CSIRO PUBLISHING
Australian Health Review, 2014, 38, 278–287
http://dx.doi.org/10.1071/AH13085

Expanding emergency department capacity: a multisite study

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Abstract

Objectives. The aims of the present study were to identify predictors of admission and describe outcomes for patients who arrived via ambulance to three Australian public emergency departments (EDs), before and after the opening of 41 additional ED beds within the area.

Methods. The present study was a retrospective comparative cohort study using deterministically linked health data collected between 3 September 2006 and 2 September 2008. Data included ambulance offload delay, time to see doctor, ED length of stay (LOS), admission requirement, access block, hospital LOS and in-hospital mortality. Logistic regression analysis was undertaken to identify predictors of hospital admission.

Results. Almost one-third of all 286 037 ED presentations were via ambulance ($n = 79\,196$) and 40.3% required admission. After increasing emergency capacity, the only outcome measure to improve was in-hospital mortality. Ambulance offload delay, time to see doctor, ED LOS, admission requirement, access block and hospital LOS did not improve. Strong predictors of admission before and after increased capacity included age >65 years, Australian Triage Scale (ATS) Category 1–3, diagnoses of circulatory or respiratory conditions and ED LOS >4 h. With additional capacity, the odds ratios for these predictors increased for age >65 years and ED LOS >4 h, and decreased for ATS category and ED diagnoses.

Conclusions. Expanding ED capacity from 81 to 122 beds within a health service area impacted favourably on mortality outcomes, but not on time-related service outcomes such as ambulance offload time, time to see doctor and ED LOS. To improve all service outcomes, when altering (increasing or decreasing) ED bed numbers, the whole healthcare system needs to be considered.

What is known about the topic? Escalating growth in demand for emergency patient services has placed increasing strain on both ambulance and hospital resources. Poor patient outcomes can result from crowded EDs and hospitals.
What does this paper add? This paper identifies that following the opening of a 41-bed ED within a health service area, there was an improvement in in-hospital mortality outcomes for those who arrived to the ED via ambulance. Data linkage enhanced our ability to report on and understand the impact on outcomes across several systems (ambulance, ED and hospital admission). This paper provides a foundation for further research regarding emergency services expansion from a geographical area-wide perspective. Easily identifiable predictors of hospital admission for ambulance-arriving patients that may be useful for informing patient flow strategies are highlighted.
What are the implications for practitioners? Practitioners need to be aware that patients arriving by ambulance to the ED are more likely to require admission if they are older, triaged to higher acuity, have circulatory or respiratory conditions and have an ED LOS of >4 h. Service planners need to consider the whole system when planning expansion.

Additional keywords: ambulance, data linkage, outcomes, service delivery.

Received 29 April 2013, accepted 27 January 2014, published online 29 May 2014

Introduction

Approximately 23% of the 7.1 million emergency department (ED) presentations made to Australian public hospitals in 2007–08 were via ambulance.[1] Compared with other Australian states and territories, Queensland reported the largest average annual increase in ED presentations (7.7% p.a.) from 2006–07 to 2010–11.[2] The utilisation rates of ambulance services in Queensland have also increased considerably at an average annual rate of 5.4% between 1999–00 and 2009–10 for urgent dispatches.[3] Escalating growth in demand from emergency patient services has placed increasing strain on both ambulance and hospital resources.[3,4] Negative outcomes, such as ambulance diversion, access block (an ED length of stay (LOS) of >8 h for patients requiring hospital admission[5]) and increased risk of hospital mortality, as a result of ED and hospital crowding have been reported in Australia and overseas.[5–7] Meeting healthcare targets within this environment can be difficult, but is becoming increasingly mandated, monitored and reported upon.

Improvements in or expansions of healthcare-related services are required in order to meet the healthcare needs of the community in a safe and sustainable fashion.[8–11] In Australia, the Federal Government (through the National Partnership Agreement) has committed to provide funding exceeding A$3 billion for new subacute beds, to meet ED and elective surgery targets and for capital and recurrent projects to improve access for patients accessing public hospital services.[10] Following a staged annual increase commencing in 2012, it is expected that by 2015 90% of ED presentations should be admitted, transferred or discharged within 4 h, thereby meeting National Emergency Access Targets (NEAT).[10] Although descriptions of opening an additional ED or expanding the size and number of beds in an existing ED are noted within the literature,[12–16] little research exists evaluating the impact these measures can make to patient, ambulance and health service delivery outcomes.

Expanding ED capacity interacts with overall service provision and patient outcomes. As such, the aim of the present study was to identify the characteristics and predictors of hospital admission and describe outcomes for patients who arrived via ambulance to three Australian public EDs before and after the opening of 41 additional ED beds within a health service.

Methods

Design and setting

The present study was a retrospective comparative cohort study undertaken in three regional public hospitals located in south-east Queensland, Australia. These three hospitals, along with three private hospitals, served a total population of approximately 800 000.[17] All three EDs were teaching facilities and treated both adult and paediatric patients. Hospital A had 45 ED beds and 473 hospital beds; Hospital B had 36 ED beds and 290 hospital beds; Hospital C had 41 ED beds and 200 hospital beds. Located approximately 15 km apart, Hospitals A and C shared operational capability; a further 50 km away, Hospital B was slightly more isolated, located midway between two main groups of larger hospitals. The ED at Hospital C opened on 3 September 2007. Seventeen permanent Queensland Ambulance Service stations were located in the direct catchment area, plus a rotary wing retrieval service.

Patients

All patient presentations arriving to three EDs over a 24-month period (3 September 2006–2 September 2008) were included in the linkage of data sources from ambulance, ED and hospital admission. Figure 1 shows the sample inclusion process. Some patient presentations were excluded from the dataset during and following the data cleaning and data linking process due to mode of arrival incorrectly coded (was not via ambulance), no name, no gender and incomplete date and time data. A power calculation showed that the sample size was more than adequate to detect a difference in the primary outcome (hospital admission) and the chance of a Type II error was negligible. Our sample size could provide 99% power, based on an α level of 0.05, model (Nagelkerke) R^2 of 0.384 and 21 predictors for the primary outcome (hospital admission).

