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The impact of aggressive driving-related injuries in Ohio, 2004–2009

Kristen A. Conner [a], Gary A. Smith [a,b,c,*]

[a] Center for Injury Research and Policy, The Research Institute at Nationwide Children's Hospital, Columbus, OH, USA
[b] The Ohio State University College of Medicine, Department of Pediatrics, Columbus, OH, USA
[c] Child Injury Prevention Alliance, Columbus, OH, USA

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ABSTRACT

Objective: This study describes the medical and financial impact (hospital charges) of aggressive driving-related injuries in Ohio. *Methods:* Statewide crash and hospital databases were probabilistically linked for 2004 through 2009. Descriptive analyses and multivariate regression modeling of multiply-imputed data on motor vehicle occupants involved in aggressive driving-related crashes were performed. *Results:* There were 821,136 motor vehicle occupants involved in aggressive driving-related crashes in Ohio from 2004 through 2009; injuries were sustained by 15.0%. The rate of aggressive driving-related crashes was highest among drivers ages 16 to 19 years (3787.1 crashes per 100,000 licensed drivers). Aggressive driving-related inpatients accrued more than $250.8 million in hospital charges and 28,366 inpatient days of treatment in 2004 through 2009. Occupants ages 16 to 19 years had higher odds of sustaining injury when involved in aggressive driving-related crashes (OR = 1.10; 95% CI = 1.07, 1.12; $p < 0.001$), but lower odds of death, inpatient admission, ISS ≥ 16, and rehabilitation. *Discussion:* Aggressive driving-related injuries have a substantial medical and financial impact in Ohio. *Practical Applications:* Compared with other highway safety issues, prevention efforts aimed specifically at aggressive driving are lacking. Targeted enforcement and public awareness campaigns are needed.

1. Introduction

Road traffic injuries are the leading cause of injury-related deaths worldwide (World Health Organization, 2004). In the United States, motor vehicle crashes are the leading cause of death among individuals ages 5 to 34 (Centers for Disease Control and Prevention, 2010). In 2009 alone, more than 2.3 million adults were treated in U.S. emergency departments for injuries sustained in motor vehicle crashes (Centers for Disease Control and Prevention, 2011). In addition to hospital costs, millions of dollars are lost annually in productivity, property damage, increased insurance costs, and municipal expenses. It was estimated that the lifetime costs of motor vehicle-related deaths and injuries topped $70 billion in 2005 (Naumann, Dellinger, Zaloshnja, Lawrence, & Miller, 2010).

Aggressive, distracted, and impaired driving have been identified as important contributors to motor vehicle-related death and disability. Impaired driving and distracted driving have received the majority of research and media attention, while aggressive driving has been relatively understudied. The paucity of attention may be, in part, due to the lack of a cohesive definition of the concept of aggressive driving and its associated behaviors and predictors in the traffic safety literature. Some studies have lumped together any aggressive driving behaviors regardless of intent (Dukes, Clayton, Jenkins, Miller, & Rodgers, 2001; Vanlaar, Simpson, Mayhew, & Robertson, 2008). Others have used intent as the primary factor to distinguish aggressive driving from road rage (Dula & Geller, 2003; Efrat & Shoham, 2013; Ellison-Potter, Bell, & Deffenbacher, 2001; Wells-Parker et al., 2002). In these cases, road rage is classified as a distinct criminal behavior with the intention of harming others through the use of a motor vehicle, while aggressive driving is used to refer to unsafe driving in violation of traffic laws. The National Highway Traffic Safety Administration (NHTSA) has taken steps to create a more formal definition and defines aggressive driving as "when individuals commit a combination of moving traffic offenses so as to endanger other persons or property" (National Highway Traffic Safety Administration, United States Department of Transportation, 2000). According to NHTSA, aggressive driving includes such behaviors as exceeding the posted speed limit, following too closely, erratic or unsafe lane changes, improperly signaling lane changes, and failure to obey traffic control devices (stop signs, yield signs, traffic signals, etc.). A study of data from the Fatality Analysis Reporting System

