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Original Article

Early Recognition and Management of Sepsis in the Emergency Department of a Tertiary Care Hospital

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ABSTRACT

Background: Sepsis is a leading cause of preventable morbidity and mortality worldwide, disproportionately affecting patients in low- and middle-income countries. Early recognition and adherence to evidence-based management protocols in the emergency department are critical for improving outcomes. Objective: To evaluate recognition and management of sepsis in the emergency department of Lady Reading Hospital, Peshawar, and to determine their association with patient outcomes. Methods: This prospective observational study enrolled 210 adult patients meeting Sepsis-3 criteria between June and September 2024. Demographic, clinical, laboratory, and management data were collected prospectively. Outcomes included ICU admission, hospital length of stay, and in-hospital mortality. Statistical analyses included chi-square tests, t tests, and multivariable logistic regression to identify independent predictors of mortality. Results: The mean age was 51.7 ± 17.6 years, with 58.1% male patients. Pneumonia (34.3%) was the most common infection source. Sepsis was recognized at triage in 61.4%, antibiotics were administered within one hour in 46.2%, and the complete SSC Hour-1 bundle was achieved in 38.6%. In-hospital mortality was 28.1%. Timely antibiotics reduced odds of death by 56% (adjusted OR 0.44, 95% CI 0.23–0.82, p=0.01), while delayed antibiotics and incomplete bundle adherence were independent predictors of mortality. Conclusion: Early recognition, prompt antibiotics, and full Hour-1 bundle adherence significantly improve survival in sepsis. Strengthening triage protocols, rapid antibiotic delivery, and staff training are essential for reducing sepsis-related mortality in resource-limited emergency departments.

Keywords: Sepsis; Emergency department; Hour-1 bundle; Antibiotics; Mortality; Low-resource settings.

INTRODUCTION

Sepsis is a life-threatening syndrome of organ dysfunction caused by a dysregulated host response to infection, contributing to an estimated 49 million cases and 11 million deaths annually worldwide (1). The burden is disproportionately higher in low- and middle-income countries, where limited healthcare infrastructure, resource constraints, and diagnostic delays exacerbate outcomes (2,3). Within this global context, emergency departments (EDs) represent the critical entry point for recognition and management, as most patients present with acute manifestations requiring immediate decisions. Delays in diagnosis and inconsistent initiation of evidence-based therapies are key drivers of preventable morbidity and mortality (4).

International guidelines, including the Surviving Sepsis Campaign (SSC), emphasize that early recognition and timely management substantially improve survival. The Hour-1 bundle—which encompasses blood culture collection, serum lactate measurement, administration of broad-spectrum antibiotics, fluid resuscitation, and vasopressor initiation when indicated—has demonstrated a strong association with reduced mortality in diverse healthcare systems (5,6). Multiple studies have confirmed that early antibiotic administration within the first hour correlates with improved survival, with each hour of delay leading to measurable increases in mortality risk (7–9). Despite this robust evidence base, compliance with the Hour-1 bundle remains variable, particularly in high-volume and resource-limited EDs, where staff workload and systemic barriers contribute to implementation challenges (10).

In Pakistan, where the healthcare system is overburdened, research on sepsis recognition and management remains limited. Previous multicenter cohort demonstrated high sepsis-associated mortality rates, underscoring the urgent need for system-level interventions (3). However, there remains a paucity of single-institution evidence examining how current ED practices align with international recommendations and the extent to which early interventions influence patient outcomes. Without such local data, tailoring sepsis protocols to the realities of resource-limited environments remains difficult.

Given this knowledge gap, the present study was conducted in the ED of Lady Reading Hospital, Peshawar—a tertiary care center serving a large population base. The objective was to evaluate patterns of sepsis recognition and management and to assess their impact on clinical outcomes, particularly in-hospital mortality. We hypothesized that timely administration of antibiotics and adherence to the SSC Hour-1 bundle would be associated with improved survival among adult patients presenting with sepsis.

MATERIAL AND METHODS

This was a prospective observational study conducted in the Emergency Department of Lady Reading Hospital, Peshawar, Pakistan, over a four-month period from June 1 to September 30, 2024. The study was designed to evaluate recognition and management of sepsis and to assess their association with patient outcomes in a high-volume tertiary care setting. The observational design was chosen to reflect real-world practices while minimizing intervention bias, in line with recommendations for sepsis epidemiology studies (11).

Eligible participants were adults aged 18 years or older presenting to the ED with suspected or confirmed infection and fulfilling Sepsis-3 criteria, defined as infection accompanied by a Sequential Organ Failure Assessment (SOFA) score of ≥2 (12). Patients with trauma, postoperative complications, cardiac arrest upon arrival, or those directly referred to other facilities were excluded to avoid confounding clinical trajectories. Recruitment followed a consecutive sampling strategy, whereby all eligible patients meeting inclusion criteria during the study period were enrolled after informed consent was obtained from the patient or a legally authorized representative.

