EMA Emergency Medicine Australasia

Emergency Medicine Australasia (2019) **31**, 405–410 doi: 10.1111/1742-6723.13181

ORIGINAL RESEARCH

Aligning ambulance dispatch priority to patient acuity: A methodology

Emily ANDREW,[1,2] Colin JONES,[1] Michael STEPHENSON,[1,2,3] Tony WALKER,[1] Stephen BERNARD,[1,2,4] Peter CAMERON[2,4] and Karen SMITH[1,2,3]

[1]Ambulance Victoria, Melbourne, Victoria, Australia, [2]Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Victoria, Australia, [3]Department of Community Emergency Health and Paramedic Practice, Monash University, Melbourne, Victoria, Australia, and [4]The Alfred Hospital, Melbourne, Victoria, Australia

Abstract

Objective: In Victoria, Australia, Emergency Medical Service (EMS) demand has increased almost 5% per annum over the past 5 years. This may adversely affect response times to time-critical patients. Additionally, >55% of cases have received Code 1 (lights/sirens) responses. Primary telephone triage occurs using the Medical Priority Dispatch System (MPDS); however, MPDS is reported to be highly sensitive, with common over-triage. The present study describes the methodology applied to better align the response allocated to MPDS determinant codes with patient acuity.

Methods: Data between October 2013 and August 2014 were extracted from the Ambulance Victoria data warehouse. The decision to allocate MPDS determinant codes to a lower response priority and/or secondary triage was based on epidemiological profiling and, in some cases, expert panel review.

Results: The review identified 105 MPDS codes receiving a Code 1 response as suitable for a Code 2 (urgent) response, and 221 Code 1 or 2 codes as suitable for secondary triage. Data analysis estimated a reduction in Code 1 responses by 28%, and an increase in the secondary triage caseload by 120%. Modelling also predicted a 2.6 percentage point improvement in the proportion of Code 1 cases attended within 15 min.

Conclusion: Analysis of a large EMS dataset supported changes to the EMS response priority for a number of MPDS determinant codes. Such changes should improve the alignment between EMS response and patient acuity, and improve response times to time-critical patients. Other EMS with electronic data could consider testing this methodology.

Key words: *emergency medical dispatch, emergency medical services, methods, patient acuity, triage.*

Key findings

- Analysis of a large electronic dataset supported changes to EMS response priorities for a number of MPDS determinant codes.
- These changes were anticipated to reduce Code 1 (lights/sirens) responses, and increase secondary triage caseload.
- Such changes should improve the alignment between EMS response and patient acuity, and improve EMS response times to time-critical patients.

Introduction

Internationally, calls to Emergency Medical Services (EMS) have increased in recent years. Possible drivers for this include population ageing and reduced access to primary care services.[1,2] EMS attendance to patients with low-acuity illnesses can utilise finite resources and reduce availability, potentially increasing response times to time-critical patients. Furthermore, low-acuity patients may be better managed by a community resource, rather than being transported to an ED by ambulance.[3]

In order to prioritise emergency medical calls and ensure time-critical patients receive the fastest ambulance response, most EMS use telephone triage tools to allocate a dispatch priority based on structured questioning.[4] A commonly used tool is the Medical Priority Dispatch System (MPDS),[4–7] which allocates calls to one of almost 1000 response determinants. Although MPDS is reportedly sensitive, it has low to moderate specificity.[6,8] Over-triage is therefore a common issue that can lead to high resource utilisation.[4]

As such, new methods of resource allocation have been implemented internationally. For example,

Correspondence: Ms Emily Andrew, Ambulance Victoria, 375 Manningham Road, Doncaster, VIC 3108, Australia. Email: emily.andrew@ambulance.vic.gov.au

Emily Andrew, BSc (Biomedical), MBiostats, Research Governance Manager; Colin Jones, GDipHlthSci (MICA), Operations Manager; Michael Stephenson, BHlthSci, GDipHlthSci (MICA), Executive Director Emergency Operations; Tony Walker, BParaMedStud, GDipEmrgHth, MEd, Chief Executive Officer; Stephen Bernard, MBBS, MD, Medical Director; Peter Cameron, MBBS, MD, Academic Director Emergency and Trauma Centre; Karen Smith, BSc (Hons), PhD, Director Centre for Research and Evaluation.

