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The rising burden of serious thoracic trauma sustained by motorcyclists in road traffic crashes

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ABSTRACT

In many countries increased on-road motorcycling participation has contributed to increased motorcyclist morbidity and mortality over recent decades. Improved helmet technologies and increased helmet wearing rates have contributed to reductions in serious head injuries, to the point where in many regions thoracic injury is now the most frequently occurring serious injury. However, few advances have been made in reducing the severity of motorcyclist thoracic injury. The aim of the present study is to provide needed information regarding serious motorcyclist thoracic trauma, to assist motorcycling groups, road safety advocates and road authorities develop and prioritise counter-measures and ultimately reduce the rising trauma burden. For this purpose, a data collection of linked police-reported and hospital data was established, and considerable attention was given to establishing a weighting procedure to estimate hospital cases not reported to police and fatal cases not admitted to hospital. The resulting data collection of an estimated 19,979 hospitalised motorcyclists is used to provide detailed information on the nature, incidence and risk factors for thoracic trauma. Over the last decade the incidence of motorcyclist serious thoracic injury has more than doubled in the population considered, and by 2011 while motorcycles comprised 3.2% of the registered vehicle fleet, one quarter of road traffic-related serious thoracic trauma cases treated in hospitals were motorcyclists. Motor-vehicle collisions, fixed object collisions and non-collision crashes were fairly evenly represented amongst these cases, while older motorcyclists were over-represented. Several prevention strategies are identified and discussed.

1. Introduction

Motorcyclists contribute significantly to road trauma around the world, and in many countries the risk of injury to motorcyclists is substantially greater than to car occupants. Per distance travelled, Australian motorcyclists are 30 times more likely to be killed than car occupants (DITRL, 2008), and in the United States, Great Britain and the European Union motorcyclists are 37, 44 and 30 times more likely to be killed than car occupants, respectively (NHTSA, 2008; UK Dept. Transport 2008; EuroRap, 2008). While substantial research has investigated reducing the severity of motorcyclist head injury with helmet technology, standards and laws, few advances have been made in reducing motorcyclist thoracic injury. While motorcyclist injury studies typically identify extremity injuries as being the most frequently sustained injuries (Table 1 – 'All injuries'), several recent in-depth injury studies of motorcyclist crashes in Australia, the United States and Europe have indicated that the thorax is the body region most often *seriously* injured (Table 1 – 'Serious injuries').

Meanwhile, substantial increases in motorcycling participation over recent decades have, in part, led to substantial increases in motorcyclist morbidity and mortality (Bambach et al., 2012b; NHTSA, 2008; EuroRap, 2008). Australia has recently committed to an ambitious target of reducing the incidence of serious injuries sustained in road crashes by 30% by 2020, and highlighted the importance of addressing the rising incidence of motorcyclist injury in achieving this goal (ATC, 2011). In order to identify and prioritise counter-measures and prevention strategies to reduce motorcyclist serious road trauma, detailed data relating to the incidence, nature and determinates of serious injury are required. The aim of the present paper is to provide such information in relation to serious thoracic injury, since this injury mode has become the most prevalent and there are currently no specific thoracic injury prevention strategies in place for on-road motorcyclists.

Considering data sources for such a study, while hospital discharge data provides complete information on injuries sustained, limited detail is provided regarding the human, vehicle and environmental circumstances of the crash. Conversely, police-reported road crash data provide a wealth of information regarding the crash, however no detail on the injuries sustained. Thus data

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Table 1
Comparison of the incidence of head, thorax and lower extremity injuries amongst motorcyclists from various international studies.

