

Implementation and compliance with the sepsis six bundle in the emergency department: A quality improvement project in a resource-limited tertiary care setting

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ABSTRACT

Objective: To assess compliance with the Sepsis Six bundle and its impact on clinical outcomes in patients presenting with sepsis in the emergency department of a resource-limited tertiary care hospital.

Material and Methods: This study was conducted between August 2025 and January 2026, including a pre-intervention and post-intervention phase. Adult patients diagnosed with sepsis according to Sepsis-3 criteria were included. qSOFA was used as a screening tool and SOFA scoring was used for diagnosis. A multifaceted intervention consisting of staff education, awareness sessions, visual reminders, standardized protocols, sepsis checklists, and regular audit-feedback mechanisms was implemented after the initial audit phase. Data on compliance with the six components of the Sepsis Six bundle within one hour of diagnosis, along with patient outcomes, were analyzed.

Results: A total of 200 patients were included, with 100 patients in each phase. Overall compliance with completion of all Sepsis Six components significantly improved from 29.3% pre-intervention to 73.0% post-intervention. Significant improvements were observed in all components (p -value: < 0.001). The intervention was associated with clinically important reductions in mortality (27.0% vs. 17.0%) and ICU admissions (32.0% vs. 21.0%), and a significant reduction in hospital length of stay (9.6 ± 4.1 vs. 7.2 ± 3.5 days; $p < 0.001$). Patients receiving incomplete bundle care had approximately threefold higher odds of in-hospital mortality than those receiving complete bundle.

Conclusion: Implementation of structured sepsis protocols and targeted quality improvement interventions significantly enhanced compliance and was associated with improved clinical outcomes among patients with sepsis.

Keywords: Sepsis, Septic shock, Sepsis six protocol.

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INTRODUCTION

Sepsis is a potentially fatal illness. The body's reaction to infection causes damage to its own tissues and organs, which eventually leads to shock, multiple organ failure and sometimes death, unless identified early and treated promptly. [1]. It can affect anyone, but vulnerable people including the very young and very old, pregnant, with chronic health conditions (chronic kidney diseases or liver cirrhosis) or with weakened immune systems are at greater risk [1].

In 2020, sepsis accounted for 11 million deaths and 48.9 million cases globally, 20% of all fatalities. Children under the age of five accounted for over half

of all estimated cases of sepsis worldwide [2]. Although sepsis can strike anyone in the world, significant disparities in incidence and mortality, with lower-middle-income countries (LMICs) experiencing the highest burden. Pakistan is a lower-middle-income country with a high burden of sepsis; however, comprehensive epidemiological data remain limited [3]. Global data highlight the need to strengthen efforts in LMICs such as Pakistan to improve the identification, prevention, and management of sepsis [2, 4].

The Institute of Healthcare Improvement (IHI) created care bundles, which are combined sets of evidence-based activities that, when carried out collectively, produces better patient outcomes than when executed separately. The prognosis of septic patients largely depends on how promptly and thoroughly the initial resuscitation is performed. This observation led to the development of early goal directed therapy and streamlined care bundles. The UK Sepsis Trust supports the Sepsis Six bundle, which consists of six-time critical interventions that should be given within the first hour of sepsis recognition [5]. This bundle

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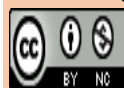
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consists of giving oxygen at high flow rates, collecting blood cultures before giving antibiotics, administering intravenous broad-spectrum antibiotics, starting intravenous fluid resuscitation, measuring serum lactate and monitoring urine output. The Surviving Sepsis Campaign (SSC) and other international guidelines strongly advise completing these bundles as soon as possible, emphasizing that every hour that antibiotic administration is delayed is linked to a marked increase in mortality [6]. This quality improvement project aimed to assess compliance with the Sepsis Six bundle and its impact on clinical outcomes in patients presenting with sepsis in the emergency department of a resource-limited tertiary care hospital.

