Traumatic Brain Injury (TBI)

A husband and wife, in their late forties, attend a support meeting of professionals in the TBI field. He is a survivor of a traumatic brain injury. The man rides in a special wheelchair, designed to help hold his head up correctly. He is a fit, but large person, over 225 pounds. Living in a rural area and lacking transportation, he was not able to obtain needed rehabilitation services. Their local community recently pulled together and helped purchase a van, equipped for his special needs. He is now able to access needed rehabilitation, as well as other resources.

He was a career professional before the injury but now his wife is his 24-hour, 7 days-a-week caregiver. This full-time, willing devotion has led to the closing of her small business. The full-time care provided by his wife, including moving and bathing him, is causing her to "burn out" mentally and physically. His job as a professional is gone, as are the resulting income and income tax contributions. Her job of running the family business is gone, as are the resulting income and income tax contributions. When her body finally gives out, the health care system will have to pay to fix it. In addition, her husband will require full-time care from a residential facility.

Defining The Problem

The Centers for Disease Control (CDC) defines traumatic brain injury, often referred to as "TBI", as "an injury to the head that disrupts the normal function of the brain".

There are an estimated two million traumatic brain injuries (TBI) each year in the United States (MacMillan). Identifying TBIs is usually done by focusing on conditions that can be measured and/or observed. Concrete indicators that can be recorded and analyzed exist in the most severe cases. When the brain injury is minor, there may be no immediate evidence that an injury has occurred. In this case, a TBI may only be recognized in the long term as evidenced by dysfunctional behaviors of the victim.

Goals

Reduce nonfatal head injuries.

HP 2010 Goal	*45 per 100,000*
OH	identify baseline
US 1998	60.6

Data source: National Hospital Discharge Survey (NHDS), CDC, NCHS.

Reduce nonfatal spinal cord injuries

HP 2010 Goal	*2.4 per 100,000*
OH	identify baseline
US 1998	4.5

Data source: National Hospital Discharge Survey (NHDS), CDC, NCHS.

Data

National Data

For persons of all ages, the incidence of TBI among males is twice that of females. The likelihood of sustaining a TBI is greater among adolescents, young adults, and elders who are older than 75. The leading causes of TBI are motor vehicle crashes, violence, and falls. The national TBI rate (combined hospitalization and mortality rate) is 95 TBI's per 100,000. Twenty-two percent of people who sustain a TBI die as a result of their injuries, according to the Centers for Disease Control and Prevention (CDC).

Regional Ohio Data

The Northwest Ohio Regional Trauma Registry (NORTR) provided injury incidence data for a three year period (1999- 2001). The complete report (*Study of the Incidence and Progress of People with Traumatic Brain Injury,* F. Barry Knotts, MD) of this data, including surveys of survivors and their families, can be obtained from the Rehabilitation Services Commission, State of Ohio. The 12-county area covered by the report is urban, suburban, and rural, and largely representative of Ohio in general.

Table 1

Race and Gender Distribution For Patients with Traumatic Brain Injury
January 1, 1999 – December 31, 2001

Race/Ethnicity	Female	Male	*Total*
Black	97	240	337
Hispanic	29	84	113
Other	16	46	62
White	1092	1828	2920
Total	1276	2254	3530*

*Race/Ethnicity and/or Gender were not reported for 110 cases

Race/ethnicity is presented as three major groups with a fourth category of "Other." Included in the "Other" category are Asian and Native Americans in addition to any other unspecified race/ethnicity.

Table 2

Cause of Injury
Selected Data From Cause of Injury by Age Group Table
January 1, 1999 – December 31, 2001

Cause of Injury	0-13 Years	14-44 Years	45 Plus Years	Total TBI Population
Bicycle	62 (56.4%)	32 (29.0%)	16 (14.5%)	110 (3.1 %)
Fall	134 (15.2%)	145 (16.5%)	601 (68.3%)	880 (25.0%)
Motorcycle Vehicle	23 (6.7%)	1198 (65.2%)	517 (28.1%)	1838 (52.2%)
Other	132 (19.0%)	398 (57.2%)	166 (23.8%)	696 (19.7%)
Total	451	1773	1300	3524

Motorcycles and other motor vehicles are the cause of TBI in more than half of the study cases. Bicycle-related injuries account for only 3% of the total TBI population, but they account for more than half of TBIs for the 0-13 age group. The number of children sustaining head injuries while bicycling indicates that use of protective helmets is not universal. Falls account for 68% of TBIs in the 45 years and older population.

Table 3

Selected Data From Protective Device Usage Group Table

Cause of Injury	Protective Devices Used	No Protective Devices Used	Unknown/ Not Documented	Total TBI Population
Bicycle	5 (4.5%)	81 (73.6%)	24 (21.8%)	110 (3.1%)
Motorcycle/ Vehicle	777 (40.7%)	849 (44.5%)	281 (14.7%)	1907 (53.3%)
Other	18 (1.2%)	581 (37.2%)	961 (61.6%)	1560 (43.6%)
Total	800 (22.4%)	1511 (42.2%)	1266 (35.4%)	3577

When bicycling is the cause of the TBI, nearly three-fourths of the riders were not wearing a protective helmet at the time of injury. If concrete information for the cases in the *Not Documented* group could be obtained, the percentage of non-helmet use may be even higher. Nearly half of people sustaining a TBI as a result of a motor vehicle/motorcycle collision reported nonuse of a protective device (i.e. seat belt/helmet respectively).

