74 years to 75+ years (239.4/100,000 persons). Rates for TBI related to motor vehicle traffic increased from the lowest rate among the 0-17 years age group (15.1/100,000 persons) to a peak rate among the 18-44 years group (27.7/100,000 persons). Rates for TBI related to motor vehicle traffic increased again in the 75+ age group (22.1/100,000 persons). The 18-44 year age group had the highest rates of TBI hospitalization for motor vehicle traffic (27.7/100,000 persons), struck by/ against (6.4/100,000 persons), and firearms (1.9/100,000 persons). The rates for both struck by/ against and firearms observed in the 18-44 years age group were twice as high as those observed in the 65 -74 years age group.

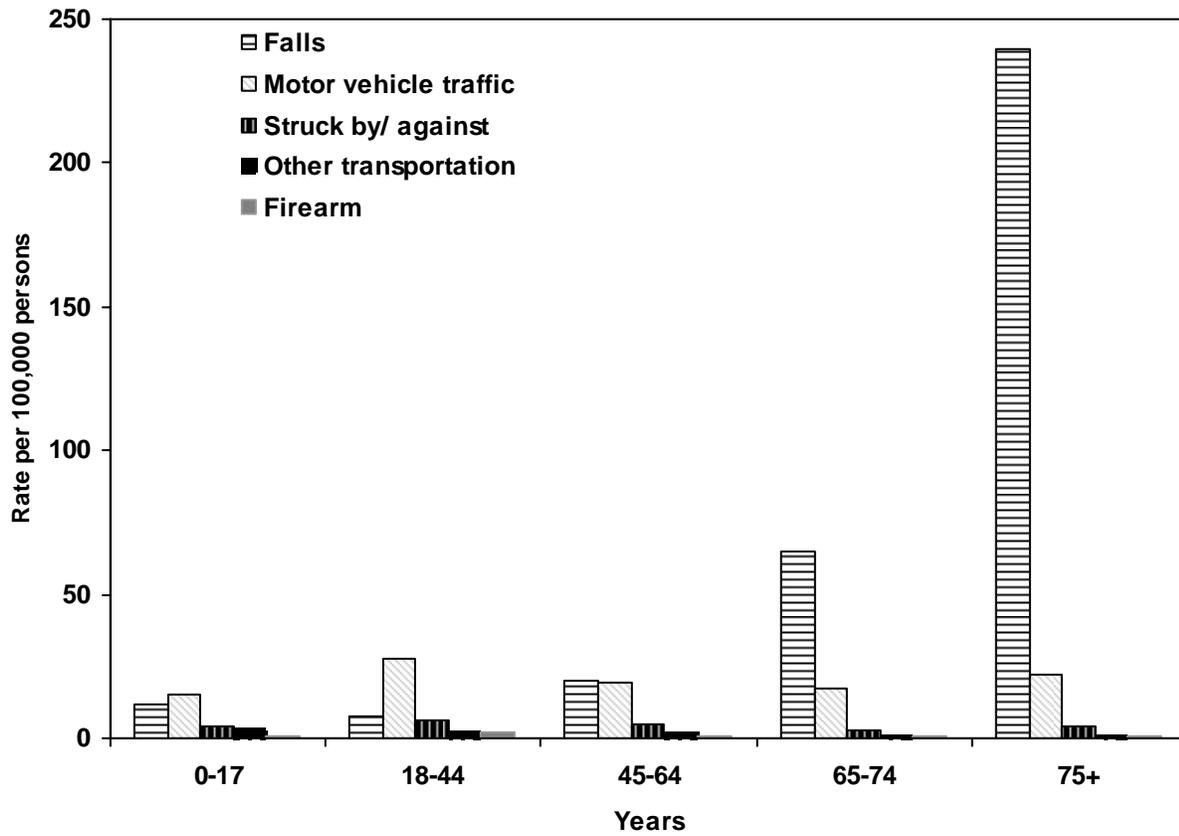
Table 4: Rate* of TBI Hospitalization by Age Group, 2004-2007

Cause of injury	Age (years)					All ages
	0-17	18-44	45-64	65-74	75+	
Falls	11.8	7.4	19.8	64.7	239.4	24.9
Motor vehicle traffic	15.1	27.7	19.0	17.4	22.1	21.5
Struck by/ against	4.3	6.4	4.6	3.1	4.3	5.1
**Other transportation	3.2	2.5	1.9	1.6	1.6	2.5
Firearms	0.4	1.9	0.8	0.7	0.9	1.1

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents in applicable age groups for years 2004-2007.

**Other transportation includes most instances of railway, bicycle, animal-drawn, watercraft, air/space, and non-traffic related injuries.

Figure 2: Rates of TBI Hospitalization by Cause and Age Group



TBI Hospitalization among Children

Table 5 describes the rates of TBI hospitalization among children (0-17 years) by cause of injury. Of cases among ages 0-17 years, 2.8% were patients diagnosed with HIV or drug and alcohol use and were categorized into the broad age range (0-17 years), thus excluded from Table 5 (see Data Parameters section).

