CSIRO PUBLISHING
Australian Health Review, 2016, 40, 149–154
http://dx.doi.org/10.1071/AH14242

Who is less likely to die in association with improved National Emergency Access Target (NEAT) compliance for emergency admissions in a tertiary referral hospital?

Clair Sullivan[1,4] MBBS (Hons), MD, FRACP, Deputy Chair of Medicine, Consultant Endocrinologist, Director of Physician Education

Andrew Staib[1] MBBS, FACEM, Deputy Director of Emergency Medicine

Rob Eley[1,2] BSc, MSc, PhD, CSci, CBiol, FSB, Academic Research Manager, Emergency Medicine Research Program

Bronwyn Griffin[1] PhD, GdipEmergN, BScNurs, Nurse Researcher, CLEAR Project

Rohan Cattell[3] PhD, Informatics Consultant

Judy Flores[1] MD, FRACP, FACP, Chair of Medicine

Ian Scott[1] MBBS, FRACP, MHA Med, Director of Internal Medicine and Clinical Epidemiology

[1]Princess Alexandra Hospital, Metro South Health, 199 Ipswich Road, Woolloongabba, Qld 4102, Australia. Email: Andrew.Staib@health.qld.gov.au; Bronwyn.Griffin2@health.qld.gov.au; Judy.Flores@health.qld.gov.au; ian.scott@health.qld.gov.au

[2]The Centre for Health Sciences Research, University of Queensland, Southern Clinical School, 199 Ipswich Road, Qld 4102, Australia. Email: r.eley@uq.edu.au

[3]The Health Roundtable Limited, 40 Port Jackson Road, Terrigal, NSW 2260, Australia. Email: rohan.cattell@healthroundtable.org

[4]Corresponding author. Email: clair.sullivan@health.qld.gov.au

Abstract

Objective. The aim of the present study was to identify patient and non-patient factors associated with reduced mortality among patients admitted from the emergency department (ED) to in-patient wards in a major tertiary hospital that had previously reported a near halving in mortality in association with a doubling in National Emergency Access Target (NEAT) compliance over a 2-year period from 2012 to 2014.

Methods. We retrospectively analysed routinely collected data from the Emergency Department Information System (EDIS) and hospital discharge abstracts on all emergency admissions during calendar years 2011 (pre-NEAT interventions) and 2013 (post-NEAT interventions). Patients admitted to short-stay wards and then discharged home, as well as patients dying in the ED, were excluded. Patients included in the study were categorised according to age, time and day of arrival to the ED, mode of transport to the ED, emergency triage category, type of clinical presentation and major diagnostic codes.

Results. The in-patient mortality rate for emergency admissions decreased from 1.9% (320/17 022) in 2011 to 1.2% (202/17 162) in 2013 ($P < 0.001$). There was no change from 2011 to 2013 in the percentage of deaths in the ED (0.19% vs 0.17%) or those coded as in-patient palliative care (17.9% vs 22.2%). Although deaths were not associated with age by itself, the mortality rate of older patients admitted to medical wards decreased significantly from 3.5% to 1.7% ($P = 0.011$). A higher mortality rate was seen among patients presenting to ED triage between midnight and 12 noon than at other times in 2011 (2.5% vs 1.5%; $P < 0.001$), but this difference disappeared by 2013 (1.3% vs 1.1%; $P = 0.150$). A similar pattern was seen among patients presenting on weekends versus weekdays: 2.2% versus 1.7% ($P = 0.038$) in 2011 and 1.3% versus 1.1% ($P = 0.150$) in 2013. Fewer deaths were noted among patients with acute cardiovascular or respiratory disease in 2013 than in 2011 (1.7% vs 3.6% and 1.5% vs 3.4%, respectively; $P < 0.001$ for both comparisons). Mode of transport to the ED or triage category was not associated with changes in mortality. These analyses took account of any possible confounding resulting from differences over time in emergency admission rates.