Data collection

The specific data used (sourced from the Queensland Ambulance Service (QAS) Emergency Department Information System (EDIS) and Hospital Based Corporate Information System (HBCIS)) are given in Table 1. The variables chosen were based

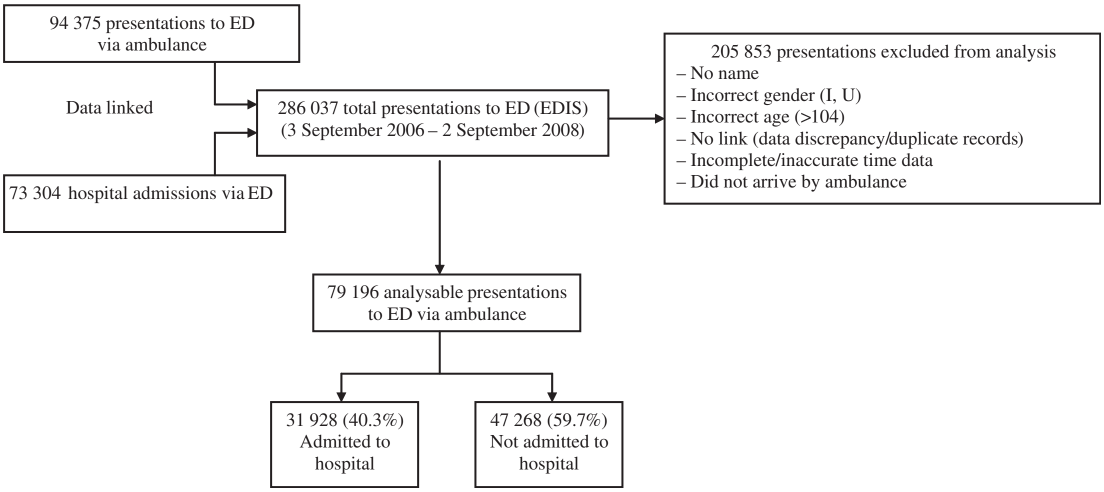

Fig. 1. Sample inclusion flow diagram (data from three hospitals, 24 months).

Table 1. Data collected from each health information source

DRG, diagnostic-related group; ED, emergency department; ICD 10, International Statistical Classification of Disease and Related Health Problems (10th revision)

Ambulance data	ED data	Hospital admission data
Unit record number	Unit record number	Unit record number
Name	Name	Name
Age	Age	Date of birth
Gender	Gender	Gender
Post code pick up	Mode of arrival	Post code
Suburb pick up	Triage category	Date and time of hospital admission
Triage code allocated by communications centre	Presenting complaint category	Date and time of hospital discharge
Suburb location of base station	Date and time of arrival	DRG
Date and time of dispatch	Date and time of triage	Discharge destination
Date and time of arrival on scene	Date and time seen by doctor	
Date and time of on-scene departure	Date and time of ED discharge	
ED transported to	ED ICD 10 diagnosis code	
Date and time of arrival to ED	Discharge disposition from ED	
Date and time of ED triage		

on previous research and related literature.[18,19] The Australasian Triage Scale (ATS) is an indicator of urgency, where a number (on a scale of 1–5) corresponds to the time frame in which patients should be seen by a doctor.[20] Patients allocated an ATS Category 1 should be seen immediately, Category 2 within 10 min, Category 3 within 30 min, Category 4 within 60 min and Category 5 within 120 min.

We used Health Data Integration (HDI; Australian eHealth Research Centre, Herston, Qld, Australia), an automated deterministic linking approach developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), to link data from the three separate health information systems databases (QAS, EDIS and HBCIS). The HDI linking strategy has been tested previously for accuracy with high sensitivity, specificity and positive predictive values.[21]

Statistical analysis

Descriptive statistics were used to describe the profile of all patients presenting to three EDs via ambulance. These statistics included median and interquartile range for age, time to see doctor, ED LOS and hospital LOS, and frequency and percentages for categorical variables (i.e. age group, gender, ATS category, day presented, season, admission, diagnostic-related group, offload time >30 min, seen within ATS time frame, ED LOS >4 h, ED LOS >8 h for admitted patients and in-hospital mortality). Inferential statistics were used to identify differences between groups before (3 September 2006–2 September 2007) and after (3 September 2007–2 September 2008) opening of the ED. The non-parametric Mann–Whitney *U*-test was used for continuous data; Chi-squared tests were used for categorical variables. Univariate followed by multivariate logistic regression models were built (using the enter and forward stepwise method, respectively) to assess the individual variable contribution followed by adjusted contribution for the main outcome, hospital admission. Multivariate procedures were used to adjust for the confounding effect because there were at least three predictor variables.[22] Predictors entered into the regression model included age, gender, ATS category, time of presentation (in 8 h blocks), day of week (as weekday or weekend), International Statistical Classification of Disease and Related Health

Problems – 10th revision (ICD 10) diagnosis code, season, ambulance offload delay >30 min, ED LOS >4 h and hospital. The ICD 10 are internationally recognised diagnostic codes that account for diagnoses, descriptions of symptoms and cause of death.[23] In Australia, patients who present to the ED are assigned a modified ICD 10 code by the treating medical officer or nurse and are entered prospectively into the ED database.[24] Crude and adjusted odds ratios (OR) are provided for the logistic regression models with results presented as OR and 95% confidence intervals (CI). Two-sided $P < 0.05$ was considered significant. Reference groups were based on previous research, cell size or the most logical comparison. Data were analysed using SPSS version 18.0 (SPSS, Chicago, IL, USA).

Ethics approval was obtained from the Health Service Districts Human Research Ethics Committee, the Queensland Ambulance Service and Queensland Health's Research Ethics and Governance Unit to use health information.

Results

Characteristics

In total, 286 037 patients presented to the three EDs in the study period. Of these presentations, 79 196 analysable patient presentations were via ambulance, with the overall number of ambulance arrivals increasing by over 2000 from one year to the next. The characteristics of patients presenting via ambulance differed between the periods before and after ED expansion in terms of the demographic and clinical characteristics of age, gender, ATS category and diagnosis (Table 2). Although a 2-year increase in median age is statistically significant, it is unclear whether this finding is clinically significant. However, a 1.5% increase in Category 1 and 2 presentations, although small, may have clinical significance. Table 3 presents the ED characteristics of ambulance-arriving presentations. Although proportions appear relatively unchanged from a clinical perspective, some characteristics differed statistically between the periods before and after ED expansion (weekday or weekend, season), whereas others did not (shift, day of week).

Predictors of hospital admission

The proportion of ambulance-arriving patient presentations that required admission within each potential predictor entered into the univariate regression model is presented in Table 4. Table 4 also displays the crude OR, 95% CI and *P*-value of each predictor. All univariate predictors were entered into the multivariate logistic regression analysis model. When stratified according to the period before and after ED expansion, similar numbers (15 and 14, respectively) and types of independent predictors, indicating higher odds of hospital admission, were identified. Predictors with OR >2 across both time frames were age ≥65 years, ATS Category 1, 2 or 3, ICD diagnoses relating to circulatory and respiratory diseases and an ED LOS >4 h.

