Improving multidisciplinary severe sepsis management using the Sepsis Six

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Each year in the UK, it is estimated that more than 100,000 people are admitted to hospital with sepsis and around 37,000 people will die as a result of the condition. We present an audit, re-audit and the implications these have had on the management of severe sepsis using the Sepsis Six, ultimately through actively promoting teamwork to initiate the protocol. This led to a significant improvement in management, decreasing admissions to the intensive care unit (ITU), length of stay in hospital and the number of patient deaths. The initial audit and re-audit were done over 2-month periods. All clerking notes of patients with a medical consultant diagnosis of 'sepsis' on post-take ward round were analysed and further screened for presence of severe sepsis according to national guidelines. There was significant improvement from only 1% of patients being appropriately managed (according to the existing guidelines) to 67% of eligible subjects adhering to the protocol (p<0.0001). Initially, 19% were admitted to the ITU (6% died), improving to 7% on re-audit (with no deaths). Length of hospital stay reduced from 10 to 7 days (p<0.0001). There was a complete change in the management of severe sepsis with trust-wide updated protocols, resulting in a decrease in hospital morbidity and mortality.

KEYWORDS: Morbidity and mortality, sepsis, Sepsis Six, severe sepsis, teamwork

Introduction

Across many acute medicine units (AMUs), there is variable awareness of local and national guidelines for the optimal management of sepsis. A 24-month improvement programme in 30 countries measuring the delivery of the severe sepsis resuscitation bundle was unreliable, with compliance rising from 10% to 21% in self-selected centres.[1]

Through reflective practice, we present a quality improvement project, which demonstrates the key to success in timely management of severe sepsis, with significant and dedicated use of appropriate teamwork.

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> **Box 1. Systemic inflammatory response syndrome (SIRS) criteria[6]**
>
> **Sepsis is confirmed if any two of the following are present:**
>
> - New onset confusion or altered mental state
> - Temperature >38.3°C or <36°C
> - Heart rate >90 bpm
> - Respiratory rate (counted over 60 minutes) >20 breaths per minute
> - Blood glucose >7.7 mmol/L in the absence of known diabetes
> - White cell count >12×10^9/L or <4×10^9/L

NHS England has established sepsis as a future indicator of the national outcomes framework.[6]

In the UK, sepsis causes approximately 37,000 deaths and 100,000 hospital admissions per year, with an overall mortality rate for admissions with severe sepsis of 35% (five times higher than for ST elevation myocardial infarction (STEMI) and stroke).[2,3]

Sepsis is a physiological response to infection and inadequate treatment may result in tissue damage, leading to multi-organ failure and, ultimately, death.[4] This is manifested by the presence of two or more systemic inflammatory response syndrome (SIRS) criteria (Box 1).[5] Sepsis is classified as severe when organ failure occurs.[6]

Lactate levels in sepsis are highly predictive of death (Table 1).[7] An initial elevation is a strong predictor of survival.

Severe sepsis is time sensitive. Crucially, for every hour delay in antibiotic administration, there is an 8% increase in mortality.[8]

The Sepsis Six is an initial resuscitation bundle that offers basic intervention within the first hour: a prospective observational study has shown that it was independently associated with survival, suggesting that if it alone were responsible for outcome differences, the number needed to treat (NNT) to prevent one death is 4.6.[9] Comparatively, the NNT is 42 for aspirin in a major heart attack and 45–90 for percutaneous coronary intervention in STEMI.[6]

Table 1. The relationship between lactate levels and mortality in sepsis patients[7]

Lactate (mmol/L)	Mortality (%)
<2	15
2–4	25
>4	38

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We propose two questions:

1 Have we fulfilled the definition of audit, ie repeating analysis with a view to change in practice in accordance with national standards?
2 Have our measures lead to a significant change in morbidity and mortality?

