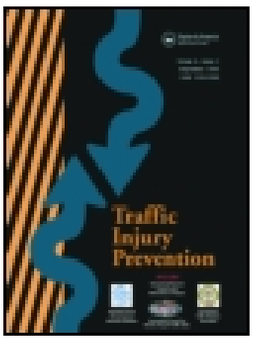

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Validity of Police-Reported Information on Injury Severity for Those Hospitalized from Motor Vehicle Traffic Crashes

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Objective: *The objective of this study was to assess the validity of police-reported information on the severity of injury for non-fatal motor vehicle traffic crashes (crashes) in New Zealand that resulted in hospitalization.*

Methods: *Details of crashes reported to the police resulting in non-fatal injury in New Zealand from January 2000 to December 2004 were obtained from Land Transport New Zealand Traffic crash reports (crash reports). Data about individuals' injuries were matched to New Zealand Health Information Service hospital discharge data. A severity score was assigned to the hospital International Classification of Diseases-10 (ICD-10) diagnosis codes, using a threat-to-life tool, the ICD-based Injury Severity Score (ICISS).*

Results: *Of the linked data, 49.3 percent of crash victims were recorded by police as having "serious" injuries on the crash report but given the police definition of serious injury, all 14,869 records should have been recorded as serious on the crash report. Of these, only 48 percent had an injury with a significant threat to life. Fifteen percent of those with a "minor" injury on the crash report had an injury with a significant threat to life.*

Conclusions: *The subjective police assessment of severity of injury was discordant in many instances with an objective measure of severity. There was variation in the concordance by personal, vehicle, and crash variables. This has implications for interpreting New Zealand's road safety statistics, the assessment of road safety programs, and the allocation of funding to target specific road safety problems.*

Keywords Severity; ICISS; Traffic; Injury; Police-reported crashes

INTRODUCTION

Motor vehicle traffic crashes (crashes) are a leading cause of mortality and morbidity in most countries. Typically in developed countries the police record details of crashes and these are entered into a national database. The data are then analyzed for purposes such as developing prevention priorities and determining the impact of interventions. Not all crashes are of equal importance. One method of determining importance in non-fatal crashes is to assess the severity of injury. Taking New Zealand as an example, any crash on a New Zealand public road resulting in injury is required by law to be reported to a police officer, as stated in Section 22(3) of the Land Transport Act 1998. For crash-related injuries, the attending police officer completes a traffic crash report. In the crash report, injuries are coded as "serious," "minor," or "fatal." "Serious" is defined as "fractures, concussions, internal injuries, crushing, severe cuts and lacerations, severe general shock necessitating medical treatment and any other injury involving removal to and detention in hospital" and includes those who die as a result of their injuries if their death occurs thirty days or more after the crash. "Minor" injury is defined as injuries "of a minor nature such as sprains and bruises" and "fatal" injuries are those that result in the death of the victim within thirty days of the crash (Land Transport Safety Authority 2004, p. 11–12). This is consistent with the International Road Traffic and Accident Database definition (OECD 2005).

Many countries including Australia, the United Kingdom, and parts of the United States use a similar system of collecting police-reported information as New Zealand. The definitions of "serious injury" vary slightly between countries but tend to be based on a requirement for medical care or hospital admission. Farmer (2003) found that there was evidence of nonrandom variation in the police assessment of injury severity in the United States with differences in the validity of injury severity by time of day, gender, and age. Overall, police officers were usually able to correctly identify those drivers who were killed or uninjured, but the levels of non-fatal injury were frequently misclassified (Farmer 2003).

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In the UK, Cryer et al. (2001) compared linked police road traffic accident reports and hospital data and found that using police-reported data alone could be very misleading. They commented that due to the difficulties in assessing injury severity at the roadside, police should not comment on injury severity at all. Rather, injury severity should be based purely on hospital discharge codes.

Despite these two studies, a number of countries continue to use police assessment of severity to develop prevention priorities and analyze the impact of interventions. In New Zealand, data on injuries resulting from road traffic crashes are collected by other agencies, such as the New Zealand Health Information Service, which collects hospital discharge data and mortality data; and the Accident Compensation Corporation, the national accident insurance provider. However, this is not linked to police data, and it is the data collected by police, through the crash reports that is predominantly used for official traffic crash statistics.

