Singapore Med J 2013; 54(11): 634-638
doi:10.11622/smedj.2013224

Can the characteristics of emergency department attendances predict poor hospital outcomes in patients with sepsis?

Irwani Ibrahim[1], MBBS, MPH, *Ian G Jacobs*[2], PhD, FERC

INTRODUCTION The emergency department (ED) is often the initial site of identification of patients with sepsis. We aimed to determine the characteristics of ED attendances that predict poor hospital outcomes.

METHODS We conducted a retrospective cohort study of adult patients in eight metropolitan EDs in Perth, Western Australia, from 2001 to 2006. Patients diagnosed with sepsis in the ED were identified using the International Classification of Diseases, 10th Revision-Australian Modification code in the Emergency Department Information System (EDIS) database. The EDIS database was subsequently linked to mortality and hospital morbidity records. The following characteristics were examined: triage category, mode of arrival, source of referral and hospital of presentation. Multivariate logistic regression was performed to identify predictors of hospital mortality, prolonged length of stay, and admission to the intensive care unit (ICU).

RESULTS In the 1,311 patients diagnosed with sepsis in the ED, the hospital mortality and ICU admission rates were 19.5% and 18.5%, respectively. The mean hospital length of stay was 12 ± 15 days. Acute triage categories predicted both hospital mortality and ICU admissions, while mode of arrival by ambulance was a predictor of all poor hospital outcomes ($p < 0.001$). Patients who presented to non-teaching hospitals had similar hospital outcomes as patients who presented to teaching hospitals. The source of referrals was not a predictor of poor hospital outcomes ($p > 0.05$).

CONCLUSION Mode of arrival and triage score, which are characteristics unique to the ED, may predict poor hospital outcomes in patients with sepsis.

Keywords: emergency medicine, medical record linkage, mortality, sepsis, triage

INTRODUCTION

Sepsis is a serious, systemic disease that occurs as a response to infection. Hospital mortality of severe sepsis is about 30% to 50%,[1,2] and up to 30% of admissions to the intensive care unit (ICU) involve patients with sepsis.[2-4] Sepsis was initially identified in the Emergency Department (ED) in a considerable proportion of patients (ranging from 12% to 70.8%).[3,5-7] The important role that the ED plays in optimising care for these patients is attributed to the development of sepsis guidelines,[8] which aim to achieve the goal of resuscitation quickly (i.e. within six hours of diagnosis).

Imperative in our understanding of a disease is the course of the disease in the acute period prior to the patient's admission to either a ward or ICU. Population-based, ED-focused studies[9,10] have explored patient characteristics that are unique to the ED setting. Among these characteristics, ambulances were observed to be a highly utilised mode of arrival, and hospitals not affiliated to medical schools were known to treat 46% of sepsis patients. However, these studies[9,10] were cross-sectional in design and therefore did not explore the influence of these characteristics on outcomes. Unlike inherent patient characteristics such as age and comorbidities, which are less amenable to modifications, characteristics unique to patients attending the ED may be modified through changes in the health system. For instance, if sepsis is shown to influence outcomes, patients with sepsis who arrive by ambulance could be conveyed to hospitals equipped with ICU facilities. Thus, we aimed to determine the characteristics of ED attendances that predict poor hospital outcomes in a population-based study.

METHODS

This retrospective cohort study involved eight metropolitan EDs in Perth, Western Australia, four of which were non-teaching hospitals. The period of study was between 1 January 2001 and 31 December 2006. Approvals for the study were obtained from the University of Western Australia Human Research Ethics Committee.

We utilised the Emergency Care, Hospitalisation and Outcome (ECHO) linked-data project, which linked all of Perth's metropolitan emergency care records to hospitalisation and mortality records for the state of Western Australia.[11] The primary data source was the Emergency Department Information System (EDIS), which was employed by all public metropolitan EDs in Perth for the purpose of collecting data on ED activity and patient acuity. It is a real-time patient

[1]Emergency Medicine Department and Department of Surgery, National University Health System, Singapore, [2]Prehospital Resuscitation and Emergency Care Research, Curtin University, Western Australia, Australia

Correspondence: Dr Irwani Ibrahim, Consultant, Emergency Department, National University Health System, 5 Lower Kent Ridge Road, Singapore 119074, Singapore
irwani_ibrahim@nuhs.edu.sg

Table I. Characteristics of emergency department attendances and hospital outcomes.