MATERIAL AND METHODS

This prospective quality improvement project, designed to assess the compliance and clinical outcomes associated with the implementation of the Sepsis Six bundle in patients diagnosed with sepsis, in emergency department of Liaquat University Hospital, Hyderabad was conducted in two phases comprising a pre-intervention baseline audit and a post-intervention evaluation. A single Plan–Do–Study–Act (PDSA) cycle was undertaken between the two audit periods, from 1st August 2025 till 31st January 2026. Sepsis was defined according to the Sepsis-3 criteria as suspected or documented infection associated with an acute increase in Sequential Organ Failure Assessment (SOFA) score of ≥ 2 points from baseline. The quick Sequential Organ Failure Assessment (qSOFA) score was calculated at presentation using three clinical variables: respiratory rate ≥ 22 breaths/min, systolic blood pressure ≤ 100 mmHg, and altered mental status (Glasgow Coma Scale < 15). A qSOFA score ≥ 2 was considered positive and indicative of an increased risk of poor clinical outcomes. qSOFA score was used as a screening tool and SOFA increase ≥ 2 was used for diagnosis (Sepsis-3). All the patients aged 18 years and above and diagnosed with sepsis, were included whereas the patients admitted after prior sepsis management from other hospital or patients with incomplete clinical data were excluded.

Medical records of included patients were reviewed for clinical characteristics, intervention data, and outcomes from admission until discharge. Compliance within 1 hour of diagnosis was recorded for administration of oxygen, blood culture collection, administration of intravenous (IV) antibiotics,

administration of IV fluids, measurement of serum lactate and monitoring of urine output.

During the baseline phase, compliance with the Sepsis Six bundle was assessed among 100 consecutive adult patients meeting sepsis criteria. Baseline data collection was conducted over a three-month period. Following identification of gaps in compliance, a standardized sepsis management protocol based on Sepsis Six guidelines was introduced in the emergency department, including staff education sessions, dissemination of Sepsis Six reminder materials, reinforcement during clinical handovers, and regular feedback to clinical teams. Staff were encouraged to follow a standardized approach for all patients with suspected sepsis and were provided with a dedicated sepsis checklist to facilitate documentation and ensure timely completion of all bundle components. Additional efforts were made to ensure the availability and accessibility of essential supplies required for sepsis. The intervention and evaluation phase was conducted over the next three months and included 100 consecutive adult patients meeting sepsis criteria. The same methodology and data collection procedures were used in both phases to ensure consistency.

As this was a quality improvement project using consecutive sampling, all eligible patients presenting during the study period were included. No formal sample size calculation was performed.

Data were entered and analyzed using IBM SPSS Statistics version 23.0. Continuous variables were calculated as mean $\pm$ standard deviation (SD), while for categorical variables frequencies and percentages were calculated. Categorical outcomes (in-hospital mortality and ICU admission) were compared using the Chi-square test. Effect sizes are reported as relative risks (RRs) with 95% confidence intervals (CIs). Continuous outcomes (length of hospital stay) were compared using the independent-samples t-test. Effect size for hospital stay is presented as the mean difference with 95% CI. Ethical approval was obtained from the Institutional Review Board LUMHS/REC/-1381/31-12-2025. Written/ verbal informed consent was obtained from all participants or their legally acceptable representatives where applicable. Patient confidentiality was maintained throughout the study. The project was initiated as a departmental quality improvement activity approved by the hospital administration. Subsequently, approval from the

Institutional Review Board was obtained for publication and dissemination of the findings.

RESULTS

A total of 200 patients were included in the study, comprising 100 patients in the pre-intervention group and 100 patients in the post-intervention group. Baseline demographic and clinical characteristics were comparable between the two cohorts (Table-I). There were no statistically significant differences in baseline demographic characteristics, comorbidities, infection source (Table-II), or illness severity between the two groups, suggesting that the cohorts were comparable prior to evaluation of the intervention effect.

Compliance improved significantly across all six components of the Sepsis Six bundle following implementation of the quality improvement intervention (Table-III).

