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EC, HT, SB, and JF developed the study. HT and EC linked the data. EC cleaned and prepared the data. EC analyzed and interpreted the results and drafted the manuscript. HT, SB, EB, DB, BP, AW and JF assisted in writing and reviewing the manuscript. All authors approved submission.

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Title

Motor vehicle crash characteristics predictive of high acuity patients: an analysis of linked ambulance and crash data.

Abstract

Background: Motor vehicle crashes (MVCs) comprise a significant component of emergency medical service workload. Due to the potential for life-threatening injuries, ambulances are often dispatched at the highest priority to MVCs. However, previous research has shown that only a small proportion of high-priority ambulance responses to MVCs encounter high acuity patients. Alternative methods for triaging patients over the phone are required to reduce the burden of over-triage. One method is to use information readily available at the scene (e.g. whether a person was a motorcyclist, ejection status or whether an airbag deployed) as potential predictors of high acuity.

Methods: A retrospective cohort study was conducted of all MVC patients in Perth attended by St John Western Australia between 2014 and 2016. Ambulance data was linked with Police crash data. The outcome variable of interest was patient acuity, where high acuity was defined as where a patient (1) died on-scene or (2) was transported by ambulance on priority one (lights & sirens) from the scene to hospital. Crash characteristics predictive of high acuity patients were identified by estimating crude odds ratios and 95% confidence intervals.

Results: Of the 18,917 MVC patients attended by SJ-WA paramedics, 6.4% were classified as high acuity patients. The odds of being a high acuity patient was greater for vulnerable road users (motorcyclists, pedestrians and cyclists) than for motor vehicle occupants (OR=3.19, 95% CI, 2.80-3.64). A ‘not ambulant patient’ (one identified by paramedics as unable to walk or having an injury incompatible with being able to walk) had 15 times the odds of being high acuity than ambulant patients (OR=15.34, 95% CI, 11.48-20.49). Those

who were trapped in a vehicle compared to those not trapped (OR 4.68, 95% CI, 3.95-5.54); and those who were ejected (both partial and full) from the vehicle compared to those not ejected (OR 6.49, 95% CI, 4.62-9.12) had higher odds of being high acuity patients.

Discussion: There were two important findings from this study: (1) few MVC patients were deemed high acuity; and (2) several crash scene characteristics were strong predictors of high acuity patients.

Introduction

Background/Rationale

Recent studies have shown that motor vehicle crashes (MVCs) make up a significant component of the workload for emergency medical services (EMS) (1, 2). Motor vehicle crashes (MVCs) are one of the ten most common call types for ambulance services (1, 2, 3), but they have relatively high non-transport rates (4). This discrepancy arises from a difficulty for emergency call-takers (dispatchers) to determine patient acuity at the scene of a crash, based on the details provided by the caller, often a bystander. Decisions about the ambulance priority at dispatch are commonly based on the mechanism alone, i.e. 'traffic incident', 'vehicle versus pedestrian' (5, 6), however, there is a considerable range in injury severity and patient acuity in MVCs. Some patients may die immediately on impact, whereas some patients may be uninjured (7). This variability is a reason many EMS routinely dispatch ambulances to MVCs at the highest priority (6), where lights and sirens (L&S) are used while driving to the scene of the crash to minimize response times.

Such 'erring on the side of caution' when dispatching ambulances to MVCs often results in 'over-triage' – defined as a priority one ambulance response where the patient's condition was not time critical (8). Assigning the highest priority dispatch to every MVC risks a misallocation of scarce EMS resources if the injury is minor or the patient does not require emergency care from ambulance paramedics. Furthermore there is increased risk of an ambulance being involved in a crash when using L&S (9). A potential way to determine ambulance dispatch priority to MVCs is by using additional information from the scene of a crash. Some studies have shown that crash scene variables can predict injury severity (10,11). For example, an on-scene injury prediction algorithm found that seatbelt usage (belted/unbelted), location (urban/rural), age and speed limit could predict an anatomical measure of severity (the Injury Severity Score) (12). However, such studies have limited utility in informing dispatch priority, as the outcome measures of interest do not adequately reflect the need for a priority one response. They are either too broad, limited to either anatomical or physiological scales that are not assessable by bystanders (e.g., Injury Severity Score; Glasgow Coma Scale), or reflect the outcome of the crash rather than patient condition at the scene (13,14).

