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Predictors of recovery in cyclists hospitalised for orthopaedic trauma following an on-road crash

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ABSTRACT

Background: As cycling-related injury rates are on the rise, there is a need to understand the long term outcomes of these patients in order to quantify the burden of injury and to inform injury prevention strategies. This study aimed to investigate predictors of return to work and functional recovery in a cohort of cyclists hospitalised for orthopaedic trauma from crashes occurring on-road.

Methods: A retrospective analysis of data from the Victorian Orthopaedic Trauma Outcomes Registry (VOTOR) was conducted for patients who were hospitalised for orthopaedic trauma following a cycling crash that occurred on-road between July 2007 and June 2015.

Results: There were 1787 injured cyclists admitted at the participating hospitals. Most cyclists were male (79%), resided in major cities (89%) and were in the highest socioeconomic quintile (52%). The majority of crashes were either non-collisions (41%) or collisions with a motor vehicle (35%). A smaller proportion of cyclists who collided with motor vehicles had returned to work and had returned to pre-injury functional levels at 12 months post-injury, when compared to collisions with other impact counterparts and non-collisions. Mixed effects logistic regression models revealed that compensable patients demonstrated lower odds of complete functional recovery and return to work when compared with non-compensable patients.

Conclusion: Cyclists who collided with motor vehicles had worse outcomes compared to crashes with other impact counterparts and non-collision events. These findings provide support for reducing the potential for interaction between cyclists and motor vehicles.

1. Introduction

Cycling has been demonstrated as a sustainable, healthy and cost-effective mode of transport, (Grabow et al., 2012; Oja et al., 2011; OECD, 2013) and governments and cycling-bodies continue to advocate for increased cycling participation globally. (Australian Bicycle Council, 2010; German Federal Ministry, 2012; United Kingdom Department, 2014) However, cyclists are recognised as vulnerable road users and serious injury rates are on the rise globally. (Henley and Harrison, 2012; Sikic et al., 2009; Sanford et al., 2015; Weijermars et al., 2016a; Tin et al., 2010) Furthermore, these injuries result in significant economic costs. (Hitchens and Palmer, 2012)

While long-term outcomes, such as return to work and functional outcomes, have been investigated in the road transport population as a whole (Gabbe et al., 2016; Holtslag et al., 2007; Vles et al., 2005; Hours et al., 2010), comparatively little is known about the outcomes of injured cyclists. Our work has previously demonstrated that while return to work rates were high in an injured cycling cohort (94%), less than

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40% of patients had returned to their pre-injury level of function at 12 months post injury;(Beck et al., 2016) a finding that is consistent with international literature on functional outcomes in all road user groups. (Hours et al., 2010) Given this, there is a need to further identify crash characteristics and patient-level factors that are associated with long-term outcomes. Such information could be used to guide prioritisation of injury prevention efforts, as well as inform the delivery of health and disability services.

The aims of this study were to investigate the demographic, crash and injury characteristics as predictors of return to work and functional outcomes in a cohort of cyclists hospitalised for orthopaedic trauma following an on-road crash.

2. Methods

2.1. Study design

A retrospective analysis of data from the Victorian Orthopaedic Trauma Outcomes Registry (VOTOR) was conducted for patients who were hospitalised following a cycling crash between 1st July 2007 and 30th June 2015.

2.2. The Victorian Orthopaedic Trauma Outcomes Registry

The VOTOR is a sentinel site registry collecting data from four hospitals in Victoria; two adult level 1 equivalent trauma centres, one regional trauma centre and one metropolitan trauma centre. All adult patients (≥16 years) admitted for an orthopaedic injury via the emergency department with a subsequent hospital admission for greater than 24 h, are included in the registry using an opt-out consent process. All eligible cases are included in the registry, and patients (or their next of kin) are provided with a letter and a brochure stating the aims of the registry, the data collected and any linkage of data, and that patients will be followed up. The brochure provides the details for how to opt-off and the opt-off rate for VOTOR is 1.5%. At each follow-up interview, verbal consent to complete the interview is obtained. The registry uses an opt-off consent process due to the impracticability of informed consent, and to reduce the potential for selection bias. All VOTOR patients are followed-up by telephone interview at 6 and 12 months post-injury. A standardised interview is used to capture functional outcomes, return to work, pain and health-related quality of life using the same methodology as patients in the Victorian State Trauma Registry (VSTR).(Edwards et al., 2006; Gabbe et al., 2010) The registry has been approved by the Monash University Human Research Ethics Committee (MUHREC) and each participating hospital. Ethics approval for the current study was received from MUHREC (CF16/1002–2016000533).

