TRAUMATIC BRAIN INJURIES IN IOWA 1995

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Division of Substance Abuse and Health Promotion
Bureau of Injury and Disability Prevention

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Traumatic brain injuries severely impact the lives of the injured person, their care givers, and society as a whole. Therefore increasing attention needs to be given to the prevention of these disabling injuries.

Traumatic brain injury identification

Traumatic brain injuries include fractures of the vault or base of the skull, concussions, cerebral lacerations, intracranial hemorrhage, and other traumatic intracranial injuries resulting in hospitalization or death.

Traumatic brain injuries (TBI) were identified through the International Classification of Diseases (9th edition) using combined data from several sources: the Iowa Central Registry for Brain and Spinal Cord Injuries; ten large Iowa hospitals; and death certificates. All three data sources were available from the Iowa Department of Public Health. Data from the three data sources were linked to avoid counting the same injurt twice (e.g., transfers between two hospitals).

What are the likely consequences of these injuries?

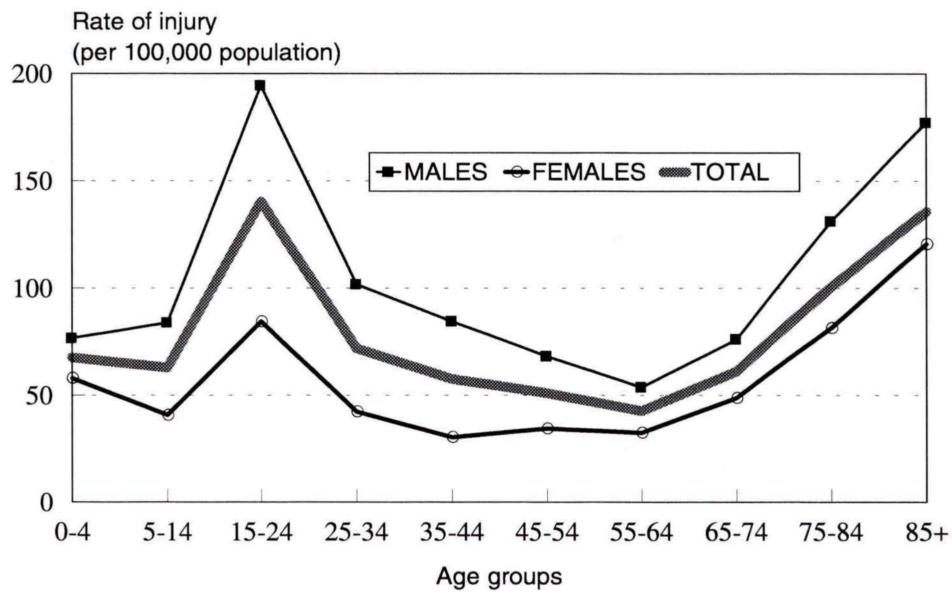
Many persons have residual losses such as physical impairments (e.g., speech, vision, and seizures), cognitive impairments (e.g., memory deficits, limited concentration, and impaired communication), and behavioral impairments (e.g., depression, mood swings, and reduced interpersonal skills).

For example, a significant percentage suffered from headaches, reduced memory, and lack of concentration three years after sustaining severe traumatic brain injuries, (Annoni et al.,1992). Additionally, persons with TBIs have difficulty walking, dressing, and using public transportation (Masson et al.,1997).

How many Iowans were injured?

A total of 2,202 traumatic brain injuries (TBI) were identified from the three data sources in 1995, a 14 percent decline from the 2,397 TBIs that were reported in 1994. For every 100,000 Iowans, an average of 78 sustained a traumatic brain injury in 1995. Nearly six Iowans sustain a traumatic brain injury every day which results in hospitalization or death. In 1995, this means that a brain injury occurred every four hours. A total of 340 Iowans died: nearly one person each day. The overall rate of occurrence was highest among Iowans age 15-24 and those 85 and older (figure 1). Males were two times more likely than females to sustain a traumatic brain injury.