Methods

Patients were audited over a 2-month period, from the middle of September to the middle of November 2014. All clerking notes of patients with a medical consultant diagnosis of 'sepsis' on post-take ward round were analysed and further screened for presence of severe sepsis according to national guidelines.

This was re-audited from the middle of April to the middle of June 2015, after presenting our findings to departmental and clinical hospital committees (specifically the accident and emergency clinical governance group), and updating of the online blood requesting system to show a 'sepsis' tab – which would show the protocol and request appropriate bloods automatically (Fig 1). This was an instrumental step.

Morbidity and mortality were assessed by reviewing the number of intensive care unit (ITU) admissions, number of deaths and the average length of hospital stay.

Data management and analysis

Date and time of admission coupled with details of administration of intravenous fluids, antibiotics and high flow oxygen, and the taking of blood cultures, monitoring of urine output and lactate measurement were collated. The information gathered was then statistically analysed using the Fisher's exact test (Tables 2 and 3).[10,11]

With the help of the clinical coding department, notes of all the patients were reviewed again later, when they were either discharged or had died, and at this stage the length of hospital stay was determined and whether they were admitted to ITU. This information was also collated as previously, using the same methods and statistical analyses. However, the unpaired *t* test was used to calculate statistical significance between the mean length of hospital stay in 2014 and in 2015 (Table 3).[10]

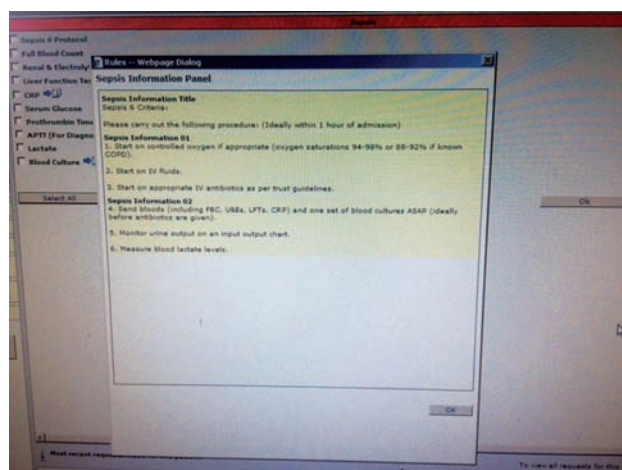A p-value of less than 0.05 was considered statistically significant.[10]

Fig 1. Online initiation of the Sepsis Six – 'sepsis' tab.

Table 2. Sepsis Six outcomes

Sepsis Six outcomes	Audit year	Appropriately managed, n (%)	p-value
All Sepsis Six completed within 1 hour	2014	1 (1)	<0.0001
	2015	36 (67)	
All Sepsis Six completed	2014	1 (1)	<0.0001
	2015	46 (85)	
Antibiotics given within 1 hour	2014	6 (9)	<0.0001
	2015	44 (81)	
Fluids given within 1 hour	2014	6 (9)	<0.0001
	2015	40 (74)	
Oxygen given within 1 hour	2014	39 (58)	<0.0001
	2015	53 (98)	
Blood cultures taken within 1 hour	2014	45 (67)	<0.0001
	2015	54 (100)	
Blood lactate checked within 1 hour	2014	39 (58)	<0.0001
	2015	50 (93)	
Urine output measured within 1 hour	2014	45 (67)	0.0175
	2015	47 (87)	

For 2014, n=67 and for 2015, n=54. Two-tailed Fisher's exact test was used to calculate statistical significance.

Results

The audit included 67 patients in 2014 and 54 patients in 2015. As presented in Table 2, the initial audit demonstrated that only 1% of appropriate patients (n=1) had been managed according to the existing guidelines, whereas, the re-audit emphatically showed a significant improvement with 85% of eligible subjects (n=46) having all of the Sepsis Six criteria met (p<0.0001), and 67% (n=36) adhering strictly to the protocol (p<0.0001).

