Factors affecting hospital charges and length of stay from teenage motor vehicle crash-related hospitalizations among United States teenagers, 2002–2007

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ABSTRACT

Motor vehicle crashes are the leading cause of death for all teenagers, and each year a far greater number of teens are hospitalized with non-fatal injuries. This retrospective cohort study used the National Inpatient Sample data to examine hospitalizations from the years 2002 to 2007 for 15–18-year-old teenagers who had been admitted due to a motor vehicle crash. More than 23,000 teens were hospitalized for motor vehicle-related crash injuries each year, for a total of 139,880 over the 6-year period. Total hospital charges exceeded $1 billion almost every year, with a median hospital charge of more than $25,000. Older teens, boys, those with fractures, internal injuries or intracranial injuries, and Medicaid/Medicare as a payer were associated with higher hospital charges and longer lengths of stay. These high charges and hospitalization periods pose a significant burden on teens, their families, and the health care system.

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1. Introduction

Motor vehicle crashes are the leading cause of death for all children between the ages of 1 and 19 years, but crash and fatality rates rise dramatically during the first year of driving, usually between the ages of 15 and 16 (Centers for Disease Control and Prevention, 2010a,b; Chen et al., 2000; Insurance Institute for Highway Safety, 2003, 2005; Shope and Bingham, 2008). Despite successful efforts to reduce teen crash rates through policies such as Graduated Driver's Licensing legislation (Hartling et al., 2004; Hedlund and Compton, 2005; Rice et al., 2004; Simpson, 2003), death, injury, and crash rates remain markedly higher for teenagers than drivers of any other age group (Mayhew et al., 2003).

In addition to the nearly 5500 deaths among teenagers due to motor vehicle crashes each year, more than 20,000 are hospitalized and more than 400,000 receive emergency medical attention (Centers for Disease Control and Prevention, 2010a,b). These injuries result in missed school days for the child, lost work days for the parent, financial strain, as well as the potential for long-term physical disability and psychological trauma (Corso et al., 2006; Gardner et al., 2007; Winston et al., 2002).

In addition to financial hardship for the family, these crashes also pose a significant burden to the health care system. The lifetime costs for the motor vehicle injuries sustained in the United States in 2000 were estimated to exceed $89 billion dollars, with more than $14 billion in medical care costs (Corso et al., 2006). However, few studies have evaluated the factors that affect these high hospital charges. One example, by Gardner et al. (2007), estimated total charges for all pediatric (under 20 years of age) road traffic-related hospitalizations in the year 2003 as $2042 million, with the highest individual charges for those 18 and 19 years of age. Gardner did not focus specifically on teenagers and examined all road users. Teenager drivers, which are recognized as a growing public health priority, may represent that highest hospitalization costs for motor vehicle occupants (Centers for Disease Control and Prevention, 2009).

We examine length of hospital stay and hospital charges for hospitalizations for motor vehicle occupant injuries among teens aged 15–18 for the years 2002–2007 in the United States to estimate the health care burden and to identify factors associated with increased charges and hospital stays.

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Table 1
Hospitalizations for teenagers aged 15–18 involved in motor vehicle traffic crashes, National Inpatient Sample, 2002–2007.

	National estimate[a]		Total hospital charges[b] ($)			LOS (days)	
	n	%	Mean	Median	Total charges (million)	Mean	Median
Total estimated cases	139,880	100	49,352	25,590	6819	5.1	2.3
Year							
2002	23,158	16.6	42,594	21,556	975	4.7	2.1
2003	26,141	18.7	48,630	24,888	1255	5	2.2
2004	26,435	18.9	48,929	26,679	1283	5.2	2.4
2005	22,126	15.8	52,121	26,686	1146	5.2	2.2
2006	21,907	15.7	49,016	26,089	1065	5.2	2.3
2007	20,113	14.4	56,049	28,595	1095	5.6	2.4
Age							
15	17,505	12.5	47,398	23,832	822	5.1	2.2
16	38,616	27.6	48,824	25,467	1868	5.2	2.4
17	39,774	28.4	47,473	25,423	1862	4.9	2.1
18	43,984	31.4	52,298	26,793	2268	5.3	2.3
Gender							
Male	82,036	58.9	51,601	26,748	4183	5.3	2.2
Female	57,138	41.1	46,306	24,108	2615	5	2.3
Patient crash involvement							
Driver of MV	56,742	40.6	49,521	26,143	2777	5.1	2.3
Passenger of MV	52,136	37.3	48,525	24,693	2505	5	2.2
Driver of motorcycle	7705	5.5	49,634	25,969	373	5.1	2.2
Passenger of motorcycle	912	0.7	62,308	29,379	56	7	2.6
Other[c]	22,385	16	50,229	26,037	1107	5.5	2.3
Mortality status							
Died	3738	2.7	85,531	59,561	316	2.9	0.7
Survived	135,914	97.3	48,188	24,980	6469	5.2	2.3