Conclusions. Improved NEAT compliance as a result of clinical redesign is associated with improved in-patient mortality among particular subgroups of emergency admissions, namely older patients with complex medical conditions, those presenting after hours and on weekends and those presenting with time-sensitive acute cardiorespiratory conditions.

What is known about the topic? Clinical redesign aimed at improving compliance with NEAT and reducing time spent within the ED of acutely admitted patients has been associated with reduced mortality. To date, no study has attempted to identify subgroups of patients who potentially derive the greatest benefit from improved NEAT compliance in terms of reduced risk of in-patient death. It also remains unclear as to what extent non-patient factors (e.g. admission practices and differences in coding of palliative care patients) affect or confound this reduced risk.

What does this paper add? The present study is the first to reveal that enhanced NEAT compliance is associated with lower mortality among particular subgroups of emergency patients admitted to in-patient wards. These include older patients with complex medical conditions, those presenting after hours or on weekends or those with time-sensitive acute cardiorespiratory conditions. These results took account of any possible confounding resulting from differences over time in emergency admission rates, deaths in the ED, numbers of short-stay ward admissions and coding of palliative care deaths.

What are the implications for practitioners? Efforts aimed at improving NEAT compliance and efficiencies at the ED–in-patient interface appear to be worthwhile in reducing in-patient mortality among particular subgroups of emergency admissions at high risk. More research is urgently needed in identifying patient- and system-level factors that predispose to higher mortality rates in such populations, but are potentially amenable to focused interventions aimed at optimising transitions of care at the ED–in-patient interface and increasing NEAT compliance for patients admitted to in-patient wards from the ED.

Received 8 December 2014, accepted 16 June 2015, published online 17 August 2015

Introduction

Many studies have shown that overcrowding in emergency departments (ED) is associated with prolonged length of ED stay and increased mortality for patients admitted acutely via the ED.[1–4] Postulated causal mechanisms that have attracted remedial interventions include delayed or missed investigation results, medications or therapeutic interventions,[5–7] delayed time to consultant review and definitive management[8,9] and poor transitions of care across the ED–in-patient interface.[10,11] In a recent study, we demonstrated an association between improved compliance with the National Emergency Access Target (NEAT), defined as discharge from the ED within 4 h of presentation, and lower all-cause mortality among patients admitted from the ED to in-patient wards of a large adult tertiary hospital.[12] As NEAT compliance improved from 32% to 62% in response to multiple interventions over a 9-month period, mean length of ED stay for admitted patients decreased significantly from 637.8 to 404.4 min. This reduction in time spent in the ED was associated with a significant decrease in crude mortality rate for admitted patients from 2.3% to 1.0% and a fall in the hospital standardised mortality rate for emergency admissions (eHSMR) from 93 to 72.

Other studies, both overseas and in Australia, have confirmed a similar association. For example, Kelman *et al.*[13] examined hospitals across 155 UK National Health Service (NHS) trusts and found that as the percentage of hospitals achieving more than 98% compliance with the <4 h target increased from 1.24% to 59.4%, the mean in-hospital mortality rate for emergency admissions across all hospitals decreased from 1.17% to 0.84%. In Western Australia, Geelhoed *et al.*[14] studied six hospitals in Perth (three tertiary and three secondary hospitals) following the introduction of the 4-h rule and found that improvements in access block and ED overcrowding were associated with an overall significant decrease in mortality rate from 1.12% to 0.98% in tertiary hospitals. Secondary hospitals had no significant improvement in access block or mortality.

As far as we are aware, no study to date has examined which subsets of patients demonstrate the most benefit in association with improved NEAT compliance in terms of reduced risk of in-hospital death. Much of the literature has focused on patient outcomes associated with access block in the ED of >8 h,[15,16] which may be less relevant to the current target of <4 h.[13,14,17]

The aim of the present study was to explore patient and system of care predictors of in-patient death for emergency admissions following the introduction of the 4-h rule at a 640-bed tertiary hospital.

