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Age-related trends in injury and injury severity presenting to emergency departments in New South Wales Australia: Implications for major injury surveillance and trauma systems

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ABSTRACT

Objectives: To describe population based trends and clinical characteristics of injury related presentations to Emergency Departments (EDs).
Design and setting: A retrospective, descriptive analysis of de-identified linked ED data across New South Wales, Australia over five calendar years, from 2010 to 2014.
Participants: Patients were included in this analysis if they presented to an Emergency Department and had an injury related diagnosis. Injury severity was categorised into critical (triage category 1–2 and admitted to ICU or operating theatre, or died in ED), serious (admitted as an in-patient, excluding above critical injuries) and minor injuries (discharged from ED).
Main outcome measures: The outcomes of interest were rates of injury related presentations to EDs by age groups and injury severity.
Results: A total of 2.09 million injury related ED presentations were analysed. Minor injuries comprised 85.0%, and 14.1% and 1.0% were serious and critical injuries respectively. There was a 15.8% per annum increase in the rate of critical injuries per 1000 population in those 80 years and over, with the most common diagnosis being head injuries. Around 40% of those with critical injuries presented directly to a major trauma centre.
Conclusion: Critical injuries in the elderly have risen dramatically in recent years. A minority of critical injuries present directly to major trauma centres. Trauma service provision models need revision to ensure appropriate patient care. Injury surveillance is needed to understand the external causes of injury presenting to hospital.

Introduction

Injury remains a leading cause of morbidity and mortality around the world [1] and accounts for almost one quarter of Emergency Department (ED) presentations in Australia [2]. Trauma systems have been shown to improve outcomes for severely injured patients, but monitoring and improving the effectiveness of trauma systems requires robust data collection at a

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population level [3]. Whilst data relating to hospital outcomes for severe trauma is routinely collected from designated trauma centres, the patients presenting to non-trauma centres are less robustly accounted for. This has the potential to affect the applicability of the age -related trends seen in trauma registries to regions, populations or non-trauma centre hospitals [4]. Use of ED presentation data, can potentially provide this information, though there are limited studies of population based injury trends using this type of data.

ED presentation databases have the advantage of capturing all injury related presentations regardless of disposition, severity of injury and hospital designation [5]. This is important given the majority of patients who present are seen and discharged from ED [6]. Compared to ED databases (unless data linkage is performed), inpatient and trauma registry data have greater detail in terms of diagnostic codes and hospital outcomes data [7]. Nevertheless, ED databases enable a broad description of epidemiological trends and clinical characteristics such as urgency, disposition and mode of arrival. These are necessary for surveillance of particular injuries such as burns, occupational injury, and geriatric trauma, and to identify gaps in a given trauma system that require additional support [7,8]. This has particular implications for current and future trauma and pre-hospital service planning in rural and remote locations. This is especially true given the current concentration of Major Trauma Services in urban environments [4], and the need for these to network with smaller hospitals serving rural and regional areas.

We sought to describe population based trends and clinical characteristics of injury related presentations to EDs, and to compare clinical characteristics of injury presentations to EDs within major trauma centres and non-trauma centres.

Materials and methods

Design and setting – This was a retrospective, descriptive analysis of de-identified linked Emergency presentations across NSW over five calendar years, 2010 to 2014. New South Wales is the most populous state in Australia, with seven designated adult major trauma centres, two specialist major paediatric trauma centres and ten regional trauma centres.4 Around 72% of the population live in metropolitan areas of New South Wales with a further 20% residing in inner regional and 8% in remote or outer regional locations and these have not changed significantly during the study period [9].

Data sources

The Emergency Department Data Collection (EDDC) registry contains routinely collected administrative and clinical data for patient level presentations across all public hospital emergency departments in NSW. Probabilistic linkage was performed by the NSW Centre for Health Record Linkage (CHereL) to obtain patient level data across all sites and avoid double counting of patient encounters due to transfers between facilities [6]. Data obtained for this analysis included arrival mode, patient registration, type of visit, triage category, mode of separation, and the ED diagnosis entered made at the time of discharge. Estimated Residential Populations (ERP) by age and sex, per year, were obtained from the Australian Bureau of Statistics [9] and used to calculate age specific population rates.

Patient population – Patients were included in this analysis if they presented to an Emergency Department and had an injury related diagnosis recorded by clinicians as their primary ED diagnosis based on Systematized Nomenclature of Medicine Clinical Terms (SNOMED-CT) concept identifiers, or Australian clinical versions 9 or 10 of the International Classification of Diseases (ICD). Patients transferred from other health facilities were excluded to avoid double counting of presentations and patients who were dead on arrival were also excluded. A number of small rural Emergency Departments (n = 35) were excluded due to incomplete data submission in 2010-11 to minimise bias in reported trends. Patient presentation was used as the unit of analysis to measure workload on ED, not individual level risk.