Characteristic	Hospital outcome (%)					
	Mortality	p-value	ICU admissions	p-value	Hospital LOS > 7 days	p-value
Australian Triage Scale category (%)		< 0.001		< 0.001		0.295
1-Resuscitation (8.7)	52.6		55.3		46.5	
2-Emergency (29.0)	27.9		28.7		55.3	
3-Urgent (47.8)	10.7		9.3		52.0	
4-Semi-urgent (14.1)	11.9		5.9		49.7	
5-Nonurgent* (0.4)	0.0		20.0		80.0	
Mode of arrival (%)		< 0.001		< 0.001		< 0.001
Ambulance (65.8)	25.1		21.1		53.9	
Royal Flying Doctors Service (5.3)	20.0		44.3		78.6	
Private transport (27.0)	6.2		7.6		42.4	
Source of referral (%)		0.008		< 0.001		< 0.001
Self-/relative-referred (49.6)	19.5		12.9		48.3	
GP/specialist clinics (13.6)	11.2		11.2		52.3	
Other hospital (24.3)	22.6		35.0		63.6	
Hospital of presentation (%)		0.138		0.004		0.019
Teaching hospital (80.6)	20.3		20.0		53.8	
Non-teaching hospital (19.4)	16.4		12.2		45.7	
Admitted to non-teaching hospitals (54.7)	16.5		7.2		42.4	
Transferred to teaching hospitals (41.7)	17.0		17.9		50.9	

*There were only five patients in this category. Excluding this category, the difference in the proportion of ICU admissions in the remaining groups remained significant. Similarly, the difference in the proportion of patients with LOS > 7 days remained nonsignificant when this group was excluded.
GP: general practitioner; ICU: intensive care unit; LOS: length of stay

tracking tool that allows ED staff to electronically record a patient's demographic, triage and clinical details as the patient moves through the ED. The EDIS dataset was linked to the mortality and hospital morbidity datasets using a probabilistic matching process conducted by the Data Linkage Unit in the Western Australia Health Department.[12] In short, probabilistic matching linked entries in the different datasets (i.e. EDIS, mortality and hospital morbidity datasets) used common pieces of information to bring together all records belonging to the same individual. Multiple records for an individual are subsequently assigned a unique personal identification number (client-identifier). Previous studies using data linkage have demonstrated only 1%–3% errors.[13,14]

We selected the study cohort using the International Classification of Disease, 10th Revision-Australian Modification (ICD-10-AM) code A41.9 in the discharge diagnosis of the ED. Code A41.9 described 'unspecified sepsis'. We included only the individual patient's first ED attendance for sepsis that resulted in admission to the hospital. The cohort was restricted to adult patients, defined as patients above 15 years of age.

We selected patients' characteristics based on ED attendance *a priori*. It included the Australian Triage Scale (ATS) category on arrival, mode of arrival, source of referral and hospital of presentation. The graded ATS categories (Categories 1 to 5) reflect the urgency of the illness in the ED, with the most acute given the lowest category of 1.[15]

Hospital mortality was defined as death from all causes occurring between the date of arrival and date of hospital discharge. All cases of mortalities in the ED were assumed to have received maximum treatment, including ventilatory support. Hospital length of stay (LOS) was defined as the time between the date of arrival and the date of hospital discharge. ICU admission was defined as the need for ICU care at any point during hospitalisation.

Statistical analysis was performed using the Statistical Package for the Social Sciences version 15.0 (SPSS Inc, Chicago, IL, USA). Categorical variables were expressed as proportions and chi-square test was used for comparison of groups. For continuous variables, we presented parametric data as mean ± standard deviation and nonparametric data as median (interquartile [IQR] range). To identify factors predictive of poor hospital outcomes, we performed multivariate logistic regression analysis. Clinically important variables (e.g. age and gender) and variables with $p < 0.05$ on univariate analysis were entered into the model using the 'enter' method. We calculated the adjusted odds ratio (OR) with 95% confidence interval for independent predictors of poor hospital outcomes. A p-value of < 0.05 was considered statistically significant. All tests were two-tailed.

