Traumatic Brain Injury in Iowa
Inpatient Hospital Data
2003-2005

Introduction

According to the Centers for Disease Control and Prevention, unintentional injury is the fifth leading cause of death for all age groups and the first leading cause of death for people from 1 to 44 years of age in the United States, while homicide remains the 2nd leading cause of death for 15 to 24 years old (CDC, 2006). In 2004, there were approximately 144,000 deaths due to unintentional injuries in the US; 53% of which represent people over 45 years of age (CDC, 2004). With 20,322 suicidal deaths and 13,170 homicidal deaths, intentional injury deaths affect mostly people under 45 years old. On average, there are 1,150 unintentional deaths per year in Iowa. In 2004, 37% of unintentional deaths were due to motor vehicle accidents (MTVCC) occurring across all age ranges and 30% were due to falls involving persons over 65 years of age 82% of the time (IDPH Health Stat Div., 2004). The most debilitating outcome of injury is traumatic brain injury, which is characterized by the irreversibility of its damages, long-term effects on quality of life, and healthcare costs. The latest data available from the CDC estimated that, nationally, 50,000 traumatic brain injured (TBI) people die each year; three times as many are hospitalized and more than twenty times as many are released from emergency room (ER) departments (CDC, 2006).

Besides the TBI registry, brain injury data is also captured through three other data sources: 1) death certificates; 2) hospital inpatient data; and, 3) hospital outpatient data. The inpatient and outpatient hospital data are managed by the Iowa Hospital Association, which provides to Iowa Department of Public Health the hospital data without personal identifiers. (The hospitals send reports to the Agency of Health Care Research and Quality, which developed the Health Care Utilization Project and its product, the National Inpatient Sample).

Methods

This report presents data about TBI hospitalizations and ER visits and not individual TBI cases from 2003 to 2005. The TBI patients were selected from the inpatient and outpatient hospital record database using the ICD9 codes identified by the Iowa Legislature as defining brain injuries (Iowa Code). The cause and type of injury was determined by the external causes of injury (E codes). The data was analyzed using the SAS software, and whenever possible a Chi-square test was applied to measure statistical

significance at the 95% confidence interval.

Results

Demographics

Iowa Inpatient Hospital data

From 2003 to 2005, there were 7,894 identified TBI hospitalizations across the state of Iowa, which corresponded to an average of 2,610 per year. There was a slight increase in TBI hospitalization rates from 2003 to 2005, from a population rate of 87.9 to 91.5 per 100,000 (Table 1). This increase corresponded to a 17% increase of the total number of TBI related hospitalizations, which could be explained by the 30% increase of falls. When comparing the hospitalization rate for 100% rural counties vs. urbanized counties there was no difference in the rate of TBI hospitalization, contrary to expectations.

The TBI patients were mostly white (76%) and male (62%), and the age range varied from less than one year to over 100 years old. The TBI cases were evenly distributed across the age groups except for those over 65 years of age who represented 37% of all TBI cases (Table 2).

Table 1: Iowa TBI hospitalization rate from 2003 to 2005

Characteristics	**Frequency**	**Population**	***Rate (per 100,000)**
Year			
2003	2,584	2,941,362	87.9
2004	2,595	2,952,904	87.9
2005	2,715	2,966,334	91.5
Location			
Urbanized	7328	2,717,467	89.9
100% Rural	566	208,857	90.33

***Notes: To calculate the urbanized vs. 100% rural rates, we used the Iowa 2000 census population.**

Table 2: 2003-2005 Iowa TBI Hospitalizations' Demographics

Characteristics	Frequency	%
Race		
Caucasians	5,972	76%
African-Americans	168	2%
Other	89	1%
Sex		
Female	2,981	38%
Male	4,911	62%
Age Groups		
<16	727	9%
16 to 24	1,238	16%
25 to 34	640	8%
35 to 44	758	10%
45 to 54	945	12%
55 to 64	659	8%
Over 65	2,927	37%

Iowa ***Outpatient Hospital Data***

There were as twice as many TBI ER visits per year than for hospitalizations. The overall ER visits' rate per 100,000 is steadily increasing, mirroring the hospitalization rates. There were no significant differences of the urbanized counties' rate of TBI ER visits as opposed to the 100% rural counties (Table 3).

Caucasians made up the majority (70%) of the ER visits as expected, which is representative of the Iowa general race distribution. Fifty-two percent of all TBI ER visits involved people under 25 years old. Like for hospitalization rates, males were more likely to go to the ER for TBI (Table 4).

Table 3: 2003-2005 Iowa TBI ER Visits Rate per 100,000

Year	Frequency	Population	Rate per 100,000
2003	5,600	2,941,362	190.4
2004	5,983	2,952,904	202.6
2005	6,632	2,966,334	223.6
Location			
Urbanized	17253	2717467	211.6
Rural	1350	208,857	215.5

Table 4: 2003-2005 Iowa TBI ER Visit Demographics

Race	Frequency	%
Caucasians	13,897	76%
African-Americans	478	3%
Other	165	1%
Unknown	3,675	20%
Sex		
Female	6,815	37%
Male	11,400	63%
Age Groups		
<16	4,809	26%
16 to 24	4,966	27%
25 to 34	1,966	11%
35 to 44	1,739	10%
45 to 54	1,532	8%
55 to 64	958	5%
Over 65	2,245	12%

Mechanism of injury and causal factors

Iowa Inpatient Hospital Data

The MTVC related TBI hospitalizations marked a 4% decrease. The number of hospitalizations due to being struck by and against was stable, hovering around 7% of all TBI related hospitalizations. As illustrated in Figure 1, falls were the most frequent cause of TBI (48% in 2005), followed by MTVC (29% in 2005) and struck by/against (7%.) There were other causes of TBI, but their relative frequency was very marginal. On average, there were 13 TBI hospitalizations a year due to firearms; 12 due to poisoning; 26 due to suffocation and drowning; 5 due to farm equipment; and others due to fires, the environment or unspecified. In this analysis, assault was distributed throughout the different etiologies.