Data variable definitions – A full list of data definitions and data collection methods for the EDDC were available at http://www0.health.nsw.gov.au/policies/pd/2009/PD2009_071.html. Emergency Department levels were defined using current NSW Ministry of Health role delineations for public hospitals, which take into account the complexity of clinical activity and the staffing and support services at a given hospital [10]. These ranged from Level 6 being tertiary referral centres to Level 1 small rural multi-purpose centres. For the purposes of this study, hospitals were divided into Major Trauma Services (n = 9, Adult and/or Paediatric centres), Tertiary non major trauma centres (n = 17, Level 5 or 6 Emergency Departments, including all regional trauma centres but excluding major trauma centres), and other non trauma centres (n = 89, all other facilities). Major and regional trauma centres were identified using the current NSW State Trauma Plan [4]. Presenting problems entered at the time of patient arrival to ED by triage nurses, and ED diagnoses entered by treating physicians were categorised into broad diagnostic groups by the investigating team based on the relevant coding system (ICD10AM codes S00.0-S99.9, T00.0-35.7, T79.2-79.9, V01.00-Y05.99, Y20.00-34.99 mapped to equivalent codes in ICD9CM and SNOMED terms). Examples of these injuries included but were not limited to burns, lacerations, sprains, strains, fractures, falls and trauma. If an ED diagnoses was not recorded, the investigating team used the presenting problem to classify injury. Only 0.7% of the dataset had an ED diagnosis or presenting problem that could not be classified.

The Australasian Triage Scale (ATS) was used to define urgency with category one indicating immediately life-threatening, category two indicating imminently life-threatening, category three indicating potentially life threatening, category four and five indicating potentially serious and less urgent presentations respectively [11]. Patient details including age, gender and Indigenous status were recorded at the time of patient registration in the ED.

Injury severities were categorised, based on ED measures of urgency and mode of separation, into critical (presenting with triage category one or two and admitted directly from ED to the Intensive Care Unit or operating theatre, or died in ED), serious (admitted as an in-patient, excluding above critical injuries) and minor injuries (discharged from ED). These categories were used instead of diagnostic codes or injury severity because we wanted to investigate workload and complexity in ED rather than post hoc measures of injury severity.

Outcomes

Outcomes of interest were rates of injury related presentations to Emergency Departments by age group and injury severity. These were reported by calendar years.

Statistical analysis

Annual rates of change for each age group were calculated using the compound interest formula $[(P_1/P_0)^{1/n}\text{-}1]^*100$ where P_1 is the final rate P_0 the initial rate and n denoting the number of years [12]. Chi square tests were used to compare characteristics between trauma centre designations. Population data for the Sydney Statistical Division was obtained from the Australian Bureau of Statistics [9] Categorical variables were compared using Chi

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squared tests. Incidence rate ratios (IRR) for age specific trends in presentation counts were estimated on aggregated data using generalised negative binomial regression using population as the exposure variable. Statistical analyses were performed using SAS Enterprise Guide version 4.3 (SAS Institute Cary NC). Age specific rates per 1000 population were calculated and plotted using Microsoft Excel.

Ethics

Approval for access to de-identified data was obtained through the NSW Population & Health Services Research Ethics Committee and the Aboriginal Health and Medical Research Council Ethics Committee.

Results

Patient population

There were 10.8 million ED presentations identified during the study period of which 2.09 million (19.4%) had an injury related primary ED diagnosis. The next most common ED diagnosis categories were abdominal/gastrointestinal (12.5%) and respiratory (8.9%) and cardiovascular (8.0%).

1.5 million individuals accounted for the 2.09 million presentations to EDs with injuries meaning that 74.8% of patients presented only once during the study period. Of all injury presentations, males comprised 59.1% of the study population, 22.1% were transported by ambulance and the overall in-patient admission rate was 15.1%. With respect to injury severity, 1777851 (85.0%) were minor, 294479 (14.1%) were serious and 19873 (1.0%) were critical injuries. The rate of critical injuries increased overall by 10.4%, serious injuries by 12.6% and minor injuries by 5.3% per annum.

Fig. 1 shows age (5 yearly intervals) specific rates of injury related presentations to ED between 2010 and 2014 demonstrating peaks in paediatric age groups and those older than 80 years of age. There was an apparent increase in presentation rates in all age groups which was most pronounced in those over 85 years of age.

