

Towards 'Sepsis with Optimal Treatment': Evaluating the sepsis care pathway in Acute Medicine and identifying scope for systems improvement

J Meyer, Z Fritz, H Burton, C Ward, A Simpson & V Ahmed

Abstract

Sepsis commonly presents to the acute medicine unit (AMU). Timely recognition and treatment can reduce the significant associated mortality, but United Kingdom AMUs and emergency departments are often inadequately equipped to manage sepsis with early-goal directed therapy.

We conducted an observational study of 50 consecutive patients admitted with severe sepsis. Demographic, physiological and microbiological data, and information about the provision and timing of care were collected in real time.

Treatment fell below "surviving sepsis" targets with only 28% of patients receiving sufficient fluid, and 64% receiving antibiotics within 3 hours, associated with delays in seeing physicians; however despite this mortality was lower than the nationally quoted average (14% at 90 days).

Keywords

Acute Medicine Units; Sepsis; Goal Directed Therapy; Quality of Care; Patient Safety Initiative

Key Points

1. Sepsis is a common cause for emergency medical admission: at least 1 patient was treated for severe sepsis per 24 hours during our study period
2. Delays in the recognition and management of sepsis can have serious implications for patient outcomes
3. Acute Medical Units must be adequately staffed and resourced to enable appropriate management to be initiated for patients with severe sepsis and septic shock.

Introduction

Severe sepsis accounts for around 37,000 deaths each year in the UK.¹ This figure approaches those for all cancer (160,000 per year), coronary heart disease (88,000 per year) and stroke (43,000 per year).² Timely recognition of patients with sepsis, and rapid treatment according to international guidelines, has been shown to improve survival.³ However the standards of immediate care including fluid and antibiotic administration are variable and often inadequate.⁴

Acute physicians and nurses play a pivotal role in the identification and provision of care of septic patients.⁵ Approximately half of cases arise from the community and medicine is the most frequent admitting specialty.⁶⁻⁹ Yet concern has been raised about the ease of implementing and maintaining evidence-based change and coordinating intensive therapeutic interventions which span the emergency, intensive care and medical departments.¹⁰⁻¹² Rivers' 'Early Goal Directed Therapy' for sepsis has previously been considered to be the 'Gold Standard'; international studies are underway to determine which aspects of this approach are effective.¹³⁻¹⁶ UK acute medicine and emergency departments may

be inadequately equipped to manage sepsis with early-goal directed therapy,^{17,18} and may need further support to implement the simple measures of early fluids and antibiotics. Previous studies have revealed that staff knowledge and education surrounding sepsis is inconsistent.^{19,20} The acute medicine services should be a major focus our efforts to optimise care and improve outcomes.

Addenbrooke's Hospital is an 1100-bedded teaching hospital in Cambridge, UK. Adult patients potentially requiring admission are assessed in the integrated Emergency Assessment Unit (EAU). In contrast to the typical configuration of the acute medical unit alongside the emergency department as set out in the Report of the Acute Medicine Task Force,²¹ all EAU patients fall under the four-hour standard and are initially seen by a combination of medical and emergency department doctors. Acute medical patients are subsequently transferred to the medical short-stay unit. A study published in 2008 demonstrated that, in addition to improving efficiency, patient mortality is lower since the introduction of the EAU²² and this significant mortality benefit has been sustained over time.²³

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This model of acute care presents a valuable opportunity to study sepsis management at the "front door". However no studies have been performed at our institution to estimate the extent of the problem posed by sepsis. We therefore designed an observational research study to a) characterize the extent and features of severe sepsis and septic shock presenting to the EAU; b) evaluate the quality of care provided to those patients, and; c) identify deficiencies in the system which could be targeted in patients' interests.

Methods

We conducted a single-centre prospective observational study of 50 consecutive adult patients admitted with severe sepsis or septic shock via the EAU between June and August 2008. The study protocol was reviewed by the Trust Audit Committee and deemed not to require submission to the research ethics committee. Potential severely septic patients for enrolment were identified in near real-time by members of the 'Sepsis with Optimal Treatment' study team.

