

Hospital-based emergency department visits in children with motor vehicle traffic accidents: estimates from the nationwide emergency department sample

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Background: The purpose of this study is to provide nationally representative estimates of children visiting hospital-based emergency departments (ED) for motor vehicle traffic accidents (MVTA) in the United States during the year of 2008.

Methods: Nationwide Emergency Department Sample for 2008 was used. All pediatric (age ≤ 18 years) ED visits with external cause for injury ICD-9-diagnostic codes for MVTA were selected. Outcomes examined included discharge status following ED visit and presence of concomitant injuries. Descriptive statistics was used to summarize the estimates.

Results: Totally 604 027 hospital-based ED visits occurred in the United States among children (age ≤ 18 years) due to MVTA. Following an ED visit, 91% were discharged routinely, while 6% were admitted as inpatients into the same hospital. A total of 928 children died in the ED. A total of 34 004 ED visits required inpatient admission into the same hospital and 768 patients died during hospitalization. Mean charge per ED visit was \$1887 and total ED charges across the United States were close to \$970 million. Among those admitted into the same hospital following ED visit ($n=34\ 004$), the mean hospitalization charge was \$53 726 and total

hospitalization charge across the entire United States were \$1.8 billion.

Conclusions: Study findings illustrate the burden associated with pediatric ED visits due to MVTA. Close to \$970 million of hospital charges were incurred by children who made an ED visit due to a MVTA during 2008 and about \$1.8 billion was incurred among those hospitalized following an ED visit.

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Introduction

In the United States, 42 million motor vehicle traffic accidents (MVTA) occurred in the year of 2008,^[1] resulting in almost 165 000 fatalities. A study of traffic accidents on the German autobahn found that daytime accidents and accidents at interchanges or construction sites were generally less severe.^[2] They also found that accidents caused by collision with objects beside the road, accidents involving pedestrians or motorbikes and accidents caused by poor visibility were generally more severe. A study in England evaluated injuries from road traffic accidents and found that 82% of pedestrians, 83% of cyclists, and 53% of car occupants incurred their injury within five kilometers of home.^[3] Another British study demonstrated evaluated MVTA related hospital admissions in relation to seasonal variation and found that more MVTA admissions occurred in winter.^[4]

One study evaluated hospitalizations associated with MVTA among teenagers in the United States^[5] and found that each hospitalization resulted in charges of \$25 000. However, little is known about the hospital emergency department (ED) resource use related to

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MVTA among children. A study of traumatic brain injury in pediatric populations found that MVTA (27.9%) was the second most common etiology.^[6] A review of hospitalizations in the United States due to facial fractures^[7] found that 16% were caused in MVTA. Several studies have considered a variety of characteristics associated with MVTA. Prior research has demonstrated that lower socioeconomic status is associated with an increased incidence of MVA and increased mortality from such accidents.^[8] Motorcycle accidents account for a disproportionately high number of the deaths from MVTA.^[9]

An Australian study evaluated the relationship between age and severity of injury from major trauma.^[10] This study demonstrated that risk of death increased with age with an inflexion point at age of 47 years. Those below the age of 15 years had a significantly lower severity of injury. The objective of the current study is to provide nationally representative estimates of hospital-based ED visits due to MVTA among children (aged 18 years or less) occurring in the United States during the year of 2008 and is focused on four-wheel motorized vehicles. The demographic characteristics of the children making these visits are examined and outcomes including charges associated with the ED visits and subsequent hospitalization are computed. The importance of this study is that it will identify the volume of ED visits being made by children due to MVTA at a national level and identify the use of hospital resource to manage these visits. This information may guide prevention programs, inform funding and training to hospitals and identify high risk groups which may be targeted for prevention programs.

Methods

The current study is a retrospective analysis of the Nationwide Emergency Department Sample (NEDS) for the year of 2008. NEDS is a component of the Healthcare Cost and Utilization Project (HCUP).^[11] The NEDS is the largest database that is a uniform, multistate dataset of community hospitals in the United States and is available for research purposes through the Agency for Healthcare Research and Quality, Rockville, Maryland. It provides information on close to 150 million ED visits.^[11] After completing the data user agreement with HCUP, one of the authors obtained the dataset and conducted the analyses. In accordance with the data user agreement, any individual cell counts less than or equal to 10 cannot be presented in order to preserve patient confidentiality. In accordance with this, such low counts are not presented in the current study.