Accepted 20 August 2018

secondary triage is utilised in Australia, the UK and North America to direct patients to more appropriate health services that can meet their clinical need.[9] Additionally, some EMS in the UK have moved away from MPDS, implementing an integrated triage system that enables more detailed clinical assessment by trained call-takers.[7]

In Victoria, Australia, EMS demand has increased on average almost 5% per annum since 2010/2011. Primary emergency triage is conducted using MPDS, although the level of response assigned to each MPDS determinant code, which may include secondary triage, is determined by the state-wide EMS in a pre-defined matrix. To decrease response times to time-critical patients and better manage low-acuity patients, increased alignment between patient acuity and the allocated EMS response was deemed necessary. In this paper, we describe the methodology used to determine patient acuity within MPDS determinants, propose changes to existing dispatch priorities, and estimate the effect of changes on EMS response times. The study was approved by the Monash University Human Research Ethics Committee.

Methods

Setting

Ambulance Victoria is the state-wide EMS in Victoria, Australia. Victoria covers 227 000 km^2 and has a population of >6 million residents. Advanced life support (ALS) paramedics and intensive care paramedics (ICP) are dispatched to medical emergencies. Basic life support-trained first responders equipped with a defibrillator are also dispatched to suspected cardiac arrest events in select areas.

The initial emergency call is triaged by non-clinical call-takers at the Emergency Services Telecommunications Authority, the state authority responsible for emergency call-taking and dispatching. Call outcomes may include Code 1 (lights and sirens) or Code 2 (urgent) EMS responses, or transfer to the

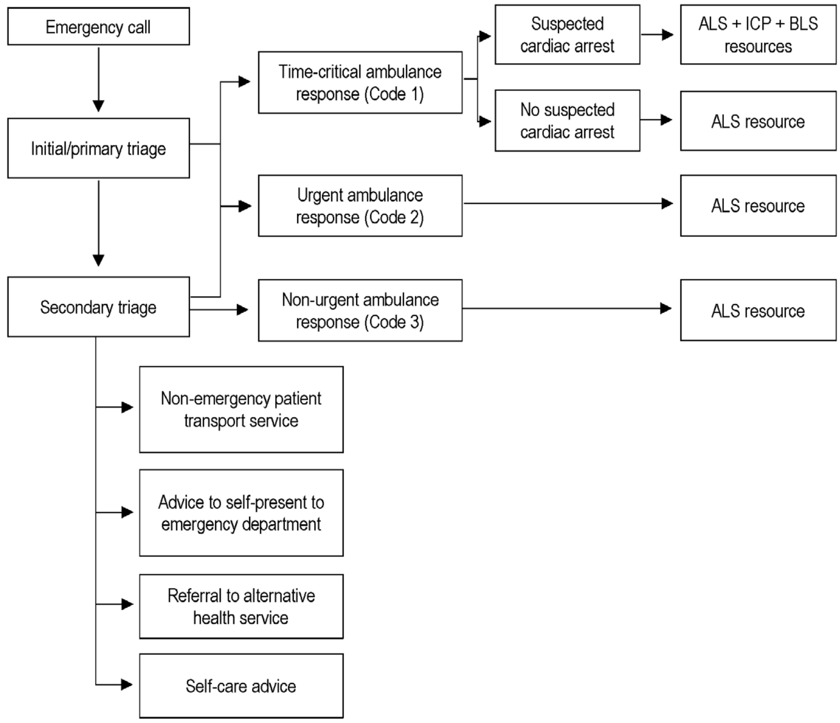

Figure 1. *Call-taking and dispatch procedure after implementation of changes to dispatch priorities.*

Ambulance Victoria Referral Service for secondary triage (Fig. 1). The Referral Service commenced in Melbourne in 2003 and state-wide in 2012, and aims to connect patients with alternative health services aligned to their clinical need.[3] The Care Enhance Call Centre triage software is used by an experienced paramedic or nurse to conduct a thorough telephone assessment. Secondary triage may result in dispatch of an emergency or non-emergency ambulance, referral to alternative services (e.g. home-visiting doctor, nurse), provision of self-care advice, or advice to self-present to an ED (Fig. 1).

Prior to 2016, Ambulance Victoria undertook almost 600 000 emergency road cases annually, with more than 400 000 in Melbourne.[10] An additional 4000 cases were managed through fixed-wing or helicopter resources, and the Referral Service handled approximately 80 000 cases. For road-based emergency cases, more than 55% received a Code 1 response, most involving dual response of both ALS and ICP resources. More than 30% were responded as Code 2, and less than 10% were Code 3 (non-urgent). Overall, less than 10% of all calls were referred to services other than an emergency ambulance.