Exclusion criteria were as follows:

- age less than 16 years
- patients transferred from another hospital
- patients not for full and active treatment
- patients not satisfying international consensus criteria for severe sepsis or septic shock.^{24, 25}

Demographic, physiological, and microbiological data, as well as information about the provision and timing of inpatient care, were collected from each patient's notes, charts, and laboratory results using a proforma adapted from the Surviving Sepsis Individual Chart Measurement Tool from the Institute for Healthcare Improvement (which has been previously validated in a UK teaching hospital).²⁶ All intervention timings were measured from "time zero" defined as the moment from which sepsis was deemed clinically recognisable. Data were collated and results analysed using Excel 2007 (Microsoft).

Results

Study population

Fifty consecutive patients admitted via the EAU to medicine with severe sepsis were identified from a cohort of 294 patients with suspected systemic inflammatory response syndrome (SIRS) or sepsis. All patients were followed up to 90 days post admission. 3 patients were lost to follow up at one year. Exclusions are shown in Figure 1. The median age of our study population was 73 years (inter-quartile range (IQR) 58 – 79) and 56% were female (Figure 2).

Clinical features

The presenting clinical features of the study population are summarised in Table 1. Two or more SIRS criteria were present in the vast majority of severely septic patients. In addition many patients had evidence of two or more organ impairment and 28% of patients had septic shock. 96% of patients had a Modified Early Warning Score (MEWS) score ≥ 3 . The commonest sources of sepsis were respiratory tract (56%), urinary tract (26%) and bowel (10%). Central nervous system (4%), joint (2%), and biliary (2%) sepsis were infrequent and in one case no source was identified.

Compliance with surviving sepsis campaign bundles

Table 2 shows compliance with the elements of the six-hour sepsis care bundle. Serum lactate was measured within the 6 hours stipulated by the Surviving Sepsis Campaign (SSC) guidelines in 92% of patients (median delay 0 h 28 min). 84% of patients had blood cultures taken (median delay 0 h 41 min) and 74% had them taken before starting antibiotics. Only 78% received fluids within 6 hours and furthermore, of those only 28% received an adequately sized bolus of fluid (of at least 20 mL/kg).

64% of patients received antibiotics within 3 hours as recommended by the Surviving Sepsis Campaign guidelines for emergency department patients. Although 25% of our patients required vasopressors promptly according to the SSC criteria, zero patients received them within 6 hours. Central

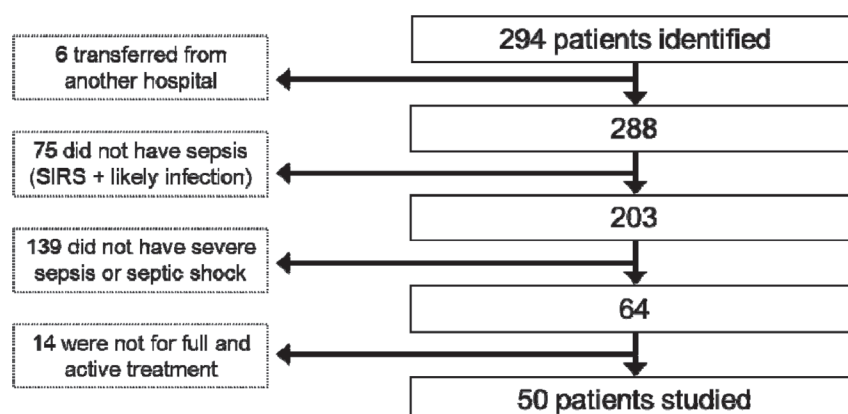


Figure 1. Consort diagram of study enrolment showing reasons for exclusion of patients.

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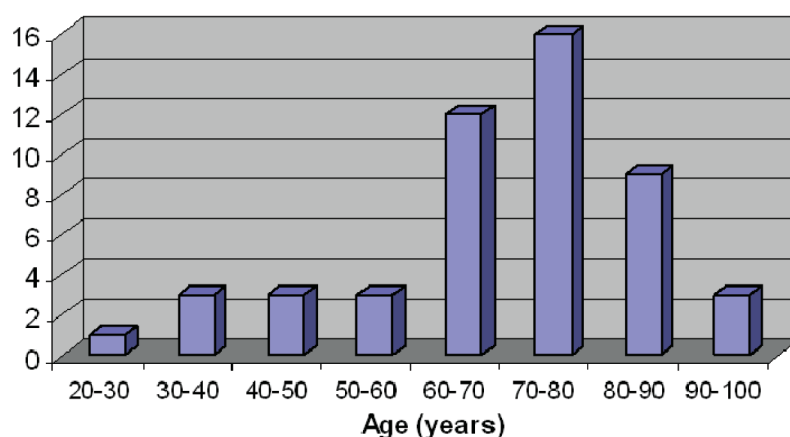