This study sought to further enhance the evidence base by comparing injury severity as assessed by New Zealand police with an objective measure of severity and to determine how this varies by person, vehicle, and crash variables. In addition to variables such as time of day, gender, age, and road user groups that were identified by Farmer (2003) and Cryer et al. (2001) as being differentially associated with validity of police-reported information on injury severity, this study sought to determine whether nonrandom variation in the validity of police assessment of injury severity existed by ethnicity, nature of injury, suspected alcohol use, vehicle damage, and accident severity.

METHODS

The crash reports for crashes between January 2000 and December 2004 in which an injury or death occurred were obtained from Land Transport New Zealand. Hospital discharge data from New Zealand Health Information Service's National Minimum Data Set (NMDS) were used because this dataset captures the vast majority of injuries that are significant in terms of threat to life. The NMDS includes records of all publicly funded discharges from hospitals following injuries occurring in New Zealand that result in inpatient treatment. The majority of injury discharges from hospitals in New Zealand are publicly funded. For 2002 it was estimated that 99 percent of all hospital injury discharges were publicly funded; thus, the NMDS offers an accurate representation of injuries resulting in hospital attendance (New Zealand Health Information Service 2005 (p. 14), 2006 (p. 18)).

The NMDS was restricted to all first admissions from January 2000 to December 2004 with a principal diagnosis code of injury (ICD-10 S00–T79) and an external cause code that indicated a traffic crash. ICD-10-AM codes that relate to crashes involving at least one moving vehicle on a public road are: V02-V04 (with a fourth digit in the range .1–.9), V09 (.2), V12-V14 (.3–.9), V19 (.4–.6), V20-V28 (.3–.9), V29-V79 (.4–.9), V80 (.3–.5), V81-V82 (.1), V83-V86 (.0–.3), V87 (.0–.8), or V89 (.2). No restrictions were placed on the length of time patients were admitted to hospital for; in other words, day patients were not excluded.

The crash reports and hospital discharge data were linked using the computer program Automatch (MatchWare Technologies Inc. 1996), which uses probabilistic record linkage (Jaro 1985). Matching variables used were name, gender, and either date of birth or age. To remain consistent with the police definition of "fatal injury," those who died in hospital within thirty days as a result of their injuries were excluded. Those whose severity on the crash report was recorded as "fatal" were also excluded.

The objective measure of severity used was the International Classification of Diseases–based Injury Severity Score (ICISS). For each of the NMDS ICD-10-AM diagnosis codes, a survival risk ratio (SRR) was obtained. The ICISS is the product of the SRRs for each diagnosis recorded for the individual:

$$\text{ICISS} = \text{SRR}(\text{diagnosis A}) \times \text{SRR}(\text{diagnosis B}) \times \text{SRR}(\text{diagnosis C}),\ \text{etc.}$$

The use of the ICISS as a measure of injury severity has been assessed and has been found to perform favorably with other comparable threat-to-life measures (Rutledge and Osler 1998; Stephenson and Henley 2004; Stephenson and Langley 2002). If the ICISS was $\leq$0.941 (i.e., a $\geq$5.9% probability of death), the injuries were considered serious in terms of threat-to-life (Cryer et al. 2004; Cryer and Langley 2006), hereafter referred to as "ICISS severe." If the ICISS was $>$0.941, the injuries were considered less serious in terms of threat to life and are referred to as "ICISS non-severe." Analysis was performed separately for those classified as "serious" and those classified as "minor" by the crash report. For each group, it was recorded whether the police assessment of injury severity was concordant or discordant with that categorized according to ICISS. Discordant cases were classified as to whether the police assessment of injury severity had been overstated (discordant overstated) or understated (discordant understated; Table I). The percentage of discordant cases for crash report "minor" and crash report serious cases for a range of factors is presented in Table II. Binomial exact confidence intervals were calculated for the percentage of discordant cases.

All variables listed in Table II except for those missing more than 5 percent of entries (alcohol suspected, vehicle damage, and vehicle year) were included in the multivariate logistic regressions (Table III). In the traffic crash report serious multivariate model, the outcome was ICISS non-severe. In the traffic crash report minor multivariate model, the outcome was ICISS severe.