Figure 1. Rate (per 100,000 population) of traumatic brain injuries by age and sex, Iowa 1995



Who paid for the acute care in Iowa?

Private insurance was charged the majority of the acute care cost (36%) for nonfatal injuries. Fourteen percent of acute care was paid for by Medicare. Medicaid and "self-pay" were charged for seven and 12 percent of this care, respectively.

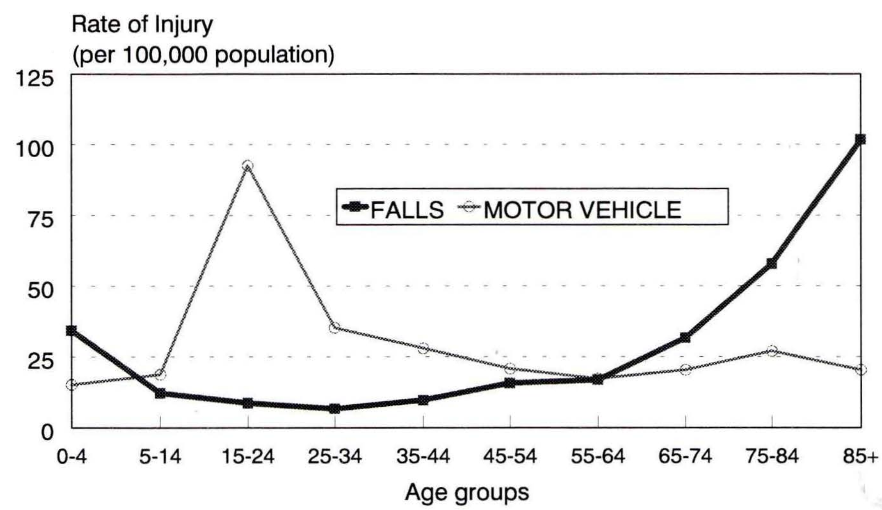
What are the causes of these injuries?

Motor vehicle crashes were the leading cause of TBIs accounting for nearly 45 percent of injuries (figure 2). Sixty-five percent of persons with TBIs did not wear seat belts at the time of their motor vehicle crash.

Falls were the second most frequent cause of TBIs accounting for one of every four injuries. They occurred most frequently among the elderly (41% of falls occurred among those aged 65+).

Motorcycles, bicycles, pedestrians, assaults, and sports each accounted for less than ten percent of the sustained injuries. The 1995 percentage of TBIs by cause was similar to that of 1994.

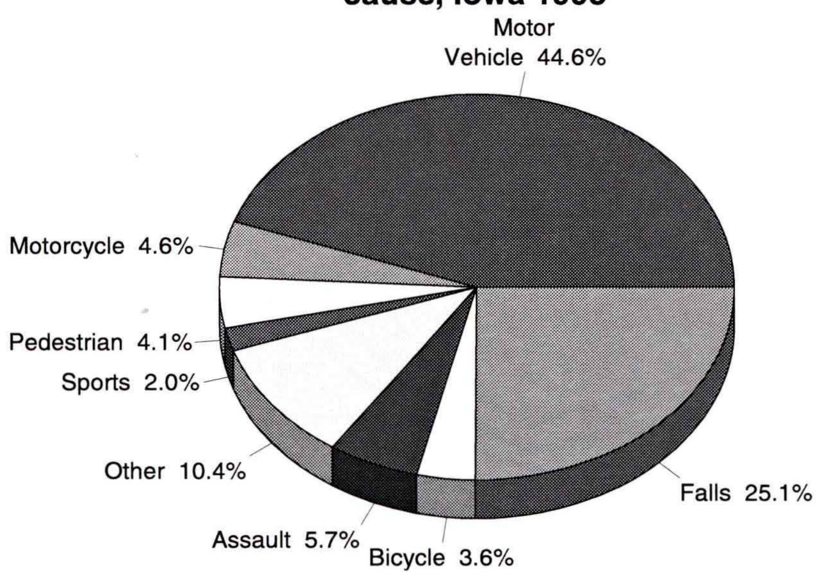
Figure 3. Rate (per 100,000 population) of traumatic brain injuries for falls and motor vehicle crashes, Iowa 1995