Outcomes

Outcomes for patients arriving at the ED via ambulance are presented in Table 5. All outcomes differed significantly between the periods before and after ED expansion. The only outcomes that improved related to in-hospital mortality, which decreased by 1.5% based on the patient's last index of admission. Outcomes that did not improve included the proportion of patients not offloaded within 30 min, admitted and access blocked; these increased by 4%, 4% and 11%, respectively. The proportion of patients seen within the recommended ATS time frame also did not improve, decreasing from 44% to 39%. Median time to see a doctor and ED LOS for both admitted and non-admitted patients did not improve, increasing by 4, 65 and 21 min, respectively. These differences were statistically significant. Due to the large sample sizes included in the study, the in-hospital LOS differed

Table 2. Clinical characteristic of patients arriving at the emergency department (ED) via ambulance before and after ED expansion
IQR, interquartile range; ATS, Australasian triage scale; ICD 10, International Statistical Classification of Disease and Related Health Problems (10th revision)

Characteristic	Before ($n = 38\,412$)	After ($n = 40\,784$)	*P*-value
Median (IQR) age (years)	45 (25–69)	47 (25–70)	<0.001
No. men (%)	19 511 (50.8%)	20 195 (49.5%)	<0.001
Triage category			<0.001
ATS 1	644 (1.7%)	819 (2.0%)	
ATS 2	6435 (16.8%)	7748 (19.0%)	
ATS 3	22 015 (57.3%)	23 031 (56.5%)	
ATS 4	8878 (23.1%)	8758 (21.5%)	
ATS 5	440 (1.1%)	428 (1.0%)	
ED ICD 10[A]			0.014
Injury, poisoning and certain other consequences of external causes (S00–T98)	9286 (26.3%)	10 008 (25.3%)	
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00–R99)	6178 (17.5%)	7005 (17.7%)	
Diseases of the circulatory system (I00–I99)	3617 (10.2%)	4021 (10.2%)	
Factors influencing health status and contact with health services (Z00–Z99)	2909 (8.2%)	3496 (8.8%)	
Diseases of the respiratory system (J00–J99)	2881 (8.1%)	3270 (8.3%)	
Mental and behavioural disorders (F00–F99)	1893 (5.4%)	2104 (5.3%)	
All other	8596 (24.3%)	9643 (24.4%)	

[A]Based on 74 907 cases where diagnosis data were entered.

Table 3. Emergency department characteristics of patients arriving at the emergency department (ED) via ambulance before and after ED expansion

Characteristic	Before (n = 38 412)	After (n = 40 784)	P-value
Shift of presentation			0.349
Morning (0700–1459 hours)	15 241 (39.7%)	16 082 (39.4%)	
Evening (1500–2259 hours)	14 811 (38.6%)	15 927 (39.1%)	
Night (2300–0659 hours)	8360 (21.8%)	8775 (21.5%)	
Day of week			0.246
Monday	5637 (14.7%)	5919 (14.5%)	
Tuesday	5257 (13.7%)	5620 (13.8%)	
Wednesday	5189 (13.5%)	5498 (13.5%)	
Thursday	5261 (13.7%)	5768 (14.1%)	
Friday	5463 (14.2%)	5934 (14.5%)	
Saturday	5762 (15.0%)	5997 (14.7%)	
Sunday	5843 (15.2%)	6048 (14.8%)	
Weekday or weekend			0.037
Weekday	26 807 (69.8%)	28 739 (70.5%)	
Weekend	11 605 (30.2%)	12 045 (29.5%)	
Season			<0.001
Summer	9372 (24.4%)	10 414 (25.5%)	
Autumn	9711 (25.3%)	9920 (24.3%)	
Winter	10 054 (26.2%)	10 330 (25.3%)	
Spring	9275 (24.1%)	10 120 (24.8%)	

significantly; however, this was not necessarily clinically meaningful because the median LOS remained constant at 2 days. Compared with National public hospital data,[25] a favourable outcome for ambulance-arriving patients included ED LOS for those who did not require hospital admission; less favourable outcomes included time to see a doctor, ED LOS for patients requiring hospital admission, being seen within ATS recommended times, admission requirement and in-hospital mortality.

Discussion

Within Queensland, more people present to the ED, arrive via by ambulance, have longer waiting times, require hospital admission, have a shorter hospital LOS and have higher mortality, higher admission costs and more potentially preventable hospitalisations compared with most other Australian states and territories.[26] The ability to link patient level records across and within systems enabled us to obtain a more informed understanding of the patient journey that encompasses the ambulance, ED and hospital admission episodes of care.

Characteristics

The proportion of ambulance-arriving patient presentations made to the EDs in the present study was higher than that of the national average (33% vs 23%).[25] With such large sample sizes and with distributions that were highly skewed, although the differences in demographic and clinical characteristics of patients presenting in the two time periods (before and after ED service expansion) reached statistical significance, clinically these small differences would make little impact on service provision. The one difference that could have influenced outcome was the 1.5% increase in ATS Category 1 and 2 patients arriving after the ED bed numbers had expanded.

Prevalence and predictors of hospital admission

Patients who present to the ED via ambulance have a relatively high admission rate. Compared with all presentations made to Australian public hospital EDs,[25] patients arriving to the EDs in the present study, via ambulance, were a group with higher admission requirements (27%[25] vs 40%). Our admission rate was similar to that reported in a Canadian study[27] (38% admission rate of ambulance arrivals), but lower than that seen in a study undertaken in Singapore (59% admission rate for ambulance arrivals).[28] The Canadian study further revealed that people arriving to the ED via ambulance had admission odds 3.15-fold those of people arriving via other means.[27] These figures indicate that further identification of specific predictors of admission used to facilitate targeted service delivery and patient flow may be useful.

Although the odds of admission changed slightly for some predictors in our study, the actual predictors themselves remained relatively unchanged between the periods before and after ED expansion. Prominent predictors of hospital admission for patients arriving to the ED via ambulance in our study are easily identifiable and include age ≥65 years, ATS Category 1, 2 or 3, ICD diagnoses relating to circulatory and respiratory diseases and an ED LOS >4 h. With the exception of ED LOS, all the predictors identified in our study can be recognised very early on in a patient's ED episode of care.