RESULTS

There was a total of 1,505,318 ED attendances of patients aged above 15 years during the study period. Of these ED attendances, 17.1% had missing ED discharge ICD 10-AM codes. ICD-10-AM code A41.9 was assigned to 1,424 ED attendances. Of these 1,424 ED attendances, 24 records had failure of linkage. The remaining 1,400 ED attendances equated to 1,333 individuals, of which 1,311 were hospitalised.

The hospital mortality rate was 19.5% (255/1,311). Of these, 11.4% (29/255) died in the ED. The proportion of patients admitted to the ICU at any point during the hospitalisation was 18.5% (242/1,311). The mean LOS was 12 ± 15 days with a median of 7 (IQR 3–14) days.

Table II. Predictors of hospital outcomes.

Characteristic	Hospital outcome [adjusted OR (95% CI)]		
	Mortality	ICU admissions	Hospital LOS > 7 days
Australian Triage Scale category (%)			
1-Resuscitation	8.48 (4.34, 16.54)	12.77 (6.10, 6.71)	0.64 (0.377, 1.07)
2-Emergency	3.05 (1.71, 5.45)	3.54 (1.84, 6.83)	0.98 (0.66, 1.45)
3-Urgent	1.14 (0.64, 2.05)	1.07 (0.54, 2.09)	1.05 (0.73, 1.52)
4/5-Semi-urgent, nonurgent	Reference	Reference	Reference
Mode of arrival			
Ambulance	2.55 (1.45, 4.50)	2.36 (1.34, 4.15)	1.50 (1.09, 2.05)
Royal Flying Doctors Service	2.31 (0.96, 5.56)	2.80 (1.26, 6.22)	3.99 (2.01, 7.91)
Private transport	Reference	Reference	Reference
Source of referral			
Other hospital	1.13 (0.65, 1.96)	0.65 (0.36, 1.16)	0.82 (0.58, 1.16)
Self-/relative-referred	1.28 (0.69, 2.36)	1.77 (0.96, 3.25)	1.17 (0.76, 1.79)
GP/specialist clinics	Reference	Reference	Reference
Hospital of presentation			
Teaching hospital	1.05 (0.63, 1.75)	*Not included	1.19 (0.84, 1.69)
Non-teaching hospital	Reference		Reference

*All four teaching hospitals have ICU facilities, while only one non-teaching hospital has ICU facilities; hence the data was not included in the analysis.
GP: general practitioner; ICU: intensive care unit; LOS: length of stay; OR: odds ratio; CI: confidence interval

The mean age of the study cohort was 62.6 ± 19.4 years, and 53.6% was male. The ATS categories reflected the urgency of illness in the ED (Table I). The two lowest triage categories (Resuscitation and Emergency) were assigned to 37.7% of the patients. The patients under these two categories had rates of hospital mortality and ICU admission that were higher than those under other categories. However, the ATS categories did not affect hospital LOS. There were five patients in the least urgent ATS category (i.e. Nonurgent), which accounted for the noticeable differences in outcomes. The exclusion of these patients in the analyses did not alter the p-values.

The most common mode of arrival was via ambulance and the patients in this group had the largest proportion of hospital mortality. In contrast, the highest proportion of patients admitted to the ICU and had a hospital LOS of > 7 days were those who came via the least common mode of arrival, the Royal Flying Doctors Service (RFDS). The RFDS provides emergency air transport services, which include both primary response and inter-hospital transfers. The latter accounted for 94.2% of the patients conveyed by RFDS in this study.

As for the source of referrals, the majority of patients were self- or relative-referred, while referrals made by general practitioners or specialist clinics formed the lowest proportion. Patients who were referred from other hospitals formed the highest proportion of all poor hospital outcomes compared to other sources of referrals.