All pediatric (age ≤ 18 years) ED visits with external cause for injury diagnostic codes for MVTA were

selected for analysis. The variables examined in the current study included age, gender, day of ED visit, disposition from the ED, insurance status, hospital region, and median household income based on the zip code income quartiles. Types of MVTA which resulted in the ED visit were examined by using ICD-9-CM codes for external cause of injury in the 4 diagnostic fields dedicated to these codes in the NEDS dataset. The types of MVTA examined included: MVTA involving collision with train (E810), MVTA involving re-entrant collision with another motor vehicle (E811), other MVTA involving collision with motor vehicle (E812), MVTA involving collision with other vehicle (E813), MVTA involving collision with pedestrian (E814), MVTA involving collision on the highway (E815), MVTA due to loss of control without collision on the highway (E816), noncollision MVTA while boarding or alighting (E817), other noncollision MVTA (E818), MVTA of unspecified nature (E819), assault by transport vehicle (E968.5), and injuries by crashing of motor vehicle: undetermined whether accidentally or purposely inflicted (E988.5). Types of injuries were identified by using clinical classification software (CCS) codes in the 15 diagnoses fields available in the NEDS dataset. The injuries examined included: trauma related joint disorders and dislocations (CCS code 225), fracture of neck of the femur (226), spinal cord injury (227), skull and facial fractures (228), fracture of the upper limb (229), fracture of the lower limb (230), other fractures (231), sprains and strains (232), intracranial injury (233), crushing or internal injuries (234), open wounds of head/neck/trunk (235), open wounds of the extremities (236), superficial injury/contusions (239), and burns (240). The outcomes examined included the ED charges, total hospitalization charges (among those admitted as inpatients into the same hospital following an ED visit), and length of stay in hospital. The hospital charges include all charges for services and goods associated with the hospitalization and exclude professional charges and non-covered charges.

Simple descriptive statistics was used to examine and present the data. All estimates were calculated to national levels using the discharge weight variable. All analyses were conducted using SAS Version 9.3 software (SAS Institute, Cary, NC).

Results

During the year of 2008, a total of 604 027 hospital-based ED visits occurred in children (aged ≤ 18 years) due to MVTA in the United States. The mean age per ED visit was 12.6 years (Table 1) and 52% of all ED visits occurred in females. Most ED visits (71%)

occurred on weekdays. Following an ED visit, 91% of the children were discharged routinely, whereas 1.5% were transferred to another hospital and 6% were admitted as inpatients into the same hospital. A total of 928 children died in the ED. The major payers were private insurance plans (55% of all ED visits) and Medicaid (21%). Uninsured comprised 17% of ED visits. Hospitals located in the southern regions of the country accounted for 44% of all ED visits. Close to 61% of ED visits were among those residing in geographical areas with zip code income levels less than \$49 000.

A total of 34 004 ED visits required inpatient admission into the same hospital following the ED visit. Following hospitalization, 83% were routinely discharged, 3% were transferred to another acute care hospital, 6.4% were transferred to a long-term care facility such as a skilled nursing facility including 5% to home health care, and 0.4% were discharged against medical advice. A total of 768 patients died during hospitalization (2.3% of ED visits that required inpatient admission into the same hospital).

The different types of MVTA are shown in Table 2. The frequently reported types of MVTA included MVTA involving collision with other motor vehicles (56%), MVTA of unspecified nature (14%), MVTA due to loss of control without collision on the highway (12%), MVTA involving collision of pedestrians (4%), other non-collision MVTA (4%), and other MVTA involving collision on the highway (3%).

The types of injuries reported while visiting the ED are summarized in Table 3. The frequently occurring injuries included superficial injuries/contusions (45%), sprains and strains (28%), open wounds of head/neck/trunk (7%), intracranial injuries (6%), fracture of the upper limbs (4%), open wounds of the extremities (4%), fracture of the lower limbs (3%), crushing injury or internal injuries (3%), skull and facial fractures (2%), and other fractures (2%).

The mean charge per ED visit was \$1887 and the total ED charges across the entire United States was close to \$970 million (Table 4). Among those admitted into the same hospital following an ED visit ($n=34\ 004$) the mean hospitalization charges were \$53 726 and the total hospitalization charges across the entire United States were \$1.8 billion. Among these patients, the mean length of stay in hospital was 4.8 days and the total hospitalization were 162 107 days.

Discussion

Existing research has shown that MVTA is the leading cause of unintentional death in children aged ≤ 19

Table 1. Characteristics of hospital-based emergency department visits due to motor vehicle traffic accidents ($n=604\ 027$)

