

ORIGINAL RESEARCH

Understanding drivers of Demand for Emergency Service Trends in Years 2010–2014 in New South Wales: An initial overview of the DESTINY project

Michael M DINH,^{1,2} Saartje BERENDSEN RUSSELL,^{1,3} Kendall J BEIN,¹ Dane CHALKLEY,¹ David MUSCATELLO,⁴ Richard PAOLONI² and Rebecca IVERS^{5,6}

¹Royal Prince Alfred Hospital, Sydney, New South Wales, Australia, ²Discipline of Emergency Medicine, The University of Sydney, Sydney, New South Wales, Australia, ³School of Nursing, The University of Sydney, Sydney, New South Wales, Australia, ⁴School of Public Health and Community Medicine, University of New South Wales, Sydney, New South Wales, Australia, ⁵The George Institute for Global Health, The University of Sydney, Sydney, New South Wales, Australia, and ⁶School of Nursing and Midwifery, Flinders University, Adelaide, South Australia, Australia

Abstract

Objective: This study aims to describe the general characteristics and data definitions used in a population-based data set of ED presentations in New South Wales (NSW), used to form the basis of future-trend analyses.

Methods: Retrospective analysis of the Emergency Department Data Collection registry, which provided clinical and demographic information of ED presentations across all EDs in NSW between 2010 and 2014. Presenting problems and ED diagnoses were classified using broad clinical categories including injury/musculoskeletal, respiratory, cardiovascular, ear nose and throat, and mental health. Presentations were linked by patient to allow for analysis of representations, and population data were obtained from the Australian Bureau of Statistics.

Results: There were 11.8 million presentations that were analysed from 150 EDs (80.6% of all EDs). The rate of ED presentations was highest in those aged 85 years and older and appears to increase across all age groups between 2010 and 2014. The most common ED diagnosis

categories were injury/musculoskeletal (27.5%) followed by abdominal/gastrointestinal (12.3%), respiratory (9%) and cardiovascular (8%). Both the Systematised Nomenclature of Medicine Clinical Terms (66%) and the International Classification of Diseases (24%) were used to code ED diagnoses.

Conclusions: The elderly population had the highest rate of ED attendances. The use of diverse diagnosis classifications and source information systems may present problems with further analysis. Patterns and characteristics of ED presentations in NSW were broadly consistent with those reported in other states in Australia.

Key words: demand, emergency department, population.

Introduction

ED overcrowding across Australia and around the world continues to be an important public health issue.^{1–4} Overcrowding is thought to be a result of a combination of factors, including increased demand for emergency services

Key findings

- This major population-based study is currently being undertaken to understand the drivers of increased demand for ED services in NSW.
- The initial analysis demonstrated that the major presenting problems were injury/musculoskeletal, abdominal/gastrointestinal, respiratory and cardiovascular presentations.
- The rate of ED presentations was highest in those aged 85 years and older.
- Issues with diagnostic coding within the dataset need to be addressed further.

and blocked access to hospital beds.^{1–5} Persistent overcrowding can lead to sub-optimal system performance,⁶ increasing patient morbidity and mortality.^{1–4} Although much has been reported about the increase in demand for emergency care at population levels, the factors behind the observed rise in demand remain poorly understood. Specific factors investigated have included access to General Practitioners, the ageing population and patient perception of appropriateness and convenience of care provided in EDs.^{4,7,8} Several studies have demonstrated the increase in ED demand from the elderly population that has grown disproportionately to population growth.^{9–12} Understanding these and other factors will allow for improved choices in the allocation of finite health resources and provide a basis for alternative models of care in ED.

Correspondence: Mrs Saartje Berendsen Russell, Royal Prince Alfred Hospital, Missenden Road, Camperdown, Sydney, NSW 2050, Australia. Email: Saartje.BerendsenRussell@sswahs.nsw.gov.au

Michael M Dinh, MBBS, Emergency Physician; Saartje Berendsen Russell, MEd, Clinical Nurse Consultant; Kendall J Bein, MBBS, Emergency Physician; Dane Chalkley, MBBS, Emergency Physician; David Muscatello, PhD, Senior Lecturer; Richard Paoloni, MBBS, Emergency Physician; Rebecca Ivers, PhD, Director.

