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Risk factors associated with the severity of injury outcome for paediatric road trauma

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ABSTRACT

Road trauma is one of the most common causes of injury for children. Yet risk factors associated with different levels of injury severity for childhood road trauma have not been examined in-depth. This study identifies crash and injury risk factors associated with the severity of non-fatal injury outcome for paediatric road trauma. A retrospective analysis was conducted of paediatric road trauma identified in linked police-reported and hospitalisation records during 1 January 2001 to 31 December 2011 in New South Wales (NSW), Australia. The linkage rate was 54%. Injury severity was calculated from diagnosis classifications in hospital records using the International Classification of Disease Injury Severity Score. Univariate and multi-variable logistic regression was conducted. There were 2412 car occupants, 1701 pedestrians and 612 pedal cyclists hospitalised where their hospital record linked to a police report. For car occupants, unauthorised vehicle drivers had twice the odds (OR: 2.21, 95%CI 1.47–3.34) and learner/provisional drivers had one and a half times higher odds (OR: 1.54, 95%CI 1.15–2.07) of a child car occupant sustaining a serious injury compared to a minor injury. For pedal cyclists and pedestrians, there were lower odds of a crash occurring during school commuting time and higher odds of a crash occurring during the weekend or on a dry road for children who sustained a serious versus a minor injury. Injury prevention initiatives, such as restraint and helmet use, that should reduce injury and/or crash severity are advocated.

Introduction

Road trauma is one of the most common injuries experienced by children worldwide [1]. Motor vehicle traffic-related deaths are the leading cause of injury mortality for young people aged 19 years or less in the United States (US) [2] and Australia [3]. In Australia, a further 14,400 individuals aged 19 years or less are hospitalised as a result of all land transport injuries each year [4]. Of these, approximately 2830 injuries are as a result of road trauma on a public road involving children aged 14 years or less [4]. Within New South Wales (NSW), the most populous state in Australia with almost 7.3 million residents, representing one-third of Australia's population [5], road trauma represents the most common cause of injury treated for children aged 15 years or less in the 14 major trauma centres [6].

Injuries sustained following road trauma, for the most part, have been examined using hospital-based administrative data collections, such as emergency department (ED) or hospital separation records or through examining data from trauma registries [7–9]. These data collections usually contain detailed information regarding the injuries experienced and treatment received, but limited information regarding the circumstances of the crash (including road infrastructure or road conditions) and associated crash (such as vehicle speed or operator fatigue) or injury risk factors (such as restraint use). While often under-enumerating the number of road crashes [10–14], police reports are able to provide information on the crash circumstances and associated crash and injury risk factors. However, police-reports usually do not contain details of injuries sustained, but in some jurisdictions, police are asked to provide an indication of the severity of injuries experienced by an individual, although injury severity is often found to be misclassified by police [11,15,16].

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By linking hospital records and police reports to examine road trauma, detailed information across the injury continuum (i.e. from crash and injury risk factors to injury event circumstances to information on injury treatment and outcomes) can be examined. In addition, injury severity estimates can be calculated from hospital administrative records using a diagnosis-based severity scale and survival outcome [17,18], negating the need to rely on police-identified estimates of injury severity. This process enables robust information across the injury spectrum (i.e. minor, moderate, and serious injuries) to also be examined for road trauma.

Information on road trauma from trauma registries usually over-represents severely injured children. Examining linked hospital admission and police-reported crash data would enable a comparison of crash and injury risk factors for all levels of injury severity to be conducted. This would provide a more representative sample of paediatric road trauma of all severities and allow the crash characteristics and risk factors associated with different levels of injury severity to be determined. The aim of this study is to identify risk factors associated with the severity of non-fatal injury outcome for paediatric road trauma using linked police-reported and hospital admission data during 2001–2011 for NSW.

Method

A retrospective analysis of paediatric injury (i.e. aged 16 years or less, based on child trauma transport protocol in NSW) following road trauma identified in linked police-reported crash and hospital admission records during 1 January 2001 to 31 December 2011 was conducted. Ethics approval was obtained from the NSW Population and Health Services Research Ethics Committee (2010/10/273).