Sixty-six percent (66%) of fall-victims were over 65 years old, as opposed to motor vehicle accident victims, 30% of whom were 16 to 25 years old. Cyclist victims were mostly 16 years of age or under (Figure 2). Compared to African-Americans, Caucasians had a greater proportion of TBI from falls, 54% vs. 23%.

Although African-Americans showed the same proportion as Caucasians in MTVC accidents, the majority (38%) of the TBI hospitalizations in African-Americans were due to MTVC in 2003 (Table 5). These results need to be taken with caution as African-Americans account for less than 3% of Iowa's general population and the age distribution is not identical.

Males were more than twice as likely to be hospitalized for TBI as females, especially after an MTVC accident (Figure 3). Using the crash outcomes data we may be able to determine the reasons such as use of seat belts, helmets, or drunk driving etc.
From 2003 to 2005, as shown in Table 6, there were 1,547 hospitalizations due to MVTC most of victims were occupants (73%), followed by motorcyclists (PEDAL CYC or PED CYC) (13.3%) and pedestrians (6.9 %). Over 90% of MTVC TBI hospitalizations occurred in urbanized counties.

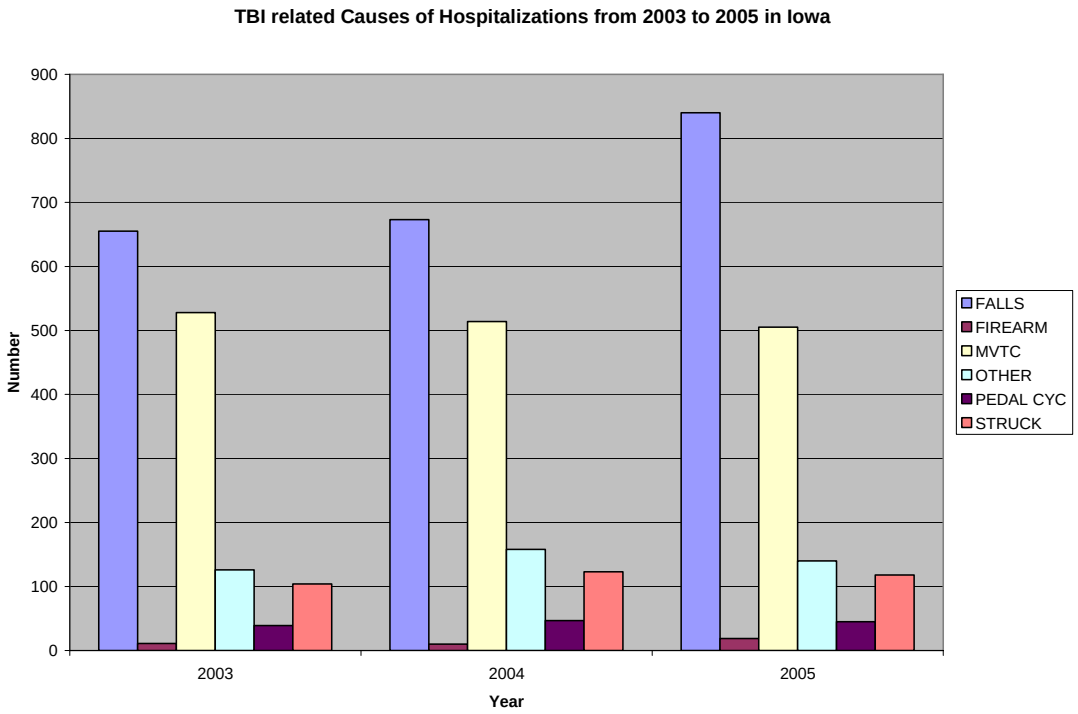


Figure 1: Major causes of TBI Hospitalizations from 2003 to 2005

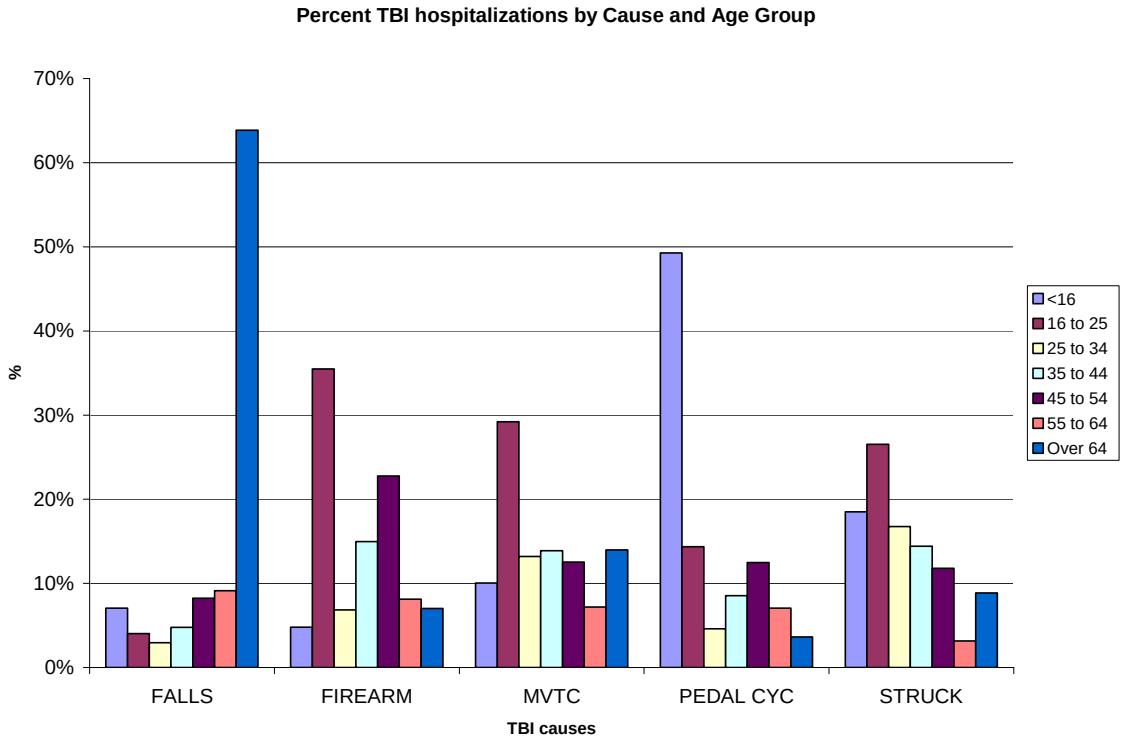


Figure 2: Percent distribution of Causes of TBI Hospitalizations by Age group

Table 5: Causes of TBI Hospitalizations by Race

Year	Cause	Race		
		Caucasians (%)	African-Americans (%)	Other/Unknown (%)
2003	FALLS	467 (47%)	9 (28%)	179 (40%)
	FIREARM	7 (1%)	2 (6%)	2 (0%)
	MVTC	335 (34%)	11 (34%)	182 (41%)
	OTHER	90 (9%)	5 (16%)	31 (7%)
	PEDAL CYC	28 (3%)	0 (0%)	11 (2%)
	STRUCK	58 (6%)	5 (16%)	41 (9%)
2004	FALLS	547 (50%)	9 (23%)	169 (42%)
	FIREARM	4 (0%)	0 (0%)	6 (1%)
	MVTC	356 (33%)	16 (41%)	142 (35%)
	OTHER	80 (7%)	8 (21%)	27 (7%)
	PEDAL CYC	31 (3%)	2 (5%)	14 (3%)
	STRUCK	73 (7%)	4 (10%)	46 (11%)
2005	FALLS	673 (54%)	10 (23%)	157 (33%)
	FIREARM	13 (1%)	0 (0%)	6 (1%)
	MVTC	369 (29%)	15 (34%)	121 (26%)
	OTHER	95 (8%)	8 (18%)	136 (29%)
	PEDAL CYC	32 (3%)	2 (5%)	11 (2%)
	STRUCK	69 (6%)	9 (20%)	40 (8%)

Table 6: 2003-2005 Motor Vehicle Accident Hospitalization by Users, Race, Sex and Location

Users	Characteristics					
	Race		Sex		Location	
	Caucasians	African-Americans	Male	Female	Urbanized	Rural
Occupant	50%	2%	44%	28%	66.3%	5.6%
Motorcyclist	9%	0%	11%	3%	13%	0%
Pedal	2%	0%	3%	1%	3.1%	0%
Pedestrian	4%	1%	4%	3%	6.5%	0%
Others	3%	0%	3%	1%	4%	0%