Abbreviations: AAA, American Automobile Association; CI, confidence interval; CDC, Centers for Disease Control and Prevention; CODES, Crash Outcome Data Evaluation System; CPI, Consumer Price Index; E-code, external cause of injury code; ED, emergency department; FARS, Fatality Analysis Reporting System; FHWA, Federal Highway Administration; GHSA, Governors Highway Safety Association; ICD-9 CM, International Classification of Diseases—Ninth Revision; ISS, injury severity score; LOS, length of stay; MPH, miles per hour; NHTSA, National Highway Traffic Safety Administration; OHA, Ohio Hospital Association; OR, odds ratio; SUV, sport utility vehicle; TBI, traumatic brain injury; US, United States; WHO, World Health Organization.

* Corresponding author at: Center for Injury Research and Policy, The Research Institute at Nationwide Children's Hospital, 700 Children's Drive; Columbus, OH 43205, USA. Tel.: +1 614 355 5850; fax: +1 614 355 5897.
E-mail address: gary.smith@nationwidechildrens.org (G.A. Smith).

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(FARS) found that 55.7% of fatal crashes involved one or more unsafe driving behaviors typically associated with aggressive driving (AAA Foundation for Traffic Safety, 2009). NHTSA considers speeding to be among the most dangerous of aggressive driving behaviors (National Highway Traffic Safety Administration, United States Department of Transportation, 2000). Despite reductions in the overall number of speed-related crashes in the United States, the proportion of speed-related fatalities has remained unchanged during the last 25 years, and almost one-third of all motor vehicle crash-related fatalities continue to be attributed to speeding (AAA Foundation for Traffic Safety, 2009). NHTSA estimates that speeding-related crashes account for 17.5% of the total economic cost of motor vehicle crashes nationwide (National Center for Statistics and Analysis, National Highway Traffic Safety Administration, United States Department of Transportation, 2007). Among drivers involved in fatal crashes, young males are most likely to be speeding. In 2007, 39% of male drivers ages 15 to 20 years involved in fatal crashes were speeding at the time of the crash (National Center for Statistics and Analysis, National Highway Traffic Safety Administration, United States Department of Transportation, 2007).

According to results from the 2011 AAA Foundation's Traffic Safety Culture Index, 88% of respondents rated aggressive drivers as a serious or extremely serious traffic safety problem. However, more than half of those surveyed reported exceeding the speed limit by 15 mph on major highways in the past 30 days, and 26% reported exceeding the speed limit on neighborhood streets (AAA Foundation for Traffic Safety, 2012). In the 2008 survey, drivers also admitted to performing numerous other potentially aggressive acts, including speeding up to beat a yellow light (58%), tailgating (22%), and deliberately running red lights (6%; AAA Foundation for Traffic Safety, 2008).

Comprehensive and detailed state-specific data regarding aggressive driving-related injuries and their medical and financial impact in Ohio are lacking. The purpose of this study is to describe demographic and incident characteristics of aggressive driving-related motor vehicle crashes and the impact of these crashes on hospital resource utilization, specifically hospital charges and length of stay, in Ohio for 2004 through 2009.

2. Methods

2.1. Study population and variable definitions

This study used two probabilistically linked statewide databases for 2004 through 2009: (a) the Ohio Crash Records, and (b) the Ohio Hospital Database containing inpatient admissions and emergency department visits. The institutional review board of the authors' institution approved the use of these databases.