The Ambulance Victoria response time target requires 85% of Code 1 cases to be attended within 15 min of the emergency call. However, this target had not been met from 2008, with between 73% and 78% of cases receiving a response within 15 min annually since 2010/2011 (median: approximately 11 min). Furthermore, only 50% of Code 1 patients were receiving any medical treatment from paramedics, and approximately 23% were not transported to hospital. Such data suggested many patients may have been clinically appropriate for referral to alternative services.

Data sources

Paramedics in Victoria complete an electronic patient care record at the conclusion of each case. Data from these records are uploaded into a data warehouse.[11] Data for the period 1 October 2013 to 31 August 2014 were extracted for analysis. Counts of out-of-hospital cardiac arrests were also sourced from the Victorian Ambulance Cardiac Arrest Registry[12] for this time period. Computer Aided Dispatch data, including MPDS determinant codes and ambulance response times, were also extracted.

Methodology to improve alignment between dispatch priority and patient acuity

Stage 1: Identifying potential high-acuity patients

Using clinical data, Ambulance Victoria developed a filter to identify potential high-acuity patients (Appendix S1). This filter searches a range of data fields to identify patients at potential risk of deterioration, including: cardiac arrest, acute coronary syndromes, acute pulmonary oedema, airway obstruction, anaphylaxis, major trauma, severe pain, respiratory arrest, stroke, haemorrhage, burns, altered consciousness, unconsciousness, sepsis, abnormal vital signs and treatments indicative of high acuity or transport to hospital with lights and sirens.

Stage 2: Determining eligibility for dispatch code downgrade

The proportion of potential high-acuity patients within each MPDS determinant code was calculated. Determinant codes that were already allocating patients to secondary triage were not examined in this review as they were already subject to regular review. Code 1 determinants containing ≥25% potential high-acuity patients (arbitrarily chosen cut-off) were deemed to contain sufficient high-acuity patients to maintain a Code 1 response. Determinant codes containing <25% high-acuity patients underwent epidemiological/clinical profiling. These profiles covered patient demographics, hospital transport rates, response time performance, ICP-specific management, vital signs on EMS arrival and paramedic assessments.

A random sample of patient care records from determinant codes containing 11–24% high-acuity patients (arbitrarily chosen) were further reviewed by panels of experienced paramedics. In total, more than 9000 patient care records were assessed to determine the likely clinical consequence to patients if their code was allocated to a less time-critical response. Clinical consequences were determined in accordance with the Australian Standard on Risk Management (AS/NZS ISO 31000–2009) using likelihood and consequence matrices. These matrices were used to determine an overall risk rating for each determinant code. Determinant codes with ≤10% potential high-acuity patients were evaluated for suitability of a lower priority response based on epidemiological profiling alone. The epidemiological profile and expert risk assessment (if conducted) of each determinant code were then evaluated by senior clinicians to determine eligibility for a less time-critical response. This process resulted in a number of recommended changes to dispatch priorities.

Stage 3: Reviewing the recommended changes

All recommended changes were assessed by the Ambulance Victoria Medical Advisory Committee. Further review was undertaken by an independent multi-disciplinary panel convened by the Victorian Department of Health and Human Services. These committees endorsed the recommended changes and the methodological approach.

Stage 4: Testing the recommended changes

Determinant codes recommended for downgrade to secondary triage underwent 'mock-triage' testing to ensure that the proportion of cases diverted back to an ambulance response was within expected ranges, and that patients had conditions suitable for referral to the available alternative services. To conduct this testing, a random sample of historical paramedic patient care records within each downgraded determinant code was selected. The clinical information within these records was then used by experienced Referral Service staff to triage the case through the secondary triage software. The referral outcome of each case was recorded.

Stage 5: Modelling the impact of recommended changes

Modelling was undertaken to predict the impact of the changes on response time performance. Retrospective Computer Aided Dispatch data were used to construct a discrete event simulation model using Optima Predict.[13] The model accounted for recommended changes, anticipated changes in 'time to dispatch', mock-triage results, and estimated demand growth. In addition, projected annual caseloads were calculated based on anticipated caseload movements and expected secondary triage outcomes. The average annual growth in demand observed since 2010/2011 (4.9%) was applied to estimate future caseloads.