Data were collected prospectively using a structured proforma. Demographic and clinical variables included age, sex, comorbidities, vital signs, and sepsis screening scores such as quick SOFA (qSOFA) and the National Early Warning Score 2 (NEWS2). Laboratory data comprised complete blood count, serum lactate, blood and urine cultures, renal and liver function tests, and other investigations as guided by clinical judgment. Management variables were meticulously recorded, including time to antibiotic administration, timing of blood culture collection, fluid resuscitation volumes, vasopressor initiation, and overall adherence to the SSC Hour-1 bundle (5). Outcomes captured included emergency department length of stay, need for intensive care unit (ICU) admission, hospital length of stay, and in-hospital mortality.

To minimize bias, trained research staff were involved in data collection, and timing of interventions was verified against electronic medical records and medication administration logs. Confounding was addressed by adjusting for age, sex, comorbidities, and baseline severity of illness in multivariable analyses. Sample size was determined as a priori using standard formulas for observational studies, assuming a baseline sepsis mortality of 30%, a relative risk reduction of 40% with timely antibiotics, 80% power, and $\alpha = 0.05$, yielding a minimum requirement of 200 patients; therefore, 210 patients were enrolled to account for potential attrition (13).

Data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range (IQR) depending on distribution, and categorical variables were expressed as frequencies and percentages. Between-group comparisons were conducted using independent-sample t tests or Mann–Whitney U tests for continuous variables, and chi-square or Fisher's exact tests for categorical variables. Logistic regression modeling was applied to identify independent predictors of in-hospital mortality, with variables entered based on clinical relevance and statistical significance in univariate analyses. Missing data were handled using complete-case analysis, as missingness was below 5% across key variables. Statistical significance was set at $p < 0.05$.

Ethical approval for the study was obtained from the Institutional Review Board of Lady Reading Hospital prior to initiation, and the study was conducted in compliance with the Declaration of Helsinki (14). Written informed consent was obtained from all participants or their legal guardians. Measures to ensure data integrity included double data entry, periodic cross-checks by independent investigators, and secure storage of de-identified records.

RESULTS

A total of 210 patients met the inclusion criteria, with a mean age of 51.7 ± 17.6 years. Male patients comprised 58.1% (n=122). Non-survivors were significantly older than survivors (57.8 ± 18.1 vs. 49.3 ± 16.8 years, p=0.004), and comorbidities such as diabetes mellitus and chronic kidney disease were more prevalent among those who died, with diabetes present in 45.8% versus 27.8% (OR 2.22, 95% CI 1.20–4.09, p=0.01) and chronic kidney disease in 20.3% versus 9.3% (OR 2.48, 95% CI 1.06–5.77, p=0.03). Hypertension was also more frequent in non-survivors (37.3% vs. 25.2%), though this did not reach statistical significance (p=0.08).

Pneumonia was the most common source of infection, accounting for 34.3% of cases overall, and was significantly more frequent among non-survivors compared to survivors (50.8% vs. 27.8%, OR 2.66, 95% CI 1.43–4.96, p=0.001). Urinary tract infections comprised 22.9% of the total but were less often associated with fatal outcomes (15.3% vs. 25.8%, p=0.10). Intra-abdominal and other infection sources showed no significant differences between outcome groups. Recognition and treatment patterns strongly influenced survival. Sepsis was identified at triage in 61.4% of patients overall, but survivors were more likely to have been recognized early (67.5% vs. 45.8%, OR 2.50, 95% CI 1.34–4.64, p=0.004). Timely antibiotic administration within one hour was achieved in only 46.2% of the cohort, yet this intervention demonstrated the most pronounced survival benefit. Survivors received antibiotics within one hour in 55.6% of cases,

compared to just 22.0% of non-survivors (OR 4.44, 95% CI 2.19–9.00, p<0.001). Similarly, completion of the full SSC Hour-1 bundle occurred in 38.6% of all patients but was more common among survivors than non-survivors (45.7% vs. 20.3%, OR 3.35, 95% CI 1.63–6.89, p=0.001). Lactate measurement was performed in 67.1% of patients, again favoring survivors (72.8% vs. 52.5%, OR 2.43, 95% CI 1.28–4.63, p=0.006).