Younger males and older females accounted for significant portions of the total number of falls. The most likely age group to sustain TBIs from falls were Iowans aged 85 and older (figure 3). This age group was more likely to sustain a TBI from a fall (rate: 101.8/100,000 population) than those aged 15-24 were to sustain a TBI from a motor vehicle crash (rate: 92.6/100,000 population).

Falls were most likely to occur at home (54%) among all age groups combined. Eighty-five percent of children aged 0-4 sustained their fall-related TBI at home. In contrast, 87 percent of Iowans aged 65 and older sustained their TBI as a result of a fall at a residential institution. Falls are expected to increase in significance as the percentage of elderly Iowans continues to grow in the coming years.

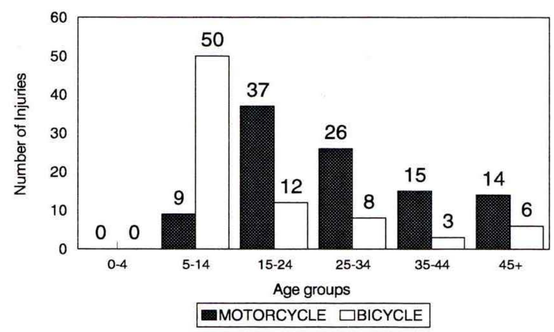
Figure 2. Percentage of severe traumatic brain injuries by cause, Iowa 1995



Motorcycles and bicycles

A total of 101 motorcyclists and 79 bicyclists sustained traumatic brain injuries in 1995 than 1994, when 111 motorcyclists and 86 bicyclists sustained TBIs.

Figure 4. Frequency of motorcycle and bicycle-related traumatic brain injuries, Iowa 1995



Motorcycle-related TBIs mostly occurred among those aged 15-44 (figure 4). Injuries among this age group accounted for 66 percent of all motorcycle-related TBIs in Iowa in 1995. Seventy-five percent of those who sustained a motorcycle-related TBI were not wearing a helmet at the time of the injury. If all persons aged 15-44 were wearing a helmet at the time of the crash, an estimated 15 TBIs would have been prevented. This was also calculated based on the prevented fraction (Morgenstern and Bursic, 1992).

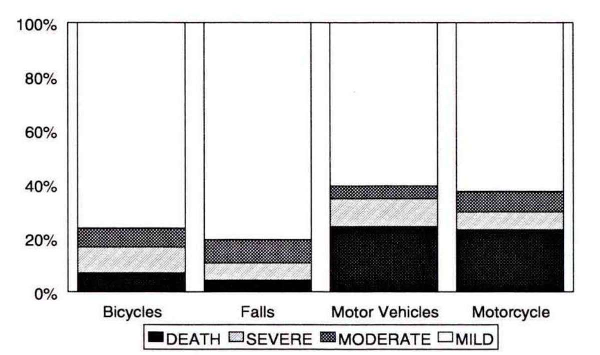
Bicycle-related TBIs occurred most frequently among children ages 5-14 in 1995 (figure 4). Sixty-one percent of these injuries occurred among this age group. Ninety percent of those who sustained TBIs did not wear a helmet at the time of the injury. If all these children had worn a helmet at the time of the crash, an estimated 30 TBIs would have been prevented. This was calculated using the statistical concept of the prevented fraction (Morgenstern and Bursic, 1982). Because of the devastating and life-altering effects TBIs may have among children aged 5-14, the potential effect of increasing bicycle helmet use will be further described on page 6.

How serious are the sustained injuries?

The Glasgow Coma Scale (GCS) was used to describe the severity of the TBIs sustained. This scale has been widely used and describes mild (GCS 13-15), moderate (GCS 9-12), and severe (GCS less than 9) TBIs. Overall, 15 percent of TBIs resulted in death. Sixty-seven percent of reported TBIs were mild, six percent were moderate, and nine percent were severe TBIs.