Accepted 8 December 2015

New South Wales (NSW) is the most populous state in Australia with a population of over 7.5 million and a land area of approximately 809 000 km².¹³ There are 186 designated EDs, ranging from small rural multipurpose centres to large metropolitan tertiary teaching hospital EDs. The Emergency Department Data Collection (EDDC) system is a population-level registry that collated information from all EDs across NSW.^{14,15} The Demand for Emergency Service Trends in Years 2010–2014 (DESTINY 10–14) project was undertaken to understand the drivers of current ED presentation trends in NSW. The present study reports on the methodology of the DESTINY project, characterises the dataset, and identifies challenges and opportunities presented with the EDDC.

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 and summarised in Table 1.

ED 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.¹⁷ These ranged from Level 6 being tertiary referral major trauma centres to Level 1 small rural multi-purpose centres (Table 1). Presenting problems entered at the time of patient arrival to ED by triage nurses, and ED diagnoses were categorised into broad diagnostic and

symptom related groups (Table 2). ED diagnoses were entered by the treating clinicians into electronic health records. Depending on the information system used, the diagnosis was translated by software into a Systematised Nomenclature of Medicine Clinical Terms (SNOMED-CT) concept identifier, or Australian clinical versions 9 or 10 of the International Classification of Diseases (ICD). Information systems may only offer a subset of the SNOMED or ICD classifications for selection. Only the principal ED diagnosis was included in the data set. Presenting problem and ED diagnosis were categorised into broad clinical groups and reviewed by the investigating team. If ED diagnoses were missing or unable to be classified (e.g. 'pain',

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.

Data sources

The EDDC contains routinely collected administrative and clinical data for patient level presentations across all public hospital EDs in NSW. Data obtained for DESTINY included arrival mode, patient registration, type of visit, triage category, mode of separation and the ED diagnosis entered made at the time of discharge. Because the reporting unit of the EDDC is the presentation rather than the individual person, probabilistic data linkage was used to obtain individual-level presentation information. This allowed for analysis of patient re-presentations and the record linkage was performed by the Centre for Health Record Linkage (CHeReL).¹⁶

Population data

Estimated Residential Populations (ERP) by age and sex, per year, were obtained from the Australian Bureau of Statistics.¹³

TABLE 1. Data variable definitions

Variable	Coding definition
Age	Age in years, and in 5 yearly increments
Sex	Male/female/indeterminate/unknown
Date and time of arrival	Time of first encounter (triage or registration) in ED
Mode of arrival	Self, ambulance or police
Mode of separation	Admitted (ward or intensive care), discharged, died, transferred to another health facility
Presenting problem	Triage nurse-entered clinical problem
ED diagnosis	SNOMED-CT or ICD (10 AM and 9CM) versions
Triage category	Australasian triage category 1 (immediately life-threatening) to 5 (non-urgent)
ED visit type	Planned representation or emergency visit
Representation within 7 days	Unplanned representation within 7 days of ED arrival date
Representation within 30 days	Unplanned representation within 30 days of ED arrival date
ED level	Designation of ED based on complexity and specialty services (Level 6 = most complex/major trauma centre, Level 5 = non trauma tertiary referral hospital, Level 4 = district-level hospital, Level 3 = small general hospital, level 1–2 = multipurpose and urgent care centres)
Metropolitan ED	Hospitals located within Greater Sydney Metropolitan Area (including Central Coast), Newcastle and Wollongong
Paediatric hospital	Sydney Children's or Westmead Children's Hospital
ED length of stay (hours)	Time between ED arrival date/time and ED departure date/time

ED, emergency department; ICD10AM and ICD9CM, International Classification of Diseases; SNOMED-CT, Systematised Nomenclature of Medicine Clinical Terms.

