INTRODUCTION

The 1988 edition of the "Arizona Health Status and Vital Statistics" annual report included a special section on "Victims of Motor Vehicle Accidents and Their Injuries".* The inclusion, as of January 1989, of International Classification of Diseases codes describing external causes of injury (E-codes) in the Hospital Charges Reporting System mandated by A.R.S. 36-125.06A made this exploratory study possible. In the almost 20 years since the publication of this report there was no attempt to update its findings.

PURPOSE

This study, like the original one, has several purposes. The first is to diagram the array of outcomes from vehicular events involving an injury and to indicate what outcomes have descriptive data available. The second is to more fully describe the fatalities from 1993 to 2007. Specifically, who were the victims of these fatal vehicular accidents, e.g. drivers, occupants or pedestrians, and what were some of their demographic characteristics such as age, gender, and race/ethnicity.

The third purpose is to explore injury morbidity in order to demonstrate the larger magnitude of the motor vehicle injury problem. This exploration involves a description of actual injuries and consequences suffered by victims of vehicular events who either visited an emergency room or were treated as inpatients in the non-federal hospitals in Arizona.

Beginning with the 2000 data year in Arizona (1999 nationally), a new revision of the International Classification of Diseases (ICD), used to classify causes of death, was implemented. The Tenth Revision (ICD-10) has replaced the Ninth Revision (ICD-9), which was in effect since 1979. Another purpose of our report was to identify the breaks in comparability of mortality statistics effective with deaths occurring in 2000 as a result from the implementation of ICD-10. ICD-10 is far more detailed than ICD-9, with about 8,000 categories compared with about 5,000 categories. Some of the coding rules and rules for selecting the underlying cause of death have been changed. Before data for 2000, mortality medical information was based on manual coding of an underlying death for each certificate in accordance with WHO rules, and done locally by the Office of Vital Records. Effective with the 2000 data year, cause-of-death data presented in this publication were coded using computerized procedures of SuperMICAR (Mortality Medical Indexing and Retrieval) and ACME (Automated Classification of Medical Entities) systems.

Last but not least, an update of an Arizona-specific study of victims and outcomes of motor vehicle accidents has been long overdue.

Joanne C. Gersten and Christopher K. Mrela: *Arizona Health Status and Vital Statistics 1988*. Arizona Department of Health Services, Office of Planning and Health Status Monitoring: January 1990.
The special section on "Victims of Motor Vehicle Accidents and Their Injuries" is on pp. 70 – 84.

METHODS AND SOURCES

Three data sources are utilized in this publication: the death certificate database, the hospital discharge database, and the population denominator databases.

The death certificate database contains demographic characteristics of the deceased (age, gender, race/ethnicity, marital status, educational attainment), and cause of death. For the purpose of mortality statistics, every death is attributed to one underlying condition or underlying cause of death. The underlying cause is defined as the disease or injury that initiated the chain of events leading directly to death. It is selected from up to 20 causes and conditions entered by the physician on the death certificate. The totality of all these conditions is known as multiple cause of death. Since 2000, the causes of death are classified by the Tenth Revision of the International Classification of Diseases (ICD-10), replacing the Ninth Revision used during 1979-1999.

The hospital discharge database contains two types of records: inpatient hospitalizations and emergency room visits. An inpatient discharge occurs when a person who was admitted to a hospital leaves that hospital. A person who has been hospitalized more than once in a given calendar year will be counted multiple times as a discharge and included more than once in the hospital inpatient discharge data set; thus, the numbers we report here are for discharges, not persons. Up to nine diagnoses are coded for each discharge. Diagnostic groupings and code numbers are based on the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). Information about the patient's race/ethnicity is available only for inpatient hospitalizations but not for emergency room visits. The "E" code classification is used to describe both the *mechanism* of injury (e.g. motor vehicle traffic, fall, poisoning), but also the manner or *intent* of the injury (e.g. self-inflicted, assault, accident). In 2007, approximately one in six inpatient hospitalizations for injury (and one in five emergency room visits) did not have an external cause code.

Beginning with the 2000 data year, a new population standard for the age adjustment of mortality rates has replaced the standard based on the 1940 population and used since 1943. The new set of age-adjustment weights uses the year 2000 estimated U.S. population as a standard. The age-adjusted rates based on the year 2000 standard are different because the year 2000 population standard, which has an older age structure, gives more weight than the 1940 standard to death rates at older ages where mortality is higher.