Figs. 2–4 to four show the change in presentation rates by broad age group and injury severity, and demonstrates the rapid increase in critical and severe injuries in those over 80 years of age (and relatively stable trend in other age groups). In particular for critical injuries, annual rates of increase are shown in Table 1.

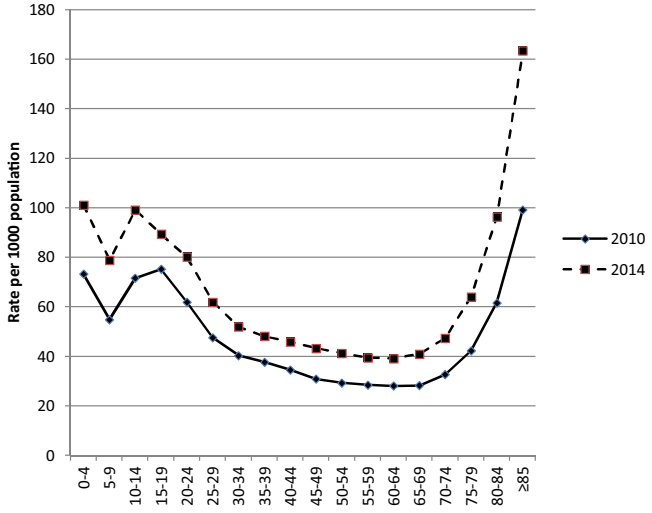

Fig. 1. Age specific rates of injury presentations to Emergency Departments in New South Wales for calendar years 2010 and 2014. Data Source: NSW Emergency Department Data Collection Registry.

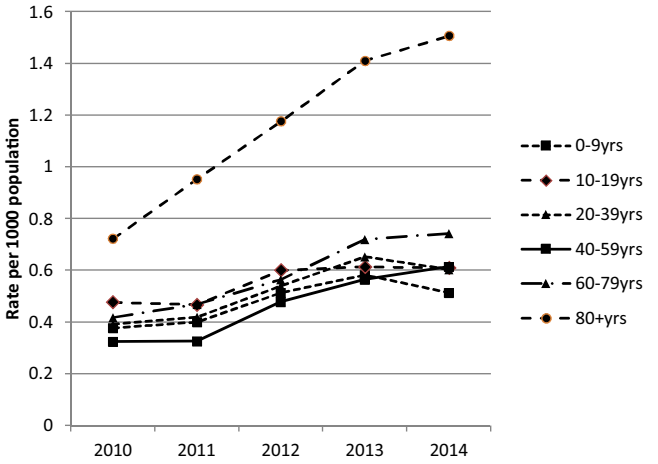

Fig. 2. Yearly trends in age specific rates of critical injury presentations to Emergency Departments in New South Wales for calendar years 2010 and 2014. Data Source: NSW Emergency Department Data Collection Registry.

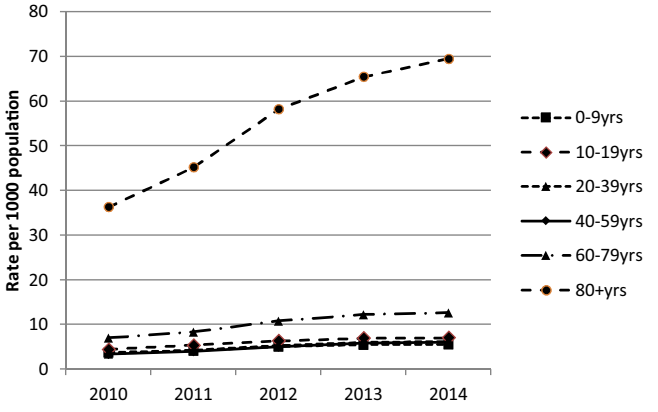

Fig. 3. Yearly trends in age specific rates of serious injury presentations to Emergency Departments in New South Wales for calendar years 2010 and 2014. Data Source: NSW Emergency Department Data Collection Registry.

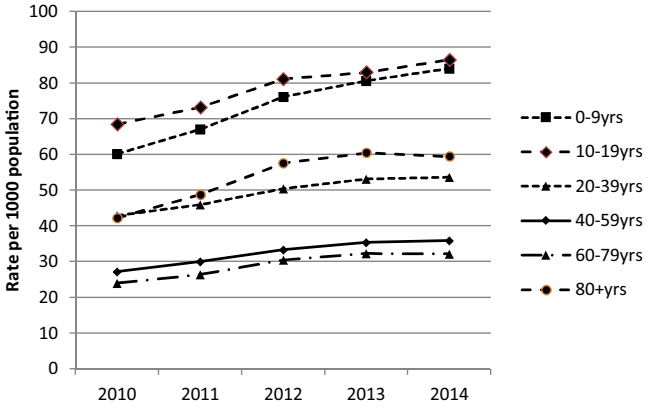

Fig. 4. Yearly trends in age specific rates of minor injury presentations to Emergency Departments in New South Wales for calendar years 2010 and 2014. Data Source: NSW Emergency Department Data Collection Registry.