Stage 6: Staged implementation and safety monitoring

The recommended changes were implemented across three stages, commencing October 2015. The first stage involved downgrade of two determinant codes from 'suspected cardiac arrest' to Code 1 and cancellation of dual-dispatch of ALS and ICPs to Code 1 cases. Stages two and three coincided with increases in Referral Service and non-emergency transport capacity and involved gradual downgrade of recommended determinant codes to Code 2 or secondary triage. Determinant codes recommended for downgrade from Code 1 to secondary triage were first downgraded to Code 2.

Implementation was overseen by a multi-disciplinary steering committee. Stage implementation was subject to 'go'/'no-go' decision points and a comprehensive monitoring process was developed to ensure clinical safety. Clinical review and audit of secondary triage cases was increased.

Results

Potential high-acuity patients

In total, 235 Code 1 MPDS determinant codes contained ≥25%

potential high-acuity patients and were deemed Code 1-suitable. Furthermore, 167 codes had 11–24% potential high-acuity patients and underwent epidemiological profiling and a risk assessment, whereas 233 codes contained ≤10% potential high-acuity patients and underwent epidemiological profiling alone.

Recommended changes

The described methodology recommended the following changes:

- 105 Code 1 codes downgraded to Code 2 (approximately 51 500 cases annually);
- 150 Code 1 codes downgraded to secondary triage (approximately 44 500 cases annually);
- 71 Code 2 codes downgraded to secondary triage (approximately 56 000 cases annually); and
- Dual-dispatch of ICPs and ALS paramedics to most Code 1 cases (excluding suspected cardiac arrests) removed.

Data analysis suggested these changes would reduce Code 1 responses by approximately 28% (96 000 cases annually after accounting for those referred for Code 1 dispatch via secondary triage), and increase secondary triage cases by 120% (>100 000 cases annually).

Additionally, two determinant codes (6D1 and 6E1A) that were being dispatched under the 'suspected cardiac arrest' protocol contained a low rate of cardiac/respiratory arrest (<1%), despite annual caseloads of >1000. These codes were recommended for downgrade from a suspected cardiac arrest response to Code 1, involving the nearest EMS resources, but not first responders.

Testing the recommended changes

Based on the mock-secondary triage, 40% of cases were estimated to be returned to an emergency ambulance dispatch (15% Code 1, 40% Code 2, 45% Code 3), 30% to non-emergency transport, and 30% to an alternative service/self-care advice. This distribution was considered acceptable and was in line with historical Referral Service trends.

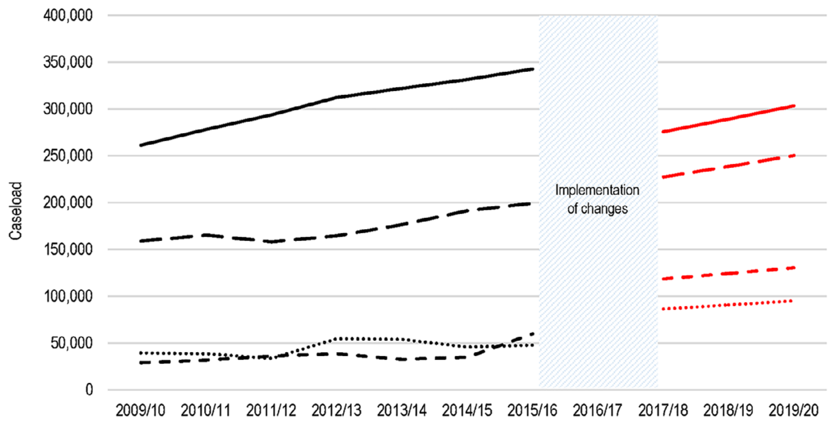

Figure 2. *Annual historical caseloads within response categories and projected caseloads based on recommended dispatch changes. 2009/2010 to 2015/2016 represent true historical caseloads. 2017/2018 to 2019/2020 represent projected caseloads based on dispatch protocol changes. (——), Code 1; (– – –), Code 2; (·········), Code 3; (- - -), non-ambulance dispatch. [Colour figure can be viewed at wileyonlinelibrary.com]*

Impact of recommended changes

Based on full-implementation of the revised dispatch procedures, the changes were modelled to improve the proportion of Code 1 cases attended within 15 min by 2.6 percentage points. Figure 2 shows historical caseloads within each response category, and the projected caseloads after the dispatch changes. After the changes, time-critical responses were estimated to comprise approximately 39% of all ambulance cases, and the proportion of cases managed without an ambulance dispatch was projected to reach 16%.

