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| RESEARCH ARTICLE

Early Recognition and Treatment of Sepsis and Its Impact on Mortality and ICU Outcomes: A Retrospective Cohort Study from Gaza, Palestine

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| ABSTRACT

Sepsis remains a leading cause of intensive care unit (ICU) admission and in-hospital mortality worldwide, with a disproportionately high burden in low-resource and conflict-affected settings. Early recognition and timely initiation of evidence-based management—particularly antimicrobial therapy and fluid resuscitation—are critical determinants of survival. However, data describing the epidemiology, management delays, and outcomes of sepsis in Gaza are scarce. To determine the prevalence of sepsis among adult internal medicine admissions at a tertiary hospital in Gaza, Palestine, and to examine the association between early recognition, treatment delays, and key clinical outcomes, including mortality, ICU transfer, and length of hospital stay.A retrospective cohort study was conducted including all adult patients admitted to the Internal Medicine Department at tertiary hospital between 3 August 2025 and 31 December 2025. Sepsis was defined as suspected or confirmed infection with evidence of acute organ dysfunction documented in the medical record. Primary outcomes were in-hospital mortality and ICU transfer; length of hospital stay was a secondary outcome. Multivariable logistic and linear regression analyses were performed using SPSS version 27.During the study period, 3,699 adult patients were admitted to the Internal Medicine Department at tertiary hospital of these, 2,145 patients (58.0%) fulfilled the clinical criteria for sepsis based on documented infection and evidence of acute organ dysfunction. Figure 1 illustrates the patient flow and classification according to sepsis status.Septic patients were significantly older than non-septic patients (mean age 57.8 ± 14.2 years vs. 53.5 ± 12.1 years, $p < 0.001$). A higher proportion of septic patients had two or more chronic comorbidities (60.0% vs. 25.0%, $p < 0.001$). Sex distribution was comparable between the two groups, with no statistically significant difference observed (Table 1).When stratified by age group, mortality increased progressively with advancing age among septic patients: 21.4% in patients aged 18–39 years, 32.7% in those aged 40–59 years, and 48.9% in patients aged ≥60 years ($p < 0.001$). The median time from documented sepsis recognition to initiation of antibiotic therapy was 2.6 hours (IQR 1.4–4.8). Septic patients who received antibiotics within 1 hour of recognition had significantly lower in-hospital mortality compared with those treated after more than 3 hours (24.3% vs. 44.8%, $p < 0.001$). A stepwise increase in mortality was observed with increasing delays in antibiotic administration (Figure 2). Septic patients experienced substantially worse outcomes than non-septic patients. In-hospital mortality among septic patients was 37.5% compared with 15.8% in non-septic patients ($p < 0.001$). ICU transfer occurred in 50.0% of septic patients versus 14.0% of non-septic patients ($p < 0.001$). The mean length of hospital stay was significantly longer in the sepsis group (14.8 ± 5.2 days) compared with the non-sepsis group (8.1 ± 4.0 days; $p < 0.001$) (Table 2). Among septic patients, those requiring ICU transfer had markedly higher mortality than those managed exclusively on the medical ward (49.6% vs. 25.1%, $p < 0.001$), reflecting more advanced disease severity at presentation or delayed escalation of care. Multivariable logistic regression analysis identified increasing age (OR 1.04 per year, 95% CI 1.02–1.07), presence of ≥2 comorbidities (OR 3.80, 95% CI 2.40–6.10), delayed

antibiotic administration (OR 1.30 per hour, 95% CI 1.15–1.48), and ICU transfer (OR 2.90, 95% CI 1.95–4.20) as independent predictors of in-hospital mortality (Table 3). Linear regression analysis demonstrated that ICU transfer (+6.0 days), presence of multiple comorbidities (+2.8 days), and delayed antibiotic initiation (+1.2 days per hour) were independently associated with prolonged hospitalization (Table 4).

| KEYWORDS
Sepsis; early recognition; antibiotic timing; fluid resuscitation; ICU transfer; mortality; length of stay; retrospective cohort.

| ARTICLE INFORMATION

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Introduction

Sepsis is a life-threatening condition characterized by organ dysfunction resulting from a dysregulated host response to infection [1]. Despite advances in antimicrobial therapy, critical care, and supportive management, sepsis remains one of the leading causes of morbidity and mortality globally, accounting for an estimated 11 million deaths annually [5]. The burden of sepsis is particularly pronounced in low- and middle-income countries (LMICs), where healthcare systems often face constraints related to workforce shortages, limited diagnostic capacity, delayed access to care, and inadequate critical care infrastructure [2,5].

Early recognition and timely initiation of appropriate treatment are the cornerstones of sepsis management. International guidelines, including the Surviving Sepsis Campaign, emphasize the importance of rapid identification, prompt administration of broad-spectrum antibiotics, early fluid resuscitation, and close monitoring for organ dysfunction [2,3]. Multiple studies have demonstrated a strong time-dependent relationship between delays in antibiotic administration and increased mortality, with each hour of delay associated with a measurable rise in the risk of death [3,6].