Motorcycle helmet laws have been debated, enacted, and repealed across the country. Following is a partial list of academic findings on the effects of wearing or not wearing a helmet while riding a motorcycle:

- "The economic costs to society that are associated with excess fatalities resulting from repeals of helmet laws total at least $180 million" (Hartunian, 1983).
- "Helmet use decreased mean cost of hospitalization by more than $6,000 per patient." "Therefore, individuals who do not wear helmets should pay higher insurance premiums" (Brandt, 2002).
- "Maryland's controversial motorcycle helmet law appears to be an effective public health policy and may be responsible for saving many lives" (Auman, 2002).
- "The repeal of a motorcycle helmet law significantly increased the number and severity of brain injuries admitted to our trauma center" (Hotz, 2002).

Table 4

Selected Data from *Evidence of Blood Alcohol by Age Group*
January 1, 1999 – December 31, 2001

Age in Years	.01-.07 mg/dL	.08-Plus mg/dL	Negative	Not Tested/Not Documented	Total TBI Population
0-13	49 (11.3%	1 (0.2%)	84 (19.4%)	300 (69.1%)	434 (13.4%)
14-20	93 (18.8%	42 (8.5%)	137 (27.7%)	222 (44.9%)	494 (15.3%)
21-54	378 (25.7%	311 (21.1%)	271 (18.4%)	512 (34.8%)	1472 (45.4%)
55 +	86 (10.2%	38 (4.5%)	130 (15.5%)	587 (69.8%)	841 (25.9%)
Total	606	392	622	1621	**3241**

The lowest recorded positive alcohol category is (.01-.07 mg/dL of blood alcohol concentration (BAC)) represented 19% of the total TBI population. If the blood was sampled one or more hours after the injury, these patients' BAC levels could have been higher at the time of injury. In Ohio and many other states, 0.08% BAC is considered the level of legal intoxication. Based on this BAC, 8.5% of the patients between the ages of 14 and 20 years old would be deemed legally intoxicated. In addition to being legally intoxicated, the patients in this age group are not of legal age to be buying or consuming alcoholic beverages.

If the cases for which blood alcohol was not documented were excluded from the study population in the 14-20 year age group, then 15% of the 272 patients in this group met or exceeded the legal limit of blood alcohol concentration. Of the total TBI population (3241), there were 392 patients (12.1%) who would have been legally intoxicated at the .08 mg/dL level of alcohol concentration. If only the people tested were considered, then one-fourth of that group would be in the 'legally intoxicated" category.

Beyond the scope of this study are the medical reasons for testing BAC on all patients with a brain injury. Some sources indicate that knowing the blood alcohol concentration is important to the treatment and near follow-up care of a brain injured person. In the registry, 1621 subjects (46%) were not tested or if tested, the alcohol level was not documented. Along with the possibilities of improving trauma care, comes the question of how many people in the "not tested" group would have tested positive.

The public needs to be educated in ways to prevent TBIs and to meet the needs of survivors.

Additional information and resources are needed by the survivor and his or her family and friends to anticipate and react appropriately to symptoms. Community resources are important for all to manage the problems that stem from the TBI.

Costs & Consequences

Table 5
2000 U.S. Census Bureau Population Data
Calculated Income and Hospital Charge Data

	POPULATION	TOTAL HOSPITAL CHARGES IN ONE YEAR 1	CALCULATED INCOME LOST PER YEAR [2]	TOTAL ONE YEAR CHARGES AND INCOME LOST
NOW	1,097,894	$27,405,533.	$375,541.	$27,781,074.
OHIO	11,054,019	$275,973,720. [3]	$3,782,701. [3]	$279,756,421. [3]

[1] The number of patients, with TBIs, in a county was multiplied by the average charges for that county and then all 12 counties in the Northwest Ohio were totaled.
[2] The average personal income in each county was divided by 364 to arrive at an average daily income for the county. The average daily income was then multiplied by the number of patients in the county and multiplied by the average length of stay for the county and then all 12 counties in the Northwest Ohio were totaled.
[3] These numbers were arrived at by extending NWO data to the state of Ohio, based on population.

The income lost figure is calculated based only on the length of stay (LOS) in the hospital and does *not* include time for rehabilitation. Since the severity of a TBI can vary so greatly, some survivors do not lose income, while others may never work again. Conservatively, an estimated $4 million in income is lost in Ohio due to TBIs during one year. The calculated hospital charges in Ohio for TBI would equal approximately $275,000,000. In the state of Ohio, nearly $280,000,000 is diverted from other spending due to TBIs. Insurance companies and the government are impacted by this spending.