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Table 1
Annual change in critical injury presentation rates (per 1000 population) to NSW Emergency Departments by age group in calendar years 2010–14. Data source: NSW Emergency Department Data Collection Registry.

Age bracket	2010	2014	Annual% change	Incidence Rate Ratio	95% CI
0–9 years	0.38	0.51	6.4%	1.10	1.04, 1.17
10–19 years	0.48	0.61	5.0%	1.08	1.04, 1.12
20–39 years	0.39	0.60	9.0%	1.14	1.09, 1.20
40–59 years	0.33	0.62	13.6%	1.20	1.14, 1.25
60–79 years	0.42	0.74	12.2%	1.17	1.13, 1.21
80 years and over	0.72	1.50	15.8%	1.19	1.15, 1.24

Critical injuries and trauma centre designation

Table 2 compares the patient characteristics with respect to trauma designation of the presenting hospital for the subset of critically injured patients (n = 19,873). Of these, 40.8% presented to a major trauma centre, 22% to a tertiary non-major trauma centre and 37.2% presented to other hospitals. Patients presenting to major trauma centres were older and more likely to be transported by ambulance compared to those at other non-trauma centres. Around half of all critical injuries presenting to tertiary non-major trauma centres and 83% of those presenting to other hospitals were transferred to another facility. There were higher proportions of head and abdominal/pelvic injuries in those presenting to tertiary non-major trauma centres compared to major trauma centres (4.3% versus 3.7%). Of the 1747 patients aged 80 years or over who had critical injuries, 6.0% were referred by a nursing home or other aged care facility, and the three most common injury diagnosis types were head injury (30%), lower limb (10.8%), and chest injury (8.3%).

Discussion

This is the first Australian study to identify the trends and characteristics of all injuries presenting to ED at a state wide level. Although increases in injury presentations were in general observed across all age groups from 2010–2014, the study highlighted a dramatic increase in the rate of critical and serious injuries in patients 80 years and over. The findings from this study has important implications for future trauma service planning and broader injury management and prevention policies [13].

Studies have pointed to the increase in proportion and cost of geriatric trauma [14]. Trauma service plans and injury management strategies in general need to take into account these demographic changes. It is clear that older trauma patients have increased mortality and morbidity for a given injury severity [15]. The management of the elderly population tends to be more complex owing to medical comorbidities, polypharmacy (including anticoagulation), social circumstances, and the need for longer recovery times and rehabilitation after injury. Given the management complexity of injured elderly patients, surgically-based trauma services may need to include greater emphasis on medical management. These may evolve from separate trauma-geriatric models of care, similar to ortho-geriatric services, to specific geriatric injury networks and referral pathways [16]. Other issues that need addressing include post discharge community support, sub-acute care and palliation for patients with advanced care directives or in whom aggressive trauma management is deemed futile.

Furthermore, the large number of presentations of patients categorised as 'critically injured' to non-major regional trauma centres requires further investigation. Currently data for severe injuries (Injury Severity Score >12), is collected only from Major Trauma Centres [17]. However, the data presented here suggests that the burden of initial treatment is shared across other hospitals,

Table 2
Comparison of characteristics in critically injured patients (n = 19873) by facility type. Data source: NSW Emergency Department Data Collection Registry.