Characteristics	<i>n</i> (%)
Gender	
Male	288 561 (48)
Female	315 209 (52)
Admission day	
Weekday	426 987 (71)
Weekends	176 986 (29)
Disposition from emergency department	
Routine	550 342 (91)
Transfer to another short term hospital	8996 (1.5)
Transfer to other facilities (skilled nursing facility)	2043 (<1)
Home health care	347 (<1)
Discharged against medical advice	2580 (<1)
Admitted as inpatient into the same hospital	34 004 (6)
Died in emergency department	928 (<1)
Unknown	4786 (<1)
Insurance status	
Medicare	1650 (<1)
Medicaid	126 200 (21)
Private insurance	329 972 (55)
Uninsured	103 191 (17)
Other insurance plans	37 283 (6)
Hospital region	
Northeast	100 948 (17)
Midwest	134 252 (22)
South	267 166 (44)
West	101 660 (17)
Teaching status	
Metropolitan non-teaching	251 762 (42)
Metropolitan teaching	235 783 (39)
Non-metropolitan	116 482 (19)
Median household income levels based on zip code	
\$1-\$38 999	182 415 (31)
\$39 000-\$48 999	176 028 (30)
\$49 999-\$63 999	129 204 (22)
>\$63 999	104 195 (17)
Age, y	
Mean age	12.6
<1	16 392 (2.7)
1	16 549 (2.7)
2	16 241 (2.7)
3	15 995 (2.6)
4	16 506 (2.7)
5	16 058 (2.7)
6	16 822 (2.8)
7	17 513 (2.9)
8	18 512 (3.1)
9	19 042 (3.2)
10	19 871 (3.3)
11	20 255 (3.4)
12	21 890 (3.6)
13	23 654 (3.9)
14	28 988 (4.8)
15	39 049 (6.5)
16	70 565 (11.7)
17	94 600 (15.7)
18	11 5525 (19.1)

Table 2. Types of motor vehicle traffic accidents

Type of motor vehicle accidents (ICD-9-CM E-code)	n (%)	Male	Female
Motor vehicle traffic accident involving collision with train (E810)	527 (<1)	268 (0.09%)	259 (0.08%)
Motor vehicle traffic accident involving re-entrant collision with another motor vehicle (E811)	635 (<1)	266 (0.09%)	369 (0.1%)
Other motor vehicle traffic accident involving collision with motor vehicle (E812)	337 621 (56)	144 288 (50.0%)	193 204 (61.3%)
Motor vehicle traffic accident involving collision with other vehicle (E813)	23 891 (4)	14 955 (5.2%)	8924 (2.8%)
Motor vehicle traffic accident involving collision with pedestrian (E814)	33 592 (6)	20 770 (7.2%)	12 807 (4.1%)
Other motor vehicle traffic accident involving collision on the highway (E815)	20 349 (3)	10 213 (3.5%)	10 128 (3.2%)
Motor vehicle traffic accident due to loss of control, without collision on the highway (E816)	72 012 (12)	38 753 (13.4%)	33 204 (10.5%)
Noncollision motor vehicle traffic accident while boarding or alighting (E817)	8587 (1)	4180 (1.4%)	4407 (1.4%)
Other noncollision motor vehicle traffic accident (E818)	24 212 (4)	14 151 (4.9%)	10 044 (3.2%)
Motor vehicle traffic accident of unspecified nature (E819)	82 688 (14)	40 772 (14.1%)	41 896 (13.3%)
Assault by transport vehicle (E968.5)	172 (<1)	82 (0.03%)	90 (0.03%)
Injury by crashing of motor vehicle: undetermined whether accidentally or purposely inflicted (E988.5)	44 (<1)	28 (0.01%)	16 (0.005%)

Table 3. Types of injuries

Types of injuries (CCS codes)	n (%)	Male	Female
Joint disorders and dislocations; trauma-related (225)	3551 (<1)	2240 (0.8)	1311 (0.4%)
Fracture of neck of femur (hip) (226)	693 (<1)	447 (0.2)	247 (0.08%)
Spinal cord injury (227)	762 (<1)	464 (0.2)	298 (0.09%)
Skull and face fractures (228)	10 242 (2)	6150 (2.1)	4080 (1.3%)
Fracture of upper limbs (229)	23 217 (4)	14 020 (4.9)	9170 (2.9%)
Fracture of lower limbs (230)	17 451 (3)	11 351 (3.9)	6074 (1.9%)
Other fractures (231)	14 422 (2)	7976 (2.8)	6438 (2.0%)
Sprains and strains (232)	172 033 (28)	67 190 (23.3)	104 818 (33.3%)
Intracranial injury (233)	36 167 (6)	20 980 (7.3)	15 144 (4.8%)
Crushing injury or internal injury (234)	16 688 (3)	9900 (3.4)	6785 (2.2%)
Open wounds of head, neck, and trunk (235)	43 476 (7)	25 477 (9.2)	16 857 (5.3%)
Open wounds of extremities (236)	22 782 (4)	13 767 (4.8)	8993 (2.9%)
Superficial injury, contusion (239)	273 089 (45)	134 830 (46.7)	138 119 (43.8%)
Burns (240)	1926 (<1)	934 (0.3)	992 (0.3%)

CCS: clinical classification software.