The lack of independence that occurred because casualty type, vehicle damage, and vehicle year are the same for all

Table I Possible outcomes from comparison of traffic crash report and ICISS severity categories

	Crash report "minor"	Crash report "serious"
ICISS Non-severe (ICISS $>$ 0.941)	Concordant	Discordant overstated (DOS)
ICISS Severe (ICISS $\leq$ 0.941)	Discordant understated (DUS)	Concordant

Table II Percentage of discordant cases for traffic crash report "minor" and "serious" injuries[a]

	Crash report "minor"			Crash report "serious"		
Variables	ICISS severe	Total	% Discordant understated (95% CI)	ICISS non-severe	Total	% Discordant overstated (95% CI)
Gender						
Male	718	4391	16.4 (15.3, 17.5)	2420	4757	50.9 (49.4, 52.3)
Female	432	3145	13.7 (12.6, 15.0)	1423	2576	55.2 (53.3, 57.2)
Missing	0			0		
Age						
0–14	117	730	16.0 (13.4, 18.9)	316	548	57.7 (53.4, 61 .8)
15–24	400	2506	16.0 (14.6, 17.5)	1171	2271	51.6 (49.5, 53.6)
25–44	296	2319	12.8 (11.4, 14.2)	1338	2475	54.1 (52.1, 56.0)
45–64	190	1228	15.5 (13.5, 17.6)	676	1333	50.7 (48.0, 53.4)
≥ 65	147	753	19.5 (16.8, 22.5)	342	706	48.4 (44.7, 52.2)
Missing	0			0		
Ethnicity						
NZ European	641	3997	16.0 (14.9, 17.2)	2287	4345	52.6 (51.1, 54.1)
Maori	220	1289	17.1 (15.1, 19.2)	608	1232	49.4 (46.5, 52.2)
Pacific Islander	61	478	12.8 (9.9, 16.1)	173	287	60.3 (54.4, 66.0)
Asian	56	495	11.3 (8.7, 14.4)	149	305	48.9 (43.1, 54.6)
Other	134	1025	13.1 (11.1, 15.3)	498	927	53.7 (50.4, 57.0)
Not stated	38	252	15.1 (10.9, 20.1)	128	237	54.0 (47.4, 60.5)
Missing	0			0		
Nature of injury						
Fracture	453	1923	23.6 (21.7, 25.5)	2191	4288	51.1 (49.6, 52.6)
Intracranial	197	864	22.8 (20.0, 25.8)	269	775	34.7 (31.4, 38.2)
Organ damage	106	161	65.8 (58.0, 73.1)	63	500	12.6 (9.8, 15.8)
Soft tissue injury	45	760	5.9 (4.4, 7.8)	257	421	61.1 (56.2, 65.7)
Superficial & open wounds	282	2736	10.3 (9.2, 11.5)	756	960	78.8 (76.0, 81.3)
Other[2]	67	1092	6.1 (4.8, 7.7)	307	389	78.9 (74.5, 82.9)
Missing	0			0		
Alcohol suspected						
No	631	4790	13.2 (12.2, 14.2)	2272	4104	55.4 (53.8, 56.9)
Yes	228	1218	18.7 (16.6, 21.0)	691	1419	48.7 (46.1, 51.3)
Missing	291	1528	19.0	880	1810	48.6
Casualty type						
Passenger vehicles	816	5759	14.2 (13.3, 15.1)	2614	5077	51.5 (50.0, 52.9)
Heavy vehicles	35	209	16.8 (12.0, 22.5)	118	239	49.4 (42.9, 55.9)
Motor cycles	81	505	16.0 (12.9, 19.5)	554	921	60.2 (56.9, 63.3)
Other	7	27	25.9 (11.1, 46.3)	14	26	53.9 (33.4, 73.4)
Cyclists	50	325	15.4 (11.6, 19.8)	168	305	55.1 (49.3, 60.8)
Pedestrians	161	711	22.6 (19.6, 25.9)	375	765	49.0 (45.4, 52.6)
Missing	0			0		
Vehicle damage						
Minor	145	1461	9.9 (8.4, 11.6)	605	854	70.8 (67.7, 73.9)
Extensive/fire	601	4004	15.0 (13.9, 16.2)	2163	4373	49.5 (48.0, 51.0)
Overturned	187	996	18.8 (16.4, 21.3)	509	1005	50.7 (47.5, 53.8)
Missing	217	1075	20.2	566	1101	51.4
Vehicle year						
2000–04	53	346	15.3 (11.7, 19.6)	229	388	59.0 (53.9, 64.0)
1995–99	124	968	12.8 (10.8, 15.1)	526	923	57.0 (53.7, 60.2)
1990–94	293	2187	13.4 (12.0, 14.9)	957	1871	51.2 (48.9, 53.4)
1985–89	232	1600	14.5 (12.8, 16.3)	836	1660	50.4 (47.9, 52.8)
1980–84	114	625	18.2 (15.3, 21.5)	367	677	54.2 (50.0, 58.0)
1920–79	32	159	20.1 (14.2, 27.2)	107	212	50.5 (43.5, 57.4)
Missing	302	1651	18.3	821	1602	51.3
Accident severity						
Fatal	80	303	26.4 (21.5, 31.8)	244	641	38.1 (34.3, 41.9)
Severe	142	904	15.7 (13.4, 18.3)	3599	6692	53.8 (52.6, 55.0)
Minor	928	6329	14.7 (13.8, 15.6)			
Missing	0			0		
Time of day						
Day (0500–2259 hrs)	960	6418	15.0 (14.1, 15.9)	3315	6204	53.4 (52.2, 54.7)
Night	169	1044	16.2 (14.0, 18.6)	498	1055	47.2 (44.2, 50.3)
Missing	21	74	28.4	30	74	40.5