Differences in rates between the 0-17 years age group in Table 4 and the overall rate in Table 5 are due to differences resulting from the exclusion of cases in Table 5. The top five causes of TBI for this age group are motor vehicle traffic, falls, struck by/against, other transportation, and drowning/ near drowning. Infants (0-1 years) had the highest rate for all TBI hospitalizations (114.1/100,000 persons) among children. Infants also have the highest rate for falls (58.7/100,000 persons); five times the rate of the 0-17 years age group (11.8/100,000 persons) and nearly eleven times the rate of the 10-14 years age group (5.0/100,000 persons). The 15-17 year old group had the highest rates for motor vehicle traffic (32.7/100,000 persons), struck by/ against (8.1/100,000 persons), and other transportation (6.4/100,000 persons.) The highest rates for drowning/ near drowning occur among the younger age groups, with the 1-4 years group having the highest rate (6.1/100,000 persons).

Table 5: Rate* of TBI Hospitalization among Ages 0-17, 2004-2007**

Cause of injury	Age (years)					
	<1	1-4	5-9	10-14	15-17	0-17
Motor vehicle traffic	11.0	9.5	10.4	11.9	32.7	14.4
Falls	58.7	16.3	7.3	5.0	6.1	11.7
Struck by/ against	4.5	3.6	2.5	3.6	8.1	4.1
Other transportation	0.3	0.8	2.2	4.8	6.4	3.2
Drowning/ near drowning	3.8	6.1	1.5	0.6	0.7	2.3
All causes of injury	114.1	42.1	27.6	30.0	59.1	42.2

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents in applicable age groups for years 2004-2007.

**Excludes Drug and alcohol use patients or those diagnosed with HIV

***Other transportation includes most instances of railway, bicycle, animal-drawn, watercraft, air/space, and non-traffic related injuries.

TBI Hospitalization by Year

Rates of TBI hospitalization, as seen in Table 6, increased every year for falls, struck by/against, and for all causes of TBI hospitalization. Rates were greater in 2007 than in 2004 for each of the top 5 causes of injury, with the greatest percent increases associated with TBI hospitalizations due to firearms and falls; 44% and 43%, respectively. Rates of TBI hospitalization for all cause of injury categories can be found in Appendix B.

Table 6: Rates* of the Top 5 Causes of TBI Hospitalization by Year, 2004-2007

Cause of Injury	Rate by Year (per 100,000 persons)				4 year rate
	2004	2005	2006	2007	
Falls	20.0	24.0	26.4	28.6	24.9
Motor vehicle traffic	20.6	21.9	22.0	21.5	21.5
**Struck by/ against	4.6	5.1	5.4	5.5	5.1
***Other transportation	2.2	2.7	2.5	2.5	2.5
Firearms	0.9	1.1	1.1	1.3	1.1
All causes of TBI	54.1	60.9	63.7	67.2	62.5

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents for the applicable year.

** struck by/against includes: unarmed fight or brawl or using blunt object, legal intervention, struck and injured unintentionally by falling or stationary objects or persons, including TBI originating from sports.

***Other transportation includes most instances of railway, bicycle, animal-drawn, watercraft, air/space, and non-traffic related injuries.

TBI Hospitalization Due to Falls

Table 7 lists rates by year for each cause of fall-related TBI hospitalization. “Other and unspecified fall” occurred at the highest rate with 11.8/100,000 persons (“Other and unspecified fall” includes “Fall resulting in striking against sharp object,” “Fall resulting in striking against other object,” and other and unspecified falls), followed by “Fall on same level from slipping, tripping, or stumbling (5.1/100,000 persons), then by “Other fall from one level to another” (4.9/100,000 persons). From 2004 to 2007, rates increased for each of the top four types of falls (“Other and unspecified fall,” “Fall on same level from slipping, tripping, or stumbling,” “Other fall from one level to another,” “Fall from stairs or steps) with the largest four year percent increase (64.9%) among the “Fall on same level from slipping, tripping, or stumbling” category. The top six types of falls comprised 98.9% of all fall-related TBI hospitalizations.

Table 7: Rate of TBI Hospitalization Due to Falls by Year, 2004-2007

Cause of Injury	Rate* by Year (per 100,000 persons)				Four-Year rate
	2004	2005	2006	2007	
Other and unspecified fall	9.8	11.5	12.2	13.6	11.8
Fall on same level from slipping, tripping, or stumbling	3.7	4.9	5.7	6.1	5.1
Other fall from one level to another	3.8	4.8	5.2	5.6	4.9
Fall from Stairs or steps	0.9	1.0	1.2	1.3	1.1
Fall on or from ladders or scaffolding	0.9	0.9	1.0	1.0	1.0
Fall from or out of building or other structure	0.7	0.7	0.8	0.8	0.8
Fall on same level from collision, pushing, or shoving, by or with other person	0.1	0.1	0.1	0.1	0.1
Suicide and self-inflicted injury by other and unspecified means	< 0.1	< 0.1	0.1	< 0.1	< 0.1
Fall into hole or other opening in surface	0.1	< 0.1	< 0.1	< 0.1	< 0.1
Falling from high place, undetermined whether accidentally or purposely inflicted	< 0.1	< 0.1	0.1	< 0.1	< 0.1
Pushing from high place	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total	20.0	24.0	26.4	28.6	24.9

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents for the applicable year.