Methods

Data sources

We retrospectively analysed routinely collected data from the ED Information System (EDIS) for the calendar years 2011 to 2013 to identify and characterise patients admitted via the ED and nominated years 2011 and 2013 as the pre- and post-NEAT intervention periods, respectively, with 2012 being classed as a transitional year. Routinely collected in-patient mortality data from 2011 to 2013 were obtained on all emergency admissions according to their medical record number (MRN). Provisional diagnoses at time of ED discharge to in-patient ward were generated from the Primary Diagnosis International Classification of Diseases version 10 (ICD-10) codes recorded in EDIS. Diagnostic and palliative care codes at time of death were derived from ICD-10 codes and acute or non-acute care classification recorded in hospital discharge abstracts.

Patient selection and variables

Patients eligible for study were those admitted via the ED to an in-patient unit. Patients who were admitted to the ED short-stay ward and then discharged home, those who died in, or were discharged home from, the ED or those who were transferred from the ED to another hospital were excluded from the study. Patients were classified as medical or surgical according to the destination in-patient unit. Patients admitted to the psychiatric unit were

excluded from the study. Patients were categorised according to: (1) age (<64, 65–74, 75–84, 85+ years); (2) time of arrival at the ED (0000–0559, 0600–1159, 1200–1759, 1800–2359 hours); (3) day of arrival (weekdays, weekend); (4) mode of arrival to the ED (ambulance, walk-in, other); (5) emergency triage category (Australian Triage Scale (ATS), www.acem.org, verified 11 November 2014); (6) type of clinical presentation (undifferentiated or differentiated); and (7) major ICD-10 diagnosis-related group (DRG) category (e.g. diseases of the circulatory system (Code I), diseases of the respiratory system (Code J). Two experienced triage nurses reviewed the ED triage presentation notes for each patient who died and categorised the presentation as differentiated (where there was a clear and obvious diagnosis such as multitrauma or subarachnoid haemorrhage confirmed by imaging) or undifferentiated (where clinical features were non-specific and in need of diagnostic work-up, such as fever or confusion). Cases involving disagreement between the two triage nurses were classified as undifferentiated.

Outcome variables

The primary outcome variable was death of admitted in-patients as defined according to coding, with deaths coded as occurring in palliative care patients excluded from the analysis on the basis that many of these are expected deaths, care goals for these patients differ markedly from those of non-palliative patients and NEAT improvement strategies are aimed at reducing avoidable deaths in acutely ill patients who do not have a terminal illness.

Mortality rates of patients admitted from the ED were calculated variously as rate per number of ED presentations, rate per number of admitted patients and rates per number of patients admitted to the same destination ward.

Statistical analysis

Comparisons of variables measured in 2011 and 2013 were undertaken using Chi-squared tests for categorical variables and ANOVA for continuous variables. Data analysis was performed using IBM SPSS Statistics version 22 (IBM Corp, Armonk, NY, USA). The study was approved by the Metro South Human Research Ethics Committee (HREC/12/QPAH/021).

Results

In 2011, excluding patients admitted to the ED short-stay ward, 17 022 of 53 419 patients presenting to the ED were admitted to in-patient surgical or medical wards (admission rate 31.9%), of whom 320 (1.88%) died, compared with 17 162 of 59 623 presentations in 2013 (admission rate 28.8%), of whom 202 (1.18%) died ($P < 0.001$ for all comparisons). There was no significant difference in the numbers of deaths (100 vs 99) or rates of death (0.19% vs 0.17%) of patients who died in the ED between the 2 years.

No significant changes were seen in the pattern of coding of deaths, either palliative or non-palliative, of patients who died on an in-patient ward after ED admission between 2011 and 2013. In 2011 there were 70 palliative deaths (representing 17.9% of all deaths in ED patients admitted to in-patient wards) and in 2013 there were 58 (22.2%; $P = 0.157$).