The hospitals of presentation were divided into teaching and non-teaching hospitals. The proportion of patients with sepsis who had presented to the non-teaching hospitals was 19.4%. In the non-teaching hospitals, 54.7% (139/254) were admitted to the hospital of presentation, while the rest were transferred to teaching hospitals. All the teaching hospitals and one of the non-teaching hospitals have ICU facilities. There was no significant difference in the proportion of hospital mortality between the hospitals of presentation. ICU admissions were required for 12.2% of the patients who presented to the ED of non-teaching hospitals. Only ten patients received ICU care in the non-teaching hospital itself, while the majority received ICU care after being transferred to teaching hospitals. The proportion of patients who had presented to non-teaching hospitals and stayed seven days or more was lower than the patients who had presented to the teaching hospitals.

On multivariate logistic regression analysis (Table II), patients assigned to ATS Categories 1 and 2 on arrival were more likely to experience hospital mortality and be admitted to the ICU. Patients who arrived by ambulance were more likely to have unfavourable hospital outcomes in all categories in our study. Patients who arrived by RFDS were more likely to be admitted to the ICU and to have LOS above seven days, although the mortality rate in this group was lower than that in patients who arrived by private transport. The sources of referral and hospital of presentation were not predictors of poor hospital outcomes.

DISCUSSION

This study provides relevant information regarding the hospital outcomes of patients diagnosed with sepsis in the ED. While the literature consistently reports hospital mortality and the need for ICU care as outcomes, we included hospital LOS in our study. Hospital LOS is a particularly significant outcome for patients with sepsis originating from the ED because not all of these patients were admitted to the ICU. Also, the course of illness in the hospital after leaving the ICU contributes to the calculation of the total cost of treating these patients. In our study, the hospital mortality and ICU admission rates were approximately 20%. The hospital mortality was lower than that observed in studies of patients in the ICU (up to 50%),[2,4,5] yet similar to previous studies that had included the entire spectrum of patients with sepsis.[1,6,16] In contrast, the ICU admission rate in our study was comparable to that of another state in Australia (23.8%),[6] but much lower than that found in a study with similar

methodology conducted in the United States (51%).[1] The variation in ICU admissions may be explained by the difference in criteria for ICU admissions, hospital discharge and follow-up care in the different healthcare settings. As for hospital LOS, we found that our study's finding (mean of 12 days and median of 7 days) is consistent with previous studies conducted in Australia and South America.[6,17,18] It was, however, much shorter than those reported in China (median 22 days)[19] and Europe (median 18–25 days).[2,5]

In this study, we identified a number of characteristics unique to the ED that could predict poor hospital outcomes. These characteristics help us to understand the course of disease prior to admission to the hospital. The two most urgent triage categories on arrival (i.e. Resuscitation and Emergency) strongly predicted hospital mortality and admissions to the ICU. The primary utility of triage categories on arrival is to ensure that patients are attended to within an appropriate time frame, commensurate with the urgency of their presenting condition.[15] Assessment into triage categories are conducted in a brief manner upon the patient's arrival in the ED. It includes the assessment of presenting complaints, physical appearance and vital parameters. In contrast to other scoring systems for assessing the severity of illness, such as APACHE[20] and MEDS score,[21] assessment into triage categories is quick and can be performed earlier by a nurse. Formal systems that score the severity of illnesses usually require a longer assessment by a doctor and the results of laboratory investigations. However, it is noteworthy to mention that patients may be re-triaged to a higher or lower category during the course of stay in the ED. While the majority of patients who have been triaged into the Resuscitation or Emergency categories on arrival usually remain ill, other patients may be re-triaged to a higher category during the time spent in the ED if subsequent evaluation indicates a less serious disease. In such circumstances, the triage category on arrival should be taken into account when assessing the possible risk of adverse hospital outcomes in the latter group of patients.