TBI Hospitalization Due to Falls among Seniors

Among the 65-74 years and 75+ years age groups, “Other and unspecified fall” was reported at the highest rates (34.5/100,000 persons and 139.6/100,000 persons), followed by “Fall on same level from slipping, tripping, or stumbling” (15.6/100,000 persons and 61.6/100,000 persons), and “Other fall from one level to another” (8.1/100,000 persons and 26.9/100,000 persons). Rates increased each year from 2004 to 2007 resulting in a 51% increase in the 65-74 years age group and a 55% increase in the 75+ age group over that time period (Tables 8 and 9).

Table 8: Rate of TBI Hospitalization Due to Falls among Ages 65-74 Years, 2004-2007

Cause of Injury	Rate by Year (per 100,000 persons)				Four-Year Rate
	2004	2005	2006	2007	
Other and unspecified fall	28.8	33.6	34.5	40.7	34.5
Fall on same level from slipping, tripping, or stumbling	11.9	14.7	17.1	18.2	15.6
Other fall from one level to another	5.9	9.0	8.9	8.5	8.1
Fall from Stairs or steps	2.8	2.1	3.5	4.1	3.2
Fall on or from ladders or scaffolding	3.0	2.2	2.6	2.6	2.6
Fall from or out of building or other structure	0.9	0.5	0.5	0.8	0.7
Fall on same level from collision, pushing, or shoving, by or with other person	0.0	0.1	0.2	0.1	0.1
Fall into hole or other opening in surface	0.0	0.0	0.0	0.1	0.0
All falls	53.3	62.2	67.3	75.0	64.7

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents for the applicable year.

Table 9: Rate of TBI Hospitalization Due to Falls among Ages 75+ Years, 2004-2007

Cause of Injury	Rate* by Year (per 100,000 persons)				Four-Year Rate
	2004	2005	2006	2007	
Other and unspecified fall	115.6	137.1	148.7	155.6	139.6
Fall on same level from slipping, tripping, or stumbling	43.3	58.4	70.6	73.1	61.6
Other fall from one level to another	20.4	25.1	29.9	31.8	26.9
Fall from Stairs or steps	5.8	7.1	9.5	9.9	8.1
Fall on or from ladders or scaffolding	2.2	2.0	2.7	2.0	2.2
Fall from or out of building or other structure	0.2	0.6	0.6	1.2	0.6
Fall on same level from collision, pushing, or shoving, by or with other person	0.1	0.3	0.2	--	0.1
Fall into hole or other opening in surface	0.4	<0.1	<0.1	--	0.1
Falling from high place, undetermined whether accidentally or purposely inflicted	<0.1	0.1	<0.1	<0.1	--
All falls	188.0	230.7	262.0	273.6	239.4

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents for the applicable year.

TBI Hospitalization Due to Motor Vehicle Traffic

As shown in Table 10, the highest rates of motor vehicle related TBI hospitalization occurred in non-motorcycle motor vehicles (15.1/100,000 persons), followed by motorcycles (2.9/100,000 persons), then by pedal cyclists (0.5/100,000 persons). Rates of motor vehicle related TBI hospitalization were consistent from 2004-2007, with the exception of motorcycle, which had a four year increase of 41% (from 2.2/100,000 to 3.1/100,000 persons). Forty-three records did not contain enough information to determine type of motor vehicle traffic injury.

Table 10: Rate of TBI Hospitalization Due to Motor Vehicle Traffic by Year, 2004-2007