(Continued on next page)

Table II Percentage of discordant cases for traffic crash report "minor" and "serious" injuries[a] (Continued)

	Crash report "minor"			Crash report "serious"		
Variables	ICISS severe	Total	% Discordant understated (95% CI)	ICISS non-severe	Total	% Discordant overstated (95% CI)
Police district						
Northland	54	456	11.8 (9.0, 15.2)	210	399	52.6 (47.6, 57.6)
Auckland	120	960	12.5 (10.5, 14.8)	276	494	55.9 (51.4, 60.3)
North Shore/Waitakere	136	1116	12.2 (10.3, 14.3)	368	696	52.9 (49.1, 56.6)
Counties/Manukau	181	1064	17.0 (14.8, 19.4)	273	569	48.0 (43.8, 52.2)
Waikato	116	771	15.1 (12.6, 17.8)	336	677	49.6 (45.8, 53.5)
Bay of Plenty	111	628	17.7 (14.8, 20.9)	364	735	49.5 (45.8, 53.2)
Eastern	47	315	14.9 (11.2, 19.3)	234	423	55.3 (50.4, 60.1)
Central	85	533	16.0 (12.9, 19.3)	405	796	50.9 (47.3, 54.4)
Wellington	32	282	11.4 (7.9, 15.6)	213	385	55.3 (50.2, 60.4)
Tasman	47	265	17.7 (13.3, 22.9)	185	383	48.3 (43.2, 53.4)
Canterbury	172	870	19.8 (17.2, 22.6)	460	878	52.4 (49.0, 55.7)
Southern	47	264	17.8 (13.4, 23.0)	512	885	57.9 (54.5, 61.1)
Missing	2	12	16.7	7	13	53.9

[a]This analysis assumes independence between the individuals involved in a crash, which is not true in all cases. However, preliminary analysis indicated that results taking into account the lack of independence were almost identical to the results that did not. This is presumably due to the fact that only 4.4% of the individuals in the dataset were from the same vehicle as another individual in the dataset. Only 26.1 percent of the individuals in the dataset were from the same crash as other individuals in the dataset.

[b]The "other" injury category includes traumatic amputation, adverse effects/complications/sequelae, foreign body entering natural orifice, burns and corrosions, poisoning, effects of other external causes and "other and unspecified."

passengers in the same vehicle; similarly, that accident severity, time of day, and police district are common for all those involved in the same crash was accounted for in the multivariate models through the use of "robust" confidence intervals (StataCorp 2005).

Stata version 9.2 was used for the analysis of the data (StataCorp 2005).

RESULTS

Sixty-seven thousand seven hundred twenty-eight crash report records and 30,025 NMDS records were included in the linkage; 15,204 (50.6%) linked. The validity of the linkage process was checked manually. From a random sample of 200 NMDS records, 102 were able to be manually matched to crash report records, at a rate of 51.0 percent.

Fourteen thousand eight hundred sixty-nine records remained after those with "fatal injuries" were excluded. Of these, 7333 had a crash report code of "serious" injury, with 7536 having a crash report code of "minor" injury. Using the police definition of serious injury, all 14,869 records should have been crash report serious, because they all required inpatient care. However, only 49 percent were classed as crash report serious. Of the crash reports with an injury code of minor, 1150 (15%) were discordant with an ICISS indicating severe injury (DUS). Of all the matched crash report serious cases, 3843 (52%) were discordant with an ICISS indicating non-severe injury (DOS).