Table 4. Hospital outcomes

Outcomes	Mean (range)	Standard error of mean	Total across entire United States
Hospital ED charges	\$1887 (\$100-\$73 794)	\$54	\$970 565 927
Total hospitalization charges among those admitted into the same hospital following ED visits	\$53 726 (\$133-\$1 272 845)	\$3074	\$1 820 580 271
Length of stay in hospital among those admitted into the same hospital following ED visits	4.8 d (<24 h-177 d)	0.2	162 107 d

ED: emergency department.

years.^[12] There are little data on the types of injuries associated with MVTA in the United States; however, a study by Peek-Asa et al^[5] found that in hospitalized patients aged 15-18 years intracranial injury was the most common individual cause of injury (24%). Our study used the Nationwide Emergency Department Sample to present nationally representative estimates of hospital-based ED visits attributed to MVTA in children aged ≤ 18 years. The most frequently reported injury documented during an ED visit following an MVTA in this age group was superficial injury and contusion (45%). Furthermore, intracranial injuries represented only 6% of ED visits due to MVTA. There are two major differences between our study and the study by Peek-Asa et al.^[5] Peek-Asa et al^[5] considered

individuals of 15-18 years old, whereas our study considered those aged from 1 to 18 years. Moreover, a previous study^[4] considered individuals hospitalized as a result of MVTA, whereas the current study considered hospital-based ED visits. In the current study, 91% of the ED visits resulted in routine discharge and only 5.6% were hospitalized. Those routinely discharged may have represented less severe injuries.

A recent study^[8] showed that lower socioeconomic status was associated with a higher incidence of MVTA. Our study confirmed this pattern in a pediatric population and showed that about 61% of ED visits were made by those residing in geographical areas with a mean income level below \$49 000. More specifically, this accounted for 358 443 ED visits by children due to

MVTA. Driver education about child safety that targets these regions with a mean income level below \$49 000 may lead to a large reduction in ED visits by children because of MVTA.

The most common type of MVTA was collision with another vehicle, which represented 60% of the ED visits due to MVTA. Modern automobiles have many safety features but have not been able to prevent accidents. For example, current technologies include the use of radar to detect a slow vehicle ahead and enhance braking capabilities. "Accident proof" vehicles that are now being developed have autonomous braking systems preventing collision with another vehicle or object. The introduction of these vehicles could lead to a major reduction in ED visits due to MVTA.

A significant number of pediatric ED visits resulting from MVTA involved loss of control on a highway without collision (12%). More comprehensive driver preparedness training for these situations could help reduce ED visits due to loss of control on a highway. Additionally, the development of "smart highways" could also reduce collisions.^[13] The Greater New Orleans reported on a local smart highway which integrates sensors to determine flow of traffic, screens to inform drivers of traffic conditions and protocols to notify police/ambulance as needed.

Peek-Asa et al^[5] examined the hospital charges associated with teenage hospitalizations due to MVTA and found that mean hospital charge was \$49 352 and the mean length of hospital stay was 5.1 days. The current study revealed very similar results and found the mean hospitalization cost to be \$53 726 with a mean length of hospital stay of 4.8 days. It should be noted that the Nationwide Emergency Department Sample dataset does not provide information on costs associated with outpatient care, rehabilitative physical therapy, prescription medicines or miscellaneous costs involved with managing the consequences of MVTA. Subsequently, the total costs association with MVTA could be substantially higher than the amount that the current study documents.

In the current study, the southern states accounted for 44% of hospital ED visits due to MVTA. Most southern states have a minimum age of unsupervised driving of 16 years which is similar to most of the rest of the United States.^[14] However, a study^[15] from the southern state of Texas found that unlicensed drivers below the age of 15 accounted for 12.3% of fatal crashes. In fact, unlicensed crash rates were higher for Texas than any other state with a comparable population. Unfortunately, our dataset does not capture information on the driver during the MVTA.

The current study focuses on individuals aged up to 18 years. This age group includes novice drivers who

are learning to drive. Existing research^[16] has shown that being a young driver is the strongest predictor of future MVTA. Unfortunately, our dataset does not capture the information who was driving the vehicle. A recent study^[17] has demonstrated that crash rates were 75% less when driving with an adult passenger. The passing of a bill that requires young drivers to have an adult passenger may lead to a reduction in hospital ED visits due to MVTA. A study^[18] from Australia found that rural dwelling children who were legally able to drive agricultural vehicles off-road before they were eligible to receive their on-road license displayed less risk taking behaviors. These children also had a large amount of off-road driving experience before they received their on-road license. Though controversial, providing early driving experience in a controlled environment may lead to less risk-taking behavior and result in a reduction in ED visits due to MVTA among young drivers.

The current study provides nationally representative estimates of characteristics of children visiting hospital-based EDs with MVTA. The nationwide hospitalization charges (\$1.8 billion) and ED charges (\$970 million) associated with MVTA during the year 2008 were documented. The public health burden associated with MVTA among children is highlighted.

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