Aim

The aim of this study is to describe clinical, demographic and crash characteristics of MVC patients attended by emergency ambulance in Perth, Western Australia, and to identify patient/crash characteristics predictive of high acuity patients.

Methods

Design, setting, and population

A population-based retrospective cohort study was conducted consisting of all MVC patients attended by St John Western Australia (SJ-WA) paramedics in Perth, Western Australia (WA) from 1st January 2014 to 31st December 2016. The Perth metropolitan area has a population of around 2.02 million, with 77% aged 18 years or older (15). The road environment consists of three expressways (those with limited access) and nine highways (those with many crossing/merges with other roads) (16). The MVC fatality rate in Perth is

3.6 per 100,000 persons per year (17), similar to San Francisco (3.2 per 100,000) and Seattle (3.8 per 100,000) (18). Emergency ambulance response times to MVCs in Perth (19) are comparable to urban areas of the United States (18) and the United Kingdom (20) (targeted to be within 15 minutes for priority one in Perth). Automatic crash notification systems are not used in Perth due to both the lack of any legislative requirement for their installation and to their unsuitability for use in regional/remote areas due to poor cell phone coverage.

SJ-WA is a single-tier ambulance service that is the contracted provider of emergency road ambulances in Perth. Within Perth, SJ-WA ambulances are staffed by two crew members, at least one of whom is a qualified paramedic. During the study period, SJ-WA used the Medical Priority Dispatch System (MPDS v12.1) to categorise emergency calls for help (6). The MPDS assigns determinant codes to each category (i.e. stroke or traffic/transportation) however, it is at the discretion of each emergency medical system (including SJ-WA) to determine their own response regarding the priority of ambulances. All emergency ambulance calls relating to MVCs in WA are assigned a priority one dispatch response, where lights and sirens can be used on the way to the scene (lights and sirens cannot be used for Priority 2 or 3 responses). SJ-WA's operational target is that 90% of priority one responses arrive within 15 minutes of dispatch (21). All emergency calls (in Australia, "000" instead of "911") are answered at a single statewide operations center. Calls for emergency medical help for a traffic incident are directed to SJ-WA, which then dispatches an ambulance. Automatic crash notification systems are not used in Perth. Police and fire services do not attend every traffic crash in Perth. Police do attend crashes where someone is killed or seriously injured, and fire departments attend when their services are needed (e.g., extrication).

Data sources

Two sources of data were used for this study: SJ-WA data (ambulance data) and Main Roads WA/Police crash data (crash data). The ambulance data contain information collected during the emergency telephone call (computer-aided dispatch) and electronic patient case records (e-PCRs) completed by paramedics. Ambulance data were extracted for all cases where the dispatch code was motor vehicle related (MPDS Protocol 29: Traffic/Transportation Incidents) (6) or identified in the e-PCR by paramedics on-scene as a MVC. To be included in the study, patients had to be involved in a MVC that included a moving vehicle fitted with an engine (car, truck, motorbike). Cases of single-bicycle or single-pedestrian events were excluded, for example, where a bicyclist fell on the road but where there was no crash with a vehicle. All deaths relating to ambulance cases were included (i.e. including records where a patient died at the scene and the patient's name could not be ascertained by the paramedic).

Ambulance records were excluded for cases that did not require primary emergency response (e.g., inter-facility transfers) or if a patient could not be located on arrival (e.g., hoax calls; patient left scene). However, we did include cases where a patient left the scene of an MVC but later called for an ambulance. Incidents involving emergency medical helicopters were excluded, as they are not routinely used in Perth.

The crash data consists of information collected retrospectively on all those persons involved in a reportable road crash as defined by the WA Police (22). A reportable road crash is a crash where the incident resulted in bodily harm to any person, the value of the property damaged exceeded $3,000 AUS or if the owner of the property damaged is not represented (22). These data contain detailed information describing the crash such as the location, vehicles' movements (i.e. right turn), and demographic details of people involved. These data are mainly collected from people involved directly in the crash using an online form but additionally may include information recorded by police officers who attended the crash (only for serious crashes) and information about road infrastructure at the crash location as recorded by the state authority responsible for transport and road infrastructure (Main Roads/MRWA).