In the 2014 audit, a mere 9% of patients (n=6) were managed appropriately – with administration of antibiotics and fluids – within the 'golden hour'; however, there was a significant improvement to 81% (n=44, p<0.0001) and 74% (n=40, p<0.0001), respectively, on re-audit in 2015. Only 58% of patients (n=39) had both oxygen given and blood lactate levels checked appropriately on initial audit, which improved significantly to 98% (n=53, p<0.0001) and 93% (n=50, p<0.0001), respectively, on re-audit. In the 2014 audit, 67% of patients (n=45) had both blood cultures taken and urine output measured appropriately within the hour, which, once again, showed a significant improvement to 100% (n=54, p<0.0001) and 87% (n=47, p=0.0175), respectively, on re-audit.

Table 3. Mortality and morbidity outcomes

Morbidity and mortality outcomes	Audit year		p-value
	2014	2015	
ITU admissions, n (%)	13 (19)	4 (7)	0.0695
			0.0498
Deaths, n (%)	4 (6)	0 (0)	0.1274
LOS, days	10	7	<0.0001

For 2014, n=67 and for 2015, n=54.
ITU = intensive care unit; LOS = length of stay

On initial audit, many of the patients were found to have continued high lactate levels over time, due to either fluids not being given on time or being given too slowly. This prompted admission to the ITU. 19% of patients (n=13) were admitted to ITU on initial audit, which improved to 7% (n=4) on re-audit (two-tailed Fisher's exact test p=0.0695, one-tailed Fisher's exact test p=0.0498). The number of deaths was reduced from 6% (n=4) on initial audit to no deaths on re-audit (p=0.1274). Length of hospital stay was reduced, from an initial audit average of 10 days, to 7 days on re-audit (p<0.0001) (Table 3).

Discussion

Sepsis is one of the leading causes of preventable morbidity and mortality in hospitals today.[11,12] However, we have demonstrated that simple measures, if consistently performed, save lives.

Our methods during presentation included assessment of prior knowledge by using questionnaires and reviewing these for pre- and post-improvement by using the same questionnaires after the presentation.[13] The audit findings emphatically demonstrate improvements as a result of using visual, auditory and readable aids.[14] The 'sepsis' tab, as mentioned, directed stepwise management of sepsis, prompting immediate diagnosis and initiation of the protocol (Fig 1).[15]

Our work has undoubtedly enhanced the recognition and management of severe sepsis using the Sepsis Six bundle. This has led to considerable reduction in cost to the NHS, particularly in length of stay – as demonstrated in the re-audit.

Based on the one-tailed p-value, there was a significant decrease in the number of ITU admissions and an overall decrease in morbidity and mortality, with no deaths on re-audit. This is likely to be related to the improved outcome on fluid resuscitation through enhanced lactate and urine output measurements.

Following dissemination of our data to the hospital, the emergency department staff have devised their own protocol, which has been shown to significantly improve multidisciplinary assessment of patients with severe sepsis and initiating the Sepsis Six (S1).

Conclusion

There was significant improvement and complete change in management of severe sepsis, resulting in trust-wide updated protocols and teamwork practice to guide timely initiation of the Sepsis Six. This led to a significant decrease in length of hospital stay, and a decrease in morbidity and mortality.

Food for thought

We hope this will be an eye opener to many national and international medical organisations. We have used multiple modality tools to present the key to success in multidisciplinary management of severe sepsis using the Sepsis Six, and making it as simple a task as checking vital observations to prompting action. ■

Supplementary material

Additional supplementary material may be found in theonline version of this article at www.clinmed.rcpjournal.org/:
S1 – Emergency department sepsis screening tool.

Author contributions

MA and GR have been involved in data collection. AB has been involved in data collection, performing statistical analysis and wrote

the manuscript. AM had overview of the whole quality improvement project and edited the submitted manuscript.

Conflicts of interest

The authors have no conflicts of interest to declare.

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