Figure 2. Frequency distribution of the age of study patients at enrolment (y axis shows actual numbers of patients).

venous pressure (CVP) was maintained between 8-12 cmH₂O in only 50% of those patients with persistent hypotension.

Care pathway

All patients were assessed and treated initially in the EAU of Addenbrooke's Hospital. There was no discernable trend in the time of day or day of week that patients arrived. Figure 3 summarises the flow of patients from EAU to the critical care and general

wards of the hospital. 66% of patients were admitted directly to medical wards, 4% to surgical wards, one patient died in EAU and the remaining 28% were referred to critical care.

The median delay from arrival to recognition of sepsis was 42 mins. The median delay from meeting criteria for sepsis to assessment by any doctor was 1 h 10 min, with 76% seen initially by a foundation or core medical specialty trainee. The median delay for senior review was 3 h 07

Table 1. Frequency with which the systemic inflammatory response syndrome (SIRS) criteria and severe sepsis criteria were met in our fifty patients. Note bold items are those identifiable immediately on clinical assessment and which do not require laboratory tests (Temp = temperature in °C, HR = heart rate, RR = respiratory rate, WCC = white cell count x 10⁹/L, PLT = platelets, INR = international normalised ratio).

SIRS criteria		Severe sepsis criteria	
Temp >38 or <36	80%	Hypoxia	48%
HR > 90	78%	Renal failure	54%
RR > 25	68%	Raised lactate	50%
WCC > 12 or <4	80%	Hypotension	28%
		Confusion	26%
		Low PLT/high INR	10%
		Raised bilirubin	8%

Table 2. Compliance with six hour sepsis care bundle items according to the Surviving Sepsis Campaign guidelines 2008. The two columns show the percentages achieved and failed for each intervention in our cohort

Six hour bundle item	Achieved %	Failed %
Blood cultures taken	84	16
Blood cultures taken before antibiotics	74	26
Antibiotics within 3 hours	64	36
Lactate measured	92	8
Adequate fluid resuscitation	28	72
CVP maintained at 8-12cmH ₂ O if needed	50	50
Use of vasopressors if needed	0	100
ScVO ₂ /SVO ₂ measured if needed	12	88
Use of inotropes if needed	20	80
Use of blood if needed	100	0

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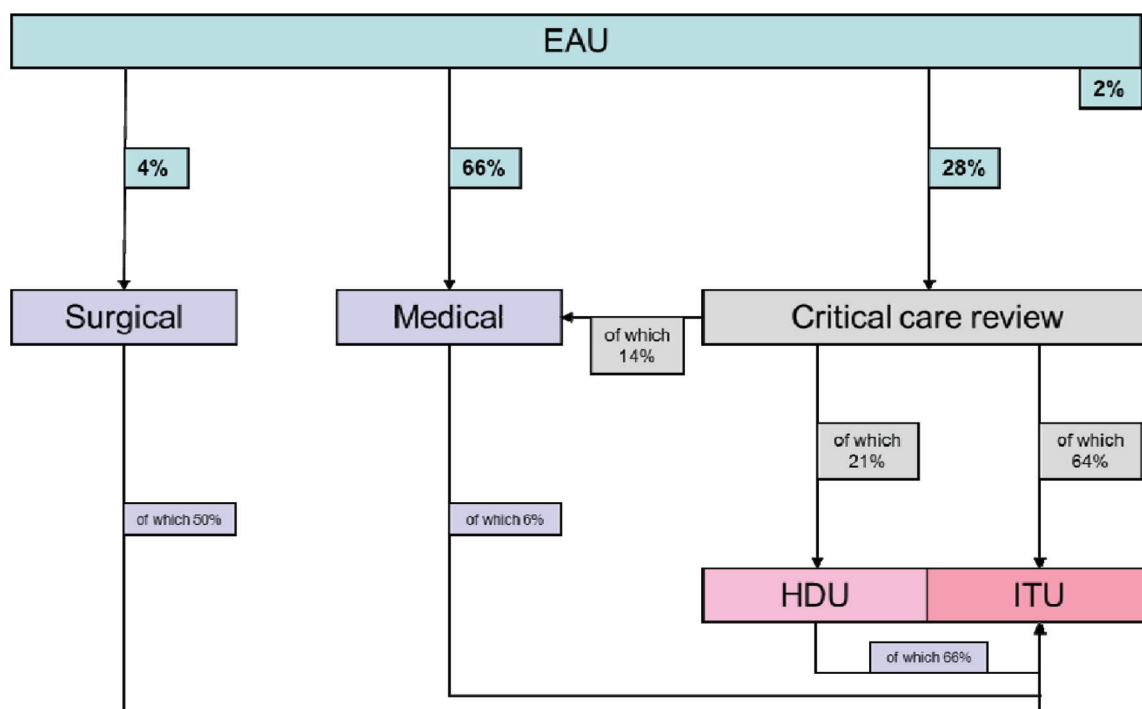