Associations between in-hospital mortality and patient variables

Destination ward

There was a significant decrease in mortality for patients admitted to either medical wards ($n = 9164$ in 2011; $n = 10\,290$ in 2013) or surgical wards ($n = 7859$ in 2011; $n = 6872$ in 2013), from 1.62% to 0.89% (45% relative reduction; $P < 0.001$) and from 2.15% to 1.60% (26% relative reduction; $P = 0.014$), respectively.

Patient age

No significant differences were seen between 2011 and 2013 in the proportion of all in-hospital deaths attributed to each of the four age groups (data not shown). However, among patients admitted to medical wards, there were significant reductions in mortality across all age groups between 2011 and 2013m except for the 64–75-year-old age group ($P = 0.057$), with the largest decrease seen in the ≥84 years age group (from 2.8% to 1.2%; $P = 0.011$; Fig. 1). A similar pattern of reduced mortality in 2013 was seen across all age groups for surgical admissions, but these reductions were not significant (data not shown).

Time and day of presentation to the ED

In 2011, admitted patients who presented to ED triage between midnight and 12 noon had a significantly higher mortality rate than those presenting in the remaining 12 h of the day (2.5% vs 1.5%, respectively; $P < 0.001$). In 2013, this diurnal variation disappeared, with respective mortality rates of 1.3% and 1.1% ($P = 0.150$).

Similarly, in 2011, admitted patients who presented to ED triage on weekends had a significantly higher mortality rate than those presenting on weekdays (2.23% vs 1.74%, respectively; $P = 0.038$). In 2013, this variation was no longer seen (1.3% vs 1.1%' $P = 0.150$).

Mode of arrival to the ED

Patients who arrived by ambulance had a significantly higher mortality rate than those who arrived by other means, and this did not change over time (2.5% vs 0.8%, respectively, in 2011; 2.5%

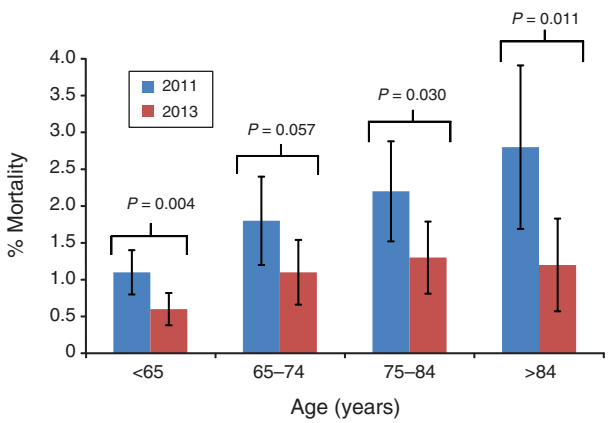

Fig. 1. In-hospital mortality of patients admitted to medical wards according to age. Data are the mean ± s.d.

vs 0.5%, respectively, in 2013; $P < 0.001$ for both comparisons). Among the patients who died as an in-patient and had been brought in by ambulance, a higher proportion were in ATS Categories 1 and 2 in both 2011 and 2013 compared with deceased patients who had arrived by other means (70.8% vs 36.9%, respectively, in 2011 ($P < 0.001$); 67.9% vs 36.0%, respectively, in 2013 ($P = 0.006$)).

Type of clinical presentation

Patients who died following presentation with differentiated syndromes spent less time in the ED than those with undifferentiated presentations in both 2011 (difference 216 min) and 2013 (difference 173 min; $P < 0.001$ for both comparisons; Fig. 2).

Diagnostic categories

Between 2011 and 2013 there was a significant reduction in mortality rates among patients coded as having circulatory diseases (ICD-10 Code I: 3.62% vs 1.70%, respectively; $P < 0.001$) and respiratory diseases (ICD-10 Code J: 3.43% vs 1.48%, respectively; $P < 0.001$), but not for the other major groups (Fig. 3).