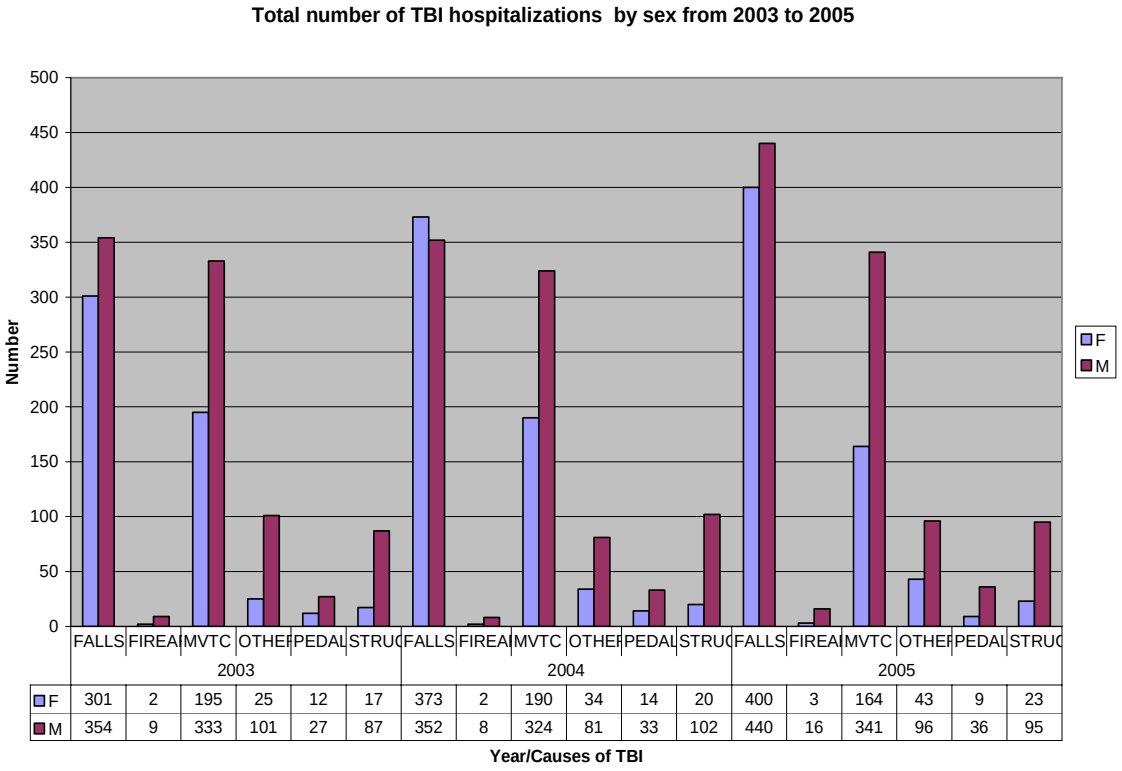


Figure 3: TBI Hospitalizations by Sex from 2003 to 2005

Outpatient data

Like hospitalizations, there was a steady increase of TBI ER visits, mostly due to falls (41%) that primarily involved individuals under the age of 16,and individuals over the

age of 65, The majority of the visits involved people between 16 and 24 years of age. The victims were mostly males (59%) and Caucasians (73%) as shown in Table 8. The 16 to 24 year age group had an overall greater risk for TBI (Table 7).
ER visits for MTVC accidents have remained steady over the three-year period, corresponding to only 22% (Figure 5). Vehicle operators were the most likely ones to visit the ER for TBI.