Figure 3. Diagram summarising patient flow from the EAU to the rest of the hospital (HDU = high dependency unit, ITU = intensive therapy unit). The proportions of surgical, medical and HDU patients undergoing secondary transfer to ITU are also shown. One patient (2% of study sample) died in the EAU.

mins but for 18% of patients no senior review was recorded. For consultant review the median delay was 11 h 45 min.

Critical care review was requested and performed in the EAU in 28% of cases, with a median delay of 3 h 55 min. Of those reviewed by critical care, 86% were admitted directly to critical care facilities, with a median transfer delay of 6 h 31 mins. The remainder of patients were not reviewed by critical

care. They received standard ward care, of which 68% were admitted to a medical ward and 4% to a surgical ward. Three patients initially admitted to general wards subsequently required admission to critical care in the first 24 hours.

Mortality

The median length of stay in hospital was 10 days (range 1 – 115 days) and the survival curve is shown

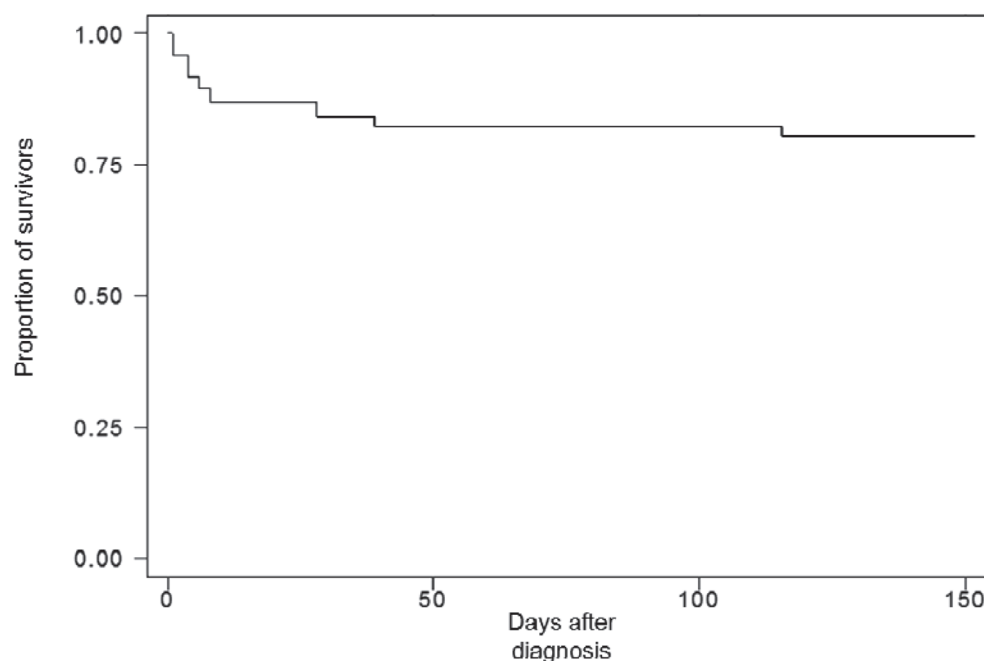


Figure 4. Kaplan –Meier survival curve showing the proportion of survivors up to 150 days after diagnosis.