TABLE 2. Classification of triage presenting problems and ED diagnoses with most common examples contained in dataset

Presenting problem/ diagnostic category	Presenting problem examples	ED diagnosis examples
Abdominal/ gastrointestinal	Abdominal pain, vomiting, diarrhoea, nausea, epigastric pain, malaena	Abdominal pain, gastroenteritis, constipation, vomiting, rectal bleeding
Cardiovascular	Chest pain, collapse, syncope, palpitations	Chest pain, atypical chest pain, syncope, atrial fibrillation, palpitations
Respiratory	Shortness of breath, cough, wheeze, pneumonia	Upper respiratory tract infection, shortness of breath, asthma, pneumonia, croup, chronic obstructive pulmonary disease
Infection	Fever, wound infection, cold symptoms, abscess	Viral illness, fever, sepsis, abscess, pyrexia, febrile illness
Injury/ musculoskeletal	Road trauma, fracture, laceration, dislocation, amputation, burn, sprain, back pain, limb pain, burns, falls	Head injury, soft tissue injury, laceration, falls, motor vehicle accident
Unwell (general)	Abnormal results, weight loss, decreased input, lethargy, general pain	Dehydration, generally unwell, lethargy, pain, hyponatraemia
Neurology	Headache, seizures, post-ictal, altered level of consciousness, stroke, cerebral haemorrhage	Headache, seizure, cerebral vascular accident, dizziness, transient ischaemic attack, migraine
Mental health	Anxiety, hallucinations, depression, suicidal, self-harm	Schizophrenia, psychosis, suicidal, self harm, behavioural problems
Toxicology/drug and alcohol	Overdose, poisoning, intravenous drug user, alcohol intoxication	Alcohol intoxication, drug overdose, opioid dependence
Ear nose and throat, eye, oral	Hypohaema, foreign body eye, epistaxis, toothache, tonsillitis	Tonsillitis, toothache, epistaxis, dental abscess, foreign body eye
Administrative procedures and non-urgent reviews	Requesting prescriptions, certificates, reviews, referrals, bloods, INR check, wound dressing	Informal referral signposted to other agency, attends outpatients, wound observation, medication administration
Urinary, renal	Urinary retention, dysuria, renal colic, hydrocele	Urinary tract infection, renal colic, urine retention, haematuria
Social	Social problems, acopia, homeless	Social problem, emotional crisis, parental concern of a child
Endocrine	Diabetes, hypoglycaemia	Hyperglycaemia, hypoglycaemia, diabetic ketoacidosis, diabetes mellitus
Obstetrics/ gynaecology	Per vaginal bleeding, miscarriage, ectopic, batholins cyst, ovarian torsion, birth	Threatened miscarriage, miscarriage, bleeding in early pregnancy
Allergy/skin	Anaphylaxis, urticaria, rash, cellulitis, psoriasis, eczema	Cellulitis, allergic reaction, skin rash, viral rash
Haematology/ oncology	Febrile neutropaenia, anaemia, malignancy, chemotherapy	Anaemia, febrile neutropenia, metastatic cancer, lymphadenopathy
Did not wait	Did not attend, not seen, left against medical advice	Did not wait for treatment, did not attend, left against medical advice
Neonatal		Newborn
Dead	Dead on arrival, died in hospital, deceased, sudden death	Dead on arrival at hospital, dead, dead-sudden death
Well	Alive and well, no abnormalities, no finding, normal appearance	Well baby, well adult, no abnormalities, physically well but worried
Uncodeable	Pain, unknown	Chief complaint, foreign body, other, seen by nurse

‘unwell’ or ‘other’), we assigned the presenting problem category where available. The Australasian Triage Scale was used to define urgency^{18,19} with category 1 indicating immediately life-threatening, category 2 indicating potentially life-threatening, category 3 indicating urgent and category 4 and 5 indicating semi-urgent and non-urgent presentations, respectively. Patient details including age, gender and Indigenous status were recorded at the time of patient registration in the ED.

Statistical analyses were performed using SAS Enterprise Guide version 4.3 (SAS Institute, Cary, NC, USA). The annual rate of change in total ED presentations was calculated using the formula $[(P1/P0)^{1/n} - 1] * 100$ where P1 and P0 were final and initial rates, respectively. The utilisation rate was defined as the number of unique individual presentations (excluding representations) as a proportion of the total population per year.

Ethics

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

Results

Completeness of dataset

There were a total of 11.8 million ED presentations from 4.3 million patients between January 2010 and December 2014.