The state also loses tax revenue that it would have collected had these individuals received income. Using 2000 U.S. Census Bureau figures, Ohioans contribute approximately 2.6% of their personal income to the state of Ohio as personal income tax. Conservatively, $100,000 of Ohio personal income tax revenue are lost each year in connection with TBI injuries.

The physical and emotional toll associated with head and spinal cord injuries can be significant for the survivors and their families. Persons with existing disabilities from head and spinal cord injuries are at high risk for further injuries and secondary disabilities.

TBI prevention is cost effective

If the number of TBIs in Ohio was reduced by 10%, the savings would be in excess of $28,000,000. Studies have shown that every dollar spent on a bicycle helmet saves $30 in direct medical and other costs.

Risk Factors

Activities

Prevention efforts should target motor vehicle crashes, falls, firearm injury, diving, and water safety.

- "Among pedalcyclists killed, most died from head injuries. Similarly, the common cause of death among motorcyclists is catastrophic head injury. Death rates from head injuries have been shown to be twice as high among cyclists in States lacking helmet laws or having laws that apply only to young riders, compared with States where laws apply to all riders."
- For individuals ages 0-13 years, over half (56%) of TBIs involve bicycles. Among this group, nearly three-fourths (74%) were **NOT** wearing protection at the time of the injury. Bicycle helmets have proven to be effective in preventing TBIs in the event of a bicycle-related crash.
- "Falls account for 87 percent of all fractures among adults aged 65 years and older and are the second leading cause of both spinal cord injury and brain injury for this age group. Falls also cause the majority of deaths and severe injuries from head trauma among children under 14 years of age. Falls account for 90 percent of the most severe playground related injuries treated in hospital emergency departments (mostly head injuries and fractures) and one-third of reported fatalities. Head injuries are involved in about 75 percent of all reported fall related deaths associated with playground equipment."
- "Many diving related incidents also result in spinal cord injury. Diving related injury first becomes an issue during adolescence. Injuries to males outnumber injuries to females. Diving injuries account for one of eight spinal cord injuries, with half of those injuries resulting in quadriplegia."

Gender & Race

- Males have twice as many TBIs as females.
- Black and Hispanic males are more likely to suffer a TBI than their white counterparts.

Age

Among children and youth aged 0 to 14 years in the U.S.:

- Each year traumatic brain injury results in an estimated
  - 3,000 deaths
  - 29,000 hospitalizations
  - 400,000 emergency department visits.*
- Traumatic brain injury is the type of injury most often associated with death.
- The annual total of TBI related deaths is
  - More than 6 times the number the number of deaths related to HIV/AIDS*
  - 20 times the number of deaths from asthma**
  - 38 times the number of deaths from cystic fibrosis.***
  - CDC

*** NCHS, Monthly Vital Statistics Report. Vol. 45, No. 3 (S), September 30, 1996.)*
**** CDC Wonder*

Policy Issues

Many of the same policy issues that relate to other types of injuries also relate to TBIs. As discussed throughout this chapter, seat belts, bicycle and motorcycle helmets and addressing alcohol-related issues can make a dramatic impact on the incidence of TBIs.

A thorough discussion of these issues can be found in the chapters on motor vehicle traffic and non-powered vehicle related injuries. A comprehensive reference of state laws relating to transportation issues can be found on the Governors Highway Safety Association's website at http://www.statehighwaysafety.org/html/state_info/stateinfo_laws.html.

Existing Programs

Ohio Rehabilitation Services Commission

Brain Injury Association of Ohio

Recommendations to Prevent Traumatic Brain Injury

Improve Surveillance

1. Provide incentives to improve data records completion for all statewide injury databases. More complete data will allow for better identification of risk factors and design of interventions.
2. Provide infrastructure for linking data sets that allow injury patients to be tracked throughout the system from traffic records, EMS reports, hospital records, rehabilitation records and coroner reports.

Legislative Activities

3. Enact primary restraint legislation for all motor vehicle occupants and support enforcement.
4. Enact a stronger motorcycle helmet law that applies to riders of all ages. (Current law applies only to riders younger than age 18).
5. Enact legislation requring helmet use while operating or riding an all-terrain vehicle (ATV).
6. Enact legislation requiring helmet use by bicycle and other non-powered vehicle riders when riding on public roads.
7. Support increased enforcement of Ohio's recently enacted .08% blood alcohol concentration (BAC) law for motor vehicle operators.
8. Increase penalties for driving under the influence of alcohol and other drugs.
9. Increase penalties for underage alcohol drinkers, their parents, and those who provide the alcohol to underage drinkers.

Evaluate Programs

10. Create a task force to review existing programs. Continue to fund programs that successfully increase seatbelt use and disseminate those programs as best practice.

Expand training

11. Implement a statewide program to raise public awareness of traumatic brain injury.
12. Increase funding for programs effective in increasing helmet use when riding motorcycles, bicycles and other non-powered vehicles.

Target resources toward high-risk groups

13. Develop and implement focused interventions to educate those at greatest risk for TBI. Efforts should be specifically focused to young, African American and Hispanic males.

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