2.3. Participants

We included all participants registered by VOTOR who were admitted to hospital as a result of a pedal cycling crash. Cyclist crashes were identified using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) external cause codes for pedal cyclists injured in a transport accident (V10–V19).

2.4. Procedures

ICD-10-AM external cause codes were used to classify collision types and crash counterparts as collisions with a: pedestrian or animal (V10), other cyclist (V11), 2-wheeled or 3-wheeled motor vehicle (V12), car, pick-up truck or van (V13), heavy transport vehicle or bus (V14), railway train or railway vehicle (V15), other non-motor vehicle (V16), fixed or stationary object (V17), non-collision (V18) or other and unspecified transport accident (V19). For comparisons of injuries and outcomes, injury causes were stratified as non-collisions (V18), collisions with motor vehicles (V13 and V14) and others.

Postcodes of residence were mapped to the Accessibility/Remoteness Index of Australia (ARIA) (a geographical index of remoteness), and the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) (which ranks areas in Australia according to relative socio-economic advantage and disadvantage). Patients' comorbid status was defined using the Charlson Comorbidity Index (CCI), mapped from ICD-10-AM codes (Charlson et al., 1987; Gabbe et al., 2005; Deyo et al., 1992), with a CCI of zero representing no CCI conditions. In Victoria, Australia, there are multiple sources of funding for care following injury. These include Medicare, which is Australia's publicly funded universal healthcare agreement that provides healthcare coverage for all Australian citizens and permanent residents, private health insurance and WorkSafe Victoria and the Transport Accident Commission (TAC), who are the no-fault, third party insurers for work and transport injury. (Gabbe et al., 2014) The TAC provides compensation for treatment, income replacement and long-term care services for people injured in land-based transport crashes, regardless of fault status. WorkSafe Victoria provide financial and health-related support to people injured in the course of their work. Private health insurance is optional in Australia, and can cover hospital and/or ancillary costs. Only the TAC and WorkSafe Victoria provide payment for loss of earnings following injury. Cyclists are covered by the TAC under specific conditions. Specifically, cyclists are only covered if the incident that resulted in their injuries was: the direct result of the driving of a motor vehicle, train or tram, if they are injured in a collision with an open or opening car door, or in cases where the cyclist has not actually collided with a motor vehicle but the crash did result from the driving of a motor vehicle. To compare outcomes by whether a patient was compensated for their injuries, compensable status was classified as 1) Compensable (WorkSafe Victoria or TAC) or 2) Not compensable (including Medicare or Private health insurance).

Injuries were coded using the ICD-10-AM. The focus of the injury analysis was on those most commonly observed: head injuries, spinal injuries and fractures. Head injuries were defined as any intracranial injury, including concussion and skull fracture. Spinal injuries were defined as fractures, dislocations, sprain and strain of joints and ligaments, and injury of nerves or spinal cord. Pelvic fractures included fractures to the sacrum, coccyx, ilium, acetabulum, pubis or ischium. Major trauma was defined if any of the following criteria were met: (1) death due to injury; (2) an injury severity score (ISS) > 12 as determined by the Abbreviated Injury Scale (AIS) (2005 version 2008 update); (3) admission to an intensive care unit (ICU) for more than 24 h and requiring mechanical ventilation for at least part of their ICU stay; and (4) urgent surgery. (Cameron et al., 2004)

Functional recovery was quantified using the Glasgow Outcome Scale-Extended (GOS-E), with a GOS-E score of 8 (upper good recovery) representing return to pre-injury function. (Wilson et al., 1998) The GOS-E is recommended for use in trauma populations. (Sleat et al., 2011; Williamson et al., 2011) Return to work, defined as returning to work in any capacity or role, to the same pre-injury organisation or to the same pre-injury role, was collected for patients who reported working for income prior to injury.

2.5. Data analysis

Data were summarised using percentages for categorical variables and median and interquartile range (IQR) for non-normally distributed continuous variables. Comparisons between crash counterparts were conducted using χ^2 or Kruskal-Wallis tests. All subsequent analyses focussed on crashes that occurred on-road. The GOS-E was dichotomised as complete functional recovery (GOS-E = 8) and incomplete functional recovery (GOS-E ≤7). To identify predictors of complete functional recovery and return to work, mixed effects logistic regression models were fitted with a random effect for the patient. Due to a strong