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in Figure 4. Mortality was 14% at 90 days and 28% (13/47) at one year (the one year data were not available for three patients).

Discussion

Sepsis is a difficult condition to manage. Patients present heterogeneously, there is no confirmatory diagnostic test, universally effective treatments are lacking, and prognosis is often difficult to predict.^{27, 28}

Previous studies of sepsis care tend to focus on the intensive care unit, or less commonly the emergency department. We set out to obtain a snapshot of sepsis care at our "front door", with the intention of evaluating both clinical and organisational factors. The study achieved its three broad aims, as discussed below.

Defining the scope of the problem posed by sepsis

We found that our cohort typified the adult septic population of the UK, with the majority of our severely septic patients aged between 60 and 90 years old and with the respiratory tract, urinary tract and bowel being the most common sources. The overall mortality was substantially lower than the quoted worldwide mortality from severe sepsis. This may be because our study did not assess subspecialty cases or secondary hospital acquired cases in which outcome may be considerably worse; we only included medical patients with sepsis on presentation to the EAU, and excluded patients for whom full active treatment was considered inappropriate. Alternatively the low mortality could be explained by the Hawthorne effect although we were careful not to widely publicise the conduct of our study.²⁹ Our study was not designed to determine whether the level of adherence to the sepsis bundles was associated with mortality rates.

Evaluating the quality of care

Grossly abnormal physiological and laboratory parameters were common in our patients indicating that detection of these severely unwell patients should be straightforward. Nevertheless when we evaluated the quality of our care against the internationally recognised SSC guidelines we were globally underperforming. No single patient received all the stated interventions within the stated timeframe. Whilst a reasonable proportion of patients received timely initial tests (lactate measured, blood culture taken), the administration of supportive (adequate fluid resuscitation, vasopressors) and specific therapies (antibiotics) shown to ameliorate outcome was inconsistent and delayed. Previous studies worldwide have found similarly disappointing baseline adherence to guidelines yet with widely variable mortality.³⁰⁻³⁷ Local factors may be as influential as guideline adherence. It is worth noting, however, that despite the poor adherence to SSC guidelines, the patients in this study had significantly lower 1 year mortality than that published in other studies.³⁸ This may be

for several reasons: adherence to SSC guidelines may be universally poor, and our unit's practice of seeing and treating all patients within 4 hours may mean that patients are receiving fluids and antibiotics more quickly than in other units or there may be other regional or hospital confounders which led to our patients' improved mortality.

Assessing the overall sepsis care system, and identifying improvements which could be made in the system.

We attempted to analyse the overall care system at our institution but unlike the clinical sepsis bundles there are no established criteria for evaluating these logistical parameters. Therefore we decided to focus on the timing, location and personnel involved in the patient pathway. We found that the median delay between sepsis recognition and any doctor assessment was over 1 hour; the delay to senior review was over 3 hours, critical care review almost 4 hours and consultant review 12 hours. These delays are unacceptably long considering the severely compromised condition of the patients.

The potential reasons include inadequately experienced clinical staff, poor flagging and prioritisation of septic patients within the EAU and a scarcity of resources and personnel. We treated on average one patient with severe sepsis or septic shock per 24 hour period. This has implications for the staffing of acute services, since each patient could wholly occupy one or more doctor(s) and nurse(s) for several hours (akin, say, to emergency thrombolysis for stroke, or percutaneous coronary intervention for myocardial infarction).

We hypothesise, that there may be a disconnection at our hospital between assessment-type items (measurement of vital signs, venepuncture), and intervention-type items (prescription of antibiotics, fluids, vasopressors) within the 6 hour sepsis care bundle. The former category are protocol-led interventions typically executed by nursing and auxiliary staff whilst the latter requires active doctor-led decision making and are historically less easily protocolised. We found that a quarter of patients in our study were admitted from the EAU directly to critical care, implicating a need for a smooth, efficient interface between acute medicine and the intensive care unit. 86% of those patients referred to critical care were accepted, and three of the patients initially sent to general wards were later admitted to critical care. These findings suggest we may be under-performing in a third category – escalation-type interventions – including prompt referral to senior colleagues and higher care.