Our findings are relatively congruent with other studies identifying the prevalence and predictors of hospital admission; however, other studies were not limited to ambulance-only arrivals and some focused on the predictors of specific demographic or illness groups. With this in mind, our discussion here focuses on the main predictors of hospital admission. Regarding age, several studies have identified an admission rate of approximately 65% for people aged ≥65 years.[28,29] Within this demographic, higher odds of admission were related to increasing patient age, higher heart rate, lower blood pressure, lower triage score and several chief complaints, such as pneumonia and stroke.[29] Knowing that older people (particularly those arriving via ambulance) comprise a high proportion of and likelihood for admission, it is possible to use this and other predictive information, such as that offered by LaMantia *et al.*,[29] to order an in-patient bed at the point of triage, thus avoiding delays in admission.

Admission requirement for people arriving by ambulance and triaged ATS Category 1, 2 or 3 was relatively high (~84%, 66% and 40%, respectively). Although these proportions were reasonably reflective of all ED presentations made to Australian public EDs during this time,[26] they are higher than those noted elsewhere.[27] Identifying higher odds of admission for people triaged as more emergent (i.e. ATS Category 1, 2 or 3) compared with the less emergent ATS Category 5 ambulance patient presentations was not surprising and, rather than 'over-triaging' (a practice where nurses allocate a triage category of higher acuity than required),[30] the finding is most likely reflective of genuine urgency and illness.

Circulatory (80% admission rate) and respiratory (55% admission rate) diseases were indicative of hospital admission for ambulance-arriving presentations made to the three study site EDs with odds six- and twofold higher than for people not admitted with these conditions. A more recent Canadian study

Table 4. Independent predictors of hospital admission for ambulance patients stratified according to pre- and post-emergency department expansion

OR, odds ratio; CI, confidence interval; ATS, Australasian triage scale; ED, emergency department; ICD 10, International Statistical Classification of Disease and Related Health Problems (10th revision); LOS, length of stay

Predictor	Pre-ED expansion						Post-ED expansion					
	Total patient presentations (*n*)	No. admitted (%)	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value	Total patient presentations (*n*)	No. admitted (%)	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Age (years)												
0–15	4256	1009 (23.7%)	1.0[A]		1.0[A]		4119	1019 (24.7%)	1.0[A]		1.0[A]	
16–64	22 704	6995 (30.8%)	1.43 (1.33–1.55)	<0.001	0.99 (0.90–1.08)	0.787	23 629	8170 (34.6%)	1.61 (1.49–1.73)	<0.001	1.17 (1.07–1.28)	0.001
65+	11 215	6678 (59.5%)	4.74 (4.37–5.13)	<0.001	2.17 (1.97–2.40)	<0.001	12 615	8057 (63.9%)	5.38 (4.97–5.82)	<0.001	2.67 (2.43–2.93)	<0.001
Gender												
Female	18 785	6911 (36.8%)	1.0[A]		1.0[A]		20 396	8396 (41.2%)	1.0[A]		1.0[A]	
Male	19 390	7771 (40.1%)	1.15 (1.10–1.20)	<0.001	1.16 (1.10–1.22)	<0.001	19 967	8850 (44.3%)	1.14 (1.09–1.18)	<0.001	1.19 (1.13–1.24)	<0.001
Triage category												
ATS 1	644	552 (85.7%)	60.15 (40.47–89.41)	<0.001	36.70 (23.82–56.53)	<0.001	814	677 (82.2%)	31.72 (22.61–44.48)	<0.001	18.83 (12.86–27.57)	<0.001
ATS 2	6417	4281 (66.7%)	20.09 (14.40–28.04)	<0.001	6.82 (4.72–9.83)	<0.001	7678	5066 (66.0%)	12.45 (9.33–16.60)	<0.001	4.29 (3.09–5.95)	<0.001
ATS 3	21 863	8259 (37.8%)	6.09 (4.38–8.47)	<0.001	2.69 (1.87–3.86)	<0.001	22 804	9522 (41.8%)	4.60 (3.46–6.12)	<0.001	1.96 (1.42–2.71)	<0.001
ATS 4	8821	1551 (17.6%)	2.14 (1.53–2.99)	<0.001	1.26 (0.87–1.82)	0.215	8659	1926 (22.2%)	1.84 (1.38–2.45)	<0.001	1.06 (0.77–1.47)	0.724
ATS 5	430	39 (9.1%)	1.0[A]		1.0[A]		408	55 (13.5%)	1.0[A]		1.0[A]	
ED ICD 10 code												
Injury, poisoning and certain other consequences of external causes (S00–T98)	9257	2624 (28.3%)	0.50 (0.47–0.52)	<0.001	1.12 (1.04–1.20)	0.004	9933	3115 (31.4%)	0.51 (0.49–0.53)	<0.001		
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00–R99)	6151	2229 (36.2%)	0.82 (0.77–0.87)	<0.001			6939	2972 (42.8%)	0.98 (0.93–1.03)	0.441		
Diseases of the circulatory system (I00–I99)	3603	2879 (79.9%)	7.19 (6.01–7.83)	<0.001	5.53 (4.97–6.15)	<0.001	3996	3204 (80.2%)	6.32 (5.83–6.85)	<0.001	4.39 (3.99–4.83)	<0.001
Factors influencing health status and contact with health services (Z00–Z99)	2879	588 (20.4%)	0.36 (0.32–0.39)	<0.001			3435	444 (12.9%)	0.17 (0.16–0.19)	<0.001	0.53 (0.47–0.60)	<0.001
Diseases of the respiratory system (J00–J99)	2866	1519 (53.0%)	1.76 (1.63–1.90)	<0.001	2.25 (2.03–2.49)	<0.001	3253	1903 (58.5%)	1.96 (1.82–2.11)	<0.001	2.20 (2.01–2.41)	<0.001
Mental and behavioural disorders (F00–F99)	1877	716 (38.1%)	0.92 (0.83–1.01)	0.069	1.59 (1.41–1.79)	<0.001	2084	863 (41.4%)	0.92 (0.85–1.01)	0.082	1.47 (1.32–1.63)	<0.001
All other	8524	3560 (41.8%)	1.09 (1.04–1.15)	<0.001	1.60 (1.49–1.71)	<0.001	9499	4425 (46.6%)	1.20 (1.14–1.25)	<0.001	1.50 (1.41–1.59)	<0.001
Shift of presentation												
Morning (0700–1459 hours)	15 165	6337 (41.8%)	1.43 (1.35–1.51)	<0.001	1.37 (1.28–1.47)	<0.001	15 967	7311 (45.8%)	1.35 (1.28–1.43)	<0.001	1.28 (1.20–1.37)	<0.001
Evening (1500–2259 hours)	14 714	5573 (37.9%)	1.22 (1.15–1.29)	<0.001	1.41 (1.31–1.51)	<0.001	15 750	6612 (42.0%)	1.16 (1.10–1.22)	<0.001	1.36 (1.27–1.45)	<0.001
Night (2300–0659 hours)	8296	2772 (33.4%)	1.0[A]		1.0[A]		8646	3323 (38.4%)	1.0[A]		1.0[A]	
Weekday or weekend												
Weekday	26 638	10532 (39.5%)	1.16 (1.11–1.22)	<0.001	1.07 (1.01–1.13)	0.016	28 456	12 423 (43.7%)	1.14 (1.09–1.19)	<0.001		
Weekend	11 537	4150 (36.0%)	1.0A		1.0A		11 907	4823 (40.5%)	1.0A			