Figure 5 displays the injury severity by mechanism of injury. Injury causes more likely to result in death of the person include motor vehicles (24%), motorcycles (24%), and pedestrians (25%). Falls and sports-related TBIs were most likely to be mild, at 81 and 97 percent, respectively.

Figure 5. Percentage of traumatic brain injuries by cause and Glasgow Coma Scale severity, Iowa 1995



Discharge from inpatient care

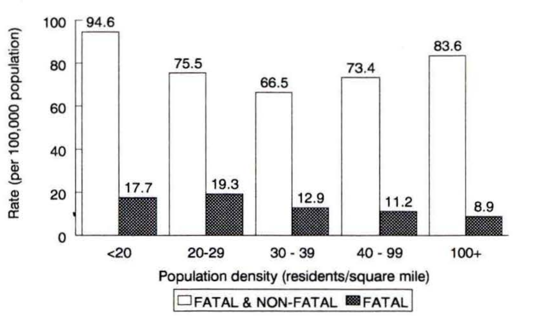
Overall, 78 percent of Iowans with TBIs who were admitted as inpatients were discharged home. Eight percent were discharged to a residential facility (with or without skilled nursing services), seven percent were discharged to inpatient rehabilitation, and 1.5 percent died as inpatients. The remainder of the patients had "other" discharges.

The percentage of persons discharged home ranged from 71 percent for falls to 100 percent for TBIs resulting from animals. Falls and motorcycles resulted in less favorable discharges.

SPECIAL FOCUS: RURAL - URBAN DIFFERENCES

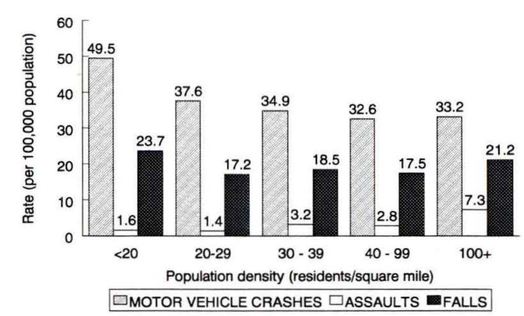
Differences between rural and urban injury occurrence are important for both injury prevention efforts as well as trauma care delivery. To describe rural-urban differences, we used the 1995 county population density (the number of residents per square mile) to increase the sensitivity of geographic variation in TBI occurrence rates. Five categories were created: less than 20 residents/square mile (21 counties); 20 - 29 (32 counties); 30 - 39 (22 counties); 40 - 99 (15 counties); and at least 100 (9 counties).

Figure 6. Overall traumatic brain injury rates and mortality rates by county population density, Iowa 1995



TBI rates were calculated for the five different county-specific population densities. Counties with a population of fewer than 20 residents per square mile (the most rural counties) were substantially more likely to sustain TBIs (94.6 per 100,000 population) than those with a population between 30 to 39 residents per square mile (66.5 per 100,000 population). Residents of counties with the highest population density were also at increased risk for TBIs (83.6 per 100,000 population) although this rate was lower than that of the most rural counties.

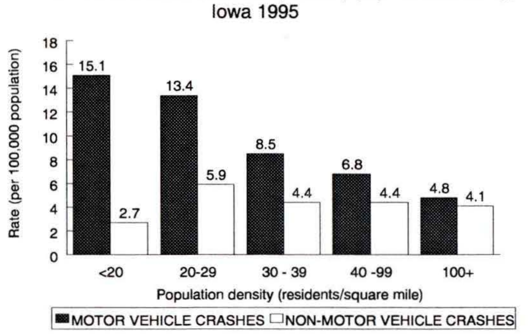
Figure 7. Traumatic brain injury rates by cause and county population density, Iowa 1995



The higher TBI rate among residents of the most rural counties (figure 6) was predominantly a result of an increased rate of motor vehicle crashes and falls as shown in figure 7. Falls and assuaults were also increased among residents of most densely populated counties. Assaults also increased with increasing population density. The TBI rate from assaults was 7.3 per 100,000 population among the most urban counties. Rates for other causes did not vary substantially among counties with varying population densities.