Age-adjustment is important for any comparative analysis of mortality risks associated with a motor vehicle-related injury because both the risk of death and the risk of being in a motor vehicle accident vary by age. The rates for 1993-1999 were recomputed for the new population standard so that mortality rates can be compared over time. Population denominators for Arizona residents, used to calculate the age-adjusted mortality rates for 1993 - 1999, are "Bridged-Race Intercensal Population Estimates for July 1, 1990 – July 1, 1999", available from the National Center for Health Statistics (NCHS: http://www.cdc.gov/nchs/about/major/dvs/popbridge/datadoc.htm). The year 2000 mortality rates are based on census enumerations. Several data sources were utilized in producing the 2001 - 2007 population estimates. Detailed information is available at http://www.azdhs.gov/plan/menu/info/pd.htm .

The average-annual mortality rates by single year of age, gender, and race/ethnicity for 1993 – 2007 were computed using the year 2000 Census enumerations (population at mid-point) multiplied by fifteen

OUTCOMES OF MOTOR VEHICLE ACCIDENTS

Figure A diagrams the possible outcomes to people injured in an event involving an automobile, truck, bus or other motor vehicle. Death certificates describe fatal outcomes (row F in diagram) to Arizona residents irrespective of where they occur. Death at the scene of the motor vehicle accident or during transit to hospital is not identified on the death certificate. Place of death is more likely to be specified if the fatal outcome occurs within the framework of institutionalized health care, i.e., on arrival to a facility, in emergency treatment or after admission to either hospital or other health care facility. However, approximately one-half of death certificates give place of death as "other" (in 2007, the category "other" was used on 538 out of 1,035 death certificates where the underlying cause of deaths was classified as motor vehicle accident: http://www.azdhs.gov/plan/report/ahs/ahs2007/pdf/2b11.pdf). Also, injury death coding gives precedence to the external cause, e.g. driver of motor vehicle, vehicular collision with pedestrian, rather than part of body harmed, so death certificate data on type of bodily trauma are limited.

Injured persons still alive at the scene of a vehicular event may require transport for health care attention or may walk away because the injury is correctly or incorrectly perceived as minor. Data are not available for either the number of injured persons who walk away or the earlier injured walk-aways who recycle for care from a private physician or – prior to 2004 – an emergency room (**Figure A**).

Data on injuries again become available when people are treated in an emergency room or admitted to inpatient care, with information on external cause of injury, type of bodily trauma, and charges for the health services provided. Starting from the pool of inpatients injured in a motor vehicle event, the proportion who die (row F), are discharged to home or self care (row C), or are discharged to another health care facility (row E) can be described.

Data on chronic impairment (row B), staying in good health (row A) and recycling into the health care system for late effects of the original motor vehicle accident are not available after persons are discharged from the hospital to other health care institutions (row E) or to home/self care (row C).