Season												
Summer	9305	3595 (38.6%)	1.01 (0.96–1.06)	0.689	1.09 (1.02–1.16)	0.008	10 281	4372 (42.5%)	0.99 (0.95–1.04)	0.631	1.08 (1.02–1.15)	0.01
Autumn	9655	3761 (39.0%)	1.03 (0.98–1.08)	0.248			9793	4268 (43.6%)	1.05 (1.00–1.10)	0.05		
Winter	9994	3949 (39.5%)	1.06 (1.01–1.11)	0.012	0.84 (0.79–0.90)	<0.001	10 257	4494 (43.8%)	1.06 (1.01–1.11)	0.01	0.87 (0.82–0.92)	<0.001
Spring	9221	3377 (36.6%)	0.90 (0.86–0.95)	<0.001			10 032	4112 (41.0%)	0.91 (0.87–0.95)	<0.001		
Offload delay												
≤30 min	34 032	12 941 (38.0%)	1.0[A]				34 296	14 734 (43.0%)	1.0[A]		1.0[A]	
>30 min	4143	1741 (42.0%)	1.18 (1.11–1.26)	<0.001			6067	2512 (41.4%)	0.94 (0.89–0.99)	0.024	0.89 (0.83–0.95)	0.001
ED LOS												
≤4 h	16 712	2917 (17.5%)	1.0[A]		1.0[A]		14 725	2582 (17.5%)	1.0[A]		1.0[A]	
>4 h	21 463	11 765 (54.8%)	5.74 (5.47–6.02)	<0.001	4.94 (4.66–5.23)	<0.001	25 638	14 664 (57.2%)	6.28 (5.98–6.60)	<0.001	5.46 (5.15–5.79)	<0.001
Hospital												
A	20 088	9157 (45.6%)	1.91 (1.83–1.99)	<0.001			16 353	8142 (49.8%)	1.62 (1.56–1.69)	<0.001		
B	18 087	5525 (30.5%)	0.53 (0.50–0.55)	<0.001	0.64 (0.61–0.68)	<0.001	17 040	5772 (33.9%)	0.53 (0.51–0.55)	<0.001	0.55 (0.52–0.58)	<0.001
C	Not included						6970	3332 (47.8%)	1.28 (1.22–1.35)	<0.001	0.93 (0.87–0.99)	0.05

[A]Reference group.
Multiple regression model parameters, Pre-ED expansion ($n = 35\,157$, 20 predictors): Cox and Snell R^2: 0.284; Nagelkerke R^2: 0.384; Hosmer and Lemeshow Test: $X^2 = 135.89$, d.f. = 8, $P < 0.001$.
Multiple regression model parameters, Post-ED expansion ($n = 39\,139$, 21 predictors): Cox and Snell R^2: 0.287; Nagelkerke R^2: 0.385; Hosmer and Lemeshow Test: $X^2 = 99.86$, d.f. = 8, $P < 0.001$.

involving all adult ED presentations also identified (to a lesser extent) high admission rates (50%) for circulatory conditions compared with other illnesses.[27] An Australian study undertaken in five Melbourne EDs focusing on patients admitted with a specific respiratory disease (chronic obstructive pulmonary disease) revealed this as a group with a higher admission rate (77%).[31] Although these two studies were not confined to ambulance-arriving patients, they do indicate that people with circulatory and respiratory conditions are highly likely to be admitted. Furthermore, these patients may benefit from early intervention and expedited admission processes, such as those offered by medical admission units.[32]

People arriving by ambulance spending more than 4 h in the ED were admitted in higher proportions (60% vs 40%) and had odds of admission sixfold higher than those spending <4 h in the ED. This finding may be explained by an inadvertent pressure on medical staff to admit, rather than discharge. Although the present study was conducted before the introduction of NEAT targets,[10] it provides evidence to indicate a need for practice and process changes. With the imperative to improve patient flow from a whole-of-hospital approach,[33–35] this finding may be useful to justify early planning and management purposes. It is suggested that planners use additional clinical information (e.g. timely reporting on diagnostic investigations)[36] and evidence-based admission prediction tools[37] to enhance predictability and avoid inappropriate admissions.

Outcomes before and after ED expansion

Our study identified both statistically and clinically significant differences for patients arriving to the ED via ambulance following ED expansion. Even though ED capacity expanded from 81 to 122 beds within a health service area, difficulty meeting several ED performance targets continued. These ongoing challenges included offloading patients within 30 min, seeing patients within the recommended ATS time frame and ED LOS >8 h.

Most patients were able to be offloaded from ambulance to ED within 30 min. Although some (11% before and 15% after ED expansion) were delayed by >30 min, the proportions are lower than those noted in recent research undertaken in New South Wales, where 17% of patients experienced a delay of >30 min.[38] This finding indicates that further research understanding specific elements of this process is required. Although some of the Queensland processes result in better outcomes than in other states, Queensland outcomes are still not perfect and alternative service models may be useful in targeting the initial 30 min for patients arriving via ambulance.