To address these shortcomings, and since these data were collected in 2008, a sequence of interventions has been implemented at the EAU. Within the initial assessment by nursing staff, a 'SWOT' (Sepsis with Optimal Treatment) trigger has been implemented:

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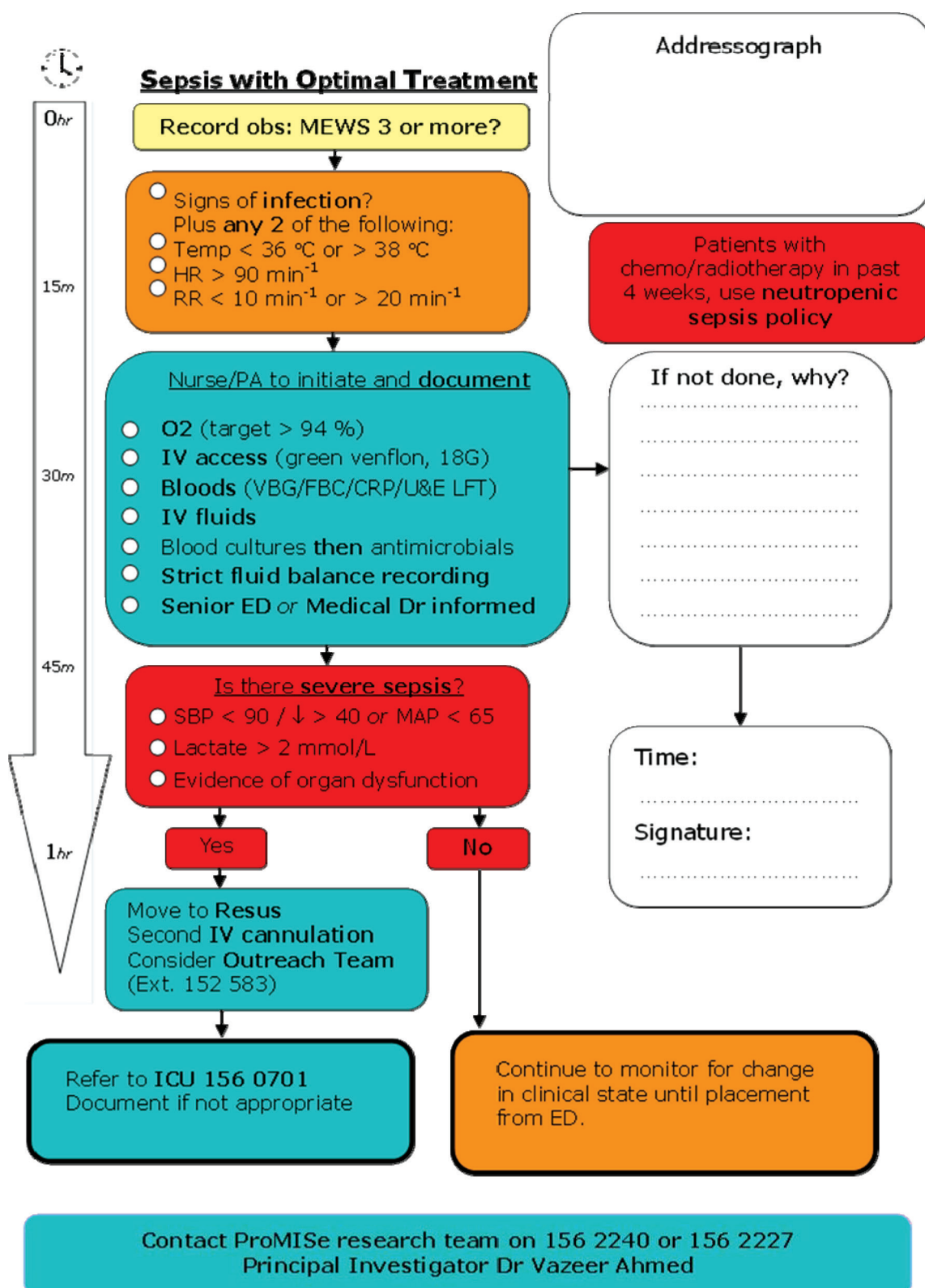


Figure 5. 'Sepsis with Optimal Treatment' patient notes sticker for prioritising and streamlining the care of septic patients.