Similar to a previous study,[10] transport via ambulance was the most common mode of arrival of patients diagnosed with sepsis in the ED. Ambulance services in Western Australia are provided by St John Ambulance Western Australia (SJA-WA), the sole source of pre-hospital emergency care in Perth. The service is available to members of the public who are seriously ill, as well as patients who need noncritical, nonurgent medical, surgical or convalescent stretcher transport. The hub of SJA-WA communications, the Ambulance Operations Centre, receives and screens all emergency calls before dispatching ambulances to various locations based on the urgency of the medical condition. In our study, arrival by ambulance positively predicted both hospital mortality and admission to ICU. This finding suggests that it may be beneficial for efforts to be directed to pre-hospital recognition of sepsis, and perhaps, for extended efforts be given to commencement of therapy, particularly if ambulance transportation time is long. In addition, policies and workflows can be set up for ambulances to convey these patients to hospitals with essential expertise.

Patients who arrived by the RFDS had a higher likelihood of ICU admissions and longer hospital stay, but not higher mortality. The RFDS is a community-based not-for-profit organisation that provides 24-hour emergency transport services to remote and rural areas in Australia, covering 80% of the continent. Apart from aeromedical evacuations, the RFDS also runs primary care clinics and conducts remote telephone consultations. In many rural and very remote areas of Western Australia, the RFDS is the sole healthcare provider. Frequent users of the RFDS are usually patients with multiple comorbidities requiring multidisciplinary and specialist care.[22] 94.2% of patients conveyed by the RFDS were inter-hospital transfers. Usually, these patients were admitted for various reasons to a primary hospital and stabilised for a period of time before being transferred to metropolitan hospitals. Hence, this group of patients could exhibit other specific characteristics that might explain the hospital outcomes we have observed, such as different site of infection, postoperative status and nosocomial nature of the infection. Interestingly, although usage of the RFDS was mostly to transport patients who were transferred from one hospital to another, the source of referral was not a predictor of poor hospital outcomes.

About 20% of patients with sepsis presented at non-teaching hospitals. At the time of writing, non-teaching hospitals in Western Australia did not have mandatory facilities for admissions or training of medical students. In contrast, teaching hospitals regulate the admissions, duties and discipline of medical students. Furthermore, these hospitals provide the teaching of medicine and facilities for research.[23] In Western Australia, teaching hospitals may be public or private, but tertiary and quaternary facilities are usually public, with both established under the legislation of the Western Australian government. Approximately half of the patients with sepsis who presented to the ED of non-teaching hospitals in our study were transferred to teaching hospitals, presumably due to the severity of their disease, as reflected by the high proportion of ICU care needed. Yet, those patients who remained in non-teaching hospitals for treatment did not have hospital mortality rates and LOS that differed from patients in teaching hospitals. We would expect patients who remained in non-teaching hospitals to have less severe illnesses and hence better hospital outcomes. These findings highlight the importance of implementing policies that are in line with current evidence-based practice across all types of hospitals, including non-teaching hospitals.

The main limitation of our study was the use of administrative datasets. This meant that our analysis was limited by the quantity and quality of the data. We did not have data on comorbidities and severity of illness. These variables have been shown to affect outcomes and would have been useful

as a comparison with the performance of the ATS. For cases that were inter-hospital transfers conveyed by RFDS, the period of hospitalisation and intervention prior to transfer would also be potential confounders. Another limitation was the assumption that ED physicians were consistent in the use of the criteria when assigning diagnoses at the ED. Although we did not examine concordance, this is a reasonable assumption due to the standard training and examination that practising ED physicians are subject to by the local medical council.

In patients diagnosed with sepsis in the ED, characteristics unique to ED attendance can predict poor hospital outcomes and are potentially modifiable to improve outcomes in patients with sepsis.

ACKNOWLEDGEMENTS

We thank Professor Judith Finn from the School of Population Health, University of Western Australia, as well as Dr Sharyn Ingarfield and Dr Nick Gibson, both from the School of Primary, Aboriginal and Rural Health Care (SPARHC), University of Western Australia, for the help rendered in this study.