The data sources used in this study included a variety of units of measurements (incidents, crashes, patients etc.). This study used patients as the primary unit of measurement in order to most accurately describe people involved in crashes.

Data Linkage

Records in the ambulance data were linked to crash data in a staged approach. First, records were linked using Fine-Grained Records Integration and Linkage Tool (v2. 1.5, Emory University, U.S.) for records where the geographic coordinates (latitude/longitude) of the dispatch location of the MVC (ambulance data) were within one kilometer (0.62 miles) of the reported location of the crash (crash data), and within one calendar day. Matches were programmatically identified where there was a match on surname, first name, date of birth and vehicle registration number, using SAS Base 9.3, with the SPEDIS function (23) used to allow for fuzzy matches on close spelling of surname and first name. It was not expected that there would be an exact match between the two data sources as not all crashes are attended by or reported to police. We included all otherwise eligible patients with available ambulance data even if crash data were not available.

Clinical, Demographic and Crash Characteristics

Clinical characteristics included Glasgow Coma Scale (GCS), systolic blood pressure (SBP) and respiratory rate (RR). Demographics characteristics were age, sex and road user type (e.g., motor vehicle occupant, motorcyclist, pedestrian). Crash characteristics included whether a patient was non-ambulatory, ejected or entrapped; whether the patient was in a vehicle that rolled over or had airbag deployment; whether the patient was in a crash that occurred at an intersection or between intersections (i.e., "midblock"); the time of day; and the weather. Ambulatory status is not a discrete element in the ambulance data. We used electronic text searches for variations and synonyms of the phrases "ambulant" and "non-ambulant" to ascertain these data. We also classified patients with injuries incompatible with walking (e.g., bilateral femur fractures) as non-ambulant. Crash characteristics derived only from ambulance data were ambulatory status, airbag deployment, entrapment, ejection and time of day. Characteristics derived from only the crash data were intersection/midblock and weather. Characteristics derived from either/both datasets included road user group and rollover. For most of the clinical, demographic and crash characteristics, we either omitted cases with missing data from each bivariate analysis, or included "unknown" as a category (i.e., for road user status). The exception was four crash events that are generally only documented when present, not as pertinent negatives: rollover, ejection, entrapment, and airbag deployment. We interpreted records that were silent on these characteristics as indicating the event did not occur. However, if any characteristic was documented in one data source but not both data sources, we deferred to the dataset with documentation.

Clinical and demographic characteristics were included to describe MVC patients attended by ambulance, whereas crash characteristics were included as potential indicators of high acuity patients that could be used over the phone to identify those patients requiring a L&S response.

Outcome variables

The outcome variable of interest was patient acuity regarding the urgency of need for paramedic care (25). High acuity was defined as patients who (1) died on-scene or (2) were transported by ambulance on priority one (L&S) (high priority) from the scene to hospital. Conversely, we defined low acuity as patients who (1) did not die on-scene and (2) were either not transported to hospital or were transported to hospital at a priority lower than priority one (not L&S).

Statistical analysis

Bivariate statistics were used to describe the cohort. Continuous data were described using medians and interquartile ranges. Group differences were assessed using the Kruskal-Wallis test for continuous variables. Categorical data were summarised as counts and percentages. To examine factors associated with the need for a priority one response (i.e. a high acuity patient), crude odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. We decided *a priori* to restrict the scope of this study to calculating univariate effect estimates.

We considered that, due to the potential for collinearity between predictors, it was beyond the scope of this study to use multivariate modelling (e.g. logistic regression).

Ethics

Ethics approval was granted as a sub-study of the Western Australia Pre-hospital Record Linkage Project by the Curtin University Human Research Ethics Committee (HR 128/2013). The St John Research Governance Committee approved the conduct of the research. The researchers and Main Roads Western Australia signed a Data Licensing Agreement for the use of the crash data.