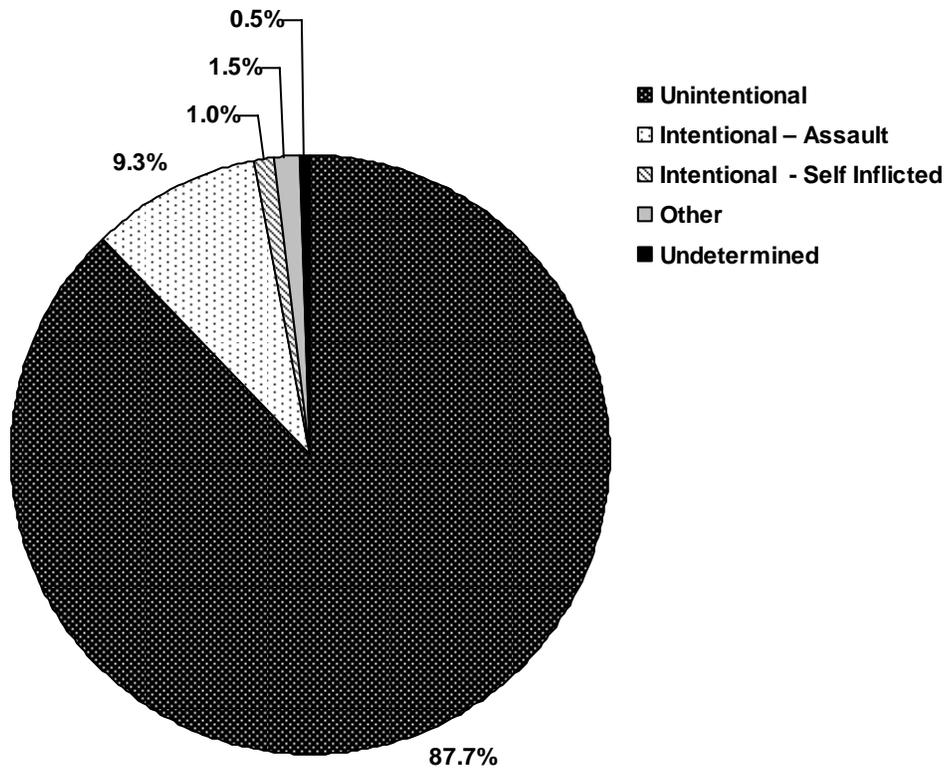
Cause of Injury	Rate* by Year (per 100,000 persons)				Four-Year rate
	2004	2005	2006	2007	
Motor vehicle (non-motorcycle)	14.7	15.7	15.2	14.7	15.1
Motorcycle	2.2	2.8	3.2	3.1	2.9
Pedal cyclist	0.5	0.5	0.5	0.4	0.5
Pedestrian	2	1.9	2	2.1	2
Unspecified	1	0.9	0.9	0.8	0.9
Other, specified	0.1	0.1	0.1	0.2	0.1
All motor vehicle traffic	20.6	21.9	21.9	21.4	21.5

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents for the applicable year.

TBI Hospitalization by Manner/Intent

Of all TBI hospitalizations (figure 3), 87.7% were unintentional, 9.3% were intentional/ assault, and 1% were intentional/self-inflicted (for more detailed information related to cause of injury, see Appendix A).

Figure 3: Percent of TBI Hospitalization by Manner/Intent of Injury, 2004-2007



Extent of TBI Hospitalization

Length of Hospital Stay by Cause of TBI

Table 11 describes the length of stay by the top 5 causes of TBI hospitalization. TBI hospitalization due to motor vehicle traffic required the greatest number of days in the hospital (174,502 days) followed by falls (135,019 days), and struck by/against (22,846 days) for the four year period. Firearms resulted in the highest average number of days hospitalized (9.2 days/stay), followed by motor vehicle traffic (8.7 days/stay). The lowest average length of stay was associated with other transportation (5.5 days/stay) and falls (5.8 days/stay). Reported length of stay spanned from 1 to 3,636 days, with 1 day stays occurring the greatest number of times (13,029). The total number of days stayed was 607,628, with an average of 8.2 days. Two cases did not contain adequate information to determine length of stay and were excluded from tables 11 and 12.

Table 11: Length of Stay by the Top 5 causes of TBI Hospitalization, 2004-2007

Cause of Injury	Cases	Length of Stay (Days)			Total Days
		Average	Standard Deviation	Max	
Falls	23,085	5.8	7.6	315	135,019
Motor vehicle traffic	19,971	8.7	13.6	362	174,502
*Struck by/against	4,777	4.8	8.8	183	22,846
**Other transportation	2,299	5.5	8.5	170	12,732
Firearm	1,020	9.2	15.2	117	9,388
All causes of TBI	74,120	8.2	19.3	3,636	607,628

* struck by/against includes: unarmed fight or brawl or using blunt object, legal intervention, struck and injured unintentionally by falling or stationary objects or persons, including TBI originating from sports.

**Other transportation includes most instances of railway, bicycle, animal-drawn, watercraft, air/space, and non-traffic related injuries.

Length of Hospital Stay by Age Category

Table 12 shows the length of hospital stay by age category. The 18-44 year group spent the greatest number of days in the hospital (208,694 days), followed by the 45-64 year group (137,324 days), and the 75+ group (121,569 days). The highest average stays were associated with the 45-64 years (9.6/100,000 persons) and 18-44 years (8.8/100,000 persons) age groups. The lowest average hospital stays were associated with the 0-17 years (6.3 days/stay) and the 75+ years (7.4 days/stay) age groups.

Table 12: Length of Stay by Age Category, 2004-2007

Age Category	Cases	Length of Stay			Total Days
		Mean	Standard Deviation	Max	
0-17	13,059	6.3	15.4	1,097	82,793
18-44	23,733	8.8	15.9	882	208,694
45-64	14,307	9.6	33.7	3,636	137,324
65-74	6,582	8.7	12.9	381	57,248
75+	16,439	7.4	7.6	107	121,569
All TBI	74,120	8.2	19.3	3,636	607,628

Hospital Discharge Status Related to TBI Hospitalization

Table 13 lists the discharge status of TBI hospitalizations. “Discharged to home or self care” was reported in the greatest frequency with 45,746 cases representing 61.8% of all TBI records. The discharge status category with the highest average length of stay was “Discharged to other health care setting” with 13.3 days and the lowest was “Left against medical advice” (3.9 days). Fifty-two records (0.1%) contained insufficient information needed to determine discharge status and were excluded from this table.