Following implementation of the quality improvement intervention, in-hospital mortality decreased from 27.0% to 17.0%, corresponding to a 37% relative

reduction in mortality risk (RR 0.63, 95% CI 0.37–1.08); however, this difference did not reach statistical significance ($p = 0.088$). Similarly, ICU admissions decreased from 32.0% to 21.0% (RR 0.66, 95% CI 0.41–1.06), although the difference was not statistically significant ($p = 0.078$). The mean length of hospital stay decreased significantly from 9.6 ± 4.1 days to 7.2 ± 3.5 days, representing a mean reduction of 2.4 days (95% CI -3.46 to -1.34 ; $p < 0.001$). Mortality and ICU admission showed clinically important reductions following the intervention, although these differences did not reach statistical significance. Hospital length of stay decreased significantly (Table-IV).

Mortality was significantly associated with Sepsis Six bundle completion. Among patients receiving incomplete bundle care, 30 of 106 patients died compared with 12 of 94 patients who received complete bundle care. Patients receiving incomplete bundle care had threefold higher odds of in-hospital mortality than those receiving complete bundle care (OR 3.0, 95% CI 1.43–6.29; $p = 0.003$) (Table-V).

Table-I: Baseline characteristics of patients in the pre- and post-intervention groups.

Characteristic	Pre-intervention (n=100)	Post-intervention (n=100)	p-value
Age, mean $\pm$ SD (years)	55.1 $\pm$ 16.4	54.5 $\pm$ 15.8	0.79
Male sex, n (%)	58 (58.0)	61 (61.0)	0.67
Diabetes mellitus, n (%)	41 (41.0)	38 (38.0)	0.67
Hypertension, n (%)	49 (49.0)	46 (46.0)	0.67
Chronic kidney disease, n (%)	15 (15.0)	13 (13.0)	0.68
Malignancy	11 (11.0)	9 (9.0)	0.64
qSOFA score ≥ 2 , n (%)	56 (56.0)	52 (52.0)	0.57

Abbreviations: SOFA = Sequential Organ Failure Assessment; qSOFA = Quick Sequential Organ Failure Assessment; CKD = Chronic Kidney Disease.

Table-II: Frequency of patients according to the type of infection associated with sepsis at presentation.

Type of Infection	Pre intervention phase n (%)	Post intervention phase n (%)
Respiratory tract	35 (35.0)	32 (32.0)
Urinary tract	12 (12.0)	16 (16.0)
Meningitis	2 (2.0)	4 (4.0)
Intra-abdominal infection	2 (2.0)	1 (1.0)
Skin and Soft tissue infection	16 (16.0)	18 (18.0)
Bacteremia	14 (14.0)	12 (12.0)
Candidemia	7 (7.0)	3 (3.0)
Catheter associated infection	7 (7.0)	9 (9.0)
Others	5 (5.0)	5 (5.0)

Table-III: Compliance with sepsis six bundle before and after intervention within 1 hour of admission in ER.

Sepsis Six Component	Pre-Intervention n (%)	Post-Intervention n (%)	p-value
Oxygen administration	48 (48.0%)	77 (77.0%)	<0.001
Blood culture collection	37 (37.0%)	70 (70.0%)	<0.001
IV antibiotics administration	45 (45.0%)	80 (80.0%)	<0.001
IV fluid administration	51 (51.0%)	78 (78.0%)	<0.001
Serum lactate measurement	34 (34.0%)	74 (74.0%)	<0.001
Urine output monitoring	42 (42.0%)	75 (75.0%)	<0.001

Table-IV: Clinical outcomes before and after intervention.

Outcome variable	Pre-Intervention n (%)	Post-Intervention n (%)	Effect Size	95% CI	p-value
In-hospital mortality	27 (27.0%)	17 (17.0%)	RR = 0.63	0.37–1.08	0.088
ICU admission	32 (32.0%)	21 (21.0%)	RR = 0.66	0.41–1.06	0.078
Mean hospital stay (days)	9.6 $\pm$ 4.1	7.2 $\pm$ 3.5	Mean difference = -2.4 days	-3.46 to -1.34	<0.001

Table-V: Association between sepsis six bundle completion and in-hospital mortality.