Discussion

Previously, we reported a near halving in in-hospital mortality rate in association with a doubling in NEAT compliance pertaining to patients admitted acutely to in-patient units via the ED.[12] In the present study, we identified subgroups of patients who appear to derive greater benefit in terms of reduced risk of in-hospital death from improved NEAT compliance, while also taking account of other non-clinical confounders that may give rise to spurious reductions in mortality rates, as suggested by other investigators. For example, Toh *et al.*[18] raised the possibility of greater numbers of lower acuity, relatively healthy patients being admitted to meet the 4-h target, rather than being processed and finally discharged from ED, as has been observed in some reports,[19] thus resulting in an artefactual lowering of in-hospital mortality.

We accounted for this by excluding patients who were admitted to the short-stay ward and noting that the admission rate to in-patient units was stable (indeed higher in 2011 than in 2013) over the 3-year period. We also found no increase in ED deaths or upcoding of in-patient deaths as palliative, both of which could contribute to spurious reductions in the number of in-hospital deaths.

We were unable to find any other reports of the diurnal variation in mortality rates according to time of ED presentation that we observed in 2011 before NEAT interventions, but which was later corrected. This correction was temporally associated with the commencement of extended night-time rostering of medical registrars (to reduce handover of yet-to-be-admitted patients from the evening peaks to the smaller number of night registrars) and more rapid processing of patients still present in the ED in the early morning hours.

Several studies have reported a 'weekend effect' whereby emergency patients admitted on weekends incur a higher risk of death than those admitted on weekdays.[20,21] In some studies this has been related to longer ED stays on weekends.[22] Our findings revealed a similar pattern that was no longer statistically significant following the implementation of better matching of resources at the ED–in-patient interface to patient presentations.

The association of prolonged ED stays and more adverse events in older patients with multiple comorbidities has been noted by various investigators.[23,24] In the present study, older complex medical patients admitted to medical wards fared better as a result of improved NEAT compliance. Similarly, several studies have associated worse outcome and increased mortality among patients with undifferentiated or non-specific presenting complaints compared with those with clear-cut diagnoses.[25–27] Although we were only able to classify patients who died as having either differentiated or undifferentiated presentations, thus preventing calculation of all-patient mortality rates, ED stay was considerably longer in the latter compared with the former, but decreased by a greater extent following NEAT interventions. We would expect, based on the previously cited studies, that this would translate to a larger survival benefit.

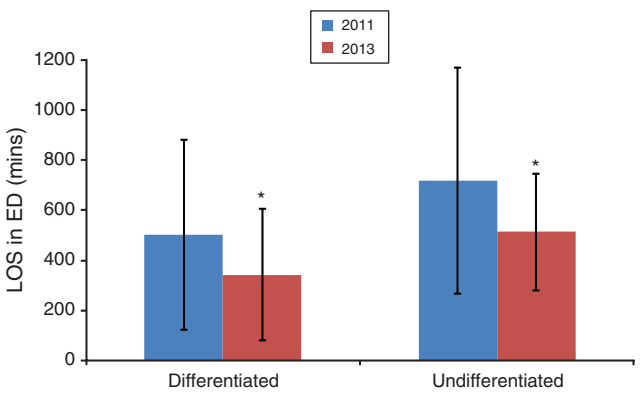

Fig. 2. Classification of triage presentation (differentiated, where there was a clear and obvious diagnosis; undifferentiated, clinical features non-specific and in need of diagnostic work-up) for patients who died after being admitted to an in-patient ward and emergency department (ED) length of stay (LOS). Data are the mean ± s.d.*$P < 0.001$ compared with 2011.