Advanced age and the presence of multiple comorbidities further increase susceptibility to sepsis and worsen clinical outcomes. Elderly patients often present with atypical symptoms, contributing to diagnostic delays, while comorbid conditions such as diabetes, cardiovascular disease, and chronic kidney disease predispose patients to both infection and organ failure [7,8]. In addition, the need for ICU transfer frequently reflects severe disease and is associated with poor prognosis, especially when critical care resources are limited [9].

In Gaza, ongoing political instability, recurrent conflict, and resource constraints have placed extraordinary pressure on the healthcare system. Hospitals frequently operate beyond capacity, with shortages of medications, diagnostic tools, and trained personnel. Despite these challenges, data on the epidemiology and outcomes of sepsis in Gaza remain limited. Understanding the local burden of disease, patterns of care, and modifiable factors such as treatment delays is essential for guiding quality improvement initiatives and informing policy decisions.

Therefore, this study aimed to (1) determine the prevalence of sepsis among adult internal medicine admissions at a major tertiary hospital in Gaza, Palestine; (2) compare clinical outcomes between septic and non-septic patients; and (3) assess the impact of early recognition and treatment delays on mortality, ICU transfer, and length of hospital stay.

Methods

Study Design and Setting

This retrospective cohort study was conducted at the Internal Medicine Department of tertiary hospital, a major tertiary referral hospital serving the southern Gaza Strip. The hospital provides secondary and tertiary care services, including limited intensive care capacity, to a large and densely populated catchment area.

Study Population

All adult patients (aged ≥18 years) admitted to the Internal Medicine Department between 3 August 2025 and 31 December 2025 were eligible for inclusion. A total of 3,699 admissions were reviewed. Patients with incomplete records for key outcome variables were excluded from multivariable analyses.

Definition of Sepsis

Sepsis was defined pragmatically as suspected or confirmed infection accompanied by evidence of acute organ dysfunction, as documented by the treating physician in the medical record. Indicators of organ dysfunction included abnormal vital signs, laboratory abnormalities (e.g., acute kidney injury, elevated liver enzymes), altered mental status, or documented respiratory, cardiovascular, renal, or hepatic failure. Formal Sequential Organ Failure Assessment (SOFA) scoring was not consistently available due to resource limitations; therefore, a clinically pragmatic definition was adopted, consistent with practices in similar low-resource settings [10].

Data Collection

Data were extracted from electronic and paper-based medical records using a standardized data collection form. Variables included demographic characteristics (age, sex), presence of two or more chronic comorbidities, sepsis diagnosis, time from documented sepsis recognition to initiation of antibiotic therapy (hours), administration of fluid resuscitation, ICU transfer, in-hospital mortality, and length of hospital stay (days).

Outcomes

The primary outcomes were in-hospital mortality and ICU transfer. The secondary outcome was length of hospital stay.

Statistical Analysis

Statistical analysis was performed using SPSS version 27. Continuous variables were summarized as mean ± standard deviation or median with interquartile range, as appropriate, and compared using the Mann–Whitney U test. Categorical variables were compared using the Chi-square test. Multivariable logistic regression was used to identify independent predictors of in-hospital mortality, while linear regression analysis was employed to assess predictors of length of hospital stay. ICU transfer was included in regression models as a proxy indicator of disease severity. A p-value <0.05 was considered statistically significant**.**

Results

Baseline Characteristics

Of the 3,699 patients included, 2,145 (58.0%) met the criteria for sepsis. Septic patients were significantly older than non-septic patients (57.8 ± 14.2 vs. 53.5 ± 12.1 years, $p < 0.001$) and were more likely to have two or more chronic comorbidities (60.0% vs. 25.0%, $p < 0.001$). The distribution of sex did not differ significantly between groups (Table 1).

Clinical Outcomes

Septic patients experienced markedly worse clinical outcomes compared with non-septic patients. In-hospital mortality was more than twice as high among septic patients (37.5% vs. 15.8%, $p < 0.001$). ICU transfer occurred in half of septic patients compared with only 14.0% of non-septic patients ($p < 0.001$). The mean length of hospital stay was significantly longer in the sepsis group (14.8 ± 5.2 days vs. 8.1 ± 4.0 days, $p < 0.001$) (Table 2).

Predictors of In-Hospital Mortality

Multivariable logistic regression analysis identified several factors independently associated with increased risk of in-hospital mortality. Increasing age, presence of two or more comorbidities, delayed initiation of antibiotic therapy, and ICU transfer were all significant predictors of death (Table 3). Each hour of delay in antibiotic administration was associated with a 30% increase in the odds of mortality.