Data were present from 150 EDs (80.6%) in NSW – 13 level one, 57 level two, 39 level three, 15 level four, 15 level five and 11 level six EDs (including two specialist paediatric centres). Data from 36 EDs, all rural level one and two centres, were unavailable. Of the 150 EDs with data, 35 had no data in one or more years between 2010 and 2013. Of these, 26 were level one or two EDs, and 10 were level three EDs. These centres made up 3.0% of all ED presentations. No level four, five or six EDs had missing years of data in the 5 year study period. Level five and six centres

comprised 51.1% of the dataset, 41.9% were from level three and four centres and the remaining 7% were from level one and two centres. Presentations to metropolitan EDs comprised 55.9% of the dataset.

Presenting problems were recorded in 97.4% of cases. A further 2.0% of presenting problems could not be classified (mainly free text entries). For ED diagnoses, 66.7% of the dataset were coded using SNOMED-CT, and 24.2% were coded using ICD (versions 9 or 10). When those with missing ED diagnoses (9.1%) were replaced with ED presenting problems, a total of 97.4% of the dataset had an ED diagnosis or presenting problem. Of these, 0.7% had an ED diagnosis or presenting problem that could not be classified.

Patient population and trends

The mean age of ED presentations was 39.0 years (SD = 0.01). Male individuals comprised 51.7% of all ED presentations (0.01% were classified as indeterminate or unknown sex). Patients identified as Aboriginal and/or Torres Strait Islander in 4.8% of ED presentations. The utilisation rate has increased from 17.7% in 2010 to 19.7% in 2014 (annual rate of change of 2.2%). Figure 1 summarises the age-specific rate of ED presentations in NSW per 1000 population. The rate was highest in those aged 80 years and over,

followed by those aged 0–4 years, with an increase in presentation rates observed across all age groups between 2010 and 2014: per annum increases were 0.3% (0–9 years), 0.7% (10–19 years), 0.9% (20–39 years), 1.1% (40–59 years), 1.0% (60–79 years) and 1.3% (80 years and over).

Presenting problem characteristics

Figure 2 shows the triage categories of ED presentations. Sixty per cent of all presentations were triage category 4 or 5. Overall, the most common presenting problem to ED was abdominal pain, followed by limb injury, chest pain, ‘unwell’, vomiting and or diarrhoea, lacerations, fever and back pain. The most common presenting problems by age groups are summarised in Table 3. When available ED diagnoses were classified into broad categories (excluding those with missing ED diagnoses), the most common presenting problem categories overall were injury/musculoskeletal (28.5%), abdominal/gastrointestinal (12.3%), respiratory (8.6%) and cardiovascular (8.0%). Mental-health diagnoses comprised 3.0% of presentations, and diagnoses relating to routine reviews, pathology, prescriptions or non-urgent procedures comprised 4.8% of all ED presentations. Overall in-patient admission rates were 28.0% and unplanned re-presentations occurred in 9.1% of cases within 7 days and 16.9% within 30 days of previous ED attendance date.

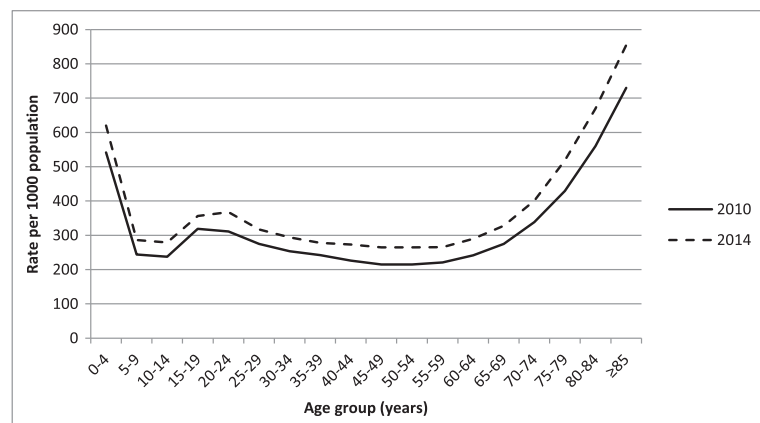


Figure 1. Rate of ED presentations per 1000 population in New South Wales in 2010 and 2014.