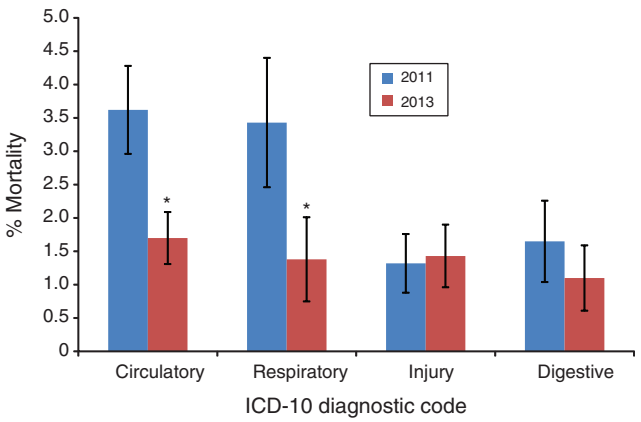

Fig. 3. Mortality rates for emergency department patients admitted to an in-patient ward according to major International Classification of Diseases version 10 (ICD-10) diagnostic codes. Data are the mean ± s.d.*$P < 0.001$ compared with 2011.

Patients presenting with time-sensitive acute circulatory or respiratory diseases, such as acute pulmonary oedema or community-acquired pneumonia, are more likely to die if indicated care is not delivered in a timely fashion. Investigations at Mid-Staffordshire revealed that highly dysfunctional interfaces between ED and in-patient units were associated with more deaths concentrated among patients presenting acutely with cardiovascular disorders.[28] Other researchers have observed associations between measures of ED stays and overcrowding and delays in resuscitation and treatment of acutely ill patients,[29,30] higher risk of adverse cardiovascular events in patients presenting with chest pain[31] and suboptimal timing of antibiotic administration[32] and increased mortality[33] in patients presenting with community-acquired pneumonia. In the present study, NEAT interventions were associated with reduced mortality rates in patients presenting with acute circulatory or respiratory diseases.

The present study has some limitations. Because we performed an observational analysis, we cannot exclude the possibility that other factors in addition to improved NEAT compliance may have contributed to the lowered in-patient mortality. However, no other major system of care or clinical process changes occurred during the study period. We report crude rather than adjusted death rates because it was not possible to develop robust risk adjustment regression models for each of several subgroup analyses involving highly heterogeneous patients. However, we have no reason to believe that the concordance observed between reductions in crude mortality and eHSMR noted in our previous study[13] for all admitted patients does not apply to individual subgroups.

Moreover, the differences in mortality rates for most subgroup analyses were highly statistically significant ($P < 0.001$), so it is likely that in regression models these subgroup predictors would fall out as independent associations. Patients coded as being palliative were excluded from analysis because many of these deaths are expected, care goals are conservative and aimed at symptom control rather than increasing survival and the effects on mortality of NEAT improvement strategies are not relevant for this group.

Finally, we were limited to measuring in-hospital mortality only, as opposed to post-discharge mortality up to 30 days after ED presentation, which may be a more accurate marker of intervention effects. However, studies suggest that most deaths relating to emergency admissions occur within 12 days of presentation.[34]

In conclusion, the present study provides the first preliminary evidence that low-cost targeted clinical redesign of the ED–in-patient interface leading to enhanced NEAT compliance is associated with improved mortality for particular subgroups of emergency patients admitted to in-patient wards. These include those at highest risk of death: elderly patients with complex medical conditions, those presenting on weekends or after hours and those with time-sensitive acute cardiorespiratory conditions. Further research is needed using larger samples to identify and validate these and other patient characteristics associated with differential benefit and to explore causal mechanisms in greater depth.

Competing interests

None declared.

Acknowledgements

The authors would like to thank Chantelle Judge and Lisette Knight who provided senior registered nurse review of triage differentiation. The authors also thank Dr Anthony Bell and Linda McCormack for their input and encouragement towards this paper. The authors also acknowledge the funding contribution from the Clinical Access and Redesign Unit (CARU) Queensland Health.

References

1 Fatovich DM, Hirsch RL. Entry overload, emergency department overcrowding, and ambulance bypass. *Emerg Med J* 2003; 20: 406–9. doi:10.1136/emj.20.5.406

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

3 Sprivulis PC, Da Silva JA, Jacobs IG, Frazer AR, Jelinek GA. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. *Med J Aust* 2006; 184: 208–12.