The Ohio Crash Records were obtained from the Ohio Department of Public Safety and contain all police-reported crash incidents that involve an injury event or property damage in excess of $400. Approximately 350,000 crashes are reported to this database by Ohio law enforcement agencies annually. Variables from this database used for this study include descriptive information about the crashes, vehicles and occupants involved, including age, gender, restraint use, motor vehicle type, time of crash, and contributing circumstances. The contributing circumstances variable is a police-reported measure of driver behavior that contributed to a crash. Aggressive driving-related crashes in this study were defined by driver behavior (contributing circumstances); a crash was considered to be aggressive driving-related if one or more of the following circumstances were reported by the police: (a) operating vehicle in erratic/reckless/careless/negligent/aggressive manner, (b) exceeded speed limit, (c) unsafe speed, or (d) followed too closely (National Highway Traffic Safety Administration, United States Department of Transportation, 2000). "Exceeded speed limit" is typically used when weather is not a factor, and a vehicle is traveling faster than the posted speed limit. "Unsafe speed" is assigned when a vehicle is traveling too fast for conditions, regardless of posted speed limit (E. Kennedy, personal communication, April 5, 2013). Due to the lack of information on intentionality in the Ohio crash record, we opted not to include red light or stop sign running in our definition, because the intent of these actions was unclear. Information on aggressive driving was not available for bicyclists or pedestrians, and these individuals were not included in this study. Rural and urban crash location was determined according to urban–rural continuum codes derived from the Office of Management and Budget, United States Department of Agriculture definitions of metropolitan and non-metropolitan counties (Butler & Beale, 1994).

The Ohio Hospital Database was obtained from the Ohio Hospital Association (OHA). There were 192 hospitals in Ohio and neighboring states that submitted clinical and financial information to the OHA database during the study years. This database includes information, such as length of stay (LOS), hospital charges, up to 15 *International Classification of Diseases—Ninth Revision (ICD-9 CM)* diagnosis codes, one or more external cause of injury codes (E-codes), and discharge status for inpatient admissions and ED visits. Injury Severity Score (ISS) was determined from ICD-9 CM injury diagnosis codes using ICDMAP-90 software (Baker, O'Neill, Haddon, & Long, 1974; Mackenzie & Sacco, 1997). Barell Matrix classification from injury diagnosis codes was used to determine nature of injury (e.g., fracture) and body region injured (e.g., torso; Barell et al., 2002). For traumatic brain injury (TBI), ICD-9 CM diagnosis code 959.01 (head injury, unspecified) was included in the study definition of TBI, in accordance with the Centers for Disease Control and Prevention's (CDC) TBI definition (Faul, Xu, Wald, & Coronado, 2010). Hospital charges were adjusted for inflation using the Hospital Services Consumer Price Index (CPI) published by the Bureau of Labor Statistics, United States Department of Labor (Bureau of Labor Statistics, United States Department of Labor, 2009). All estimates of charges presented in this study are in 2009 dollars. Due to the large volume of records and to facilitate data linkage, a sub-dataset containing only those hospital records containing an ICD-9 CM diagnosis code in the range of 800.00–959.9, or an E-code indicating an external cause of injury (E800–E999, or V714), was created and used for data linkage.

For the purposes of this study, an individual was considered injured if either the crash record or hospital record indicated an injury. In the crash record, injury status is noted by the responding police officer according to the KABCO injury designation system. The KABCO system was created for injury coding by police officers at the scene and does not require that police officers make a medical judgment (National Safety Council, 1990). In this study, a vehicle occupant was considered injured if the crash record indicated fatal, incapacitating, non-incapacitating, or possible injury according to the KABCO system. For those individuals with a linked hospital record, the primary cause of injury was defined as the first-listed E-code in the hospital record. Cases with an E-code in the range of E870–E879 and E930.0–E948.9, indicating the adverse effects of medical care or drugs, were excluded. For individuals involved in motor vehicle crashes without a linked hospital record, a death was determined to have occurred if the crash record indicated a fatal injury according to the KABCO system. For those with a linked hospital record, a death was determined if the hospital record indicated a fatality.

3. Theory/calculation

3.1. Probabilistic linkage

Probabilistic record linkage was used to link the crash and hospital databases. Probabilistic linkage has been described in detail elsewhere (Fellegi & Sunter, 1969; Jaro, 1995; McGlincy, 2004). Using a hierarchical Bayesian model, probabilistic record linkage is accomplished by comparing multiple fields to calculate linkage likelihood ratios, match weights, and a probability that two records refer to the same person or event. The statewide data sets used in this study lack common unique