[a] Weighted to discharges from all U.S. community, non-rehabilitation hospitals.
[b] Total hospital charges were weighted for national estimates of total charges and adjusted to the year 2007 inflation rates for in-hospital care.
[c] Other includes railway, animal, bicycle, and pedestrian crashes in motor vehicle traffic.

2. Methods and materials

2.1. Data source

This retrospective cohort is composed of hospitalizations for 15–18-year-old teenagers who had been admitted due to a motor vehicle crash. Data were from the Nationwide Inpatient Sample (NIS) of the Health Care Utilization Project (HCUP) provided by the Agency for Healthcare Research and Quality (AHRQ) for the years 2002–2007 (AHRQ, 2004). The NIS is the largest all-payer inpatient care database in the United States. Each year, the NIS provides information on 5–8 million inpatient stays from approximately 1000 hospitals located in 35 states (AHRQ, 2004).

The NIS is designed to approximate a 20-percent sample of U.S. hospitals, defined as "all nonfederal, short-term, general, and other specialty hospitals, excluding hospital units of institutions" (AHRQ, 2004). A stratified probability sample of hospitals was used with sampling probabilities proportional to the number of U.S. hospitals in each stratum. The five hospital characteristics used to define the strata were: ownership/control, bed size, teaching status, urban/rural location, and region (AHRQ, 2004).

To select our study cases, we used the Clinical Classifications Software (CCS), a uniform and standardized coding system developed by HCUP that classifies diagnosis and procedures into clinically meaningful categories based on the *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) (Clinical Classification Software, 2010). All patients aged 15–18 with a diagnosis of a motor vehicle traffic crash (CCS diagnosis of 2607) were included for analysis (which corresponds to ICD codes: E810-E819, E9685, and E9885). This classification excludes any transport, bicycle, or pedestrian injury that does not involve motor vehicle traffic.

The main outcomes were hospital length of stay in days and hospital charges per discharge. Hospital charges were obtained from the discharge data and reflect the billing amount for the hospitalization. These charges may not reflect total medical care costs for the injury. These were compared across patient characteristics including year of hospitalization, age, gender, patient crash involvement (MV driver, passenger, motorcycle driver, passenger), and mortality status. Outcomes were also examined by injury characteristics including primary diagnosis, alcohol and drug comorbidity diagnoses, discharge status, and payer source. Primary diagnoses were identified using CCS diagnosis codes. Alcohol use and drug comorbidities are included in the database as comorbidity codes (codes 2910 and 2913 for alcohol abuse and 64830–64834 for drug dependency). Alcohol and drug toxicology reports that indicate use at admission are not included in the NIS data.

2.2. Analysis

National estimates of hospitalizations were calculated using discharge-level weighting provided by the HCUP (AHRQ, 2004). Means and medians were examined for hospital length of stay (LOS) and hospital charges. Medians were included because the data were heavily skewed. Hospital charges were adjusted to the year 2007 (last quarter) levels, using the consumer price index for inpatient hospital services provided by the Bureau of Labor Statistics (Bureau of Labor Statistics, 2008).

Linear regression models were used to assess patient and injury characteristics associated with LOS and hospital charges per discharge. Models were adjusted for patient characteristics including age, gender, primary diagnosis, and payer source and clustered on hospital and variables used for hospital strata (ownership/control, bed size, teaching status, urban/rural location, and region). Log transformation was performed to account for the skewed distribution of LOS and hospital charges per discharge, and log transformation increased the normality of the residuals from the regression models.

The Cook's *D* statistic was used in the model diagnostics. The cutoff $D_i > 4/n$ was used, where n was the sample size, to exclude the influential observations that do not fit with the regression model. The findings reported from the linear regression models were based