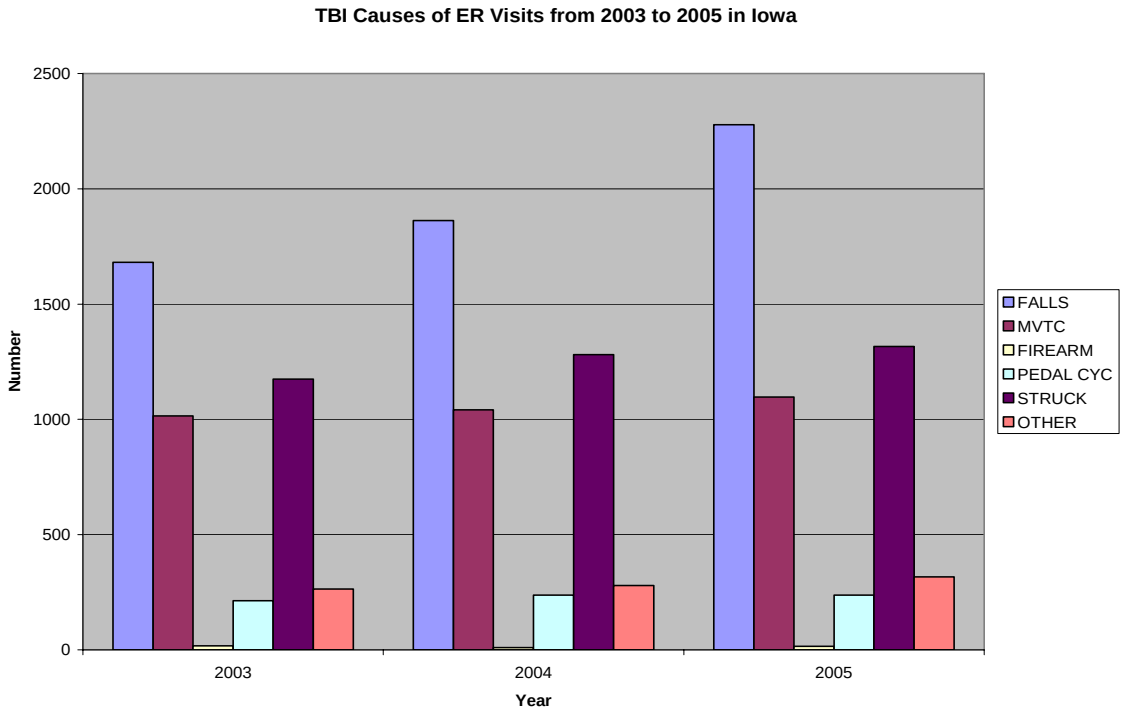


Figure 4: 2003-2005 Causes of TBI ER visits

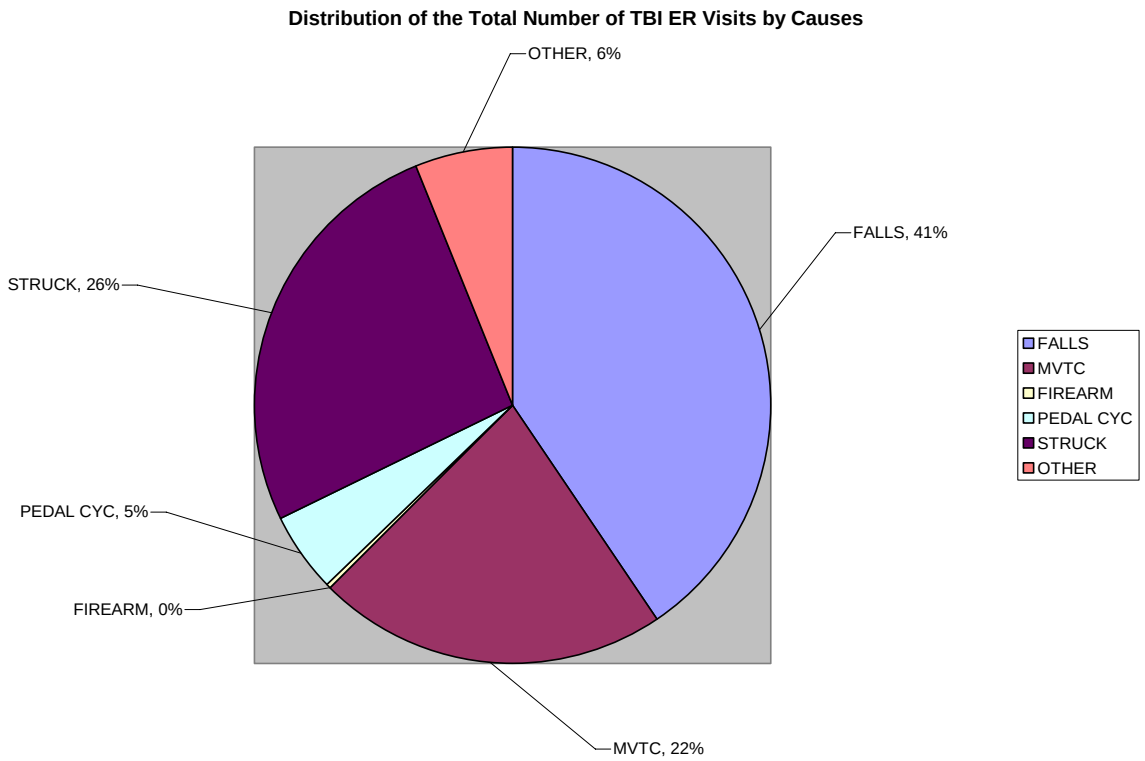


Figure 5: Percent distribution of TBI ER visit causes from 2003 to 2005

Table 7: Percent Distribution of TBI ER visits' Causes by Age Groups

Causes	Age Groups						
	<16	16 to 24	25 to 34	35 to 44	45 to 54	55 to 64	Over 64
FALLS	31%	14%	6%	7%	9%	7%	25%
MVTC	12%	40%	13%	13%	9%	6%	7%
FIREARM	2%	37%	14%	18%	17%	6%	7%
PEDAL CYC	65%	13%	4%	5%	7%	4%	2%
STRUCK	27%	40%	14%	8%	6%	2%	2%
OTHER	21%	25%	16%	16%	12%	6%	5%

Table 8: Percent distribution of TBI ER visits due to MTVC accidents by Race Sex and Location

Users	Characteristics					
	Race		Sex		Location	
	Caucasians	African-Americans	Male	Female	Urbanized	100% Rural
Occupant	57%	2%	43%	35%	71%	7%
Motorcyclist	8%	0%	8%	2%	10%	0%
Pedal	2%	0%	3%	1%	3%	0%
Pedestrian	3%	0%	3%	2%	5%	0%
Others	3%	0%	2%	2%	4%	1%

Prognosis

