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Factors affecting injury severity of vehicle occupants following road traffic collisions

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ABSTRACT

Aim: We aimed to define factors affecting injury severity of vehicle occupants following road traffic collisions (RTC).
Patients and methods: 422 vehicle occupants (343 males, 81.3%) with RTC-related injuries were prospectively studied over 18 months. General linear model was used to test the effect of age, gender, alcohol and drug use, time of injury, mechanism of injury, size and speed of the vehicle, position in the vehicle, seatbelt usage, and air bag deployment on the Injury Severity Score (ISS) of the vehicle occupants.
Results: The mean (range) age of patients was 28.2 (1–78) years and the mean (range) ISS was 7.9 (1–50). Front impact was the most common mechanism of injury (32.9%) followed by rollover (25.6%) and side impact (22.3%). 18.2% used seatbelts. The general linear model was highly significant and showed that mechanism of injury ($p < 0.0001$), speed of the vehicle ($p = 0.02$), and age of the vehicle occupant ($p = 0.03$) significantly affected the Injury Severity Score.
Conclusions: The mechanism of the RTC, the vehicle speed, and age of the vehicle occupant are the most important factors affecting the severity of road traffic collision injuries. A detailed history of the mechanism of injury is important for alerting clinicians to severity of injury, the need for admission, and workup of the patients. Furthermore, strict speed limit enforcement is an injury prevention priority in our community.

Introduction

Road traffic collisions (RTCs) are a global health care problem that dramatically affect the lives of road users and impact the economic development. They cause approximately 1.24 million deaths and another 20–50 million nonfatal injuries per year worldwide [1]. The cost of RTCs in the United Arab Emirates (UAE) during the period of 2009–2011 was estimated to be 4.6 billion US dollars (1.6% of the gross national product) [2]. Factors increasing the severity RTC-related injuries have to be well-studied and brought into attention so as to define priorities of RTC prevention.

Different independent factors affect the severity of RTC injuries of vehicle occupants including age, gender and body mass index of the occupant, driver impairment due to alcohol or sleep, mechanism of injury, speed and size of the vehicle, position of the occupant in the vehicle, and use of safety belts and air bags [3–10]. The relationship between vehicle speed and RTC mortality is exponential, so high vehicle speed is associated with high RTC mortality [11]. The effects of these factors will vary in different settings. Previous studies on factors affecting the severity of road traffic collision injuries used different approaches. Outcome variables in these studies varied between being binary categorical (like death or survival); multiple categories (nominal), or ordinal in nature with different levels of severity [12].

Injury Severity Score (ISS) is well accepted as a good clinical marker of injury severity of RTCs. Changing ISS into categorical data will weaken the strength of the statistical analysis. In comparison, analyzing the real value of ISS as an outcome variable, which ranges between 1 and 75, will enable us to use the general linear model to define the factors affecting injury severity and will strengthen the analysis [13]. We have previously used this approach to study complex mechanisms of injury like

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horse-related injuries [14]. We are not aware of any study that has used the real values of ISS of vehicle occupants, ranging between 1 and 75, as an outcome variable in a general linear model.

Al-Ain city, which is located in the east of UAE, has a population of about half a million inhabitants and a very modern road infrastructure. Its population is very young, with a male: female ratio of 2:1. More than 90% of its manpower is expatriate young workers [15]. We aimed in the present study to define factors affecting the Injury Severity Score (ISS) of injured vehicle occupants following RTCs using a general linear model.

Patients and methods

Ethics statement

Approval for the study was obtained from the Local Ethics Committee of Al-Ain Health District Area (UAE RECA/02/44). All patients or their caregivers signed a consent form for permitting the use of anonymous data for research or audit. They were assured that the data will be used only for research and audit purposes, and that their personal information will be kept confidential and not passed to a third party.

Setting

Al-Ain and Tawam Hospitals are the only two public hospitals admitting and treating road traffic injured patients in Al-Ain city which had a population of about half a million at the time of the study [16]. Wide modern well-structured paved highways with proper electrical lighting having three lanes in each direction connect different parts of the city and extend horizontally over a wide area of 20 km × 30 km. The two directions of the highways are separated by land islands planted with palm trees. Paved pedestrian side pathways are located on both sides. The speed limit for these highways inside the city is 80 km per hour. 90% of Al-Ain city licensed vehicles are light vehicles including small cars and sport utility vehicles (SUVs) [17]. These are modern vehicles with high standard safety requirements including seatbelts and front air bags.