4 Viccellio A, Santora C, Singer AJ, Thode HC, Jr, Henry MC. The association between transfer of emergency department boarders to inpatient hallways and mortality: a 4-year experience. *Ann Emerg Med* 2009; 54: 487–91. doi:10.1016/j.annemergmed.2009.03.005

5 Derlet RW, Richards JR. Overcrowding in the nation's emergency departments: complex causes and disturbing effects. *Ann Emerg Med* 2000; 35: 63–8. doi:10.1016/S0196-0644(00)70105-3

6 Hwang U, Richardson L, Livote E, Harris B, Spencer N, Morrison RS. Emergency department crowding and decreased quality of pain care. *Acad Emerg Med* 2008; 15: 1248–55. doi:10.1111/j.1553-2712.2008.00267.x

7 Kocher KE, Meurer WJ, Desmond JS, Nallamothu BK. Effect of testing and treatment on emergency department length of stay using a national database. *Acad Emerg Med* 2012; 19: 525–34. doi:10.1111/j.1553-2712.2012.01353.x

8 Kelly AM, Bryant M, Cox L, Jolley D. Improving emergency department efficiency by patient streaming to outcomes-based teams. *Aust Health Rev* 2007; 31: 16–21. doi:10.1071/AH070016

9 King DL, Ben-Tovim DI, Bassham J. Redesigning emergency department patient flows: application of lean thinking to health care. *Emerg Med Aust* 2006; 18: 391–7.

10 Horwitz LI, Meredith T, Schuur JD, Shah NR, Kulkarni RG, Jenq GY. Dropping the baton: a qualitative analysis of failures during the transition from emergency department to inpatient care. *Ann Emerg Med* 2009; 53: 701–10.e4. doi:10.1016/j.annemergmed.2008.05.007

11 Walters EH, Dawson DJ. Whole-of-hospital response to admission access block: the need for a clinical revolution. *Med J Aust* 2009; 191: 561–3.

12 Sullivan CM, Staib A, Flores J, Aggarwal L, Scanlon A, Martin JH, Scott IA. Aiming to be NEAT: safely improving and sustaining access to emergency care in a tertiary referral hospital. *Aust Health Rev* 2014; 38: 564–74. doi:10.1071/AH14083

13 Kelman S, Friedman JN. Performance improvement and performance dysfunction: an empirical examination of distortionary impacts of the emergency room wait-time target in the English National Health Service. *J Public Admin Res Theory* 2009; 19: 917–46. doi:10.1093/jopart/mun028

14 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

15 Harris A, Sharma A. Access block and overcrowding in emergency departments: an empirical analysis. *Emerg Med J* 2010; 27: 508–11. doi:10.1136/emj.2009.072546

16 Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects, and solutions. *Ann Emerg Med* 2008; 52: 126–36.e1. doi:10.1016/j.annemergmed.2008.03.014