Discussion

This methodology aimed to increase the proportion of low-acuity EMS patients referred to non-emergency transport or alternative care. The analysis used a large body of clinical data to inform decisions about which MPDS determinant codes could safely be allocated to a more appropriate response. Overall, the recommended changes were estimated to reduce Code 1 responses by 28% and increase referral to secondary triage by 120%. The changes were also modelled to improve response times to time-critical patients.

Other EMS internationally have also reported increasing demand and challenges providing a fast response to critically ill patients.[14,15] In 2015, the Welsh Ambulance Service Trust, which also uses MPDS, implemented a revised dispatch model that placed an increased focus on the caller's clinical condition. Recognising that cardiac arrest is the most dependent clinical condition on a fast EMS response,[16,17] the Welsh model aimed to prioritise patients with suspected cardiac arrest. Concurrently, it allowed additional time for clinical questioning of other callers to facilitate an appropriate outcome.[14] An evaluation reported improvements in response time to life-threatening cases, and utilisation of fewer resources per case.

Similarly, an ambulance response programme aimed at reducing operational inefficiencies and improving patient care was trialled by a number of EMS in England.[15] That programme also aimed to quickly identify cardiac arrest while allowing time for additional questioning of other cases. Although the programme did not increase the proportion of calls managed through provision of telephone advice, an evaluation reported improvements in resource utilisation, and no adverse impacts on patient safety.[15]

Patient safety is the most important consideration in revising dispatch procedures. Our revised model aimed to shorten response times to time-critical patients, in turn positively influencing patient outcomes. Although other ambulance services have focussed on improving response times to cardiac arrest, a growing body of evidence suggests that a focused prehospital response and timely definitive care may also improve outcomes for patients with acute myocardial infarction,[18] stroke,[19] trauma[20] and severe sepsis.[21] Accurate identification of these conditions during the initial emergency call is therefore crucial.

It follows that allocating MPDS determinant codes to lower response priorities carries a small risk as the EMS response to those patients, if required, may be delayed. The specificity of MPDS may prevent some high-acuity patients from being identified and patients may receive a protracted response time. On the other hand, secondary triage can provide a safety net, with experienced clinicians able to identify patients in need of a Code 1 response when this was not initially allocated.

Importantly, the increase in patients referred to alternative health services is likely to positively impact the wider health system. ED overcrowding is an international issue, in part related to increasing demand.[22] It has been associated with adverse events, such as treatment delays and increased mortality.[23] With the increase in secondary triage in our system, it is anticipated EMS transports to EDs will decrease.

Limitations

Hospital outcome data was not obtained for analysis. Follow-up analyses of the revised dispatch protocols are required to assess the effectiveness of this methodology. Future analyses should also follow-up patients referred to alternative care to validate the safety of this methodology. However, previous work from our setting suggested that secondary triage appropriately identifies ED-suitable cases, and that most cases referred to alternative services do not subsequently present to the ED.[24] Finally, this methodology does not overcome non-modifiable factors that challenge the provision of a timely EMS response, such as increasing traffic congestion.

Conclusion

This methodology highlights the importance of collecting EMS data electronically to drive reform. Such changes should improve the alignment between EMS response and patient acuity and improve response times to time-critical patients. Although a post-implementation study is required to review observed *versus* predicted outcomes, this methodology could be tested by other EMS agencies that use MPDS.

Author contributions

KS, EA, CJ, MS, TW and SB contributed to development of the described methodology. EA drafted the manuscript and collected the presented data. All authors reviewed the manuscript and made critical revisions for intellectual property.

Competing interests

PC is a section editor for *Emergency Medicine Australasia*.