Results

Cohort selection

There were 23,589 records associated with a patient in a MVC in the ambulance data. A total of 3,129 ambulance records were excluded before linkage (20,460 remaining for linkage). The main reasons for exclusion was empty records. This occurs where there was no electronic record of any assessment, intervention, or clinical case notes due to a patient not meeting a paramedic assessed need for care/assessment/intervention (n=2,051). Other reasons are where no patient could be found (n=532), or records not for a MVC emergency, such as those cases incorrectly classified as an MVC (n=486).

Data Linkage

Of the 20,460 ambulance records, 12,872 records (62.9%) had a matching record in the crash data. We did not expect a 100% linkage rate between the two datasets because not all people involved in a reportable road crash (crash data) require an ambulance (e.g. where there is damage to property, but no significant injuries); and conversely, not all people using an ambulance after a MVC must report their crash to government authorities. Figure 1 details the linkage process.

During the study period, there were 20,460 ambulance attendances for 18,917 patients in 14,846 road crashes. Most patients had one attending crew (92.5%); some had two crews (7.0%), three crews (0.4%) or four crews (0.1%). Of the patients attended for a MVC, most were transported to an emergency department (ED) (63.9%).

Demographic Characteristics

As shown in Table 1, for the 18,917 MVC patients in the ambulance data the median age was 34.0 years (IQR: 23 to 53), with ages ranging from less than 1 to 101 years. There was a statistically significant difference between the median age for males compared to females ($p<0.01$), with males being slightly younger than females (median age 34.0 years compared to 36.0 years respectively). Patients were mainly occupants of a vehicle (60.7%). A small proportion were motorcyclists (9.4%), pedestrians (4.0%) or cyclists (3.4%). Data on road user type was not available for 22.5% of cases. Cyclists had the highest median age (40.0 years) and pedestrians the lowest (29.0 years).

Clinical Characteristics

A small proportion of patients had a Glasgow Coma Scale score of less than 14 (3.3%), a systolic blood pressure of < 90mmHg (0.7%) or a respiratory rate of <10 or >29 breaths per minute (2.1%).

Characteristics of high acuity versus low acuity patients

There were 1,214 high acuity patients (6.4% of all patients). Of these, 50 people died on-scene and 1,164 were transported from the scene to hospital at priority one.
Clinical, demographic and crash characteristics for high acuity patients were compared with those defined as low acuity patients (Table 1). A higher proportion of males (8.7%) versus females (3.7%) were classified as high acuity (Table 1). A higher percentage of vulnerable road users (motorcyclists (14.9%), cyclists (9.2%), pedestrians (15.1%)) than motor vehicle occupants (MVOs (4.8%)) were classified as high acuity (Table 1). Being ejected from a vehicle had the highest proportion of high acuity patients (30.1%) (Table 1). This rate was similar to that for patients who were not ambulant at scene (26.3%) and for those patients entrapped in a vehicle (21.8%) (Table 1). High acuity patients comprised only 6.6% of those in a rollover and 3.9% of those where airbags deployed (Table 1).

Unadjusted odds ratios (ORs) of high acuity (relative to the odds of low acuity) were calculated according to demographic and patient crash characteristics (Table 2). Adults were less likely than children to be high acuity, and this was true among all adult age groups (See Table 2). The odds of being classified as a high acuity patient were significantly greater for pedestrians (OR=3.56, 95% CI, 2.86-4.42) and motorcyclists (OR 3.49, 95% CI 2.98-4.08) than for motor vehicle occupants (MVOs). Not ambulant patients had 15 times the odds of being high acuity than ambulant patients (OR=15.34, 95% CI, 11.48-20.49). Patients who were ejected from the vehicle, compared to those not ejected, (OR 6.49, 95% CI, 4.62-9.12); and those who were trapped compared to those not trapped, had higher odds of being high acuity patients (OR 4.68, 95% CI, 3.95-5.54). Additionally, patients in night-time MVCs had higher odds than patients in day-time MVCs of being high acuity (OR 2.21, 95% CI, 1.94-2.52), as did those involved in crashes at a midblock versus intersection (OR 2.02, 95% CI, 1.75-2.34) – see Table 2.