As can be seen in Table II, females were more likely than males to have an ICISS non-severe injury overstated (DOS) and males were more likely to have an ICISS severe injury understated (DUS). Of all age groups, those aged 65 years and over were least likely to have the severity of their injuries overstated. In comparison, those least likely to have the severity of their injuries understated were those aged 25 to 44 years.

There was marked variation in the concordance between crash report and ICISS severity by diagnostic groups. Organ damage was very infrequently overstated in terms of injury severity. Compared to fractures, those with "soft tissue injury," "superficial injury and open wounds," and "other" were more likely to have their injury severity overstated. Of those injuries classified as minor on the crash report, organ damage was the diagnosis most likely to be DUS. Compared to fractures, organ damage was almost three times as likely to be DUS (RR = 2.8, 95% CI 2.4, 3.2).

Of the crash report serious records, ICISS non-severe injuries were significantly less likely to be DOS when alcohol was thought to be involved compared to when alcohol was not suspected (RR = 0.88, 95% CI 0.83, 0.93).

Compared to those traveling in passenger vehicles, those on motorcycles were significantly more likely to have the severity of their injuries overestimated (DOS). Of those who were thought by police to have minor injuries, pedestrians were 1.6 (95% CI 1.4, 1.9) times more likely to have a severe injury overlooked (DUS), compared to those in passenger vehicles.

Those involved in a crash where the vehicle damage was assessed as being minor were significantly more likely to have a non-severe injury coded as serious (DOS) on the crash report compared to those in which the vehicle damage was classified as "extensive/fire" or "overturned." Of the crash report minor records, ICISS severe injuries were significantly more likely to be DUS when vehicle damage was extensive/fire or overturned compared to minor. There was variation in the concordance between crash report and ICISS severity by vehicle year, with

Table III Multivariate analyses for traffic crash report "minor" and "serious" injuries

	Crash report "minor"			Crash report "serious"		
Variables	OR (95% CI)		P-value	OR (95% CI)		P-value
Gender						
Male	1.00	Reference		1.00	Reference	
Female	0.88	(0.77, 1.01)	0.07	1.16	(1.04, 1.29)	0.006
Age (years)						
0–14	1.00	(0.77, 1.30)	1	1.31	(1.05, 1.63)	0.02
15–24	1.25	(1.05, 1.49)	0.01	0.93	(0.82, 1.05)	0.2
25–44	1.00			1.00		
45–64	1.17	(0.95, 1.44)	0.2	0.84	(0.73, 0.97)	0.02
≥65	1.48	(1.17, 1.87)	0.001	0.73	(0.61, 0.88)	0.001
Ethnicity						
NZ European	1.00			1.00		
Maori	1.17	(0.97, 1.42)	0.1	0.87	(0.75, 1.00)	0.05
Other	0.79	(0.67, 0.93)	0.005	1.06	(0.94, 1.20)	0.3
Nature of injury						
Fracture	1.00			1.00		
Intracranial	0.91	(0.74, 1.11)	0.4	0.50	(0.43, 0.59)	<0.001
Organ damage	6.47	(4.53, 9.23)	<0.001	0.14	(0.11, 0.18)	<0.001
Soft tissue injury	0.23	(0.17. 0.32)	<0.001	1.52	(1.23, 1.88)	<0.001
Superficial and open wounds	0.38	(0.32, 0.44)	<0.001	3.67	(3.09, 4.36)	<0.001
Other	0.21	(0.16, 0.27)	<0.001	3.58	(2.78, 4.61)	<0.001
Casualty type						
Motorized	1.00			1.00		
Non-motorized	1.66	(1.37, 2.01)	<0.001	0.80	(0.69, 0.93)	0.003
Accident severity						
Fatal	1.00			1.00		
Severe	0.52	(0.38, 0.73)	<0.001	1.78	(1.50, 2.13)	<0.001
Minor	0.48	(0.36, 0.64)	<0.001			
Time of day						
Day (0500–2259 hrs)	1.00			1.00		
Night	1.18	(0.96, 1.44)	0.1	0.78	(0.67, 0.90)	0.001
Police District						
Auckland	1.00			1.00		
Northland	0.87	(0.60, 1.27)	0.5	0.84	(0.63, 1.11)	0.2
North Shore/Waitakere	1.03	(0.79, 1.36)	0.8	0.82	(0.64, 1.06)	0.1
Counties/Manukau	1.51	(1.15, 1.98)	0.003	0.62	(0.48, 0.81)	<0.001
Waikato	1.04	(0.77, 1.39)	0.8	0.75	(0.59, 0.97)	0.03
Bay of Plenty	1.12	(0.83, 1.53)	0.5	0.87	(0.67, 1.11)	0.3
Eastern	0.93	(0.63, 1.38)	0.7	1.04	(0.79, 1.39)	0.8
Central	1.13	(0.82, 1.56)	0.5	0.87	(0.68, 1.11)	0.2
Wellington	0.62	(0.40, 0.96)	0.03	1.09	(0.82, 1.45)	0.6
Tasman	1.17	(0.78, 1.76)	0.4	0.79	(0.59, 1.05)	0.1
Canterbury	1.38	(1.05, 1.81)	0.02	0.94	(0.74, 1.19)	0.6
Southern	1.12	(0.75, 1.67)	0.6	1.07	(0.84, 1.36)	0.6