Table 13: Discharge Status of TBI Hospitalizations, 2004-2007

Status at Discharge	Cases	Percent	Average Stay (days)
Discharged to home to self care	45,746	61.8%	6.1
Discharged to other health care setting	21,422	28.9%	13.3
Expired	5,163	7.0%	6
Discharge to Hospice	877	1.2%	9.2
Left against medical advice	776	1.0%	3.9
Still patient	49	0.1%	11.8
Discharged to care of home IV provider	26	0.0%	11.3
Admitted as inpatient to this hospital	11	0.0%	11.7
All cases	74,070	100.0%	8.2

Discharge Status by Age Category

Table 14 describes rates related to discharge status by age group. Rates rise as age group increases for “Discharged to other health care setting,” “Expired,” and “Discharged to hospice.” The 75+ age group was “Discharged to other health care setting” at a much higher rate (236.1/100,000 persons) than the other age groups. This age group also had the highest rates of “Expired” (39.7/100,000 persons) and “Discharge to Hospice” (15.1/100,000 persons).

Table 14: Rates* of TBI Hospitalization Discharge Status by Age Group, 2004-2007

Status at Discharge	Age Category (Years)					All ages
	0-17	18-44	45-64	65-74	75+	
Discharged to home to self care	44.6	48.1	44.2	58.9	101.6	49.2
Discharged to other health care setting	4.5	9.9	17.8	60.7	236.1	23.1
Expired	2.5	3.8	4.7	9.6	39.7	5.6
Discharge to Hospice	<0.1	0.1	0.5	2.4	15.1	0.9
Left against medical advice	0.1	1.2	1.1	0.8	1.0	0.8
Still patient	<0.1	<0.1	<0.1	0.1	0.3	0.1
Admitted as inpatient to this hospital	-	<0.1	<0.1	<0.1	0.1	<0.1
Discharged to care of home IV provider	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
All cases	51.7	63.1	68.5	132.6	394.1	79.8

*Crude Rates are per 100,000 persons. The population used to calculate rates is the number of Texas residents in applicable age groups for years 2004-2007.

Hospital Charges Associated with TBI Hospitalization

Primary payer source is described in Table 15. The total TBI-related hospital charges for the time period reviewed were \$3,832,000,000. Medicare was the largest primary payment source for TBI hospitalizations (29.4%), followed by insurance companies (26.2%), and Medicaid (12.9%). Mean hospital charge ranged from \$39,509 (disability insurance) to \$66,277 (Medicaid). The greatest total charges were attributed to cases in which insurance companies were the primary payer source, accounting for 27.1% (\$1,040,000,000) of hospital charges. Cases for which Medicare and Medicaid were the primary payer source accounted for 40.1% of hospital charges (\$1,535,800,000). There were 170 records that did not contain information related to primary payment source, and are indicated by “Missing” in Table 15.

Table 15: Primary Payer Source of TBI Hospitalization, 2004-2007
Hospital Charges

Primary Payment Source	Cases	Percent of Cases	Mean	Standard Deviation	Total Charges
Medicare	21,792	29.4%	\$41,467	\$76,024	\$903,700,000
Insurance company	19,425	26.2%	\$53,515	\$83,843	\$1,040,000,000
Medicaid	9,537	12.9%	\$66,277	\$127,910	\$632,100,000
Self-pay	6,942	9.4%	\$56,697	\$81,811	\$393,600,000
Blue cross	4,467	6.0%	\$53,269	\$82,000	\$238,000,000
Workers Compensation	1,741	2.3%	\$58,192	\$86,341	\$101,300,000
Other non-federal programs	1,619	2.2%	\$59,190	\$77,202	\$95,830,000
Champus	700	0.9%	\$49,722	\$117,923	\$34,810,000
Other federal programs	629	0.8%	\$50,667	\$66,397	\$31,870,000
Disability insurance	5	0.0%	\$39,509	\$14,638	\$197,543
Other	7,095	9.6%	\$49,994	\$76,231	\$354,700,000
Missing	170	0.2%	\$37,646	\$47,708	\$6,399,826
All payment sources	74,122	100.0%	\$51,697	\$88,191	\$3,832,000,000

Hospital Charges by Cause of TBI Hospitalization

Among the five most frequently reported causes, mean hospital charges [Table 16] ranged from \$32,833 (struck by/against) to \$71,813 (firearms). Although there were fewer cases due to motor vehicle traffic than for falls, motor vehicle traffic was associated with the greatest percent of the total charges (35.8%, \$1,370,000,000), followed by falls (21.5%, \$825,000,000), and struck by/against (4.1%, \$156,900,000). Motor vehicle traffic and falls together accounted for 57.3% of all hospital charges.