Bundle Completion Status	Died, n (%)	Survived, n (%)	Total
Incomplete bundle care	30	76	106
Complete bundle care	12	82	94

DISCUSSION

In this quality improvement study, compliance with the Sepsis Six bundle within the recommended time window was found to be suboptimal, which is consistent with findings reported from other low- and middle-income countries (LMICs) [7]. Timely implementation of evidence-based sepsis bundles remains challenging in resource-constrained healthcare systems due to multiple operational and systemic barriers. Following implementation of the quality improvement intervention, adherence to the Sepsis Six protocol improved significantly and was associated with better patient outcomes.

Studies conducted across LMIC settings have similarly demonstrated low compliance with early sepsis management bundles, mainly due to deficiencies in triage systems, delayed laboratory turnaround times, and limited access to critical care facilities [7][8].

The mean age of patients in our cohort was 52 ± 16 years, which is consistent with the findings in other studies [9]. In many LMICs, communicable diseases continue to represent a significant public health burden, predisposing relatively younger individuals to severe infections and sepsis. Delayed healthcare-seeking behavior, socioeconomic constraints, self-medication practices, and limited access to primary healthcare services may also contribute to advanced disease presentation at younger ages [10].

Male predominance was observed in our study, in terms of both, admission due to sepsis and the mortality associated with it. Similar gender distributions have been reported in local studies [11]. Possible explanations include greater occupational exposure to environmental and infectious hazards among men.

and infectious hazards, higher prevalence of smoking and co morbid risk factors, and increased likelihood of presenting to tertiary healthcare facilities. Additionally, previous epidemiological studies have suggested possible biological differences in immune responses between males and females, which may influence susceptibility to severe infections and sepsis outcomes [11].

Compliance improved across all components of the Sepsis Six bundle following implementation of the quality improvement intervention. The largest improvement was observed in serum lactate

measurement, which increased from 34.0% to 74.0%.

This may reflect increased clinician awareness of the role of lactate in early sepsis recognition and the emphasis placed on its measurement during the intervention. Substantial improvements were also seen in intravenous antibiotic administration, blood culture collection, and urine output monitoring, likely due to enhanced staff education and the use of standardized sepsis management pathways.

In contrast, intravenous fluid administration showed the smallest improvement, although compliance still increased considerably from 51.0% to 78.0%. This may be explained by its relatively higher baseline compliance and the need for individualized clinical decision-making in patients with comorbidities such as cardiac or renal disease. Overall, these findings suggest that targeted quality improvement measures can effectively enhance adherence to key elements of the Sepsis Six bundle, particularly those related to sepsis recognition and timely treatment.

A substantial proportion of patients in this study required intensive care support, which may be attributable to delayed recognition of sepsis and delayed initiation of appropriate treatment, which leads to rapid progression of organ dysfunction, septic shock, and increased need for advanced organ support. Previous studies have consistently demonstrated that delayed implementation of sepsis bundles is associated with increased organ failure, prolonged hospital stay, greater ICU utilization, and higher mortality rates [12]. Early identification of sepsis in the emergency department and prompt implementation of the Sepsis Six bundle has been shown to improve tissue perfusion, reduce progression to septic shock, and enhance survival outcomes [13] [14]. Studies have shown that the Sepsis Six protocol is easy for junior doctors and nurses to implement and represents a cost-effective strategy for improving patient outcomes. [15]. Importantly, our study findings suggest that relatively simple and low-cost interventions can significantly improve adherence to sepsis management pathways in resource-constrained healthcare settings.

Problems contributing to decreased adherence to the Sepsis Six in LMICs included staff shortages, inadequate education and training, limited laboratory facilities, and restricted access to antibiotics [7]. Ideally, lower nurse-to-patient ratios would facilitate

more consistent compliance with sepsis management protocols. Studies show 30-day-mortality and 60-day-mortality increase when a single nurse was responsible for an excessive number of patients [15]. High patient volumes, limited opportunities for patient reassessment, and delayed communication of preliminary laboratory results are additional barriers to compliance [16]. Local literature shows that in a tertiary care emergency department of Pakistan, sepsis recognition rate in triage was 61.4% and compliance with sepsis six protocol was 38.6%. As seen in our study, incomplete adherence to bundle and delayed antibiotics were independent predictors of mortality [17].