Inpatient data

Most of TBI hospitalized patients (70%) were sent home, or sent to retirement and nursing homes, except for Firearm related cases. The proportion of death following firearm-related brain injuries was 67% (Table 9). The length of stay (LOS) had a wide range, from 1 day to up to 753 days, and a mean of 7.6 days. TBI due to poisoning had a greater mean of LOS (around 22 days) while others averaged 7 to 10 days (Figure 4).

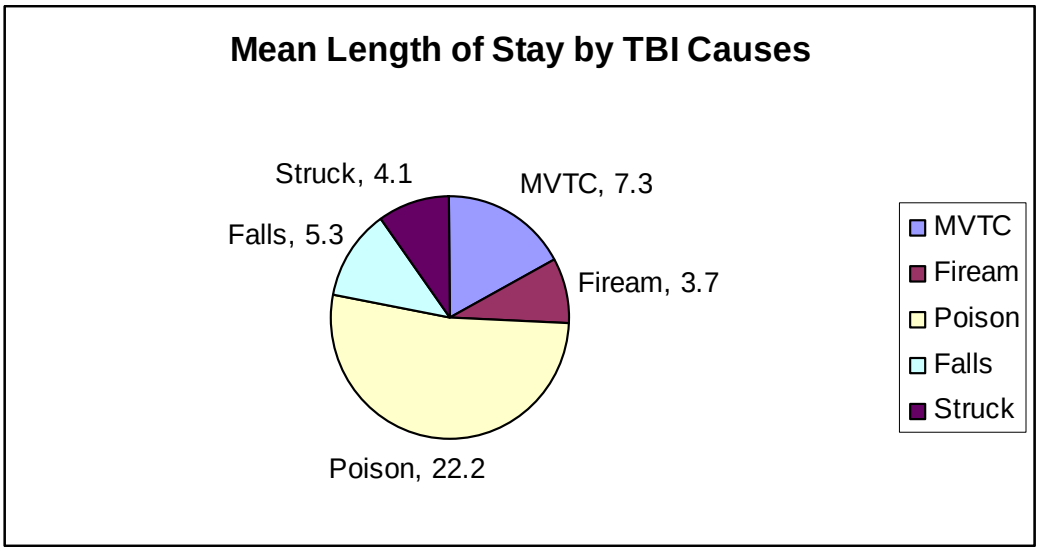


Figure 6: Mean Length of Stay by Specific TBI Causes

Table 9: Outcomes of TBI related Hospitalizations

Causes	Home	Transfer	LTC	Dead	Rehabilitation	Other
MTVC	778 (75%)	89 (9%)	43 (4%)	58 (6%)	54 (5%)	20 (2%)
Firearm	5 (24%)	1 (5%)	0 (0%)	14 (67%)	1 (5%)	0 (0%)
Falls	805(58%)	122 (9%)	284(21%)	120 (9%)	34 (2%)	15 (1%)
Struck	204 (90%)	9 (4%)	6 (3%)	1 (0%)	3 (1%)	4 (2%)
Other	247 (76%)	28 (9%)	17 (5%)	16 (5%)	8 (2%)	11 (3%)