Table 16: Hospital Charges by the Top 5 Causes of TBI Hospitalization, 2004-2007

Cause of TBI	Cases	Percent of cases	Mean	Standard Deviation	Total Charges	Percent of Charges
Falls	23,085	45.1%	\$35,737	\$51,991	\$825,000,000	32.6%
Motor vehicle traffic	19,971	39.0%	\$68,601	\$95,734	\$1,370,000,000	54.2%
*Struck by/against	4,778	9.3%	\$32,833	\$57,337	\$156,900,000	6.2%
**Other transportation	2,299	4.5%	\$44,779	\$69,181	\$102,900,000	4.1%
Firearm	1,020	2.0%	\$71,813	\$102,963	\$73,250,000	2.9%
Top 5 causes	51,153	100.0%	\$49,422	\$76,131	\$2,528,050,000	100.0%

* struck by/against includes: unarmed fight or brawl or using blunt object, legal intervention, struck and injured unintentionally by falling or stationary objects or persons, including TBI originating from sports.

**Other transportation includes most instances of railway, bicycle, animal-drawn, watercraft, air/space, and non-traffic related injuries.

CONCLUSIONS

Based on information obtained from hospital discharge data, from 2004-2007:

General TBI Statistics

- 74,122 Texans were discharged from Texas hospitals after sustaining a TBI-related injury.
- The top 5 types of TBI injury; “Subarachnoid, subdural, and extradural hemorrhage following injury”, “Fracture of base of skull”, and “Concussion” contributed the largest proportion of diagnoses associated with 87.8% of all TBI hospitalizations.
- The top 5 causes of TBI hospitalizations; falls, motor vehicle traffic, struck by/against, other transportation, and firearms, contributed to 88% of all TBI hospitalizations; falls accounted for 40% of all TBI hospitalizations, and falls and motor vehicle traffic together accounted for 74% of all TBI related hospitalizations.
- TBI hospitalization rates for motorcycle traffic incidents increased 41% from 2004 to 2007.
- The longest average hospital stays were associated with TBI due to firearm injury.

Gender Differences

- Males had higher rates of TBI related hospitalization than females. The highest male-to-female ratio (2.5) was found in the 18-44 years age group.
- Males had higher rates of TBI hospitalizations due to motor vehicle traffic, struck by/against, other transportation, and firearms.
- Males were more likely to be hospitalized for TBI related to injuries sustained during an assault.
- Females had slightly higher rates of TBI hospitalization due to falls.
- Males were nearly seven times as likely as females to be hospitalized for a TBI related to a motorcycle traffic incident, and more than four times as likely due to a bicycle traffic incident.

Age-Related Differences

- Fall-related TBI hospitalization rates were greatest among the two oldest age groups (65-74 years and 75+ years).
- Among children, infants less than one year had the highest rate of TBI hospitalization due to falls.
- Children 1-4 years of age had the highest rate for TBI hospitalization due to drowning/ near drowning.
- Young drivers, 15-17 years, had the highest rate of TBI hospitalization due to motor vehicle traffic.
- The longest average hospital stays were experienced by the 45-64 years age group.
- The 75+ years age group had the second shortest average hospital stays but the highest rate of discharge due to death.
- The two oldest age groups (65-74 years and 75+ years) had higher rates of discharge to other health care facilities and hospice.
- The highest rate of TBI hospitalization was experienced by the oldest age group (75+ years).

Cost Associated with TBI Hospitalizations

- Over the period reviewed, the hospital costs for TBI related injuries were \$3,832,000,000.
- Cases for which Medicare and Medicaid were the primary payer source accounted for 40.1% (\$1,535,800,000) of hospital charges.
- The greatest total charges were attributed to cases in which insurance companies were the primary payer source, accounting for 27.1% (\$1,040,000,000) of hospital charges.
- TBI hospitalizations due to motor vehicle traffic and falls represented 56.9% of all TBI-related hospital charges.
- Average hospital charges by cause ranged from \$32,833 for struck by/against-related TBI hospitalizations to \$71,813 for firearm-related TBI hospitalizations.

LIMITIATIONS

Due to THCIC policy, to protect patient and physician confidentiality, hospital discharge datasets cannot currently be linked to other datasets (e.g. vital statistics, EMS/Trauma Registry). Therefore, due to potential case duplication, it is not feasible to combine unlinked datasets. In 2003, the CDC conducted a nine state study to examine TBI hospitalization rates, in which hospital discharge and vital statistics datasets were linked (4). Because the dataset used for this report could not be linked with vital statistics data, Texas TBI rates could not be compared to those calculated in the CDC study.

Due to suppression of personal identifiers, patients discharged and then re-admitted to another hospital could not be identified, thus some duplication may be present within this dataset.

If an ICD-9CM code indicates drug or alcohol use or an HIV diagnosis, the patient's age is reported using a broad age range (e.g. 0-17 years). Therefore, it is impossible to analyze more narrowly defined age groups (e.g. 0-4, 5-9) without omitting these patients. Gender is suppressed for the same diagnoses.

Of 74,122 cases, 16,034 (21.6%) did not contain enough information to adequately define the cause; thus, frequencies reported for cause of injury are likely to be underestimated.

The costs related to rehabilitation and post-hospital treatment is not included in hospital charges; thus, hospital charges are likely to underestimate the total cost of TBI treatment.