a trend for occupants of newer cars to have their injury severity overstated more frequently (DOS).

Those involved in severe crashes[1] were significantly more likely to have a non-severe injury coded as serious (DOS) on the crash report compared to those involved in fatal crashes (RR = 1.4, 95% CI 1.3, 1.6). Survivors of fatal crashes were significantly more likely to have a severe injury overlooked (DUS) than those involved in non-fatal crashes.

Those involved in crashes during the night were less likely to have non-severe injuries stated as serious on the crash report (DOS), compared to those who were in crashes during the day (RR = 0.88, 95% 0.83, 0.95). There was variation in the concordance between crash report and ICISS severity by police district, with a trend for the South Island districts to overlook severe injury more frequently (DUS).

The results from the multivariate analyses (Table III) were similar to those for the univariate analyses. Some points of interest from the multivariate analysis follow. When casualty type was categorized on the basis of motorization, there was strong evidence to suggest that those whose mode of transport was "nonmotorized" were significantly more likely to have their serious injury overlooked (DUS) and significantly less likely to have their minor injury recorded as crash report serious (DOS) compared to those in "motorized" vehicles. Including ethnicity with three categories (New Zealand European, Maori, Other)

[1] Accident severity is a crash-related variable recorded on the crash report that is defined by the worst injury sustained by an individual in that crash.

indicated that those of "other" ethnicity were less likely to have their serious injury overlooked (DUS) compared to New Zealand Europeans. There was some evidence of a slight degree of confounding, most evident in the variation by police district. In addition, the U-shaped trend of poorer concordance at the extremes of age became less pronounced.

DISCUSSION

For those individuals with crash reports that could be linked to the NMDS, the overall validity of the police-reported severity information was poor when compared to severity as indicated by ICISS. There are two likely reasons for this. The first relates to the definition of serious injury on the crash report. The inclusion of diagnoses such as "fracture" means that some of the diagnoses will be serious by any measure of severity, such as a fracture of a cervical vertebra, but will also include some relatively trivial injuries, such as uncomplicated fracture of a digit. In addition, the criterion of ". . . any other injury involving removal to and detention in hospital" is broad (Land Transport Safety Authority 2004). Though this includes some serious injuries, it captures a lot of minor injuries also.

The second reason for poor overall validity is due to inappropriate assessment of injury. There are a number of factors that limit an officer's ability to precisely assess injury severity. This is not an area of their expertise and must be performed at the same time as many other responsibilities. The results showed that some groups were significantly more likely to have the severity of their injuries overstated, including females and the young. These two groups may be considered by the attending police officer to be "frail," leading to an assessment of injuries as serious when they are non-severe. Those with soft tissue and superficial injuries were more likely to have the severity overstated. This may be because of the differences between the two definitions of injury severity that were used in this study. Another factor that may be influencing this is that visible injuries are detected more easily and can initially look more serious than they are.