References

1. Lowthian JA, Cameron PA, Stoelwinder JU *et al*. Increasing utilisation of emergency ambulances. *Aust. Health Rev*. 2011; **35**: 63–9.
2. Pittet V, Burnand B, Yersin B, Carron P-N. Trends of pre-hospital emergency medical services activity over 10 years: a population-based registry analysis. *BMC Health Serv. Res*. 2014; **14**: 380.
3. Eastwood K, Morgans A, Smith K, Hodgkinson A, Becker G, Stoelwinder J. A novel approach for managing the growing demand for ambulance services by low-acuity patients. *Aust. Health Rev*. 2016; **40**: 378–84.
4. Ball SJ, Williams TA, Smith K *et al*. Association between ambulance dispatch priority and patient condition. *Emerg. Med. Australas*. 2016; **28**: 716–24.
5. Hodell EM, Sporer KA, Brown JF. Which emergency medical dispatch codes predict high prehospital nontransport rates in an urban community? *Prehosp. Emerg. Care* 2014; **18**: 28–34.
6. Feldman MJ, Verbeek PR, Lyons DG, Chad SJ, Craig AM, Schwartz B. Comparison of the medical priority dispatch system to an out-of-hospital patient acuity score. *Acad. Emerg. Med*. 2006; **13**: 954–60.
7. Deakin CD, England S, Diffey D. Ambulance telephone triage using 'NHS pathways' to identify adult cardiac arrest. *Heart* 2017; **103**: 738–44.
8. Sporer KA, Youngblood GM, Rodriguez RM. The ability of emergency medical dispatch codes of medical complaints to predict ALS prehospital interventions. *Prehosp. Emerg. Care* 2007; **11**: 192–8.
9. Eastwood K, Morgans A, Smith K, Stoelwinder J. Secondary triage in prehospital emergency ambulance services: a systematic review. *Emerg. Med. J*. 2015; **32**: 486–92.
10. Ambulance Victoria. 2015–16 Annual Report. 2016.
11. Cox S, Martin R, Somaia P, Smith K. The development of a data-matching algorithm to define the 'case patient'. *Aust. Health Rev*. 2013; **37**: 54–9.
12. Nehme Z, Bernard S, Cameron P *et al*. Using a cardiac arrest registry to measure the quality of emergency medical service care: decade of findings from the Victorian ambulance cardiac arrest registry. *Circ. Cardiovasc. Qual. Outcomes* 2015; **8**: 56–66.
13. Karnon J, Stahl J, Brennan A, Caro JJ, Mar J, Möller J. Modeling using discrete event simulation. *Med. Decis. Making* 2012; **32**: 701–11.
14. Public and Corporate Economic Consultants. NHS Wales Ambulance Service Emergency Ambulance Services Committee: Clinical Model Pilot Evaluation Final Report. 2017. [Cited 10 Sep 2018.] Available from URL: http://www.wales.nhs.uk/sitesplus/documents/1134/Final%20evaluation%20report.pdf
15. Turner J, Jacques R, Crum A, Coster J, Stone T, Nicholl J. *Ambulance response programme – Evaluation of Phase 1 and 2 Final report*. Sheffield: The University of Sheffield, 2017.

16. De Maio VJ, Stiell IG, Wells GA, Spaite DW. Optimal defibrillation response intervals for maximum out-of-hospital cardiac arrest survival rates. *Ann. Emerg. Med.* 2003; **42**: 242–50.
17. Pell JP, Sirel JM, Marsden AK, Ford I, Cobbe SM. Effect of reducing ambulance response times on deaths from out of hospital cardiac arrest: cohort study. *BMJ* 2001; **322**: 1385–8.
18. Chew DP, Scott IA, Cullen L *et al.* National Heart Foundation of Australia & Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Management of Acute Coronary Syndromes 2016. *Heart Lung Circ.* 2016; **25**: 895–951.
19. National Stroke Foundation. *Clinical Guidelines for Stroke Management*. Melbourne: National Stroke Foundation, 2010.
20. Cameron PA, Gabbe BJ, Smith K, Mitra B. Triaging the right patient to the right place in the shortest time. *Br. J. Anaesth.* 2014; **113**: 226–33.
21. Dellinger PR, Levy M, Rhodes A *et al.* Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. *Crit. Care Med.* 2013; **41**: 580–637.
22. Di Somma S, Paladino L, Vaughan L, Lalle I, Magrini L, Magnanti M. Overcrowding in emergency department: an international issue. *Intern. Emerg. Med.* 2015; **10**: 171–5.
23. Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects, and solutions. *Ann. Emerg. Med.* 2008; **52**: 126–36.
24. Eastwood K, Smith K, Morgans A, Stoelwinder J. Appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: a retrospective cohort study. *BMJ Open* 2017; **7**: e016845.

Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Appendix S1. Potential high-acuity patient identification data filter.