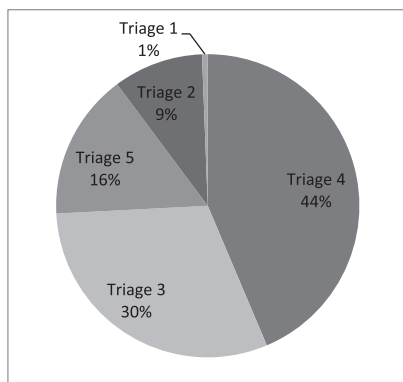


Figure 2. Proportion of ED presentations according to Australasian Triage Scale categories.

Discussion

This large study aimed to characterise emergency presentations in NSW over a 5 year period, in order to establish a framework for further analyses of factors behind increased ED demand over recent years. In this respect, the study has important implications. First, an overall description of the clinical case-mix and workload in EDs as a whole has not been attempted at a state-wide population level in NSW. A recent population-based study from Western Australia²⁰ found that ED presentations had increased 4.6% per annum in the period between 2007 and 2013 and that three quarters of this increase was due to demographic changes alone. The increase in the utilisation rate is slightly higher than those reported in the analyses of Australian Institute for Health and Welfare (AIHW) data.²¹ Furthermore, the utilisation rate of around 20% is much lower than the 30% previously reported as this represents individuals that used the ED per annum rather than total ED presentations, as a proportion of the total population.

Building on this work, we sought to characterise and code not only triage and demographic details but also clinically relevant diagnostic categories, representations and length of stay. These factors are necessary to evaluate overall clinical care provided in ED and plan future models of acute-care delivery. The present study will allow further analyses of trends and gaps in care for populations within broad clinical categories, particularly the

elderly, injury, mental health and Indigenous populations.

Second, a few distinctions can already be observed. In-patient admission rates from ED were lower in NSW (28% compared with 38% in Victoria)¹¹ including admission to short-stay units. The proportion of non-urgent presentations (Triage category 4 and 5) was higher in NSW compared with data from Victoria (60% vs 56%). The proportion of ED patients who identified as Aboriginal or Torres Strait Islander was 4.8% and was higher than the estimated population proportion in NSW of 2.9%,^{22,23} but consistent with the 5.4% of presentations reported by the AIHW.²⁴

The rate of ED presentations per 1000 population follows a similar U-shaped age distribution to those reported by Lowthian *et al.*¹¹ and data from Western Australia.²⁰ It also continues the observed trend across Australia of increasing ED presentations disproportionate to population increases between 2010 and 2014.^{9,11,20} The increases in ED presentation rates are likely to be multi-factorial and include the ageing population, access to General Practitioners and improved service provision in public hospitals in general.¹¹ However, in contrast, there appears to be a spike in presentations in those aged 20–29 years in the present study, such that the rate of presentations in this age group was around 55% higher in NSW compared with Melbourne, Victoria (310 vs 200 presentations per 1000 population). Similarly, the rate of ED presentations was 23% higher in the 85 years and over age bracket in NSW compared with Melbourne (730 vs 594 presentations per 1000 population) during similar time periods.¹¹

These observations suggest at the very least that there may be scope to further investigate and improve healthcare strategies for young adults and the elderly in NSW, aimed at reducing the need for unplanned hospital presentations. Of concern is the high proportion (16.9%) of patients who have an unplanned return to ED within a month of presentation. This is the subject of ongoing in-depth analyses of individual-patient representations by the investigators.

The findings of the present study already provide valuable insights into

ED clinical workload. Injuries and musculoskeletal problems account for over a quarter of ED presentations, the largest proportion of all diagnostic categories. Overall ‘abdominal pain’ was the most common single presenting problem. The increase in elderly presentations disproportionate to population increases is likely to have a multiplier effect on public hospitals. Increased numbers combined with increased complexity and length of stay in this patient group will further challenge hospital resources. Further studies to investigate trends and patterns of ED use amongst particular groups of patients such as the elderly are therefore warranted to try and promote alternative models of care for this patient population.