Differences in *fatal* TBI rates were also found (figure 8). Fatal motor vehicle rates were substantially higher among residents of the most rural counties (15.1 per 100,000 population) but declined dramatically with increasing county population density. The rate for the most urban counties was only one-third the rate of the most rural counties (4.8 per 100,000 population). No clear trend was found for fatal TBIs attributable to other causes.

Figure 8. Traumatic brain injury mortality rates for motor vehicle and non-motor vehicle crashes by county population density, Iowa 1995



Counties with populations less than 20 residents per square mile	Adair, Adams, Audubon, Clarke, Davis, Decatur, Franklin, Fremont, Greene, Guthrie, Ida, Kossuth, Monona, Monroe, Osceola, Palo Alto, Pocahontas, Ringgold, Taylor, Van Buren, Wayne
Counties with populations between 20 and 29 residents per square mile	Allamakee, Appanoose, Butler, Calhoun, Cass, Cherokee, Chickasaw, Clayton, Crawford, Emmet, Fayette, Grundy, Hamilton, Hancock, Harrison, Howard, Humboldt, Iowa, Keokuk, Louisa, Lucas, Lyon, Madison, Mitchell, Montgomery, O'Brien, Plymouth, Sac, Shelby, Tama, Worth, Wright
Counties with populations between 30 and 39 residents per square mile	Benton, Buchanan, Buena Vista, Carroll, Cedar, Clay, Delaware, Dickinson, Floyd, Hardin, Jackson, Jefferson, Jones, Mahaska, Mills, Page, Poweshiek, Sioux, Union, Washington, Winnebago, Winneshiek
Counties with populations between 40 and 99 residents per square mile	Boone, Bremer, Cerro Gordo, Clinton, Dallas, Henry, Jasper, Lee, Marion, Marshall, Muscatine, Pottawattamie, Wapello, Warren, Webster
Counties with populations of at least 100 residents per square mile	Black Hawk, Des Moines, Dubuque, Johnson, Linn, Polk, Scott, Story, Woodbury

The potential effect of increasing bicycle helmet use in Iowa.

One method to identify priority areas for reducing the occurrence of TBIs in Iowa is to determine the potential number of injuries prevented resulting from program implementation. The potential effect of increasing bicycle helmet use on TBI occurrence will be evaluated. A technique called the impact fraction (Morgenstern and Bursic, 1982) was used to estimate the reduction in TBI occurrence by increasing helmet use.

Bicycle-related TBI prevention is focused on Iowans aged 5-14, since the majority of these injuries occurred among this age group. Based on 1995 Iowa Behavioral Risk Factor Surveillance System (BRFSS) data, although 26 percent of children aged 5-9 always wore their bicycle helmet according to their parents, only eight percent of children aged 10-15 did the same. Overall, 12 percent of those age 5-15 always wore a bicycle helmet. Research has shown that those not wearing a helmet are nearly three times more likely to sustain a TBI than those wearing a helmet (Thompson et al.,1996). Other studies have even shown larger risks for TBI occurrence as a result of not wearing helmets (Thompson et al.,1989).

Table 1. The potential impact each year of increasing bicycle helmet use among children aged 5-14 in Iowa.