Data collections

The Admitted Patient Data Collection (APDC) includes information on all inpatient admissions from all public and private hospitals, private hospital day procedures, and public psychiatric hospitals in NSW. The APDC contains information on patient demographics, source of referral, diagnoses, external cause(s), hospital separation type (e.g. discharge, death) and clinical procedures. Diagnoses and external cause codes are classified using the International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM) [19]. Any APDC records with the separation coded as death (i.e. died in hospital) were excluded. Only APDC records where the patient was aged 16 years or less at the time of admission were included.

The CrashLink data collection contains information on all police-reported road traffic crashes on a public road in NSW where a person was unintentionally fatally or non-fatally injured, or at least one motor vehicle was towed away. Information pertaining to the crash and conditions at the incident site, the traffic unit or vehicle, and the vehicle controller and any casualties resulting from the crash are recorded. Each individual is identified as being non-injured, injured or killed (i.e. died within 30 days). No information on injury severity is available. Individuals who were non-injured or killed were excluded. Road users were identified using traffic unit group and included only the three most common traffic unit groups for paediatric injuries (i.e. car occupants, pedal cyclists, pedestrians). School commuting time was identified as either travel to or from school from 0730 to 0930 h and from 1430 to 1700 h on a weekday during school terms.

Data linkage

The APDC was probabilistically linked to the police-reported crashes in CrashLink by the Centre for Health Record Linkage (CHeReL) using *ChoiceMaker* software [20]. The CHeReL uses identifying information (e.g. name, address, date of birth, gender) to create a person project number (PPN) for each unique person identified in the linkage process. A successful link was defined as when the PPN matched in both data collections, and the admission date in the APDC was on the same day or the next day as the crash date in CrashLink. Upper and lower probability cut-offs started at 0.75 and 0.25 for a linkage and were adjusted for each individual linkage to ensure false links were kept to a minimum. Record groups with probabilities in between the cut-offs were subject to clerical review. The overall linkage rate for road trauma recorded by the police to road traffic-related hospital admissions was 54%.

Injury severity

Injury severity was calculated using the International Classification of Disease Injury Severity Score (ICISS). The ICISS has been compared with the Abbreviated Injury Scale (AIS) and has proved equivalent or superior in assessing mortality risk [17,21,22]. The ICISS is derived for each person by summing the probability of survival for each injury diagnosis using survival risk ratios (SRR) calculated for each injury diagnosis [17]. In a prior study of all land transport trauma using linked police-reported crashes, hospitalisation and mortality records, the diagnosis classifications recorded within hospital records and survival outcome from mortality records for 109,843 individuals were used to generate SRRs for all ICD-10 injury codes during 2001–2007 [18]. These data represent a census of all land transport trauma in NSW during the period, and for each ICD injury (ICD_i) the SRR was calculated from Eq. (1).

$$SRR_{ICD_i} = \frac{\text{Number of individuals with injury } ICD_i \text{ that survived}}{\text{Total number of individuals with injury } ICD_i} \quad (1)$$

In the current study, injury severity was calculated using each individual's injury diagnosis classifications, using the previously developed SRRs. The ICISS has been compared with the Abbreviated Injury Scale (AIS) and has proved equivalent or superior in assessing mortality risk [17,21,22]. Dayal et al. [23] suggested ICISS levels to define minor, moderate and serious injury, with an ICISS of $\leq$0.941 used to define serious injury in order to minimise threats to validity [24] (Table 1). This is equivalent to a survival probability of 94.1% or a 5.9% probability of death. These severity definitions were used for the current study.

Data management and analysis

All analyses were performed using SAS version 9.4 [25]. Individual (e.g. age, gender), vehicle (e.g. road user, collision mode), environmental (e.g. single/multiple vehicle, curved road, intersection, time of day, weekend), and injury (e.g. injury type, injury severity, length of hospital stay) risk factors for road trauma were identified. Univariate predictors of injury severity were examined using logistic regression for each road user. The univariate predictors of injury severity were then included in multi-variable logistic regression models for each road user using the method of purposeful selection [26], where statistical significance was assessed using 0.25. In the multi-variable model the significance of both main effects and interactions was assessed at 0.1, with each interaction effect assessed separately. Each non-significant variable was also reinserted back into the multi-variable model to assess for possible confounding (i.e. change in the parameter estimates of 15% compared against the full model). If confounding was identified the variable was retained in the model.

In the multi-variable model the dependent variable was injury severity for each road user. All sub-categories of each data variable