	Major Trauma centre (9) N = 8108	Tertiary non major trauma centre (17) N = 4373	Other non trauma hospital (89) N = 7392	P value
Age (%)				<0.001
0–9yrs	686 (8.5)	472 (10.8)	1089 (14.7)	
10–19yrs	869 (10.7)	471 (10.8)	1183 (16.0)	
20–39yrs	2316 (28.6)	1124 (25.7)	1923 (26.0)	
40–59yrs	1899 (23.4)	1019 (23.3)	1571 (21.3)	
60–79yrs	1539 (19.0)	865 (19.8)	1096 (14.8)	
80 + yrs	798 (9.8)	421 (9.6)	528 (7.1)	
Male (%)	5744 (70.8)	3095 (70.8)	5283 (71.5)	0.62
Ambulance (%)	7295 (90.0)	3181 (72.7)	3191 (43.2)	<0.001
NSW Metropolitan Hospital Presentations (%)	8108 (100)	2661 (60.5)	2100 (28.4)	<0.001
Mode of separation (%)				<0.001
Critical Care ward	4735 (57.4)	1537 (35.2)	831 (11.2)	
Operating theatre	2038 (25.1)	521 (11.9)	302 (4.1)	
Died in ED	285 (3.5)	150 (3.4)	121 (1.6)	<0.001
Transferred	1050 (13.0)	2165 (49.5)	6138 (83.0)	
Injury type (%)				
Head injury	1844 (22.7)	1083 (24.8)	1211 (16.4)	
Chest injury	500 (6.2)	246 (5.6)	388 (5.3)	
Abdominal/pelvic	302 (3.7)	187 (4.3)	200 (2.7)	
Upper limb	667 (8.2)	491 (11.2)	1418 (19.2)	
Lower limb	595 (7.3)	283 (6.5)	766 (10.4)	
Spine/vertebral column	206 (2.5)	147 (3.4)	216 (2.9)	
Penetrating injury	119 (1.5)	82 (1.9)	195 (2.6)	<0.001

IRRs reflect the change per annum estimated using data from all 5 years, and the annual% change is based on a comparison between the first and last year's only.

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and including data from these hospitals increases the estimate of the numbers of severely injured patients in New South Wales. A substantial proportion of critically injured patients presented to "other hospitals" and the majority of these were rural hospitals with limited direct access to the metropolitan major trauma centres. The number of Major Trauma cases reported by NSW Major Trauma Centres in 2013 was 3,411 (Injury Severity Score >12) [17] whereas the number of critical injuries in the same year identified in our study was 43.5% higher (4881 cases). The distribution of critical injuries across all types of facilities in this study highlights the need for a coordinated system of care and data collection across the state. Ambulance transport accounts for 43% of critically injured patients presenting to non-trauma/non-tertiary centres. These are largely smaller rural centres where access to ambulance and retrieval services may be lacking and where improved pre-hospital services may lead to direct transportation to more appropriate regional and major trauma centres. An effective retrieval and inter-hospital transport service has been shown to reduce mortality in severely injured patients [18].

The definition of critical injury used in trauma registries is based on post admission injury severity scores [4]. The definition used in our study is based on death or the allocation of a high urgency triage category together with the need for transfer, operating theatre or intensive care unit admission. This reflects those requiring urgent or complex specialist interventions in the ED context. Moreover the 3% mortality of these critically injured patients of observed in this study is consistent with that reported in a study of patients transported on ambulance major trauma transport protocols [19]. Further study linking this data to major trauma data of the same patient group will help establish the validity of this definition of injury severity with respect to the anatomic injury scores used in trauma registries.

Given the large proportion of injury presentations treated and discharged (85%) from ED, and the lack of detailed external cause of injury data recorded in ED systems, there is a significant gap in our knowledge about the true burden of injury in Australia. [20]. Injury surveillance systems which include external cause data are essential to injury prevention through the identification of the numbers, causes, mechanisms, and risk factors for injury [21,22], and routine emergency department patient databases in Australia do not facilitate injury surveillance. There are some advances in mining the presenting problem text which is commonly recorded in ED data which may allow for further interrogation of ED data, however for more systematic injury surveillance purposes the inclusion of a designated data field to capture external cause of injury coded data in ED systems is needed [23,24].

Besides the definition of critical and severe injuries, another limitation to the study is the use of injury based ED diagnoses. These are likely to underestimate the true rate of injuries because symptom-based diagnoses such as ankle pain or chest wall pain were specifically excluded from the injury category used. As the analysis was performed on presentations and not patients we did not account for any representations of the same individuals. These are particularly relevant in the elderly who are more likely to return with, for example, recurrent falls. Gender differences with increasing age were also not accounted for in this analysis, with a higher proportion of females expected in those over 80 years of age. However, on a clinical and health service level, the assessment and treatment of injured patients, in general, is not impacted by the number of times they represent or the patient's gender [25]. The increase in critical injuries may be related to increased utilisation of Intensive Care Units or higher triage category for a given injury occurring in the elderly population. Although it is unclear from the data presented in this report, it is more likely a reflection of increasing numbers of serious head injuries occurring after falls in the elderly [15]. Either way this finding would be of importance from a trauma service planning and hospital resource perspective and requires further elaboration.

This study highlights the need to urgently address trauma models of care, trauma service provision, and referral networks to ensure quality service provision for the growing demand on injury care. ED-based injury surveillance, which includes external cause data and short text-based injury descriptions are also needed to better understand the causes of injuries to allow the targeting of prevention activities to reduce the high rate and growth in geriatric trauma.

Conflicts of interest

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