	Increase bicycle helmet use to			
	25%	50%	75%	100%
Total TBIs prevented	125	357	593	829
Yearly savings*	$25.0	$71.4	$118.6	$165.8
Hospitalized or fatal TBIs prevented	5	13	22	30
Number of upper and middle facial injuries prevented	148	507	861	1221
Total injuries prevented	273	864	1,454	2,050

** cost at $200,000 per TBI; savings per $1 million.*

Table 1 describes the potential impact of increasing helmet use from the current 12 percent. A total of 829 TBIs will be prevented each year if all children aged 5-14 always wear helmets, a yearly savings of $166 million. An assumption is that children who sustained a TBI would not have been injured at all when wearing a helmet. Additionally, because the parents reported helmet use by their children, it is expected that usage is actually lower and the number of TBIs and facial injuries that can be prevented each year is even higher than described in this report.

The potential injury reduction is even larger (2,050 injuries) when upper and middle facial injuries are included, which helmets also prevent (Thompson et al.,1996). The upper facial area includes the forehead, eyes, and ears. The middle facial area includes the nose, cheeks, and upper jaw.

Local communities can make important contributions in reducing the occurrence of traumatic brain injuries among Iowa's children. Research has shown that bicycle helmets costing $14 to $20 for 5- through 9-year-olds will be cost-effective when helmet use reaches 40 to 50 percent (Thompson et al.,1993). With reported helmet use at 26 percent and helmets costing less than $15 in many Iowa stores, this should be attainable.

Since 1992, the Iowa Department of Public Health has administered bicycle safety programs through local bicycle clubs or coalitions containing a bicycle club. Approximately 18 local clubs and two regional projects have been funded. Awards are based on demonstrated need and the number of injuries reported to the Public Health Department. Clubs have conducted bicycle rodeos, poster contests, helmet distribution and education programs. The Governor's appointed Advisory Council on Head Injuries recently provided funding for local Safe Kids coalitions to buy and distribute helmets. More than 350 helmets were provided to low income children by Safe Kids coordinators in their coalition areas.

References

- Annoni JM, Beer S, Kesselring J: Severe traumatic brain injury-epidemiology and outcome after 3 years. Disab and Rehab 14, 23-26, 1992.
- Masson F, Vecsey J, Salmi LR, et al.: Disability and handicap 5 years after head injury: A population-based study. J Clin Epidemiol 50, 595-601, 1997.
- Morgenstern H, Bursic ES: A method for using epidemiologic data to estimate the potential impact of an intervention on the health status of a target population. J Comm Health 7, 292-309, 1982.
- Thompson DC, Rivara FP, Thompson RS: Effectiveness of bicycle safety helmets in preventing head injuries. A case-control study. JAMA 276, 1968-1973, 1996.
- Thompson DC, Nunn ME, Thompson RS, Rivara FP: Effectivness of bicycle safety helmets in preventing serious facial injury. JAMA 276, 1974-1975, 1996.
- Thompson RS, Rivara FP, Thompson DC: A case-control study of the effectiveness of bicycle safety helmets. NEJM 320, 1361-1367, 1989.
- Thompson RS, Thompson DC, Rivara FP, Salazar AA: Cost-effectivness analysis of bicycle helmet subsidies in a defined population. Pediatrics 91, 902-907, 1993.

BICYCLE HELMET USE AMONG CHILDREN AGED 5-14

HOW TO CALCULATE THE EXPECTED REDUCTION IN BRAIN INJURIES IN YOUR COMMUNITY

Step 1. Number of children aged 5 - 14 in your community: ____________________

Step 2. Multiply the population aged 5-14 from step 1 by the expected brain injury rate *(45/100,000 population)*
_______________ x 0.0045 = _____________
***NOTE:** This is the calculated number of children aged 5-14 who sustain brain injuries in your community every year*

Step 3. Identify or estimate the percentage of children aged 5-14 always wearing a bicycle helmet in your community: _________________ %

Step 4. Estimate helmet use after implementation of your intervention: ______________ %

Step 5. Find the intersection in table 1 of current helmet use (from step 3) and the estimated percentage of helmet use (from step 4): ____________ %
***NOTE:** This is the anticipated reduction in the percentage of brain injuries following the implementation of your intervention.*

Step 6. Multiply the percentage from step 5 by the number of brain injuries in your community from step 2:
___________ % x _____________ brain injuries = ______________ brain injuries prevented each year.
***NOTE:** Divide the percentage by 100 before multiplying The result is the anticipated reduction in the number of brain injuries following the implementation of your intervention..*

Table 1. Anticipated percentage reduction in number of brain injury from the current percentage of helmet users to the expected percentage of helmet users among children aged 5-14.