A full time Trauma Research Fellow (HOE) daily interviewed the RTC injured patients or their relatives soon after hospital admission. The patients were then followed up through the whole period of hospitalization. Data on speed, type of vehicle, and mechanism of injury were collected by self-reporting of the patients. Patients with decreased level of consciousness at the time of admission who became fully conscious during their hospital stay were interviewed after they could recall the collision and answer questions.

Data collection and scoring

All patients who were admitted to Al-Ain and Tawam Hospitals, or who died in the Emergency Departments after being involved in a road traffic collision were included in the Road Traffic Collision (RTC) Injury Registry of Al-Ain city. Data were collected prospectively from April 2006 to October 2007 on a specially designed hard copy form and then entered into our electronic registry. Patients who were treated at the Emergency Department and discharged home or those who arrived dead to the hospital were excluded. Inclusion criteria for the subjects of the study were every (1) occupant of a small car (sedan, 5 passengers or less) or a SUV who was (2) included in the Road Traffic Collision Registry of Al-Ain city and (3) had the data on the speed of vehicle at collision.

Buses, light trucks, heavy trucks and unknown vehicles were excluded to make the data more homogenous and strengthen the statistical analysis. During the study period, 86% of vehicles involved in road traffic collisions in UAE were small cars and SUVs [18] which is similar to our Registry [19]. Patients who did not have data on speed of the vehicle were excluded from the study. Data studied included age, gender, alcohol and drug use, time of injury, size of the vehicle (small vehicle or sport utility vehicle (SUV)), speed of vehicle, mechanism of injury, position of the occupant in vehicle, seatbelt usage, and air bag deployment.

Mechanisms of injury were classified as follows: rear impact, front impact, side impact, rollover and ejection from vehicle. When there were multiple mechanisms, the later mechanism in this list was designated as the mechanism of injury. This classification depended on published data on severity of injury depending on the mechanism [20–26]. The Injury Severity Score (ISS) was calculated manually, using the abbreviated injury scale handbook [27].

Statistical methods

The general linear model (GLM) was used to define the relationship between a dependent continuous outcome variable and multiple independent variables. It needs only the outcome dependent variable to have a normal distribution while the independent variables can be binomial, ordinal or continuous. This model allows testing for different interactions between dependent variables [28].

The data were repeatedly transformed and tested until the best approximation to normal distribution was reached. Log transformation of the ISS produced the best normal distribution. The general linear model tested was as follows: Log ISS = gender of the patient, age of the patient, alcohol and drug use, time of injury, speed of vehicle, size of vehicle, mechanism of injury, position in vehicle, seatbelt usage and air bag deployment. Age and speed were entered as continuous data while the other variables including the mechanism of injury as categorical data.

Different models with different interactions were tested in the general linear model. The studied interactions included the interaction between speed and mass of the vehicle, mechanism of injury and seatbelt use, mechanism of injury and speed, and finally seatbelt use and air bag deployment. All these interactions were not significant and were omitted from the final analysis. The model included type III sum of squares error because the data were unbalanced. The residuals of the final model were examined to determine whether the assumptions of the statistical analysis were correct. These assumptions included the normal distribution and homogeneity of data. Data were analyzed using the Statistical Package for the Social Sciences (IBM-SPSS version 20, Chicago, IL). A p value of less than 0.05 was accepted as statistically significant.

Results

The total number for RTC injured patients in our registry was 1008 patients, 783 were vehicle occupants. 653 were small vehicle or SUV occupants. Out of the 653 small vehicle or SUV occupants, 422 (65%) had complete data on speed of the vehicle and were included in the study. Table 1 shows the demography of the studied population. 343 were males (81.3%). The patients had a mean (range) age of 28.2 (1–78) years and a mean (range) ISS of 7.91 (1–50). 177 patients (42%) had an ISS of less than 5. Only 71 patients (16.8%) had an ISS of more than 15. Front impact was the most common mechanism of injury (32.9%) followed by rollover (25.6%) and side impact (22.3%). 78% were in vehicles having a speed higher than the legal limit of 80 km/h. 19.2% were in vehicles travelling in speeds higher than 120 km/h reaching up to 220 km/h. Only 18.2% used seatbelts and air bags were deployed in 10.2% of the cases. 12.6% were back seat passengers. Eight patients (1.9%) were under the effect of alcohol or drugs. 129 (30.8%) had