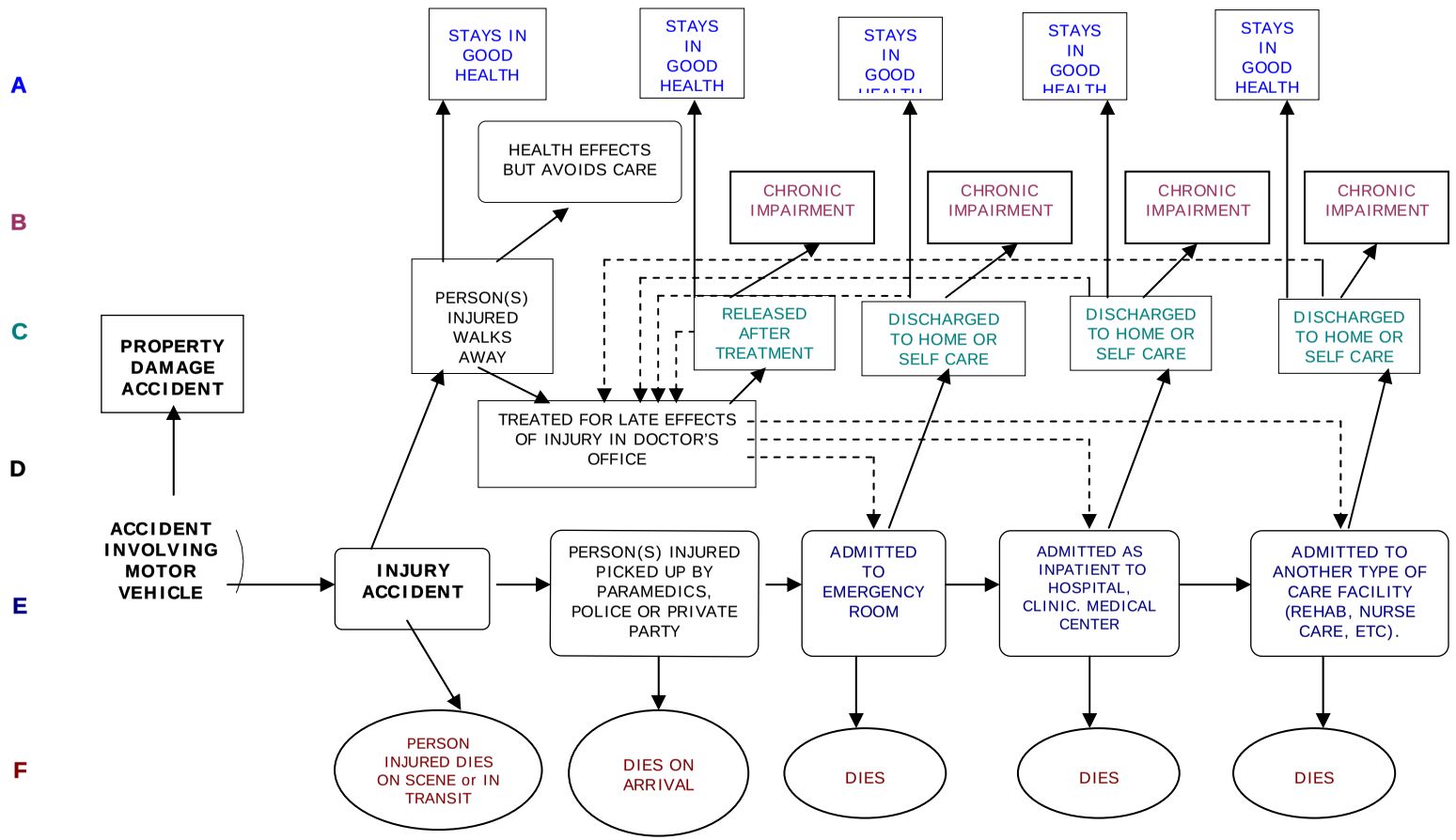


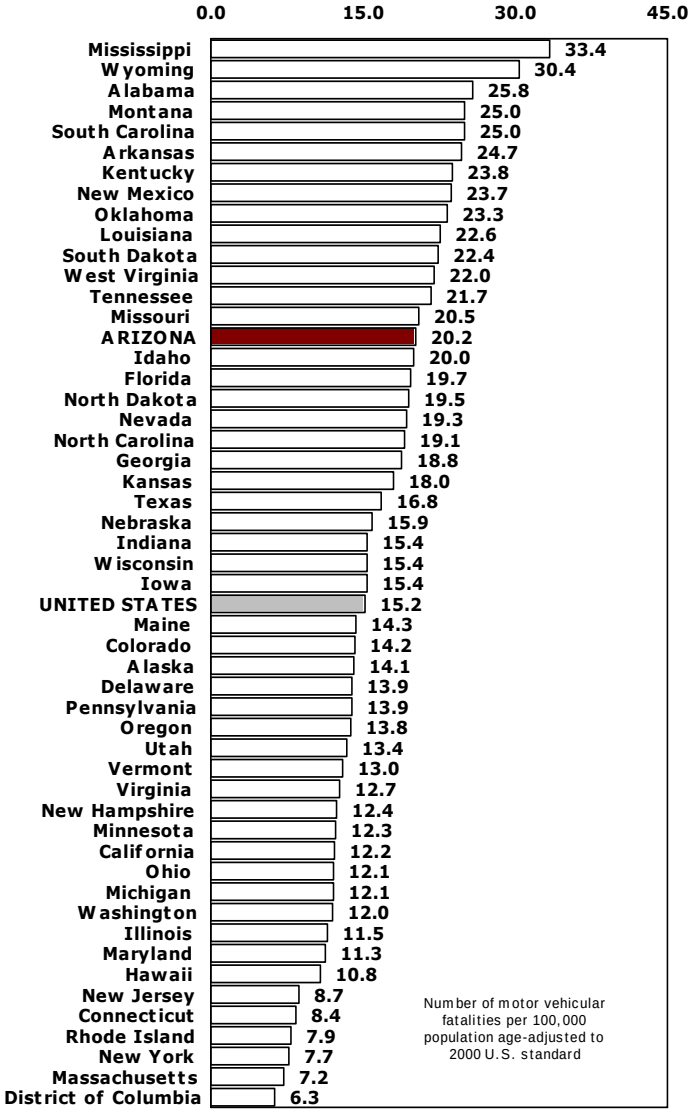
Figure A. Possible Outcomes of Motor Vehicle-Related Injuries