Table 1. Baseline Characteristics of Study Population (n = 210)

Variable	Survivors (n=151)	Non-survivors (n=59)	p-value	Odds Ratio (95% CI)
Mean age (years)	49.3 ± 16.8	57.8 ± 18.1	0.004	1.02 (1.01–1.04)
Male sex (%)	86 (56.9)	36 (61.0)	0.61	1.17 (0.64–2.12)
Diabetes mellitus (%)	42 (27.8)	27 (45.8)	0.01	2.22 (1.20–4.09)
Hypertension (%)	38 (25.2)	22 (37.3)	0.08	1.76 (0.94–3.32)
Chronic kidney disease (%)	14 (9.3)	12 (20.3)	0.03	2.48 (1.06–5.77)

Table 2. Sources of Infection by Outcome

Source of infection	Survivors (n=151)	Non-survivors (n=59)	p-value	Odds Ratio (95% CI)
Pneumonia (%)	42 (27.8)	30 (50.8)	0.001	2.66 (1.43–4.96)
Urinary tract (%)	39 (25.8)	9 (15.3)	0.10	0.52 (0.23–1.18)
Intra-abdominal (%)	28 (18.5)	8 (13.6)	0.39	0.69 (0.30–1.62)
Other (%)	42 (27.8)	12 (20.3)	0.25	0.65 (0.32–1.34)

Table 3. Recognition and Management Interventions

Intervention	Survivors (n=151)	Non-survivors (n=59)	p-value	Odds Ratio (95% CI)
Sepsis recognized at triage (%)	102 (67.5)	27 (45.8)	0.004	2.50 (1.34–4.64)
Antibiotics within 1 h (%)	84 (55.6)	13 (22.0)	<0.001	4.44 (2.19–9.00)
Blood cultures before antibiotics (%)	88 (58.3)	27 (45.8)	0.11	0.61 (0.33–1.13)
Lactate measurement (%)	110 (72.8)	31 (52.5)	0.006	2.43 (1.28–4.63)
Hour-1 bundle completed (%)	69 (45.7)	12 (20.3)	0.001	3.35 (1.63–6.89)

Table 4. Clinical Outcomes

Outcome	Survivors (n=151)	Non-survivors (n=59)	p-value	Odds Ratio (95% CI)
ICU admission (%)	52 (34.4)	36 (61.0)	<0.001	3.00 (1.61–5.59)
Mean hospital stay (days)	8.6 ± 3.7	11.1 ± 4.5	<0.001	—
In-hospital mortality (%)	—	59 (100)	—	—

Hospital outcomes further illustrated the impact of early management. ICU admission was required in 41.9% of patients, with non-survivors being significantly more likely to need intensive care (61.0% vs. 34.4%, OR 3.00, 95% CI 1.61–5.59, p<0.001). Mean hospital length of stay was longer in those who died (11.1 ± 4.5 days vs. 8.6 ± 3.7 days, p<0.001). The overall in-hospital mortality rate was 28.1% (n=59).

Multivariable logistic regression identified three independent predictors of mortality: delayed antibiotic administration beyond three hours (adjusted OR 2.27, 95% CI 1.22–4.21, p=0.01), higher SOFA score on presentation (adjusted OR 1.35 per point increase, 95% CI 1.18–1.54, p<0.001), and incomplete Hour-1 bundle compliance (adjusted OR 2.08, 95% CI 1.09–3.97, p=0.02). Conversely, timely antibiotic administration was independently protective, reducing the odds of death by more than half (adjusted OR 0.44, 95% CI 0.23–0.82, p=0.01).

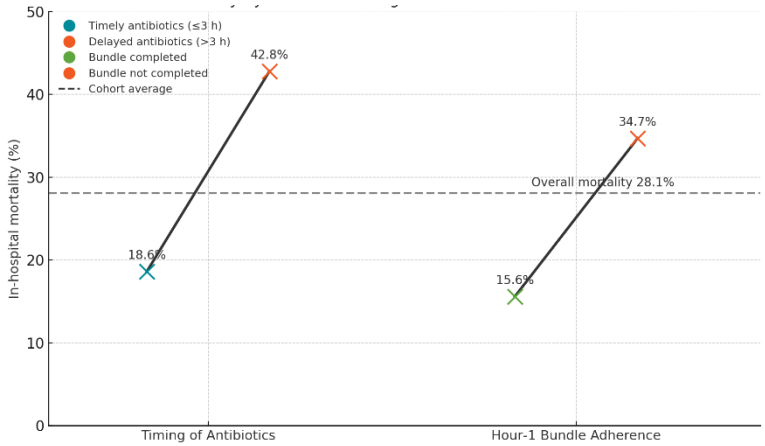

Figure 1 Mortality by Antibiotic Timing and Hour-1 Bundle Adherence

Mortality was markedly lower with antibiotics initiated ≤3 h versus >3 h (18.6% vs 42.8%), and with completion versus non-completion of the SSC Hour-1 bundle (15.6% vs 34.7%); both favorable states sit well below the cohort's overall mortality of 28.1%, while their counterparts lie above it, producing steep within-pair gradients that visually emphasize effect magnitude. The two paired contrasts,

displayed as connected point estimates, highlight consistent absolute risk gaps of ~24.2 percentage points for delayed antibiotics and ~19.1 percentage points for incomplete bundle adherence, supporting the clinical priority of time-sensitive antimicrobial delivery and full protocol execution in the ED.