Current	**Expected helmet use after intervention**							
use	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**80%**	**100%**
5%	3.4	10.1	16.8	*23.5*	30.3	37.0	50.4	63.9
15%		3.6	10.8	18.0	25.2	32.4	46.9	61.3
25%			3.8	11.6	19.4	27.1	42.7	58.2
35%				4.2	12.6	21.1	37.9	54.7

Risk of sustaining a brain injury when not wearing helmet in a bicycle crash: 2.86 (Thompson et al. JAMA 276, 1974-5 1996)

EXAMPLE:

Step 1. Number of children aged 5-14 in my community: *5,000*

Step 2. 5,000 children x 0.00450 = 23 brain injuries sustained every year

Step 3. *5 percent* of children always wear their bicycle helmets

Step 4. Helmet use will increase to *40 percent.*

Step 5. The intersection between 5 percent current and 40 percent anticipated use is *23.5 percent.*

Step 6. 23.5 / 100 x 23 = *5.4 (rounded 5)* injuries prevented by the intervention each year.

Prepared by Mario Schootman, Ph.D., Epidemiologist. Iowa Department of Public Health, Des Moines, Iowa, October 1997.

Suggestions to reduce the burden of traumatic brain injuries in Iowa.

1. Implement interventions aimed at reducing brain injuries among residents of the most ***rural counties*** in Iowa by focusing on motor vehicle crashes and falls among the elderly. The overall TBI rate is highest among these residents as well as the specific rate from motor vehicle crashes and falls. The acute care charges were highest among residents of the most rural counties. Implementation of strategies among rural populations require special considerations about the unique characteristics of this population.

2. Implement interventions aimed at reducing TBIs from ***assaults*** in Iowa's most urban counties. TBIs from assaults were most frequent among urban residents. Although Iowa may not have an urban population as large as some other states, assaults leading to TBIs do warrant a closer look.

3. Implement interventions to reduce the occurrence of ***falls among the elderly*** of the most rural and urban counties. Among all age groups, those who sustained falls were least likely to return home compared to TBIs from other causes. Additionally, a large proportion of falls among the elderly were sustained by residents of nursing homes. The long-term consequences of falls among the elderly are more serious than for younger individuals who sustained falls.

4. Implement interventions to reduce the occurrence of ***bicycle-related TBIs among children age 5-14.*** Community-based programs as well as local ordinances can significantly impact the local injury burden. With distribution of low cost bicycle helmets, a significant number of injuries can be prevented. Local communities are now able to calculate the potential effect of program implementation.

5. Implement interventions aimed at increasing ***seat belt use***. Only 35 percent of persons wore a seat belt at the time of the crash that resulted in the traumatic brain injury. Studies have shown that rural adolescents were substantially less likely to wear seat belts and are therefore at significantly increased risk of sustaining a TBI in a motor vehicle crash.

6. Continue implementation of a ***state-wide trauma care delivery system***. Deaths from TBIs may be significantly reduced among rural Iowans. Several factors could be related to improved outcome of patients who sustained TBIs after the establishment of a trauma system, such as rapid transport to trauma centers with neurological care and intensive care units. Also, application of Advanced Trauma Life Support principles in rural trauma centers will result in expedient and optimal management of airway, breathing, and circulation, which limits "secondary brain injury" resulting from hypoxia.

Data about Traumatic Brain Injuries can be used to

- Evaluate the implementation of prevention strategies and legislation;
- Set priorities based on the potential impact of interventions and trauma system development;
- Continue to identify Iowans at increased risk of sustaining these disabling injuries;
- Evaluate the receipt and appropriateness of service delivery by conducting follow-up surveys.

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