Length of Hospital Stay

Linear regression analysis demonstrated that ICU transfer, multiple comorbidities, and delayed antibiotic initiation were independently associated with prolonged hospitalization. ICU transfer was associated with an average increase of six additional hospital days (Table 4).

Discussion

This large retrospective cohort study demonstrates that sepsis constitutes a substantial proportion of internal medicine admissions at a tertiary hospital in Gaza and is associated with alarmingly high in-hospital mortality, frequent ICU utilization, and prolonged hospitalization. More than half of all admissions met criteria for sepsis, underscoring the immense burden of infectious disease and acute organ dysfunction in this resource-constrained, conflict-affected setting.

The observed in-hospital mortality rate of 37.5% among septic patients is considerably higher than rates reported in high-income countries, where mortality typically ranges from 15% to 25% [5,9]. This disparity likely reflects delayed presentation, limited diagnostic and monitoring capacity, intermittent shortages of antimicrobials, and constrained ICU resources. Similar mortality rates have been reported in other low-resource and humanitarian settings, reinforcing the external validity of our findings.

A key finding of this study is the strong, time-dependent association between delayed antibiotic administration and adverse outcomes. Each hour of delay increased the odds of death by 30%, consistent with prior landmark studies demonstrating the critical importance of early antimicrobial therapy in sepsis and septic shock [3-6]. Patients receiving antibiotics within one hour of sepsis recognition had substantially lower mortality than those treated after prolonged delays, highlighting a clear and modifiable target for quality improvement.

Advanced age and multimorbidity were also independently associated with increased mortality and longer hospital stays. Elderly patients often present with atypical manifestations of infection and may experience delays in diagnosis, while chronic comorbidities reduce physiological reserve and increase vulnerability to organ dysfunction [7,8]. These findings emphasize the need for heightened vigilance and early screening in high-risk populations.

The high rate of ICU transfer among septic patients likely reflects late recognition and advanced disease severity rather than ICU admission being a direct cause of mortality. In settings with limited ICU capacity, delayed escalation of care may occur only after significant clinical deterioration. Implementation of ward-based sepsis screening tools, early warning scores, and standardized escalation pathways could facilitate earlier intervention and potentially reduce the need for ICU transfer.

Overall, this study provides important locally generated evidence supporting the implementation of standardized sepsis protocols, including rapid triage, early antibiotic administration, and structured monitoring, even in highly resource-limited environments.

Limitations

This study has several limitations. Its retrospective, single-center design limits generalizability and precludes causal inference. The absence of standardized severity scoring systems such as SOFA or APACHE II may have resulted in residual confounding. Data accuracy depended on the completeness of medical record documentation. Despite these limitations, the large sample size and focus on a resource-limited, conflict-affected setting provide valuable insights.

Conclusions

Sepsis is highly prevalent among internal medicine admissions at Nasser Hospital in Gaza and is associated with substantial in-hospital mortality, frequent ICU transfer, and prolonged hospitalization. Delays in recognition and initiation of antimicrobial therapy significantly worsen outcomes. Early identification of sepsis and prompt protocolized management represent achievable and high-impact interventions that could meaningfully reduce sepsis-related morbidity and mortality in Gaza and similar low-resource settings.

Declarations

Ethics approval and consent to participate: Approved by the Local Ethics Committee of tertiary hospital.
Consent for publication: Not applicable.
Data availability: Data are available from the corresponding author upon reasonable request.
Competing interests: The authors declare no competing interests.
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Authors' contributions: SJS conceived and designed the study and supervised data collection. MJAA, AB and GA contributed to data analysis and manuscript drafting. All authors reviewed and approved the final manuscript.
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Tables:

Table 1. Baseline characteristics of septic and non-septic patients

Characteristic	Septic (n = 2,145)	Non-septic (n = 1,554)	p-value
Age, years (mean ± SD)	57.8 ± 14.2	53.5 ± 12.1	<0.001
Male sex, n (%)	925 (43.1)	674 (43.4)	0.88
Female sex, n (%)	1,220 (56.9)	880 (56.6)	—
≥2 comorbidities, n (%)	1,287 (60.0)	389 (25.0)	<0.001

Table 2. Clinical outcomes

Outcome	Septic (n = 2,145)	Non-septic (n = 1,554)	p-value
In-hospital mortality, n (%)	804 (37.5)	245 (15.8)	<0.001
ICU transfer, n (%)	1,071 (50.0)	217 (14.0)	<0.001
Length of stay, days (mean ± SD)	14.8 ± 5.2	8.1 ± 4.0	<0.001

Table 3. Multivariable logistic regression – mortality predictors

Variable	OR	95% CI	p-value
Age (per year)	1.04	1.02–1.07	0.001
≥2 comorbidities	3.80	2.40–6.10	<0.001
Delayed antibiotics (per hour)	1.30	1.15–1.48	<0.001
ICU transfer	2.90	1.95–4.20	<0.001