The issue of ambulance offload delay has been of concern to patients, hospitals and the Queensland State Government. A recent Queensland report into this issue presented 15 recommendations for implementation in EDs across the state.[39] Examples of these recommendations include: having an off-stretcher key performance indicator within the health service; the development of performance-based hospital access incentive-funding framework; aborting hospital authority to 'bypass' or divert ambulances to another hospital; rest responsibility of sharing ambulance distribution with the ambulance service; that major public hospitals introduce senior clinical nurses to care for waiting

Table 5. Outcomes for patients arriving at the emergency department (ED) via ambulance before and after ED expansion
Data are presented as the number of patients in each group, with percentages in parentheses, or as the median (interquartile range), as appropriate. Time to see doctor, based on 75 129; ED length of stay (LOS) (total): based on 79 191 patient presentations; ED LOS (not admitted), based on 46 605 patient presentations; ED LOS (admitted), based on 31 928 patient presentations; seen within Australasian Triage Scale (ATS), based on 75 129 ED presentations. AIHW, Australian Institute of Health and Welfare; IQR, interquartile range; N/A, not available

Outcomes	Present study: ambulance-arriving ED patient presentations, three public hospitals			AIHW: all ED patient presentations, public hospitals[22]
	Before (n = 38 412)	After (n = 40 784)	P-value	
Offload time >30 min	4167 (10.8%)	6123 (15.0%)	<0.001	N/A
Time to see doctor (min)	38 (14–90)	42 (15–101)	<0.001	23 min
ED LOS (total) (min)[A]	268 (164–428)	310 (187–517)	<0.001	na
ED LOS (admitted) (min)[A]	391 (266–575); n = 14 682	456 (303–695); n = 17 246	<0.001	244 min
ED LOS (not admitted) (min)[A]	209 (132–321); n = 23 489	230 (145–361); n = 23 116	<0.001	281 min
Seen within ATS	15 829 (44.1%)	15 421 (39.3%)	<0.001	70%
Admitted[A]	14 682 (38.5%)	17 246 (42.7%)	<0.001	27%
Access blocked[B]	5197 (35.4%)	8016 (46.5%)	<0.001	na
Hospital LOS (days)[C]	2 (1–6)	2 (1–6)	<0.001	3.1 (acute care admission); 6.3 (excluding same day separations)
In-hospital mortality, patient's last admission[D]	562 (5.6%)	564 (4.1%)	<0.001	1.24%
In-hospital mortality, all admissions[E]	575 (3.9%)	569 (3.3%)	0.003	1.24%

[A]Admitted: based on 78 538 ED patient presentations.
[B]Access blocked: based on 31 928 ED presentations requiring hospital admission.
[C]Hospital LOS: based on 31 928 ED presentations requiring hospital admission.
[D]In-hospital mortality based on patient's last admission (n = 23 711).
[E]In-hospital mortality based on all admissions (n = 31 928) within time frame.

patients; and the establishment of a high-level Emergency Services Management Committee to provide policy advice to the Minister on issues affecting consumer access to (and delivery of) public hospital emergency services.[39] The extent to which and outcomes from the implementation of recommended changes are, to date, unknown. In Canada, a dedicated advanced practice nurse, tasked with receiving care of and providing early management for ambulance-arriving patients, has been a model in place (funded by the ambulance service) for several years.[40] A formal evaluation would benefit other health services interested in implementing a similar model.

The results of the present study indicate that expansion of ED bed capacity did not lead to improvements in compliance with ATS categories for time to be seen by a doctor for ambulance-arriving patients. Furthermore, in this study setting, greater proportions of patients exceeded ATS category cut-offs for the time to be seen by a doctor, both before and after ED expansion, compared with the national average for all patient presentations (56% before and 61% after ED expansion vs 32% nationally).[25] Other service delivery models to address this stage of the patient journey are required. Nurse practitioners and/or doctors to assist in triage[41] or shortly thereafter[42] may be worth trialling.

Accessibility (which includes waiting times for ED care) is one of the health system performance indicators of the National Health Performance Framework.[25] Waiting time (from arrival to treatment) is one of three distinct phases of a patient's journey through the ED.[19] The other two are time to triage (from arrival) and LOS, both for non-admitted and admitted patients.[19] Regarding LOS, our findings indicate that the EDs performed well on the portion of the indicator for non-admitted ED LOS, which was 72 min (before) and 51 min (after ED expansion) shorter than the national average of 281 min.[25] This may be explained, in part, by the use of efficient models of care for minor injuries.[43] However, on the portion of the indicator for ED LOS for admitted patients, ED LOS was far higher (by 147 and 212 min before and after ED expansion, respectively) than the average of 244 min.[25] This long ED LOS for admitted patients is reflected in the high levels of access block also identified (35% and 47% before and after ED expansion, respectively) and the 4% increase seen in the admission rate for ambulance-arriving patients. Additional in-patient beds did not accompany the ED expansion in the study hospitals, and this may explain, to some extent, the reason why further improvements in these outcomes were not identified.

For those patients requiring hospital admission, hospital LOS remained unchanged (at 2 days), which was considerably less than the 3.1 days (for all acute care admissions) and 6.3 days (excluding same day separations) noted in a national report.[25] In-hospital mortality rates found in our study were higher than the national average of 1.2%.[25] This finding may be reflective of the high acuity and admission likelihood of our study group (patients arriving via ambulance only). However, in-hospital mortality rates did decrease between the before and after ED expansion periods. This may be explained by the following: (1) patients were discharged earlier due to access block pressures and they may have died elsewhere; (2) there may have been better care, but this was unable to be captured in the parameters we collected and presented herein; or (3) after ED expansion, the proportion of patients who presented in ATS Categories 1 and 2 increased by 1.5%. Although it may be argued that improvements beyond those identified here may have been expected, it may be that the high access block rates reflect a crowded system that extends beyond the ED. As has been noted by Han *et al*.,[16] if the volume and complexity of presentations increase and in-patient beds are not available to enable transfer out of the ED, then this limits the ED's capacity to improve performance.[16] A whole-of-hospital approach that involves shared responsibility and communication between the ED and wards to better meet ED targets and reduce overcrowding and mortality rates has been reportedly successful in Western Australia[44] and warrants consideration by other Australian states.

Limitations

There are several limitations to the present study. First, because this was a retrospective analysis of prospectively collected data, there may have been inaccuracies within the data provided. However, we did implement data-cleaning measures in order to account for and manage inaccuracies. In addition, with the intention of understanding service delivery from an area-wide perspective, our analysis reflects pooled data from three EDs. Therefore, improvements to individual sites are not evident. Second, results indicating statistical significance may not necessarily relate to clinically meaningful significance due to the extensive volume of data used.[45] However, not all outcomes were significant, indicating that sample size was not the only factor determining significance. Third, our study was limited to the impact of opening additional ED beds only and comprised patients arriving to the ED via ambulance only. No accompanying hospital beds were opened at the same time, and we did not compare those arriving to the ED via ambulance with those arriving via other means. In addition, factors outside the scope of the present study, such as changes to working practices within the pre-hospital and ED settings and changes to health policy and funding arrangements, may have impacted on our results. Thus, the interpretation of our findings should consider these facts. Fourth, the present study did not include the effect on the three private hospitals within the local area or the other seven public hospitals within the broader geographic region. As such, there may have been a network effect that extended beyond the sites included in this study. Fifth, although we found ED LOS >4 h to be correlated with admission likelihood, it is difficult to ascertain whether this was caused by the wait or contributed to the cause for admission. Given that the ED LOS was shorter than the national average for non-admitted patients and longer than the national average for admitted patients, this indicates that the long ED LOS is likely caused by difficulties moving the patients from the ED to the hospital. However, this (i.e. ED LOS >4 h) and other predictors used were chosen based on related literature and clinical expertise. Finally, research examining structures, processes and other outcomes not described within our study (e.g. costs, time to triage, re-presentation, readmission rates and other crowding measures noted by Hwang *et al.*[46] and Liu *et al.*[47]) can be useful in providing further insight into the care quality and outcomes of this change in service and to this patient group. Further research accounting for these limitations is warranted.