PUBLIC HEALTH IMPLICATIONS

Based on the information reviewed for this report we have made the following recommendations to reduce TBI-related hospitalizations:

Recommendation 1: Reduce TBI-related injuries due to falls in the elderly by implementing a state-wide falls prevention program aimed at older adults

Falls are the most common cause of injury related death among older adults, and more than one-third of adults 65 years and older fall each year in the United States (5). Fall-related TBI hospitalization accounted for 31% of all TBI hospitalizations, with the majority occurring in older adults. Fall-related TBI hospitalizations have resulted in \$825 million dollars in hospital charges; approximately 21.5% of all TBI related hospital charges. The Texas Falls Prevention Coalition was recently formed with four priority areas: physical mobility, medication management, home safety, and environmental safety in the community. The coalition works with Area Agencies on Aging to implement the intervention program *A Matter of Balance*, which seeks to reduce fear of falling and increase activity levels among older adults. Successful implementation of evidence-based falls prevention programs could reduce fall-related TBI hospitalizations and hospital costs.

Recommendation 2: Reduce TBI-related injuries due to motor vehicle collisions by improving education and training for the youngest drivers

The highest rates for motor vehicle-related TBI hospitalization occur among the youngest drivers, with the highest rates among 15-17 year olds. Motor vehicle-related injuries account for 2 of 5 deaths among teens 16-19 years (6). Motor vehicle-related TBI hospitalizations were associated with the highest total hospital charges with a cost of 1.37 billion dollars. According to a CDC report, studies show graduated driver licensing, the system of laws and practices that gradually introduce young drivers into the driving population, may be an effective way of reducing motor vehicle-related injuries among the youngest drivers (6).

Recommendation 3: Reduce TBI-related injuries in young children by providing parents with information on common causes of TBI in young children

Among children, those less than one year had the highest rate of TBI hospitalization due to falls. One to four year old children had the highest rates due to drowning/ near drowning. The CDC lists several prevention tips aimed at reducing injuries in children including: supervision, home safety improvements, and safe sports and play (7). Frequently hospitals, doctor's offices, schools, and injury prevention programs such as *Safe Kids* distribute information related to reducing injuries in children. Increasing distribution and providing educational materials in multiple languages have the potential to reduce injuries in young children.

Recommendation 4: Improve the ability to obtain the epidemiologic data needed to better understand the causes of TBI-related injuries

Injuries have been identified as a leading cause of mortality and morbidity both in the nation and in Texas. Most injuries are unintentional preventable events; however, in order to develop intervention programs to prevent injuries it is essential to identify the frequency of the events as well as the risk factors (who they occur to, where they occur, when they occur) for their occurrence. Like other non-communicable diseases, understanding the basic causes of why injuries occur presents a challenge; however, to better understand TBI and associated injuries, quality data and the ability to link datasets are essential. Rules governing the sharing or linking of data often prohibit or limit the ability to adequately analyze the data. Such restrictions also can prevent the comparison of state data to national data and may limit eligibility for funding opportunities where data linking is required. Promoting collaboration and data sharing between research entities is another way to improve the ability to obtain pertinent data. For example, the National Violent Death Reporting System (NVDRS) collects data from multiple sources including death certificates, police reports, medical examiner and coroner reports, and crime laboratories. Participation in

NVDRS could foster better inter-agency collaboration, allow for state and national comparisons, and provide targeted intervention opportunities.

Appendix A: Cause of Injury by Manner of Injury for TBI Cases, 2004-2007

Cause of Injury	Manner/ intent					Total	Percent
	Unintentional	Intentional- self-inflicted	Intentional- assault	Other	Undetermined intent		
Motor vehicle traffic	19,928 (21.5)	9 (<0.1)	31 (<0.1)	0 (0)	3 (<0.1)	19,971 (21.5)	34.4%
Firearms	148 (0.2)	333 (0.4)	458 (0.5)	20 (<0.1)	61 (0.1)	1,020 (1.1)	1.8%
Poisoning	93 (0.1)	45 (<0.1)	1 (<0.1)	0 (0)	37 (<0.1)	176 (0.2)	0.3%
Falls	23,002 (24.8)	40 (<0.1)	10 (<0.1)	0 (0)	33 (<0.1)	23,085 (24.9)	39.7%
Suffocation	14 (<0.1)	18 (<0.1)	2 (<0.1)	0 (0)	1 (<0.1)	35 (<0.1)	0.1%
Drowning/ near drowning	752 (0.8)	5 (<0.1)	3 (<0.1)	0 (0)	12 (<0.1)	772 (0.8)	1.3%
Fire/ burn	29 (<0.1)	1 (<0.1)	2 (<0.1)	0 (0)	2 (<0.1)	34 (0)	0.1%
Cut/ pierce	51 (0.1)	13 (<0.1)	172 (0.2)	0 (0)	2 (<0.1)	238 (0.3)	0.4%
Struck by/ against	1,993 (2.1)	0 (0)	2,757 (3)	28 (<0.1)	0 (0)	4,778 (5.1)	8.2%
Machinery	146 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	146 (0.2)	0.3%
Other pedal cyclist	674 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	674 (0.7)	1.2%
Other pedestrian	194 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	194 (0.2)	0.3%
Other transportation	2,298 (2.5)	0 (0)	0 (0)	0 (0)	1 (<0.1)	2,299 (2.5)	4.0%
Natural/ environmental	222 (0.2)	1 (<0.1)	0 (0)	0 (0)	0 (0)	223 (0.2)	0.4%
Overexertion	7 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	7 (<0.1)	<0.1%
Other specified	687 (0.7)	68 (0.1)	292 (0.3)	1 (<0.1)	6 (<0.1)	1,054 (1.1)	1.8%
Not elsewhere classifiable	144 (0.2)	35 (<0.1)	496 (0.5)	4 (<0.1)	41 (<0.1)	720 (0.8)	1.2%
Not specified	544 (0.6)	6 (<0.1)	1,180 (1.3)	4 (<0.1)	89 (0.1)	1,823 (2)	3.1%
Medical care - adverse	0 (0)	0 (0)	0 (0)	173 (0.2)	0 (0)	173 (0.2)	0.3%
Drugs - adverse	0 (0)	0 (0)	0 (0)	666 (0.7)	0 (0)	666 (0.7)	1.1%
Total	50,926 (54.8)	574 (0.6)	5,404 (5.8)	896 (1)	288 (0.3)	58,088 (62.5)	100.0%
Percent	87.7%	1.0%	9.3%	1.5%	0.5%	100.0%	