17 Khanna S, Boyle J, Good N, Lind J. New emergency department quality measure: from access block to National Emergency Access Target compliance. *Emerg Med Aust* 2013; 25: 565–72.
18 Toh DJ, Thompson CH, Thomas JS, Faunt J. Letter to the Editor: emergency department overcrowding and mortality after the introduction of the 4-hour rule in Western Australia. *Med J Aust* 2012; 196: 499–500.
19 Nash L, Tacey M, Liew D, Jones C, Truesdale M, Russell D. Impact of emergency access targets on admissions to general medicine: a retrospective cohort study. *Intern Med J* 2013; 43: 1110–6. doi:10.1111/imj.12260
20 Aylin P, Yunus A, Bottle A, Majeed A, Bell D. Weekend mortality for emergency admissions. A large, multicentre study. *Qual Saf Health Care* 2010; 19: 213–17. doi:10.1136/qshc.2008.028639
21 Clarke MS, Wills RA, Bowman RV, Zimmerman PV, Fong KM, Coory MD, Yang IA. Exploratory study of the 'weekend effect' for acute medical admissions to public hospitals in Queensland, Australia. *Intern Med J* 2010; 40: 777–83. doi:10.1111/j.1445-5994.2009.02067.x
22 Clark K, Normile LB. Influence of time-to-interventions for emergency department critical care patients on hospital mortality. *J Emerg Nurs* 2007; 33: 6–13. doi:10.1016/j.jen.2006.08.002
23 Ackroyd-Stolarz S, Read Guernsey J, Mackinnon NJ, Kovacs G. The association between a prolonged stay in the emergency department and adverse events in older patients admitted to hospital: a retrospective cohort study. *BMJ Qual Saf* 2011; 20: 564–9. doi:10.1136/bmjqs.2009.034926
24 Liu SW, Thomas SH, Gordon JA, Hamedani AG, Weissman JS. A pilot study examining undesirable events among emergency department-boarded patients awaiting inpatient beds. *Ann Emerg Med* 2009; 54: 381–5. doi:10.1016/j.annemergmed.2009.02.001
25 Djarv T, Castren M, Martenson L, Kurland L. Decreased general condition in the emergency department: high in-hospital mortality and a broad range of discharge diagnoses. *Eur J Emerg Med* 2015; 22: 241–6. doi:10.1097/MEJ.0000000000000164
26 Nemec M, Koller MT, Nickel CH, Maile S, Winterhalder C, Karrer C, Laifer G, Bingiser R. Patients presenting to the emergency department with non-specific complaints: the Basel Non-specific Complaints (BANC) study. *Acad Emerg Med* 2010; 17: 284–92. doi:10.1111/j.1553-2712.2009.00658.x
27 Safwenberg U, Terént A, Lind L. The emergency department presenting complaint as predictor of in-hospital fatality. *Eur J Emerg Med* 2007; 14: 324–31. doi:10.1097/MEJ.0b013e32827b14dd
28 Wood H, Fontain P, Harvey D, Catford G, Hills A, Holland B. Investigation into Mid Staffordshire NHS Foundation Trust. London: Commission for Healthcare Audit and Inspection; 2009.
29 Hong KJ, Shin SD, Song KJ, Cha WC, Cho JS. Association between ED crowding and delay in resuscitation effort. *Am J Emerg Med* 2013; 31: 509–15. doi:10.1016/j.ajem.2012.09.029
30 McCarthy ML, Zeger SL, Ding R, Levin SR, Desmond JS, Lee J, Aronsky D. Crowding delays treatment and lengthens emergency department length of stay, even among high-acuity patients. *Ann Emerg Med* 2009; 54: 492–503.e4. doi:10.1016/j.annemergmed.2009.03.006
31 Pines JM, Pollack CV, Diercks DB, Chang AM, Shofer FS, Hollander JE. The association between emergency department crowding and adverse cardiovascular outcomes in patients with chest pain. *Acad Emerg Med* 2009; 16: 617–25. doi:10.1111/j.1553-2712.2009.00456.x
32 Pines JM, Localio AR, Hollander JE, Baxt WG, Lee H, Phillips C, Metlay JP. The impact of emergency department crowding measures on time to antibiotics for patients with community-acquired pneumonia. *Ann Emerg Med* 2007; 50: 510–6. doi:10.1016/j.annemergmed.2007.07.021
33 Jo S, Kim YJ, Kim K, Lee JH, Rhee JE, Suh GJ, Jin YH. Emergency department crowding is associated with 28-day mortality in community-acquired pneumonia patients. *J Infect* 2012; 64: 268–75. doi:10.1016/j.jinf.2011.12.007
34 Baker M, Clancy M. Can mortality rates for patients who die within the emergency department, within 30 days of discharge from the emergency department, or within 30 days of admission from the emergency department be easily measured? *Emerg Med J* 2006; 23: 601–3. doi:10.1136/emj.2005.028134