COMPARISON OF THE AGE-ADJUSTED MORTALITY RATES FOR MOTOR VEHICLE-RELATED INJURIES BY STATE

In 2005, the age-adjusted rates of mortality from unintentional injuries related to motor vehicles ranged from 6.3 deaths per 100,000 residents in the District of Columbia (**Figure B**) to 33.4/100,000 in Mississippi. Arizona had the 15th highest motor vehicle accident death rate among the 50 states and the District of Columbia. Twenty years earlier, in 1985, Arizona ranked 10th highest nationally.

Injuries as a result of motor vehicle accidents have killed Arizonans at a rate 33 percent greater than the national rate of 15.2 deaths per 100,000 population in 2005.

Figure B
Age-Adjusted Mortality Rates for Motor Vehicle-Related Injuries by State in 2005*



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*The latest available year. All age-adjusted mortality rates by state discussed in this section are from the Web-based Injury Statistics Query and Reporting System (WISQARS), available online at http://www.cdc.gov/ncipc/wisqars/ . The 2005 rate for Arizona computed using the WISQARS site is higher than the age-adjusted rate of 18.9 in our publications (see Table 1-1). The rates differ because both the numerators and the denominators are different. Briefly, WISQARS uses the National Center for Health Statistics (NCHS) death data from all registration areas. Unlike our mortality database, the NCHS data collected by the state of occurrence include all out-of-state deaths of Arizona residents in motor vehicle accidents and from other causes. On the other hand, the annual population estimates for Arizona from the U. S. Census Bureau have been historically lower than the estimates developed locally under the auspices of the Population Technical Advisory Committee. To conclude, the rates computed on WISQARS site are based on more motor vehicle-related deaths (1,200 vs. 1,137) and a smaller estimated population (5,952,083 vs. 6,044,985).

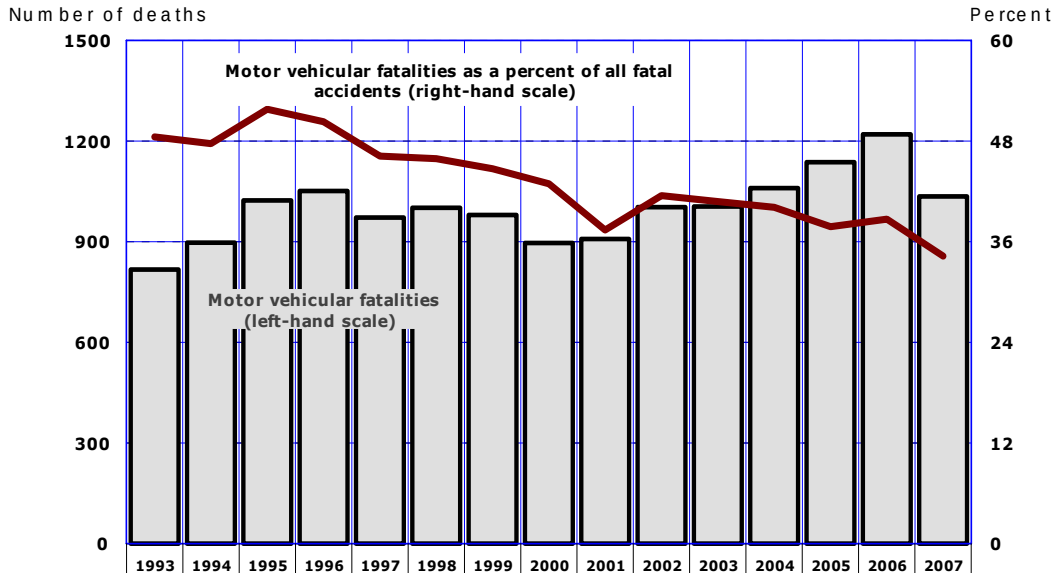
CHANGES IN THE PROPORTIONAL CONTRIBUTION OF FATAL VEHICULAR ACCIDENTS TO ALL UNINTENTIONAL INJURY DEATHS