Limitations

Analysis of the data set has revealed a number of important limitations, which will need to be considered in future analyses. As reported, the data set contained missing data in at least 1 year from 35 EDs (mainly small level 1 and 2 centres). These accounted for around 3% of the data set and, although unlikely to bias the observed trends in this study, may still need to be excluded from future trend analyses that include years 2010 to 2012. Importantly, by 2014, all 150 EDs in the data set had complete data available. Future analyses of trends will also need to exclude presentations that represented transfers from other hospitals within NSW, which make up another 3% of presentations.

SNOMED-CT coding accounted for around two-thirds of ED diagnoses within the data set. SNOMED-CT was developed in an attempt to codify clinical nomenclature, with structured relationships used to represent the granularity of information typically present within clinical documentation.^{25,26} Its use as a diagnostic classification system for research remains problematic. Unlike ICD coding systems, the value and ordering of the SNOMED concept identifiers used as diagnoses do not contain implicit meaning, which makes it particularly difficult to categorise a large data set. Indeed, the interpretation of SNOMED diagnostic codes in this project required

TABLE 3. Most common triage presenting problems by age group

0–9 years N = 1 997 136			10–19 years N = 1 374 011			20–39 years N = 3 038 502		
Presenting problem	n	%	Presenting problem	n	%	Presenting problem	n	%
Fever	151 156	7.6	Injury – limb	115 942	8.4	Pain – abdomen	201 657	6.6
Vomiting	71 132	3.6	Pain – abdomen	82 284	6.0	Injury – limb	106 958	3.5
Cough	66 968	3.4	Pain – limb	47 841	3.5	Pain – chest	72 920	2.4
Rash	61 459	3.1	Injury – laceration	34 907	2.5	Vomiting	61 533	2.0
Resp. SOB	54 402	2.7	Headache	17 101	1.2	Per vaginal bleed	50 762	1.7
Injury – laceration	49 874	2.5	Pain – chest	15 889	1.2	Headache	44 261	1.5
Injury – limb	44 737	2.2	Vomiting	15 504	1.1	Unwell	42 479	1.4
Pain – abdomen	41 464	2.1	Unwell	14 135	1.0	Pain – back	40 725	1.3
Injury – head	39 304	2.0	Sore throat	13 347	1.0	Care – patient review	37 939	1.2
Unwell	32 968	1.7	Fever	11 375	0.8	Other	32 553	1.1
40–59 years N = 2 390 456			60–79 years N = 2 008 134			80+ years N = 1 073 101		
Presenting problem	n	%	Presenting problem	n	%	Presenting problem	n	%
Pain – chest	125 684	5.3	Pain – chest	138 573	6.9	Resp. SOB	63 348	5.9
Pain – abdomen	110 956	4.6	Pain – abdomen	79 455	4.0	Falls	62 297	5.8
Injury – limb	45 822	1.9	Unwell	56 954	2.8	Pain – chest	48 144	4.5
Pain – back	44 150	1.8	Resp. SOB	43 178	2.2	Unwell	38 606	3.6
Unwell	43 378	1.8	Care – patient review	32 919	1.6	Pain – abdomen	31 616	2.9
Pain – limb	42 067	1.8	Pain – limb	32 463	1.6	Pain – back	14 918	1.4
Care – patient review	34 432	1.4	Pain – back	29 983	1.5	Fever	11 682	1.1
Headache	33 183	1.4	Dizziness	27 130	1.4	Collapse	10 236	1.0
Other	26 376	1.1	Other	23 508	1.2	Vomiting	9 594	0.9
Review	25 086	1.0	Fever	20 931	1.0	Urinary problems	8 232	0.8

re-conversion of code to text, and analysis of text descriptors associated with over 5000 of the most common SNOMED codes.