Table 4. Linear regression – length of stay predictors

Predictor	Coefficient (B)	95% CI	p-value
ICU transfer	+6.0 days	4.9–7.2	<0.001
≥2 comorbidities	+2.8 days	1.3–4.1	0.01
Delayed antibiotics (per hour)	+1.2 days	0.4–2.0	0.01

Figure 1. Flow diagram of adult internal medicine admissions at Nasser Hospital (August–December 2025)

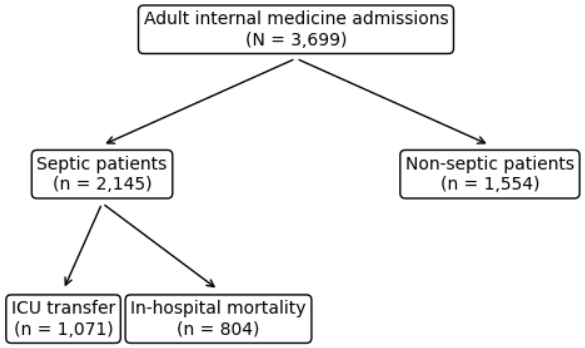

Figure 1. Flow diagram of the study population and clinical outcomes.
Adult patients admitted to the Internal Medicine Department at Nasser Hospital between August and December 2025 were screened for sepsis. Patients were categorized as septic or non-septic, and outcomes among septic patients, including ICU transfer and in-hospital mortality, are shown.

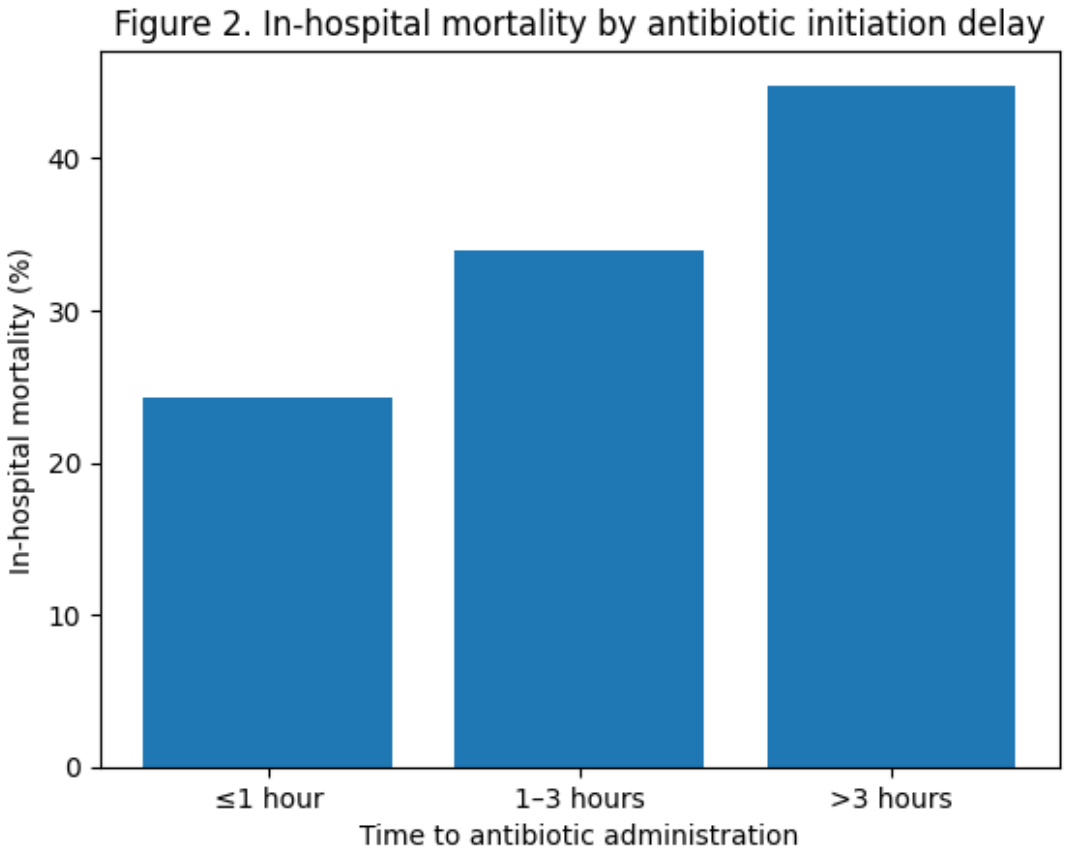

Figure 2. In-hospital mortality among septic patients according to time to antibiotic administration. Mortality rates are stratified by time from sepsis recognition to initiation of antibiotic therapy (≤1 hour, 1–3 hours, >3 hours), demonstrating increased mortality with longer delays