Of high acuity patients around a quarter has at least one high acuity indicator (73.4%) (being either a vulnerable road user, non-ambulant, ejected, trapped, on a midblock or at night-time) and a fifth a protective factor (18.2%) (being either in a vehicle where an airbag deployed or in rainy weather). – see Table 3.

Discussion

The aim of this study was to describe and identify patients and the characteristics of the MVCs they were involved in that were associated with high acuity. Specifically, we sought to identify those factors that could be reported to an ambulance dispatcher by a bystander during the emergency phone call. Ambulance data was linked with police crash data, comprising n=18,917 unique patients, with 6.4% of patients being classified as high acuity (defined here as priority one transport to hospital, or died at the scene).

There are two important findings from this study. The first reflects the imbalanced proportion of high compared to low acuity patients at the scene of MVCs. Nearly all patients attended by paramedics to motor vehicle crashes were of low acuity in this study, with 93.6% of patients neither dead on-scene, nor transported priority one to hospital. This could suggest that an other than priority one response, where lights and sirens are not used on the way to the scene of a crash, could be an appropriate ambulance response, unless there is specific updated information provided by the on scene caller. While the imbalanced nature of MVCs towards being primarily low severity is well known (26), some of the research in this field uses crude ordinal categories (fatality/hospitalization/minor injury/property damage) that reflect the outcome of injuries in a crash and do not adequately translate to describing the need for a priority one ambulance response to MVCs (14). Therefore, as patient acuity described in this study relates to the need for paramedic care as indicated by either L&S transport or death at the scene, , this study makes a unique contribution to confirming the disparity between high and low acuity patients regarding urgent need for an ambulance.

The second main finding of our study was similar to that identified by Lerner et al. (25), namely that 'not all crash scene characteristics are created equal'. The strongest predictor was ambulation, with not ambulant patients having over 15 times the odds of high acuity than ambulant patients (OR=15.34, 95% CI, 11.48-20.49). However, ambulatory status had to be deduced by searching text words in the ePCR, and could not be determined for 34% of the patients. Significant associations were found for other variables, including whether a patient was ejected from the vehicle (OR 6.49, 95% CI, 4.62-9.12) or trapped in vehicle (OR 4.68, 95% CI, 3.95-5.54). Additionally, adults were less likely than children to be high acuity. However, this could be related to paramedic concern for/discomfort with injured children and not just the severity of the condition.

One crash scene characteristic with some contention as to its relevance to be used in triage is vehicle rollover (27–29). Vehicle rollover has been used to aid in triage in different settings, including ambulance dispatch (6) and transport from the field to trauma centers (24). This study found that being in a vehicle rollover did not significantly increase the odds of being classified as a high acuity patient (OR=1.04; 95% CI, 0.75-1.43), while others have found that vehicle rollover is a criterion with suitable predictive ability (for trauma team activation) (30). Previous studies have suggested that using rollovers as a dispatch criterion to identify the acuity of patients could be improved when combined with other crash characteristics (31) such as whether the patient remained in the vehicle or was ejected (32). The crash characteristics identified in this study need to be further explored regarding their suitability to be used to determine ambulance dispatch priority.

It is important to note that many of the crash characteristics presented here (ambulatory status, time of day and intersection status) are not currently part of commonly used systems for emergency dispatch, such as the Medical Dispatch Priority system, and therefore offer new and novel information to potentially improve the accuracy of ambulance prioritization.

This study has affirmed that a single crash scene variable cannot predict patient acuity. Multiple crash characteristics used in combination could have better sensitivity and specificity. For example, Isenberg, Cone and Steill (33) have suggested a dispatch rule where any MVC on a highway/interstate, involving only a single vehicle, or with a non-ambulatory patient should receive priority one response. This multiple characteristic approach is already used by automatic crash notification (ACN) systems such as URGENCY (34). However, ACN is not available in all communities, and many of the crash characteristics used by those systems ae not reliably reportable by witnesses or bystanders (e.g., speed at collision, steering wheel deformation, vehicle intrusion depth).