	Reference	Study origin	Outcome	Crash mode[a]	Helmet use (%)	Number of motorcyclists	Severity	Head (%)	Thorax (%)	Lower extremity (%)
All injuries	Ankarath et al. (2002)	United Kingdom	Injured	All	90	1239	AIS 1+	12	17	57
	Ankarath et al. (2002)	United Kingdom	Fatal	All	81	74	AIS 1+	57	32	58
	Moskal et al. (2007)	France	Injured/fatal	All	100	14,749	AIS 1+	11	10	63
	Forman et al. (2012)	Europe	Injured/fatal	All	–	12,994	AIS 1+	25	8	28
Serious injuries	Moskal et al. (2007)	France	Injured/fatal	All	100	328	AIS 4+	45	50	4
	Kraus et al. (2002)	United States	Fatal	All	–	548	AIS 3+	73	65	32
	Bambach et al. (2012a)	Australasia	Fatal	Roadside barriers	97	70	AIS 3+	44	81	39
	Bambach et al. (2012b)	Australia	Fatal	All	89	35	AIS 3+	60	77	29
	Bambach et al. (2013)	Australia	Injured/fatal	Fixed objects	88	1007	SRR ≤ 0.965	19	27	15
	Daniello and Gabler (2012)	United States	Injured/fatal	All	81	1707	AIS 3+	22	41	22
	Brown et al. (2010)	United States	Injured/fatal	All	73	61,689	AIS 3+	10	13	8
	Present study	Australia	Injured/fatal	All	87	19,979	SRR ≤ 0.965	18	24	18

[a] The crash mode "All" indicates all single- and multi- vehicle crashes, SRR = Survival Risk Ratio.

linkage of police-reported road crashes and hospital records were performed, which provided detailed descriptive information for motorcyclists that sustained serious thoracic injury, and for statistical analyses to identify risk factors for motorcyclists sustaining such injuries. However, a known drawback to data linkage is under-enumeration in police-reported crash databases since not all crash victims that are treated in hospital following a road crash had their crash reported to police (Alsop and Langley, 2001; Daniello and Gabler, 2012; Dischinger et al., 2006; Lujic et al., 2008; Wilson et al., 2012). This is especially true for motorcyclists, where linkage rates have been found to be as low as 42% (Daniello and Gabler, 2012). Police-reporting rates also differ amongst different crash modes, thus the proportion of motorcyclists in each crash mode is different in police-reported, hospital and linked police-hospital datasets (Alsop and Langley, 2001; Wilson et al., 2012), raising questions regarding whether linked police-hospital motorcyclist datasets are representative. While the hospital dataset may be considered a population-level data collection, the police-reported and linked police-hospital datasets should be considered samples of these data. Additionally, a known drawback to hospital data is that a substantial proportion of motorcyclists that are fatally injured in a road crash are not admitted to hospital (died at the scene), resulting in an under-enumeration of fatal cases (Dischinger et al., 2006; Forman et al., 2012). In order to generate a dataset of motorcyclist road crashes that contains both crash and injury information, and represents motorcyclist casualties and fatalities at the population level (rather than a sample), a weighting procedure was developed to weight both the linked police-hospital data and the fatality data. In order to assess trends over time, a temporal period of 11 years was analysed. The study location was New South Wales (NSW), Australia, during the years 2001–2011 (inclusive). NSW is the most populous state in Australia, and in 2011 consisted of a population of 7.21 million with 496,249 licenced motorcyclists and 178,670 registered motorcycles (Transport for NSW, 2011).

2. Methods

2.1. Data collections

The Admitted Patient Data Collection (APDC) includes information on all inpatient admissions from all public and private hospitals, private day procedures, and public psychiatric hospitals in NSW. The APDC contains information on patient demographics, source of referral, diagnoses, external cause(s), separation type and clinical procedures. Diagnoses and external cause codes are classified using the International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM) (National Centre for Classification in Health, 2006). Data were extracted for motorcyclists involved in road traffic crashes, identified by the ICD-10-AM external cause codes (Table 2).

The CrashLink data collection contains information on all police-reported road traffic crashes where a person was unintentionally fatally or non-fatally injured, or at least one motor vehicle was towed away and the incident occurred on a public road in NSW. 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 (died within 30 days). Data were extracted for motorcyclists that were injured or killed, and are termed 'motorcyclist casualties'. Data for motorcyclists that were non-injured were excluded, since these incidents are rarely reported to police and the group is thus difficult to identify and may suffer from selection bias. Data were extracted from both data collections from 1 January 2001 to 31 December 2011.