Crude Rates (in parentheses) are per 100,000 persons. Rates based on frequencies with fewer than 20 occurrences are considered unstable and should be interpreted with caution.

16,034 cases did not have information needed to determine cause of death and are excluded from this table

Appendix B: Cause of Injury by Year for TBI Cases, 2004-2007

Cause of Injury	Year				Total	Percent
	2004	2005	2006	2007		
Motor Vehicle Traffic	4,640 (20.6)	5,036 (21.9)	5,153 (22)	5,142 (21.5)	19,971 (21.5)	34.4%
Firearms	210 (0.9)	247 (1.1)	259 (1.1)	304 (1.3)	1,020 (1.1)	1.8%
Poisoning	40 (0.2)	41 (0.2)	46 (0.2)	49 (0.2)	176 (0.2)	0.3%
Falls	4,507 (20)	5,525 (24)	6,196 (26.4)	6,857 (28.6)	23,085 (24.9)	39.7%
Suffocation	11 (<0.1)	8 (<0.1)	6 (<0.1)	10 (<0.1)	35 (<0.1)	0.1%
Drowning/ near drowning	186 (0.8)	201 (0.9)	199 (0.8)	186 (0.8)	772 (0.8)	1.3%
Fire/ burn	11 (<0.1)	7 (<0.1)	5 (<0.1)	11 (<0.1)	34 (<0.1)	0.1%
Cut/ pierce	48 (0.2)	68 (0.3)	57 (0.2)	65 (0.3)	238 (0.3)	0.4%
Struck by/ against	1,027 (4.6)	1,168 (5.1)	1,270 (5.4)	1,313 (5.5)	4,778 (5.1)	8.2%
Machinery	26 (0.1)	39 (0.2)	39 (0.2)	42 (0.2)	146 (0.2)	0.3%
Other pedal cyclists	146 (0.6)	178 (0.8)	177 (0.8)	173 (0.7)	674 (0.7)	1.2%
Other pedestrian	40 (0.2)	62 (0.3)	47 (0.2)	45 (0.2)	194 (0.2)	0.3%
Other transportation	486 (2.2)	626 (2.7)	592 (2.5)	595 (2.5)	2,299 (2.5)	4.0%
Natural/ environmental	49 (0.2)	47 (0.2)	58 (0.2)	69 (0.3)	223 (0.2)	0.4%
Overexertion	4 (<0.1)	0 (0)	1 (<0.1)	2 (<0.1)	7 (<0.1)	0.0%
Other specified	249 (1.1)	220 (1)	316 (1.3)	269 (1.1)	1,054 (1.1)	1.8%
Not elsewhere classifiable	155 (0.7)	161 (0.7)	192 (0.8)	212 (0.9)	720 (0.8)	1.2%
Not specified	385 (1.7)	461 (2)	436 (1.9)	541 (2.3)	1,823 (2)	3.1%
Medical care - adverse	43 (0.2)	33 (0.1)	47 (0.2)	50 (0.2)	173 (0.2)	0.3%
Drugs - adverse	180 (0.8)	167 (0.7)	161 (0.7)	158 (0.7)	666 (0.7)	1.1%
Total	12,443 (55.3)	14,295 (62.1)	15,257 (65)	16,093 (67.2)	58,088 (62.5)	100.0%
Percent	21.4%	24.6%	26.3%	27.7%	100.0%	

Crude Rates (in parentheses) are per 100,000 persons. Rates based on frequencies with fewer than 20 occurrences are considered unstable and should be interpreted with caution.

16,034 cases did not have information needed to determine cause of death and are excluded from this table

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