Limitations

A limitation of this study was there are currently no validated criteria that explicitly determine the need for a priority one ambulance dispatch. We therefore used a proxy measure defined as (1) death at the scene or (2) priority one transport from the scene to hospital. While this proxy measure is indicative of the severity of injuries sustained by the MVC patient, it is possible that some conditions that are potentially life-threatening can be managed by paramedics at the scene and therefore not have required a priority one transport to hospital. These could have included conditions such as an obstructed airway and bleeding, which all require urgent paramedic intervention at the scene but not necessarily urgent transport to hospital. Furthermore, paramedic decision-making about L&S transport from the scene is not necessarily or solely dependent on patient acuity, but may also be influenced by other factors such as training or system protocols related to mechanism of injury (e.g., ejection; rollover), patient age (pediatric or geriatric) and non-clinical factors such as transport distance or traffic congestion.

The road user status (i.e. motor vehicle occupant, motorcyclist, cyclist, pedestrian) is a variable of interest to this study as it reflects the level of protection that a patient has in the crash and therefore the potential need for a priority one ambulance response. Yet, for around a quarter of patients in this study, the road user status was unknown (22.5%). However, where the road user status was unknown, nearly all these patients were low acuity (94.7%) and nearly half were not transported from the scene (49.3%). Therefore, it is expected that the primary cohort of interest in this study ('high acuity' patients) were not disproportionately represented in this unknown road user group. This assessment was made and the same conclusion reached for other crash variables investigated that had a high proportion of missing values, such as for ambulatory status which had 66.1% unknowns.

We excluded crashes with an ambulance response where no patient was found or no patient assessment was performed. There is no way of enumerating this in a retrospective study – however, it is not envisaged that the numbers would be large and these arguably could be considered low-priority crashes.

Future Research

Future research could consider how crash characteristics might be incorporated for use in determining ambulance dispatch priority. While it is not feasible for ambulance emergency call-takers to ask bystanders about physiologic or anatomic criteria (35), we suggest that future research investigate the potential to use combinations of crash characteristics (and possibly environmental characteristics) to develop reliable algorithms to distinguish between those MVCs that do and do not require a priority ambulance response.

Additionally, future research might assess the validity of the indictor of high and low acuity patients at the scene of a MVC used in this paper, against standard outcome measures such as mortality, length of hospital stay or immediate surgery need.

Conclusion

While motor vehicle crashes can result in serious injuries and even death, over 93% of MVC patients attended by ambulance paramedics in Perth, WA were classified as low acuity. We found that some crash scene characteristics of patients (including ambulation, person ejected, trapped, or involving a vulnerable road user) were significant predictors of high acuity. In addition, a crash characteristic currently used in dispatch systems to triage for MVCs (whether the vehicle rolled over) appears to be a weak predictor of patient acuity. There is a need to further investigate the potential for crash scene characteristics, as identified by bystanders, to be incorporated into algorithms to determine ambulance dispatch priority.