Motorized casualties were more likely to have the severity of their injuries overstated, with pedestrians having a higher likelihood of severe injuries not being recognized. The reason for this is unclear. Those involved in crashes in which one victim subsequently dies (i.e., accident severity is classified fatal) were more likely to have severe injuries overlooked. A possible reason that this occurs is the need for emergency services to focus their attention on the most severely injured victims. There was a tendency for the severity of injuries to be underestimated if alcohol was thought to be involved. This is consistent with the misconception that alcohol can protect from severe injury once a crash has occurred. Vehicle damage is known to be of use as a proxy for injury severity, because the degree of damage often reflects the magnitude of the forces involved. However, there was still a propensity to overlook severe injuries even in the presence of significant vehicle damage. There was a tendency for passengers in newer cars to have minor injuries coded as severe. It is possible that the benefits of safety features that tend to be present in more modern cars are not recognized as well as they could be when assessing injury severity.

Regional variation in the validity by police district did not follow any particular trend in terms of population density or region. However, what is of most interest in any regional variation is whether all ICISS severe injuries are being detected. This has important implications for the allocation of funds for road improvements. This study only examined those subjects for which both a crash report and NMDS record existed and could be linked. It would be useful to know how many ICISS severe cases existed in the unmatched NMDS that police were unaware of.

One of the strengths of this study includes the ability to use five years of national data. This large sample helped in producing reliable estimates. The NMDS is well maintained with good quality assurance with regard to coding of data (Langley and Stephenson 2006). Being able to use discharge diagnoses that were determined by a health professional and an objective empirically derived measure of severity was advantageous.

Limitations of the study relate to the subset of crashes that were unable to be analyzed. For those who were involved in a crash but who were not hospitalized, we were unable to assess the validity of police-reported injury severity information. Only 51 percent of the cases identified from the NMDS could be linked to a crash report, which indicates inherent difficulties in linking the two datasets. That said, a 100 percent linkage rate would be unexpected because the NMDS is a hospital discharge dataset, so cases identified by the period January 1, 2000–December 31, 2004, will include individuals injured in crashes that occurred before January 1, 2000. These individuals will not be located in the set of crash reports that includes crashes from January 1, 2000. In addition, any crash in which a crash report was not completed or those where particular details on the crash report were missing or incorrect would not have linked. This could occur if the attending police officer did not complete a crash report or if the police either did not attend or were unaware of the crash. The latter may happen, for example, when an intoxicated driver involved in a single-vehicle crash flees the scene of the accident. The probabilistic linkage was consciously conservative to reduce the frequency of false-positive matches. Although the linkage process included using Soundex (code assigned to names based on what they sound like) to overcome spelling inconsistencies, this code is based on Anglo-Saxon phonetics and thus its performance with non-Anglo-Saxon names may have biased the linkage.

For this study we chose an ICISS threshold of 0.941 because this has been used elsewhere to define severe injury (Cryer et al. 2004). In this context we wish to emphasize that contrary to popular conceptions, many injuries resulting in admission to hospital are not severe in terms of threat to life. Nevertheless, it

could still be argued that the threshold used was too high. We note, however, that significant numbers of crash report serious injuries had low threat-to-life scores and conversely a significant number of crash report minor injuries had high threat-to-life scores.

An additional concern is that injuries that are not severe in terms of threat to life could be severe in terms of disability (e.g., eye injury resulting in loss of sight). This dimension of severity should also be a consideration when determining road safety priorities. Clearly the police are unable to assess threat of disability. Identification of these injuries could be achieved by linkage with injury compensation schemes, where they exist, that record details such as the lump sum payments for impairment (e.g., loss of vision) or time off one's normal occupation due to injury.

There are a number of implications resulting from incorrect assessment of injury severity. In economic analyses of crashes, often benefit/cost ratios are used. An underestimate of the total cost of traffic crash–related injury will influence this benefit/cost ratio and consequently the amount invested in road safety programs will be affected, as well as the evaluation of existing programs.

The findings reported here demonstrate that police measurement of non-fatal injury severity, in terms of threat to life, has poor validity. Though this may be able to be improved with police training, the value of doing so in NZ is questionable given that (1) a significant portion of serious injuries are not captured by NZ police, (2) the severity scale used by NZ police lacks discrimination, and (3) the NZ hospital discharge data provide a better source from which to derive injury severity for all seriously injured persons. We acknowledge that the situation may be different in other countries with respect to the issues outlined above and this may influence the generalizability of our findings. Nevertheless, these findings together with those of Farmer (2003) suggest that users of police injury severity data would be wise to verify their validity.

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