REFERENCES

1. Angus DDC, Linde-Zwirble WWT, Lidicker JJ, et al. Epidemiology of severe sepsis in the United States: analysis of incidence, outcome, and associated costs of care. Crit Care Med 2001; 29:1303-10.
2. Padkin A, Goldfrad C, Brady AR, et al. Epidemiology of severe sepsis occurring in the first 24 hrs in intensive care units in England, Wales, and Northern Ireland. Crit Care Med 2003; 31:2332-8.
3. Vincent JL, Sakr Y, Sprung CL, et al. Sepsis in European intensive care units: results of the SOAP study. Crit Care Med 2006; 34:344-53.
4. Harrison DA, Welch CA, Eddleston JM. The epidemiology of severe sepsis in England, Wales and Northern Ireland, 1996 to 2004: secondary analysis of a high quality clinical database, the ICNARC Case Mix Programme Database. Crit Care 2006; 10:R42.
5. Brun-Buisson C, Meshaka P, Pinton P, Vallet B. EPISEPSIS: a reappraisal of the epidemiology and outcome of severe sepsis in French intensive care units. Intensive Care Med 2004; 30:580-8.
6. Sundararajan V, Macisaac CM, Presneill JJ, Cade JF, Visvanathan K. Epidemiology of sepsis in Victoria, Australia. Crit Care Med 2005; 33:71-80.
7. Sands KE, Bates DW, Lanken PN, et al. Epidemiology of sepsis syndrome in 8 academic medical centers. JAMA 1997; 278:234-40.
8. Rivers E, Nguyen B, Havstad S, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med 2001; 345:1368-77.
9. Strehlow MC, Emond SD, Shapiro NI, Pelletier AJ, Camargo CA Jr. National study of emergency department visits for sepsis, 1992 to 2001. Ann Emerg Med 2006; 48:326-31.
10. Wang HE, Shapiro NI, Angus DC, Yealy DM. National estimates of severe sepsis in United States emergency departments. Crit Care Med 2007; 35:1928-36.
11. Sprivulis P, Da Silva JA, Jacobs I, Jelinek G, Swift R. ECHO: the Western Australian Emergency Care Hospitalisation and Outcome linked data project. Aust N Z J Public Health 2006; 30:123-7.
12. Holman CD, Bass AJ, Rouse IL, Hobbs MS. Population-based linkage of health records in Western Australia: development of a health services research linked database. Aust N Z J Public Health 1999; 23:453-9.
13. Ingarfield SL. The epidemiology of respiratory infections diagnosed in Western Australian hospital emergency departments 2000 to 2003 (thesis). Western Australia: University of Western Australia, 2007.
14. Gibson NP. The epidemiology of acute asthma managed by ambulance paramedics in the pre-hospital setting in Western Australia (thesis). Western Australia: University of Western Australia, 2006.
15. The Australasian College for Emergency Medicine. Guidelines for implementation of the Australian Triage Scale in Emergency Departments. Canberra: Australian Govertment, 2007.
16. Martin GS, Mannino DM, Eaton S, Moss M. The epidemiology of sepsis in the United States from 1979 through 2000. N Engl J Med 2003; 348:1546-54.
17. ARISE; ANZICS APD Management Committee. The outcome of patients with sepsis and septic shock presenting to emergency departments in Australia and New Zealand. Crit Care Resusc 2007; 9:8-18.
18. Jaimes F, Garcés J, Cuervo J, et al. The systemic inflammatory response syndrome (SIRS) to identify infected patients in the emergency room. Intensive Care Med 2003; 29:1368-71.
19. Cheng B, Xie G, Yao S, et al. Epidemiology of severe sepsis in critically ill surgical patients in ten university hospitals in China. Crit Care Med 2007; 35:2538-46.
20. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med 1985; 13:818-29.
21. Shapiro NI, Wolfe RE, Moore RB, et al. Mortality in Emergency Department Sepsis (MEDS) score: a prospectively derived and validated clinical prediction rule. Crit Care Med 2003; 31:670-5.
22. Garne DL, Perkins DA, Boreland FT, Lyle DM. Frequent users of the Royal Flying Doctor Service primary clinic and aeromedical services in remote New South Wales: a quality study. Med J Aust 2009; 191:602-4.
23. State of Western Australia. University Medical School, teaching hospitals Act 1955 -Sect 4. Western Australia: State Law Publisher.