Conclusions

The aim of the present study was to identify characteristics and predictors of hospital admission and describe the outcomes for patients who arrived via ambulance to three EDs following the opening of 41 additional ED beds within the area. The results demonstrate that for this group of patients, after the additional emergency capacity was operational, improvements to in-hospital mortality outcome could be realised. However, improvements to other outcomes, such as time to be offloaded from an ambulance, time to see a doctor, ED LOS and hospital LOS, were not realised and further research related to novel models of care are required. Easily identifiable predictors for hospital admission were noted in both pre- and post-ED expansion cohorts and included older age, assignment of higher (more emergent) triage categories and certain diseases pertaining to circulatory, respiratory and mental health groups. Understanding these predictors may be useful for implementing new strategies and managing certain patient groups who arrive to the ED via ambulance. Focused care pathways for these patients likely to be admitted, but spending lengthy times in the ED, may be required. Although conducted before NEAT, our findings (higher admission rate in patients with prolonged ED LOS and lower mortality rate) provide important information regarding the use of time-related targets.

Competing interests

The authors declare they have no competing interests.

Acknowledgements

The authors acknowledge and thank staff from the hospital and ambulance service decision support services for extracting data for the researchers. The authors also acknowledge funding received from the Queensland Emergency Medicine Research Foundation, Gold Coast Hospital Foundation and Queensland Ambulance Service to undertake this study.

References

1 Australian Institute of Health and Welfare. Australian hospital statistics 2007–2008. Health services series no. 33. Catalogue no. HSE 71. Canberra: AIHW; 2009.

2 Australian Institute of Health and Welfare. Australian hospital statistics 2010–11: emergency department care and elective surgery waiting times. Health services series no. 41. Catalogue no. HSE 115. Canberra: AIHW; 2011.

3 Tippett VC, Toloo G, Eeles D, Ting JYS, Aitken PJ, FitzGerald GJ. Universal access to ambulance does not increase overall demand for ambulance services in Queensland, Australia. *Aust Health Rev* 2013; 37: 121–6. doi:10.1071/AH12141

4 Lowthian J, Cameron PA, Curtis A, Currrell A, Cooke MW, McNeil JJ. Increasing utilisation of emergency ambulances. *Aust Health Rev* 2011; 35: 63–9. doi:10.1071/AH09866

5 Richardson D. Increase in patient mortality at 10 days associated with emergency department overcrowding. *Med J Aust* 2006; 184: 213–16.

6 Cha WC, Shin SD, Cho JS, Song KJ, Singer AJ, Kwak YH. The association between crowding and mortality in admitted paediatric patients from mixed adult–paediatric emergency departments in Korea. *Pediatr Emerg Care* 2011; 27: 1136–41. doi:10.1097/PEC.0b013e31823ab90b

7 Sun BC, Hsia RY, Weiss RE, Zingmond D, Liang L-J, Han W, McCreath H, Asch SM. Effect of emergency department crowding on outcomes of admitted patients. *Ann Emerg Med* 2012; doi:doi.org/10.1016/j.annemergmed.2012.10.026

8 World Health Organization. The world health report. Health systems: improving performance. 2000. Available at http://www.who.int/whr/2000/en/whr00_en.pdf [verified 22 April 2013].

9 World Health Organization. Everybody's business: strengthening health systems to improve health outcomes; WHO's framework for action. 2007. Available at: http://www.who.int/healthsystems/strategy/en/ [verified 22 April 2013].