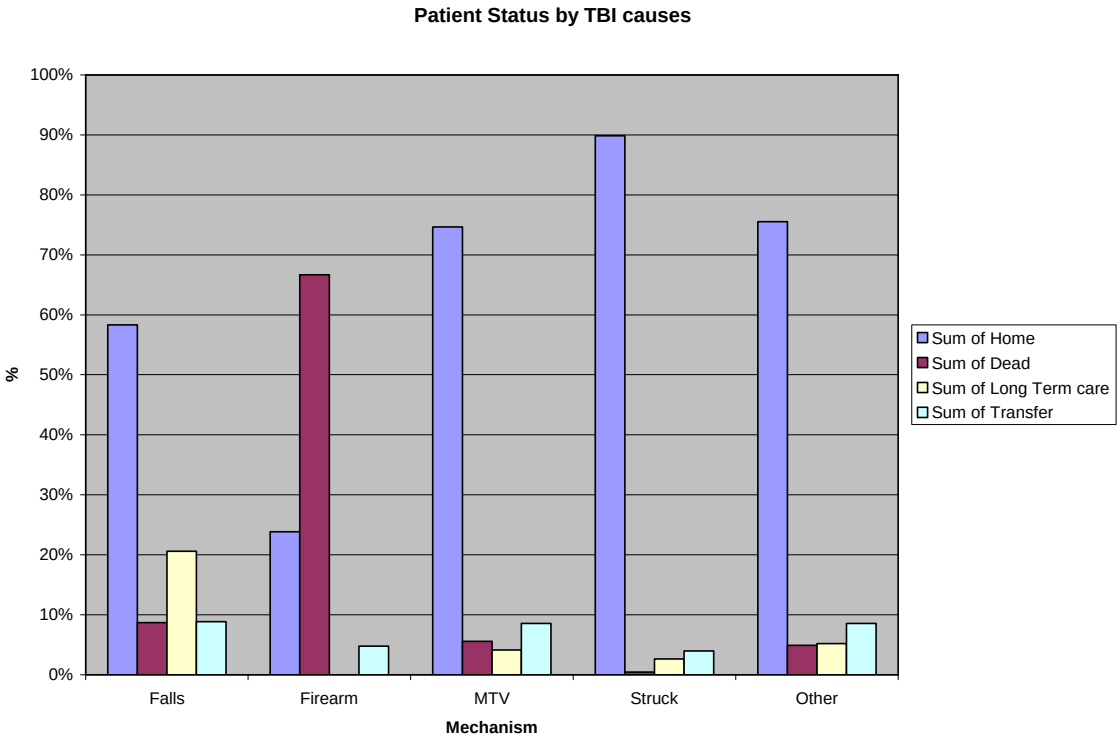


Figure 7: Patient Outcomes by TBI causes

Outpatient data

Approximately 80% of all TBI diagnosed patients were sent home and 18% transferred to other hospital services after the ER visit (Table 10).

Table 10: Outcomes of TBI related ER Visits from 2003 to 2005

Cause	Home	Transfer	LTC	Dead	Rehabilitation	Other
MTVC	71%	26%	0%	2%	0%	1%
Firearm	21%	56%	0%	23%	0%	0%
Falls	78%	20%	1%	0%	0%	1%
Struck	91%	8%	0%	0%	0%	0%
PED CYCL	85%	14%	0%	0%	0%	0%
Other	74%	21%	1%	4%	0%	1%

Discharges

Inpatient data

Private funds were utilized to pay for most of the hospital charges (over $16 million). Public funding, including Medicaid and Medicare, contributed a total of $11 million for TBI-related medical expenses. Motor vehicle accidents had the highest amount of hospital charges. We cannot say for sure why; however we may suspect the differences in charge methods and the fact that most of private payers are related to motor vehicles, which present a greater LOS and perhaps worse debilitating outcomes.