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any patient scoring a MEWS of at least 3 is assessed for Sepsis using a SWOT sticker (see figure 5). If the patient meets criteria for sepsis, their care is then prioritised and streamlined (in an analogous manner to patients identified as having an MI or stroke) for early interventions: a second large bore cannula, an arterial blood gas, early medical assessment and prescription of antibiotics, and appropriate fluid resuscitation. By doing this, lactate measurement and antibiotic delivery is more likely to occur in the first hour. The Royal College of Physicians has recently published a report with the aim of standardising the assessment of acute illness severity in the NHS, advocating the use of a 'National Early Warning Score' (NEWS).³⁹ In this system, a score of three is obtained by having a systolic blood pressure of < 90, or saturations of ≤ 93% on oxygen, or ≤ 91% on air. Using NEWS may therefore facilitate national emergency department screening for severe sepsis.

To facilitate rapid treatment of sepsis, two "sepsis trolleys" with all necessary equipment have been made, streamlined antibiotic guidelines for sepsis and severe sepsis have been created with the microbiology department, and nursing and medical staff have been educated and provided with "SWOT" cards, to remind them of the triggers and treatments. The aim is to perpetuate a long-lasting culture of sepsis prioritisation. All organisations must address their own performance and needs, and many have already introduced new pathways and equipment to do so. Daniels *et al*'s 'Sepsis six' is one such evidenced measure.¹ The observational study reported here strengthens the case for change. The fact that 96% of our patients had a MEWS score of 3 or more, supports use of an Early Warning Score in the early evaluation of these patients.

We acknowledge the limitations to our study, notably its single centre observational design and low sample size chosen based on the estimated frequency of recruitment and deemed a practically feasible number from which to draw substantial conclusions on a local level. The subset of severe sepsis or septic shock was chosen so as to include patients with definite abnormal physiology and a significant mortality and who would be most likely to benefit from future improvements in the care pathway. Patients were identified prospectively according to clinical criteria for sepsis (rather than retrospectively by confirmed blood culture positivity)²⁶ in order to mimic the real-time challenges of sepsis care and to maximise the quality of data collection. The study

was restricted to the EAU where the majority of septic patients present to the hospital at a single entry point and whereby our findings would be most applicable to the acute medicine community.

We believe this work is of relevance to acute hospitals around the UK. Whatever the structure of the "front door" services in each hospital, there will be deficiencies in the care pathway. This pathway must be capable of being evaluated, especially when significant service restructuring occurs as was the case in our EAU. In this study we have shown that this is feasible using a validated data proforma and achievable without specific funding. To our knowledge the following UK institutions have published comparable studies: Blackpool Victoria Hospital,⁴⁰ Derriford Hospital,⁹ Good Hope Hospital,¹ Kent & Sussex Hospital,⁴¹ Nottingham University Hospital,²⁶ Royal Berkshire Hospital⁴² and St George's Hospital.⁴³ Our findings contribute to this expanding data pool, while also providing examples of how the deficiencies we found in our system have been addressed with changes in practice, at low cost.

In conclusion, performance against international sepsis guidelines in our EAU was poor and our study identified several opportunities to intervene at the system level to improve adherence. A nationally coordinated registry of acute medicine activity and outcomes could contribute to improvements in this field. Evaluating the effectiveness of a complex set of interventions rather than a single therapy is not straightforward.⁴⁴ Whilst UK multicentre trials like Protocolised Management in Sepsis¹⁴ are important to determine the effectiveness of goal-directed therapy for sepsis, it is equally important for individual acute medical units to evaluate organisational factors which could be impeding care, and apply practical solutions to facilitate the delivery of rapid treatment for our sickest patients.

Competing Interests

JM, ZF, HB, CW, AS and VA have no competing or conflicting interests.

Acknowledgements

The authors wish to thank the following people for their expert help and advice in the planning and conduct of this study: Rowan Bernstein, Duncan McAuley, Simon Johnston, Matthew Hayman, Stephen Haydock, Sani Aliyu and Nicholas Brown.

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