Motor vehicle-related injuries continue to be the leading cause of unintentional injury deaths both nationally and in Arizona. From 1993 to 2007, 15,005 Arizonans were fatally injured in a motor vehicle accident for an average annual count of 1,000 deaths per year. Excessive annual death rates meant that almost 4,000 Arizonans died who would not have died if they had the same mortality odds as their U.S. counterparts. From 1993 to 2007, Arizona males accounted for 2.2 times more motor vehicle fatalities than did females (10,277 and 4,728 respectively).

However, the proportional contribution of fatal vehicular accidents to all unintentional injury deaths has been gradually declining in Arizona. In 1995, motor vehicle accidents accounted for 51.8 percent of all fatal accidents (**Figure C**), compared to 34.3 percent in 2007.

The decline in the proportional contribution of motor vehicle accidents to all unintentional injury deaths cannot be attributed to the decrease in the number of fatal vehicular accidents. Rather, it can be ascribed to the increasing incidence of fall injuries and drug overdoses. The number of fatal drug overdoses increased 4.4 times from 153 in 1993 to 669 in 2007. The number of deaths from fall injuries increased 2.9 times from 248 in 1993 to 720 in 2007. In 2007, fall injuries and drug overdoses accounted for a combined 46.1 percent of unintentional injury deaths in the State.

Figure C
Number of Motor Vehicular Fatalities and Motor Vehicular Fatalities as a Percent of all Fatal Accidents by Year, Arizona Residents, 1993-2007



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Motor vehicular fatalities	817	897	1023	1051	972	1001	980	896	908	1003	1005	1060	1137	1220	1035
All fatal accidents	1686	1879	1973	2091	2104	2182	2192	2087	2430	2416	2466	2641	3006	3156	3014
Percent of all fatal accidents	48.5	47.7	51.8	50.3	46.2	45.9	44.7	42.9	37.4	41.5	40.8	40.1	37.8	38.7	34.3

DATA ORGANIZATION

The charts and tables comprising *Injuries and Deaths of Arizona Residents in Motor Vehicle Accidents* are organized into seven major sections:

1. Trends in Age-Adjusted Mortality Rates for Motor Vehicle-Related Injuries by Gender and Race/Ethnicity, Arizona Residents, 1993-2007

2. Patterns in Mortality from Motor Vehicle-Related Injuries by Single-Year of Age, Gender and Race Ethnicity, Arizona Residents, 1993-2007

3. Characteristics of Persons Fatally Injured by Motor Vehicles, Arizona Residents, 1993-2007

4. Emergency Room Visits and Inpatient Discharges with Motor Vehicle-Related Injury Diagnosis by Type of Injured Person, Arizona Residents, 2005-2007

5. Types of Injuries and Types of Injured Persons among Emergency Room Visits and Inpatient Discharges with Motor Vehicle-Related Injury Diagnosis, Arizona Residents, 2005-2007

6. Probability of Various Outcomes for Inpatient Discharges and Emergency Room Visits with Motor Vehicle-Related Injury Diagnosis by Type of Injury and Type of Injured Person, Arizona Residents, 2005-2007

7. Hospital Charges Incurred by Patients with Motor Vehicle-Related Injury Diagnosis by Type of Injured Person and Type of Injury, Arizona Residents, 2005-2007

SUMMARY OF FINDINGS

√ From 1993 to 2007, 15,005 Arizonans were fatally injured in a motor vehicle accident for an average annual count of 1,000 deaths per year.

√ Excessive annual death rates meant that almost 4,000 Arizonans died who would not have died if they had the same mortality odds as their U.S. counterparts.

√ The mortality rate for motor vehicle-related injuries declined by 29.9 percent from a recent peak of 23.1 deaths per 100,000 age-adjusted population in 1995 to 16.2/100,000 in 2007. Both males and females had nearly equal reductions in the death rate for motor vehicle-related injuries.