Without the implicit classification and restriction required to group SNOMED codes into clinically relevant subgroups, assumptions about many of the most common diagnostic codes were made. For example, without further qualifications, ‘chest pain’ (SNOMED code 29857009) was assumed to be cardiovascular and ‘abdominal pain’ assumed to be abdominal/gastrointestinal-related presentations. It is acknowledged that this is not ideal, particularly given the possible overlaps in diagnostic categories

possible with unqualified diagnoses such as ‘shortness of breath’. However, without linkage to a gold standard diagnostic coding system, it is not currently possible to evaluate the validity of these assumptions. Nevertheless, the proportion of presenting problems in these diagnostic categories was broadly consistent with the most recent reports of ED presentations from the AIHW. Based on ICD coding blocks, injury and musculoskeletal presentations comprised around 27%, cardiovascular 9%, respiratory 9% and mental health 2.4% of all ED presentations.²⁴

The use of SNOMED-CT for diagnoses was also inconsistent with inpatient admission data sets in Australia,

which currently code using ICD,^{27,28} which is in turn used to generate diagnosis-related groups required for case-mix funding.²⁹ Making these coding systems consistent across data sets would allow easier interpretation of alternate data sources and facilitate standardised reporting for quality of care and other reporting requirements. If SNOMED is to be used, placing common examples into clinically relevant categories such as those reported here, and restricting the use of redundant or meaningless codes (e.g. ‘unwell’ or ‘pain, other’ or ‘seen by nurse’) will assist in the design of more effective clinician-user interfaces and health information systems. Standardisation

of diagnosis reference sets across alternative information systems and classifications would also facilitate meaningful use of the data. Similarly, the use of over 6000 unique presenting problems entered by triage, including free text, could be more efficiently designed. It was estimated by investigators that the current list could be limited to less than 500 different presenting problems, classified under the same broad clinical categories, with further granularity provided by an existing triage free text description field. This will be the subject of ongoing studies.

Conclusions

ED presentations in NSW continue to increase beyond population changes, with the highest presentation rates in those over 85 years of age. The use of disparate ED diagnoses classification systems within the EDDC and presenting problems require further refinement and classification to optimise its usefulness in future research. However, patterns of presentations and ED diagnoses categories within this data set appear consistent with patterns seen across Australia.

Acknowledgements

This project was funded by the NSW Agency for Clinical Innovation and the Emergency Care Institute (reference number ACI/D14/2288). We acknowledge the NSW Ministry of Health and the Centre for Health Record Linkage (CHeReL) for access and linkage of data.

Competing interests

None declared.