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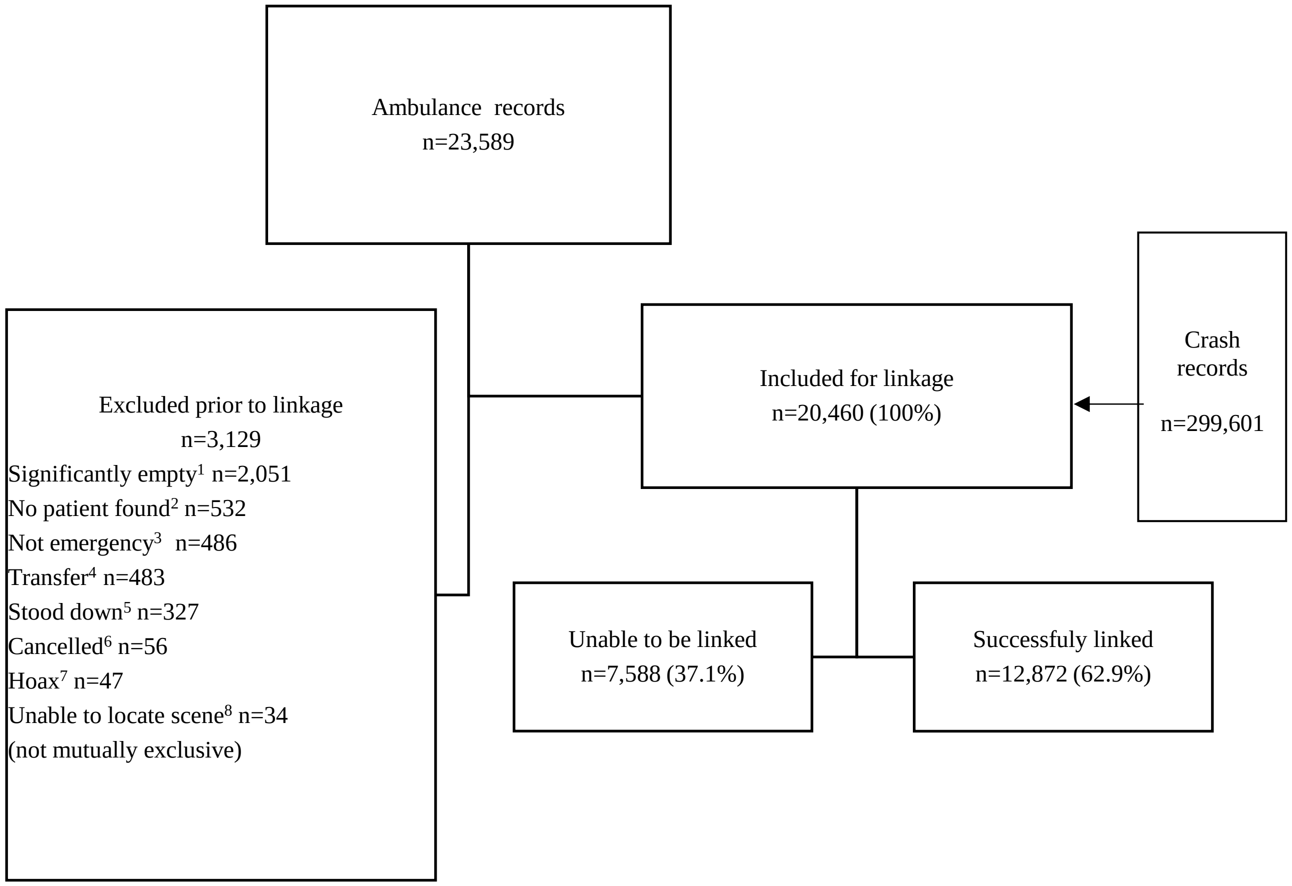
Figure 1. Flow diagram of included/excluded patient records and linkage process between ambulance dispatch record and road crash notification records



[1] No electronic record of assessment, intervention, or clinical case notes; [2] Paramedics arrived on-scene but there was no patient present (e.g. patient absconded); [3] Use of the ambulance for other than delivering patient care, such as transport of equipment; [4] Patient transfer between hospitals; [5] Ambulance dispatched but then received a higher priority job or another crew was closer to the scene; [6] Individual calls from the scene and states they no longer require the ambulance; [7] Call for an ambulance is falsely and deliberately made; [8] Ambulance is sent but cannot locate the MVC.

Table 1. Characteristics of MVC patients by 'high/low acuity'[1]