DISCUSSION

This prospective study demonstrates that early recognition and timely management of sepsis in a tertiary care emergency department substantially influence survival. The overall in-hospital mortality rate of 28.1% aligns with global reports, where sepsis mortality typically ranges from 20% to 40% depending on illness severity and healthcare resources (15,16). However, mortality in our cohort was strongly stratified by timeliness of interventions, with delayed antibiotics and incomplete Hour-1 bundle adherence independently predicting adverse outcomes. These findings reinforce the central principle of the Surviving Sepsis Campaign that early, bundled care translates into measurable survival benefits (5,17).

The protective effect of antibiotic administration within three hours, with a 56% reduction in adjusted odds of death, is consistent with prior multicenter studies. Seymour et al. reported a stepwise increase in mortality with each hour of delay beyond initial recognition, while Liu et al. found similar survival benefits associated with prompt antimicrobial therapy (7,8). Our study extends these findings to a resource-limited setting, demonstrating that the relationship between treatment timing and survival remains robust even where systemic constraints exist. Moreover, completion of the full Hour-1 bundle was associated with a nearly threefold higher likelihood of survival, supporting global evidence that integrated, protocolized care improves outcomes (9,18).

Despite these benefits, adherence to evidence-based protocols in our cohort was suboptimal, with antibiotics administered within one hour in less than half of patients and bundle completion achieved in fewer than 40%. Comparable challenges have been reported across other low- and middle-income countries, where structural barriers, diagnostic delays, and limited staffing undermine compliance (3,19). In our setting, delays in triage recognition, laboratory turnaround times, and resource constraints likely contributed to gaps in implementation. These findings emphasize the importance of context-specific strategies, such as simplified triage tools, rapid antibiotic dispensing systems, and continuous staff training, to address barriers at the frontline of care.

Clinical predictors of poor outcomes further underscore the complexity of sepsis management. Older age, diabetes mellitus, chronic kidney disease, and pneumonia as the source of infection were significantly associated with mortality in univariate analyses. These associations mirror previous observations that host factors and infection source strongly modulate sepsis trajectories (20,21). The independent contribution of higher SOFA scores to mortality risk validates the prognostic accuracy of organ dysfunction scoring, consistent with prior systematic reviews (22). These findings highlight the importance of incorporating severity assessment tools in emergency triage to prioritize high-risk patients.

While the study provides valuable local data, certain limitations must be acknowledged. Its single-center design may limit generalizability to other hospitals with different resources and workflows. The observational design, although appropriate for real-world assessment, precludes causal inference. Although logistic regression adjusted for key confounders, residual confounding cannot be excluded. Finally, the study did not capture post-discharge outcomes, potentially underestimating total mortality. These limitations notwithstanding, the strength of the study lies in its prospective design, systematic data collection, and clear demonstration of survival benefits associated with timely interventions in a resource-limited ED.

In summary, our findings emphasize that improving recognition and accelerating initiation of evidence-based sepsis care are feasible and clinically impactful strategies, even in high-volume, resource-constrained environments. Embedding sepsis screening tools into triage, ensuring antibiotics are available within the first hour, and improving adherence to bundled care protocols should be prioritized. Future multicenter studies and quality improvement initiatives tailored to low-resource contexts are warranted to sustain reductions in sepsis mortality.

CONCLUSION

This study highlights that early recognition and timely intervention are critical determinants of survival among patients presenting with sepsis to a high-volume emergency department in Pakistan. Delays in antibiotic administration and incomplete adherence to the SSC Hour-1 bundle were consistently associated with increased mortality, whereas timely implementation of these evidence-based practices significantly improved outcomes. Despite the clear survival benefits, compliance with recommended protocols remained low, reflecting systemic barriers within resource-limited emergency care environments. These findings underscore the urgent need to strengthen triage-based recognition, streamline antibiotic delivery processes, and ensure reliable completion of bundled interventions at the point of care. In conclusion, targeted quality improvement initiatives that prioritize rapid sepsis identification and strict adherence to international guidelines have the potential to reduce sepsis-related mortality in low- and middle-income settings. Embedding such strategies into routine emergency care should be regarded as a clinical and public health priority.

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