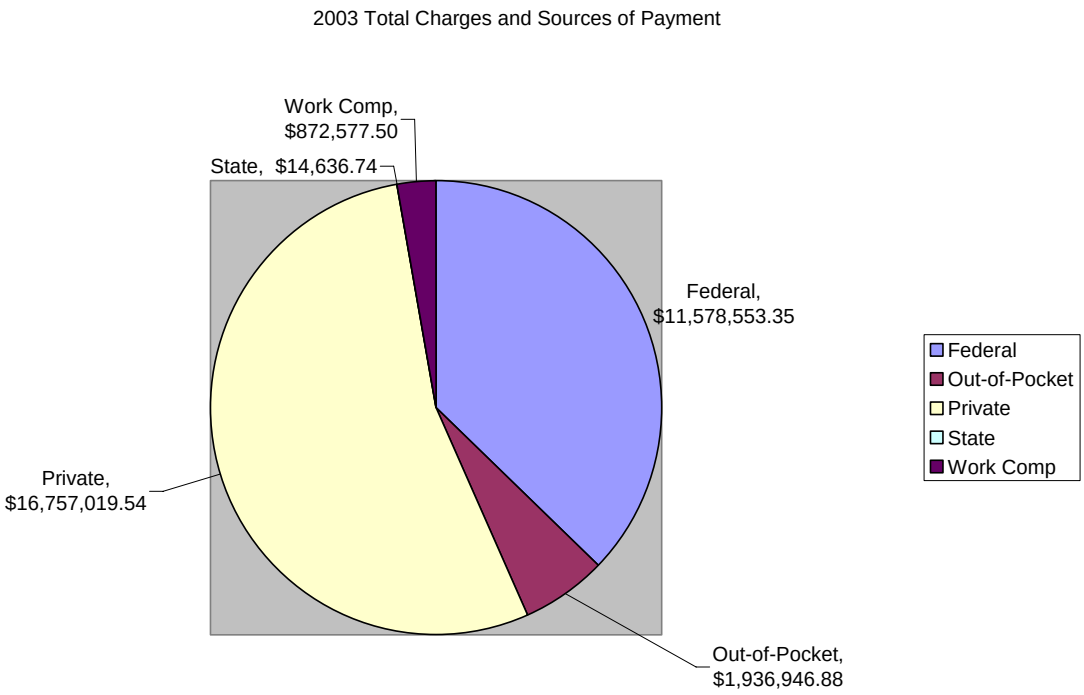
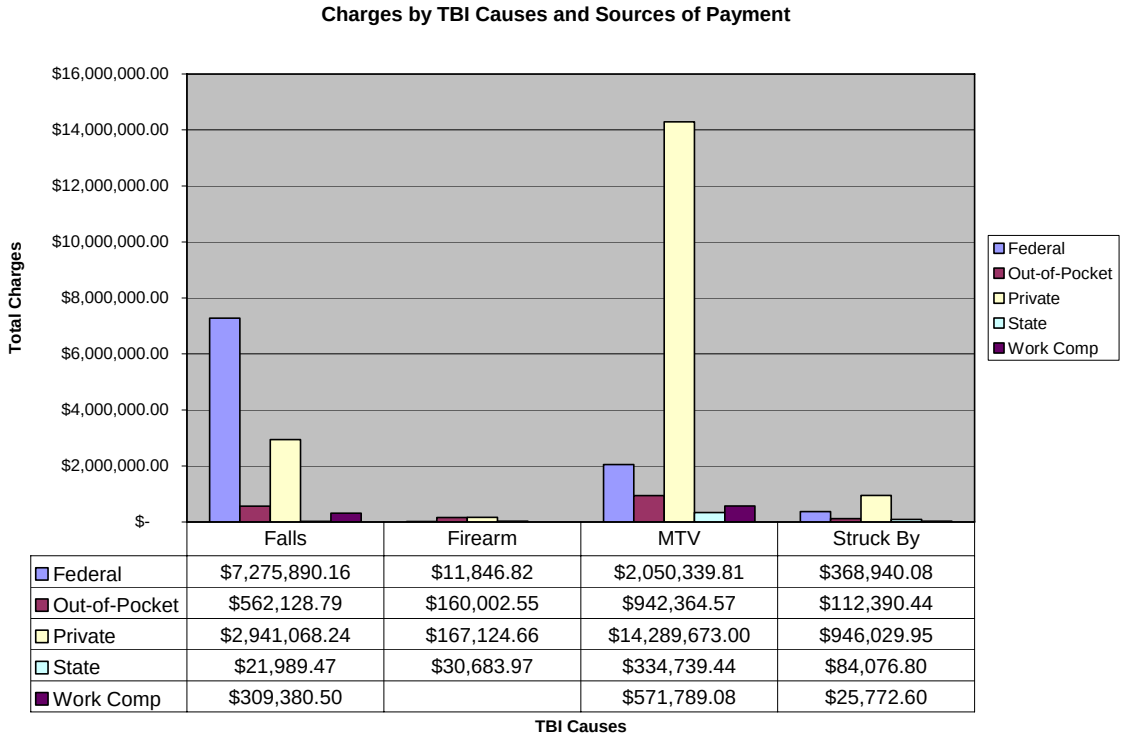


Figure 8: Sources of Payment and Total Hospital Charges



	Falls	Firearm	MTV	Struck By
Federal	$7,275,890.16	$11,846.82	$2,050,339.81	$368,940.08
Out-of-Pocket	$562,128.79	$160,002.55	$942,364.57	$112,390.44
Private	$2,941,068.24	$167,124.66	$14,289,673.00	$946,029.95
State	$21,989.47	$30,683.97	$334,739.44	$84,076.80
Work Comp	$309,380.50		$571,789.08	$25,772.60

Figure 9: Sources of Payment and Total Charges by TBI causes

Outpatient data

As for hospitalizations, private payers were the most frequent payer, equaling almost 55% of all charges. Out-of-pockets payments constituted 20% of all charges, illustrating the difficulties faced by hospital outpatient departments. There were few differences to inpatient visits with regard to the relation between the payer and the cause of TBI visits. Motor vehicle ER visits were generally charged to the private sector while falls were almost equally billed to private and federal payers. The relative increase of private share in the economic cost of falls is due to the greater proportion of younger individuals experiencing brain injuries.