	Low n (%)	High n (%)	All n (100%)
Total	**17,703 (93.6%)**	**1,214 (6.4%)**	**18,917**
Clinical characteristics (1st observation)			
Glasgow Coma Scale <14	170 (27.5%)	449 (72.5%)	619
Systolic blood pressure <90 mmHg	58 (42.6%)	78 (57.4%)	136
Respiratory rate <10 or >29 breaths per minute	181 (44.6%)	225 (55.4%)	406
Demographic characteristics			
Age - years			
<=16	3,281 (90.7%)	336 (9.3%)	3,617
17-24	3,179 (94.1%)	198 (5.9%)	3,377
25-64	9,160 (94.2%)	566 (5.8%)	9,726
65+	2,083 (94.8%)	114 (5.2%)	2,197
Sex			
Male	8,735 (91.3%)	837 (8.7%)	9,572
Female	7,557 (96.3%)	290 (3.7%)	7,847
Road User			
Motor vehicle occupant	10,925 (95.2%)	584 (4.8%)	11,473
Motorcyclist	1,521 (85.1%)	266 (14.9%)	1,787
Cyclist	581 (90.8%)	59 (9.2%)	640
Pedestrian	639 (84.9%)	114 (15.1%)	753
Other/unknown	4,037 (94.7%)	227 (5.3%)	4,264
Crash characteristics[2]			
Vulnerable road user[3]	2,741 (86.2%)	439 (13.8%)	3,180
Other road users	10,925 (95.2%)	548 (4.8%)	11,473
Not ambulant	263 (73.7%)	94 (26.3%)	357
Ambulant	5,922 (97.7%)	138 (2.3%)	6,060
Rollover	592 (93.4%)	42 (6.6%)	634
Other crash type	17,112 (93.6%)	1,171 (6.4%)	18,283
Ejected	114 (69.9%)	49 (30.1%)	163
Not ejected	17,589 (93.8%)	1,165 (6.2%)	18,754
Trapped	708 (78.2%)	198 (21.8%)	906
Not trapped	16,995 (94.4%)	1,016 (5.6%)	18,011
Intersection	6,774 (95.0%)	358 (5.0%)	7,132
Mid-block (not intersection)	4,254 (90.3%)	455 (9.7%)	4,709
Airbags deployed	4,623 (96.1%)	185 (3.9%)	4,808
Airbag not deployed	13,080 (92.7%)	1,029 (7.3%)	14,109
Rainy weather	543 (93.3%)	39 (6.7%)	582
Fair weather	5,857 (90.2%)	635 (9.8%)	6,492
Night-time (7:30pm-5am)	2,669 (88.6%)	342 (11.4%)	3,011
Day-time (5am-7:30pm)	15,034 (94.5%)	872 (5.5%)	15,906

[1] High acuity was defined as patients who (1) died on-scene or (2) were transported by ambulance on priority one (L&S) (high priority) from the scene to hospital. Low acuity was defined as patients who (1) did not die on-scene and (2) were either not transported to hospital or were transported to hospital at a priority lower than priority one (not L&S).
[2] Categories may not sum to the total where the crash characteristic was unknown.
[3] Vulnerable road users were either motorcyclists (incl. pillion), cyclists or pedestrians.

Table 2. Odds Ratios (OR) of being classified as a 'high acuity patient' (with Referent group)

	OR (95% CI)
Age group (years)	
0-16	*1.00*
17-24	0.61 (0.51-0.73)
25-64	0.60 (0.52-0.69)
65 and over	0.53 (0.43-0.67)
Sex	
Male	*1.00*
Female	0.40 (0.35-0.46)
Road user group	
Motor vehicle occupant	*1.00*
Motorcyclist	3.49 (2.98-4.08)
Cyclist	2.02 (1.53-2.68)
Pedestrian	3.56 (2.86-4.42)
Vulnerability[3]	
Not-vulnerable (MVO)	*1.00*
Vulnerable	3.19 (2.80-3.64)
Ambulatory status	
Ambulant	*1.00*
Not ambulant	15.34 (11.48-20.49)
Vehicle rollover status	
Not a rollover	*1.00*
Rollover	1.04 (0.75-1.43)
Patient ejection status	
Not ejected	*1.00*
Ejected	6.49 (4.62-9.12)
Trapped status	
Not trapped	*1.00*
Trapped	4.68 (3.95-5.54)
Road position	
Intersection	*1.00*
Midblock	2.02 (1.75-2.34)
Airbag status	
Airbags not deployed	*1.00*
Airbags deployed	0.51 (0.43-0.60)
Weather	
Not rainy weather	*1.00*
Rainy weather	0.66 (0.47-0.93)
Day/Night	
Not night-time	*1.00*
Night-time (7:30pm-5am)	2.21 (1.94-2.52)

Table 3. Number of patients who had at least one/no high acuity indicator, or at least one/no protective factor

	Had at least one high acuity indicator[1]	Had no high acuity indicator	Had at least one protective indicator[2]	Had no protective indicator
Low acuity patient (n)	8,063	9,640	4,987	12,716
High acuity patient (n)	891	323	221	993

[1] High acuity indicators were: vulnerable road users; non-ambulant; ejection; trapped; midblock and night-time.

[2] Protective indicators were: airbag deployed and rainy weather.