References

- Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects and solutions. *Ann. Emerg. Med.* 2008; 52: 126–36.
- Sprivilis PC, Da Silva J, Jacobs IG, Jelinek GA, Frazer ARL. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. *Med. J. Aust.* 2006; 184: 208–12.
- Nagree Y, Camarda V, Fatovich DM *et al.* Quantifying the proportion of general practice and low-acuity patients in the emergency department. *Med. J. Aust.* 2013; 198: 612–5.
- Lowthian JA, Curtis AJ, Cameron PA, Stoelwinder JU, Cooke MW, McNeil JJ. Systematic review of trends in emergency department attendances: an Australian perspective. *Emerg. Med. J.* 2011; 28: 373–7.
- FitzGerald G, Toloo G, Romeo M. Emergency healthcare of the future. *Emerg. Med. Australas.* 2014; 26: 291–4.
- Higginson I, Whyatt J, Silvester K. Demand and capacity planning in the emergency department: how to do it. *Emerg. Med. J.* 2011; 28: 128–35.
- FitzGerald G, Toloo GS, Aitken P, Keijzers G, Scuffham P. Public use and perceptions of Emergency Departments: A population survey. *Emerg. Med. Australas.* 2015; 27: 336–42.
- Durand A-C, Palazzolo S, Tanti-Hardouin N, Gerbeaux P, Sambuc R, Gentile S. Non-urgent patients in emergency departments: rational or irrational consumers? Perceptions of professionals and patients. *BMC Res. Notes* 2012; 5: 525.
- Dinh MM, Bien KJ, Latt M, Chalkley D, Muscatello D. Age before acuity: the drivers of demand for emergency department services in the Greater Sydney Area. *Emerg. Med. J.* 2015; 32: 708–11.
- Arendts G, Lowthian J. Demography is destiny: an agenda for geriatric emergency medicine in Australasia. *Emerg. Med. Australas.* 2013; 25: 271–8.
- Lowthian JA, Curtis AJ, Jolley DJ, Stoelwinder JU, McNeil JJ, Cameron PA. Demand at the emergency department front door: 10-year trends in presentations. *Med. J. Aust.* 2012; 196: 128–32.
- Roberts DC, McKay MP, Shaffer A. Increasing rates of emergency department visits for elderly patients in the United States, 1993 to 2003. *Ann. Emerg. Med.* 2008; 51: 769–74.
- Australian Bureau of Statistics. Estimated Residential Population by single year of age, New South Wales. [Cited 15 July 2015.] Available from URL: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3101.0Jun%202014?OpenDocument>
- Gale M, Muscatello DJ, Dinh M *et al.* Alcopops, taxation and harm: a segmented time series analysis of emergency department presentations. *BMC Public Health* 2015; 15: 468.
- McCallum LK, Liu B, McIntyre P, Jorm LR. Estimating the burden of pertussis in young children on hospitals and emergency departments: a study using linked routinely collected data. *Epidemiol. Infect.* 2014; 142: 695–705.
- NSW Health. Centre for Health Record Linkage. 2011. [Cited Aug 2015.] Available from URL: <http://www.cherel.org.au>
- NSW Health. Guide to the role delineation of health services. Third edition. State Health Publication No. SWS 990186. 2002. [Updated 24 Jan 2014; cited 15 Aug 2015.] Available from URL: <http://www.health.nsw.gov.au/Hospitals/Pages/role-delineation-levels.aspx>
- NSW Health. *Triage of patients in NSW Emergency Departments PD 2013_047*. Ministry of Health: North Sydney, 2013.
- Australasian College for Emergency Medicine. Guidelines on the Implementation of the Australasian Triage Scale in Emergency Departments Version 3. [Cited 12 Aug 2015.] Available from URL: <https://www.acem.org.au/getattachment/d19d5ad3-e1f4-4e4f-bf83-7e09cae27d76/G24-Implementation-of-the-Australasian-Triage-Scale.aspx>
- Aboagye-Sarfo P, Mai Q, Sanfilippo FM, Preen DB, Stewart LM, Fatovich DM. Growth in Western Australian emergency department demand during 2007–2013 is due to people with urgent and complex care needs. *Emerg. Med. Australas.* 2015; 27: 202–9.
- FitzGerald G, Toloo S, Rego J, Ting J, Aitken P, Tippet V. Demand for public hospital emergency department services in Australia: 2000–2001 to 2009–2010. *Emerg. Med. Australas.* 2012; 24: 72–8.
- Australian Bureau of Statistics. Estimates of Aboriginal and Torres Strait Islander Australians. 2011. [Cited 18 Aug 2015.] Available from URL: <http://www.abs.gov.au/ausstats/abs@.nsf/mf/3238.0.55.001>
- Australian Indigenous Health Info Net. Western Australia. 2015. [Cited 18 Aug 2015.] Available from URL:

- <http://www.healthinfonet.ecu.edu.au/health-facts/health-faqs/aboriginal-population#>
24. Australian Institute of Health and Welfare. Australian Hospital Statistics 2013–14: Emergency Department Care. Health services series no. 58. AIHW cat. no. HSE 153.
 25. Lee D, de Keizer N, Lau F, Cornet R. Literature review of SNOMED CT use. *J. Am. Med. Inform. Assoc.* 2014; **21**: e11–9.
 26. Fung KW, Xu J. Synergism between the Mapping Projects from SNOMED CT to ICD-10 and ICD-10-CM. *AMIA Annu. Symp. Proc.* 2012; **2012**: 218–27.
 27. O’Connell DL, Goldsbury DE, Davidson P *et al.* Acute hospital-based services utilisation during the last year of life in New South Wales, Australia: methods for a population-based study. *BMJ Open* 2014; **4**: e004455.
 28. Rosenwax LK, McNamara BA, Murray K, McCabe RJ, Aoun SM, Currow DC. Hospital and emergency department use in the last year of life: a baseline for future modifications to end-of-life care. *Med. J. Aust.* 2011; **194**: 570–3.
 29. Independent Hospital Pricing Authority. Consultation paper on the Emergency Department International Classification of Diseases – 10th Revision – Australian Modification (ICD-10-AM) principal diagnosis short list. [Cited 15 Aug 2015.] Available from URL: https://consultation.ihoa.gov.au/classifications-and-coding-standards/emergency-department-principal-diagnosis/consult_view