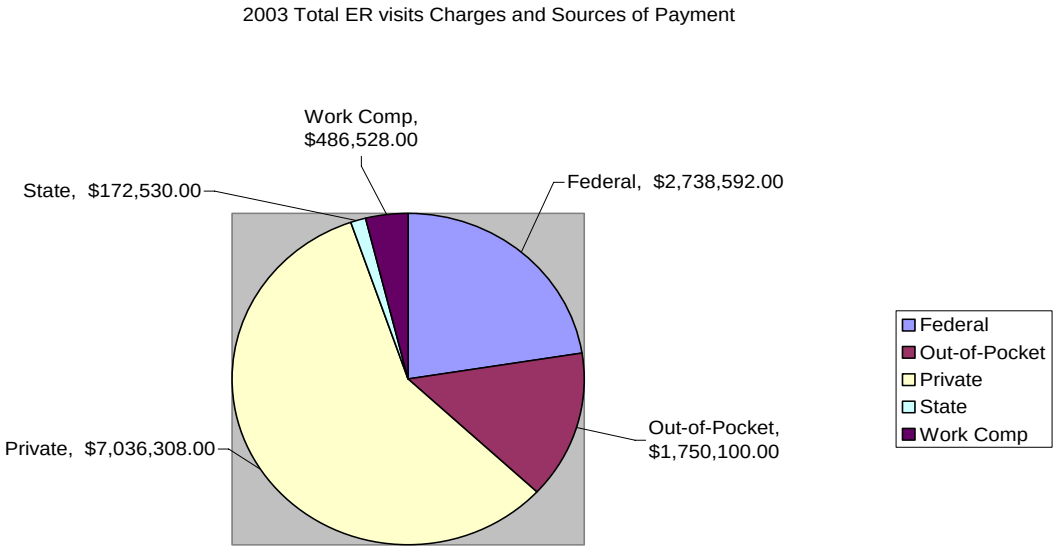
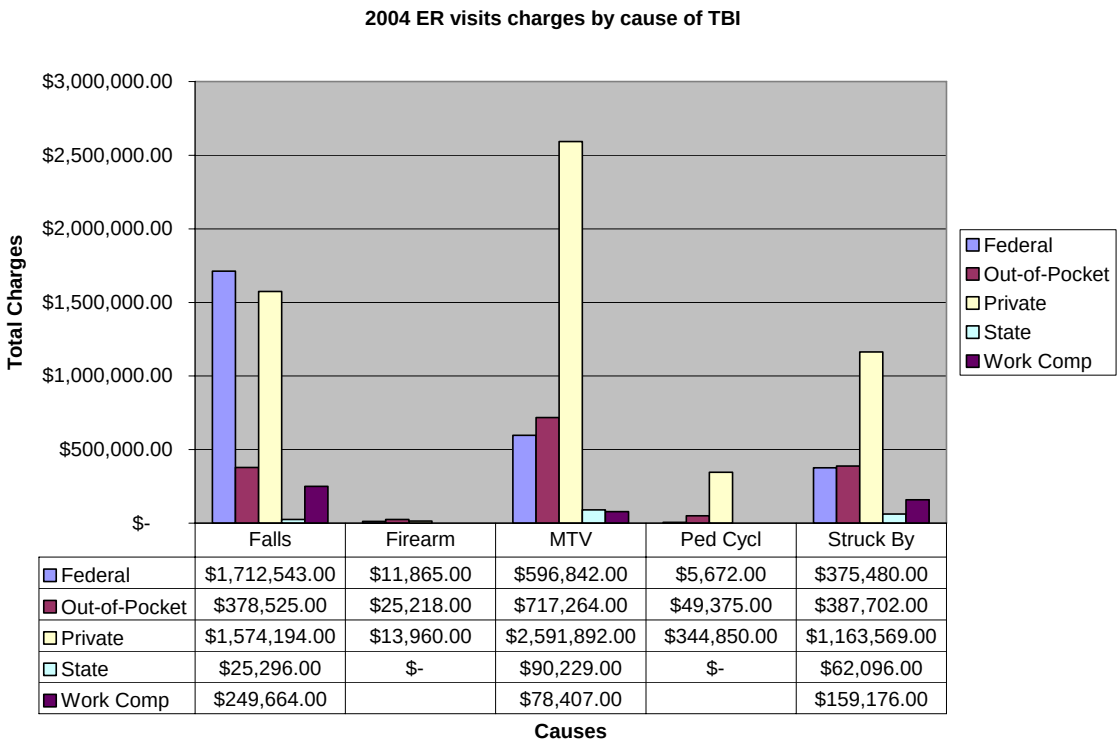


Figure 10: TBI ER Visit Payers



	Falls	Firearm	MTV	Ped Cycl	Struck By
Federal	$1,712,543.00	$11,865.00	$596,842.00	$5,672.00	$375,480.00
Out-of-Pocket	$378,525.00	$25,218.00	$717,264.00	$49,375.00	$387,702.00
Private	$1,574,194.00	$13,960.00	$2,591,892.00	$344,850.00	$1,163,569.00
State	$25,296.00	$-	$90,229.00	$-	$62,096.00
Work Comp	$249,664.00		$78,407.00		$159,176.00

Figure 11: ER Visits Charges by Causes

Conclusions

Even though the hospital and ER data have structural problems (over 30% of missing values), they still give us valuable information regarding TBI. The inpatient and outpatient data show a notable increase of brain injury rate in Iowa. There were no significant differences in the overall rate of TBI between urbanized counties and rural counties. Rural counties had a greater rate of falls than urbanized counties, which had greater rates of motor vehicle-related TBI. The inpatient data show that falls are the main cause of TBI in adults, who subsequently rely on the Medicaid and Medicare payment system. Motor vehicle accidents are prevalent in young adults and are mostly paid for by private insurance companies. The charges billed to payers are different whether the payer is private or governmental; and there are many other questions that warrant a more in-depth analysis of the inpatient data.

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This report was prepared by:

Ousmane Diallo (Bureau of Disability & Violence Prevention, IDPH)
Suning Cao (Bureau of Health Statistics, IDPH)