√ From 1993 to 2007 males were 2.2 times more likely than females to be motor vehicle fatalities.

√ In 1993-2007, the distribution of mortality rates for motor vehicle accidents was bimodal, reaching the first peak at age 21 (40.1 deaths per 100,000 persons), tapering off, and then rising to a second peak at age 84 (40.2 deaths per 100,000 persons). Interestingly, 21 year olds shared the mortality risk in motor vehicle accidents with persons exactly 4 times their age.

√ While no specific age confers immunity from injuries and/or deaths in motor vehicle accidents, reaching the legal age to become a licensed driver of a motor vehicle, dramatically increases the mortality risk for both males and females.

√ In 1993-2007, compared to a male mortality rate of 13.4/100,000 at age 14, the mortality rate at age 18 was 3.9 times greater (52.3/100,000), and 4.3 times greater at age 21 (58.2/100,000). The magnitude of the increase in the mortality was not quite as steep among females. Compared to a female mortality rate in motor vehicle accidents of 8.4/100,000 at 14, the mortality rate was 2.2 times as high at age 16 (18.7/100,000), and 2.8 times greater at age 18 (23.9/100,000).

√ Adolescents and young adults 15-24 years old were the age group with the second highest death rate from motor vehicle accidents in every year observed (in 1993-2007, Arizonans 85 years old and older had the highest mortality rate among the age groups).

√ The mortality rate for motor vehicle-related injuries among adolescents and young adults 15-24 years old declined by 31.4 percent from a recent peak of 40.7/100,000 in 1995 to 27.9/100,000 in 2007.

√ Beginning in 2000 the mode of transport has been unknown for the majority of the motor vehicle fatalities. It is an unintended result of the implementation of the Tenth Revision of the International Classification of Diseases. Unfortunately, it is not possible to design an effective prevention strategy without taking into consideration characteristics of victims of motor vehicle accidents. Air bags and seat belts are known to decrease the number of serious injuries and fatalities among the occupants of motor vehicles, but they do nothing for persons outside of vehicles. Similarly, wearing a helmet may work well for a motorcycle rider but it's unlikely to help a pedestrian.

√ From January 1, 2005 to December 31, 2007, 151,196 Arizona residents were treated in the emergency rooms (ER) because of motor vehicle-related injuries; additionally, 22,608 persons were admitted as inpatients to non-federal, short-stay hospitals.

√ In 2005-2007, among those who were treated in emergency rooms (ER) drivers were most prevalent at 52.2 percent, followed by occupants at 25.5 percent, motorcycle riders at 8.8 percent, pedestrians at 3.7 percent, and pedal cyclists at 2.1 percent

√ Three hundred of the ER injury patients died during the treatment for a case-fatality rate of 0.2 percent. Pedestrians' case fatality rate was the highest (1.2 percent), followed by motorcycle riders (0.4 percent), and pedal cyclists (0.3 percent).

√ Among the 22,608 Arizonans who survived long enough to become inpatients, 534 died during their hospital stay for a case fatality of 2.4 percent. Again, pedestrians' case fatality rate was the highest (4.9 percent), followed by pedal cyclists (3.2 percent). Pedestrians also were more likely than any other victim category to require aftercare (25.9 percent).

√ The average length of stay for inpatients with motor vehicle-related injury diagnosis was 5.2 days. Average lengths of stay in the hospital varied by the five major victim types. Pedestrians, followed by motorcycle riders had the highest average length of stay (6.8 days and 5.4 days, respectively). Non-driving occupants of motor vehicles had the shortest average stay (4.6 days).

√ In 2007, total charges incurred by ER patients with a motor vehicle-related injury diagnosis exceeded $150 million ($156,230,596).

√ Patients who had injury to blood vessels had the highest average ER charges ($19,956). Pedestrians, followed by motorcycle riders, and pedal cyclists had the highest average ER charges ($3,369, $3,297, and $3,201, respectively).

√ In 2007, the total hospital bill for the injured inpatients was more than $450 million ($452,433,771).

√ Inpatients who had burns had the highest average inpatients charges ($204,658). Pedestrians, followed by motorcycle riders, had the highest average hospital charges ($72,949 and $60,230).