10 Australian Government Department of Health and Ageing. National health reform: progress and delivery. 2011. Available at http://www.yourhealth.gov.au/internet/yourhealth/publishing.nsf/Content/nhr-progress-delivery [verified 22 April 2013].
11 Queensland Health. Queensland health strategic plan: 2007–12. Available at http://www.health.qld.gov.au/about_qhealth/strat_plan/7-12/documents/plan.pdf [verified 22 April 2013].
12 Metral CT, Marvinney DE. Planning and moving to a new emergency department: one hospital's experience. *J Emerg Nurs* 1995; 21: 22–6. doi:10.1016/S0099-1767(95)80007-7
13 Huddy J, McKay JI. The top 25 problems to avoid when planning your new emergency department. *J Emerg Nurs* 1996; 22: 296–301. doi:10.1016/S0099-1767(96)80018-3
14 Forsythe L. Planning a new emergency department: one Pacific northwest hospital's experience. *J Emerg Nurs* 2003; 29: 330–4. doi:10.1067/men.2003.128
15 Finefrock SC. Designing and building a new emergency department: the experience of one chest pain, stroke, and trauma center in Columbus, Ohio. *J Emerg Nurs* 2006; 32: 144–8. doi:10.1016/j.jen.2005.11.014
16 Han JH, Zhou C, France DJ, Zhong S, Jones I, Storrow AB, *et al*. The effect of emergency department expansion on emergency department overcrowding. *Acad Emerg Med* 2007; 14: 338–43. doi:10.1111/j.1553-2712.2007.tb02018.x
17 Australian Bureau of Statistics. National regional profile 2006–2010. 2010. Available at http://www.ausstats.abs.gov.au/ausstats/nrpmaps.nsf/NEW+GmapPages/national+regional+profile?opendocument [verified 22 April 2013].
18 Asplin BR, Magid DJ, Rhodes KV, Solberg LI, Lurie N, Camargo CA. A conceptual model of emergency department overcrowding. *Ann Emerg Med* 2003; 42: 173–80. doi:10.1067/mem.2003.302
19 Sibbritt D, Isbister GK, Walker R. Emergency department performance indicators that encompass the patient journey. *Qual Manag Health Care* 2006; 15: 27–38. doi:10.1097/00019514-200601000-00004
20 Australasian College for Emergency Medicine (ACEM). Policy on the Australasian triage scale. West Melbourne: ACEM; 2006.
21 Crilly J, O'Dwyer J, O'Dwyer M, Lind J, Peters J, Tippett V, *et al*. Linking ambulance, emergency department and hospital admissions data: understanding the emergency journey. *Med J Aust* 2011; 194(Suppl): S34–7.
22 Polit DF, Beck CT. Essentials of nursing research: appraising evidence for nursing practice. 7th edn. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010.
23 ICD 10. International Statistical Classification of Disease and Related Health Problems (10th revision). 2010. Available at http://apps.who.int/classifications/icd10/browse/2010/en [verified 3 April 2014].
24 Queensland Government. Data quality issues impacting on reporting on presentations to emergency departments in Queensland hospitals: coding of diagnosis in emergency department data for selected conditions, 2010/11. Available at http://www.health.qld.gov.au/hsu/tech_report/ED10.pdf [verified 3 April 2014].
25 Australian Institute of Health and Welfare (AIHW). Australian hospital statistics 2008–2009. Health series no. 17. Catalogue no. HSE 84. Canberra: AIHW; 2010.
26 Australian Institute of Health and Welfare (AIHW). Australian Hospital Statistics 200–2011. Health Service Series no. 43. Catalogue no. HSE 117. Canberra: AIHW; 2012.
27 Xie B. Development and Validation of models to predict hospital admission for emergency department patients. *Int J Stats Med Res* 2013; 2: 55–66.
28 Sun Y, Heng BH, Tay SY, Seow E. Predicting hospital admissions at emergency department triage using routine administrative data. *Acad Emerg Med* 2011; 18: 844–50. doi:10.1111/j.1553-2712.2011.01125.x
29 LaMantia MA, Platts-Mills TF, Biese K, Khandelwal C, Forbach C, Cairns CB, *et al*. Predicting hospital admission and returns to the emergency department for elderly patients. *Acad Emerg Med* 2010; 17: 252–9. doi:10.1111/j.1553-2712.2009.00675.x
30 Considine J, Ung L, Thomas S. Triage nurses' decisions using the National Triage Scale for Australian emergency departments. *Accid Emerg Nurs* 2000; 8: 201–9. doi:10.1054/aaen.2000.0166
31 Considine J, Botti M, Thomas S. Early predictors of hospital admission in emergency department patients with chronic obstructive pulmonary disease. *Australas Emerg Nurs J* 2011; 14: 180–8. doi:10.1016/j.aenj.2011.05.004
32 Scott I, Vaughn L, Bell D. Effectiveness of acute medical units in hospitals: a systematic review. *Int J Qual Health Care* 2009; 21: 397–407. doi:10.1093/intqhc/mzp045
33 Bernstein SL, Aronsky D, Duseja R, Epstein S, Handel D, Hwang U, *et al*. The effect of emergency department crowding on clinically oriented outcomes. *Acad Emerg Med* 2009; 16: 1–10. doi:10.1111/j.1553-2712.2008.00295.x
34 Handel DA, Pines J, Aronsky D, Genes N, Ginde AA, Hackman J, *et al*. Variations in crowding and ambulance diversion in nine emergency department. *Acad Emerg Med* 2011; 18: 941–6. doi:10.1111/j.1553-2712.2011.01149.x
35 Pines JM, McCarthy M. The crowding-effectiveness link: it doesn't matter how fast we deliver care if we don't deliver it right. *Ann Emerg Med* 2011; 57: 201–2. doi:10.1016/j.annemergmed.2010.12.005
36 Beardsell I, Robinson S. Can emergency department nurses performing triage predict the need for admission? *Emerg Med J* 2011; 28: 959–62. doi:10.1136/emj.2010.096362
37 Boyle J, Jessup M, Crilly J, Green D, Lind J, Wallis M, *et al*. Predicting emergency department admissions. *Emerg Med J* 2012; 29: 358–65. doi:10.1136/emj.2010.103531
38 Cone DC, Middleton PM, Marashi Pour S. Analysis and impact of delays in ambulance to emergency department handovers. *Emerg Med Australas* 2012; 24: 525–33. doi:10.1111/j.1742-6723.2012.01589.x
39 Metropolitan Emergency Department Access Initiative. A report on ambulance ramping in metropolitan hospitals. Brisbane: Queensland Government; 2012. Available at http://www.health.qld.gov.au/publications/medai-report/final_medai_report.pdf [verified 22 October 2013].
40 Ontario Local Health Integration. Emergency Department Task Group. Presentation of draft final report to CE LHIN board. 2008. Available at http://www.centraleastlhin.on.ca/uploadedFiles/Home_Page/Board_of_Directors/Board_Meeting_Submenu/ED_and_ALC_TG_Board_presentation_June_6_%282%29.pdf [verified 22 April 2013].
41 Edwards T. The introduction of a rapid asessment team in an emergency department reduced waiting time and accesslerated patients flow. *Emerg Nurse* 2011; 19: 27–30. doi:10.7748/en2011.10.19.6.27.c8752
42 Shetty A, Naren G, Byth K, Vukasovic M. Senior streaming assessment further evaluation after triage zone: a novel model of care encompassing various ED throughput measures. *Emerg Med Australas* 2012; 24: 374–82. doi:10.1111/j.1742-6723.2012.01550.x
43 Wallis M, Hooper J, Kerr D, Lind J, Bost N. The effect of an emergency department discharge planner on patient outcomes in a minor injuries unit. *Aust J Adv Nurs* 2009; 27: 21–9.
44 Geelhoed GC, de Klerk NH. Emergency department overcrowding, mortality and the 4-hour rule in Western Australia. *Med J Aust* 2012; 196: 122–6. doi:10.5694/mja11.11159
45 Sachin S, Bhardwaj SS, Camacho F, Derrow A, Fleische AB, Feldman SR. Statistical significance and clinical relevance: the importance of power in clinical trials in dermatology. *J Am Med Assoc Dermatol* 2004; 140: 1520–3.
46 Hwang U, McCarthy ML, Aronsky D, Asplin B, Crane PW, Craven CK, *et al*. Measures of crowding in the emergency department: a systematic review. *Acad Emerg Med* 2011; 18: 527–38. doi:10.1111/j.1553-2712.2011.01054.x
47 Liu SW, Singer SJ, Sun BC, Camargo CA. A conceptual model for assessing quality of care for patients boarding in the emergency department: structure–process–outcome. *Acad Emerg Med* 2011; 18: 430–5. doi:10.1111/j.1553-2712.2011.01033.x