However, although early administration of antibiotics within the recommended one-hour window may contribute to reduced mortality in patients with suspected sepsis, indiscriminate or unnecessary use of broad-spectrum antimicrobials within this limited timeframe may also increase selective antimicrobial pressure and potentially contribute to the emergence and propagation of AMR [18].

Future research should focus on large multicenter prospective studies evaluating the long-term effectiveness and sustainability of Sepsis Six implementation across diverse healthcare settings, particularly in low- and middle-income countries where resource limitations may influence compliance and outcomes. Future investigations should also evaluate the role of rapid diagnostic platforms, molecular testing, and biomarker-guided therapies in improving early pathogen identification and facilitating targeted antimicrobial therapy, thereby enabling more individualized sepsis management and reducing unnecessary broad-spectrum antibiotic exposure.

[19]. Moreover, emerging technologies such as artificial intelligence (AI) and integrated electronic surveillance systems may support early sepsis recognition, risk stratification, prediction of clinical deterioration, and optimization of treatment decisions [20].

LIMITATIONS

This study has several limitations that should be acknowledged. First, the study was conducted in a single tertiary care center, which may limit the generalizability of the findings to other healthcare settings. Additionally, this was a before-and-after quality improvement study without a concurrent control group, causal relationships between the intervention and observed outcomes cannot be definitively established. Second, the association

between infection type and clinical outcomes was not evaluated. Third, patients with hospital-onset sepsis were not included.

Besides these, several factors beyond the intervention itself may have influenced the observed improvements in Sepsis Six compliance and patient outcomes. First, changes in staffing levels, staff experience, or clinical leadership during the study period could have affected sepsis recognition and management practices. However, no major changes in departmental staffing structures or sepsis management protocols occurred during the study period.

Second, seasonal variation in infection patterns may have influenced the incidence, severity, and source of sepsis presentations. Although the pre-intervention and post-intervention phases were conducted within the same institution and over relatively comparable periods, residual effects of seasonal variation cannot be excluded.

Third, differences in patient case-mix between the two study periods may have contributed to the observed findings. To address this concern, baseline demographic and clinical characteristics were compared between groups and were found to be broadly similar. Nevertheless, unmeasured differences in illness severity or underlying risk factors may have remained.

Finally, healthcare system factors such as ICU bed availability, accessibility to antimicrobials, laboratory capacity, and access to supportive care may have influenced patient outcomes independently of the intervention. During the study period, no major changes in ICU capacity, antimicrobial formulary availability, or institutional sepsis management policies were identified. However, as with all single-centre quality improvement studies, the potential influence of unmeasured organizational factors cannot be completely excluded.

These limitations should be considered when interpreting the observed associations between the intervention and improvements in Sepsis Six compliance and clinical outcomes. Future multicentre studies with longer follow-up periods and adjustment for potential confounders are warranted to further evaluate the effectiveness and sustainability of Sepsis Six implementation strategies.

CONCLUSION

Overall, our findings show that compliance with the Sepsis Six bundle remains inadequate in the emergency department setting, potentially

contributing to increased ICU admission and adverse patient outcomes. However, identification of barriers, implementation of early recognition systems, staff education, and strengthening of standardized sepsis protocols were associated with reductions in sepsis-related morbidity and mortality

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CONFLICT OF INTEREST

None

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Declared none

AUTHORS CONTRIBUTION

Yusra Shafquat: Substantial contribution to study concept, study design, acquisition of data, analysis and interpretation of data, manuscript writing, final approval, responsible for every aspect of the research

Ikram Din Ujjan: Substantial contribution to analysis and interpretation of data, critical review, final approval, responsible for every aspect of the research

Ravi Shankar, Santosh Kumar, Lajpat Rai, Kabir Sothar: Substantial contribution to analysis and interpretation of data, critical review, final approval, responsible for every aspect of the research

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