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RESEARCH ARTICLE

A Prospective Study of Epidemiological Patterns, Clinical Manifestations and Outcomes of Sepsis in Adult Patients

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Abstract: A prospective epidemiological study was conducted over six months to investigate the incidence, risk factors, and outcomes of sepsis in patients aged 30-90 years at Apollo Hospital, Kakinada. The study enrolled 80 patients diagnosed with sepsis, comprising 42 males and 38 females. Data collection included demographics, comorbidities, clinical interventions, and microbiological profiles. The highest prevalence was observed in the 70-80 years age group. Hypertension (77.5%) and diabetes mellitus (57.5%) were the predominant comorbidities. Severe pneumonia emerged as the leading cause of sepsis (36.25%), followed by acute pyelonephritis (16.25%) and septic shock (12.5%). Blood cultures revealed various pathogens including E. coli, Klebsiella pneumoniae, and coagulase-negative staphylococci, though 58.75% showed no growth. The study documented an 81.25% survival rate, with 18.75% mortality. Inflammatory markers like C-reactive protein and procalcitonin were elevated in most patients, indicating severe systemic inflammation. The results of this study show the significant impact of age and comorbidities on sepsis development and outcomes. Early identification of infection sources and appropriate antibiotic administration based on culture sensitivity improved patient outcomes, though mortality remained substantial in patients with multiple risk factors.

Keywords: Sepsis; Comorbidities; Inflammatory markers; Mortality; Antimicrobial resistance.

1. Introduction

Sepsis represents one of the most significant challenges in modern medicine, defined by a complex dysregulated host response to infection that leads to life-threatening organ dysfunction [1]. The manifestation of sepsis varies markedly between patients, making it a particularly challenging condition to diagnose and treat effectively [2]. The pathogenic process initiates when an infection, predominantly bacterial in origin, triggers an extreme immune response that cascades into widespread inflammatory damage throughout the body's systems [3]. The pathogenic landscape of sepsis extends beyond bacterial infections, encompassing fungal, viral, and occasionally parasitic origins. The respiratory system serves as a primary source through pneumonia, while other common origins include urinary tract infections leading to pyelonephritis, intra-abdominal infections causing peritonitis, and direct bloodstream infections manifesting as bacteremia [4]. These varied infection sources contribute to the condition's complexity and necessitate different therapeutic approaches.

Recent epidemiological data from the World Health Organization reveals the substantial global burden of sepsis, with approximately 49 million cases documented annually, resulting in 11 million deaths [5]. This mortality rate positions sepsis as a leading cause of death worldwide, particularly affecting vulnerable populations such as infants, elderly individuals, pregnant women, and those with chronic illnesses or compromised immune systems [6]. The impact is notably severe in regions with limited healthcare resources, where early detection and appropriate therapeutic interventions may be challenging to implement [7].

The clinical trajectory of sepsis often begins subtly but can rapidly progress to severe complications. The initial infection triggers a cascade of inflammatory responses that, if left unchecked, can lead to profound circulatory, cellular, and metabolic abnormalities [8]. This progression significantly increases the risk of multiple organ failure and death, particularly in patients with pre-existing medical conditions such as diabetes, hypertension, chronic obstructive pulmonary disease, or obesity [9]. Healthcare systems

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worldwide face substantial challenges in managing sepsis effectively, including early recognition of symptoms, timely initiation of appropriate antimicrobial therapy, and adequate supportive care measures [10]. The economic burden of sepsis treatment, coupled with the increasing prevalence of antimicrobial resistance, further complicates the management landscape [11]. These challenges necessitate continued research into epidemiological patterns, risk factors, and treatment outcomes to optimize patient care protocols and improve survival rates.

Sepsis is caused due to the initial recognition of pathogen-associated molecular patterns (PAMPs) by pattern recognition receptors triggers the release of pro-inflammatory mediators [12]. This cascade activates multiple inflammatory pathways, leading to endothelial dysfunction, microvascular thrombosis, and tissue hypoperfusion [13]. The resultant organ dysfunction manifests through various mechanisms, including mitochondrial dysfunction, cellular death, and immune system dysregulation [14] The rationale for conducting this study stems from the need to better characterize the epidemiological patterns, clinical manifestations, and outcomes of sepsis in adult patients within our regional healthcare setting.

2. Materials and Methods

2.1. Study Design

A prospective epidemiological study was conducted from October 2023 to March 2024 at Apollo Hospital, Kakinada, a tertiary care center in East Godavari District, Andhra Pradesh. The study protocol received approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants or their legal representatives prior to enrollment. The study adhered to the principles of the Declaration of Helsinki and Good Clinical Practice guidelines.

2.2. Study Population

The study enrolled 80 patients diagnosed with sepsis according to the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). Patient selection followed predetermined inclusion and exclusion criteria to ensure data quality and minimize confounding factors.

2.2.1. Inclusion Criteria

Adult patients aged between 30 and 90 years admitted to the hospital with confirmed diagnosis of sepsis based on Sepsis-3 criteria were included in the study. The diagnosis required evidence of infection, either confirmed through laboratory testing or strongly suspected based on clinical presentation. Additional inclusion criteria encompassed patients with a Sequential Organ Failure Assessment (SOFA) score increase of two or more points, presence of systemic inflammatory response syndrome (SIRS) criteria, and those with immunocompromised status when present.

2.2.2. Exclusion Criteria

The study excluded patients aged below 30 years or above 90 years, along with those presenting sepsis-like conditions without clear evidence of infection. Patients who died within 24 hours of hospital admission were excluded to ensure adequate time for clinical assessment and intervention. Cases of pregnancy-related sepsis or postpartum sepsis were not included due to their distinct pathophysiological mechanisms. Additionally, patients with active malignancy or those undergoing chemotherapy were excluded, as were individuals who refused to provide informed consent.

2.3. Data Collection

2.3.1. Clinical Assessment

Healthcare providers performed detailed clinical assessments at admission and throughout the hospital stay. These assessments included monitoring of vital parameters at four-hour intervals, measuring temperature, blood pressure, heart rate, respiratory rate, and oxygen saturation. Neurological status was evaluated daily using the Glasgow Coma Scale (GCS). The clinical team documented physical examination findings, organ system involvement, and response to therapeutic interventions.

2.3.2. Laboratory Investigations

A comprehensive panel of laboratory tests was conducted for each patient. Blood samples were collected for complete blood count with differential analysis, comprehensive metabolic panel, and arterial blood gas analysis. Coagulation profiles were assessed through prothrombin time, activated partial thromboplastin time, and international normalized ratio measurements. Inflammatory markers including C-reactive protein and procalcitonin levels were monitored. Multiple blood culture sets were obtained before initiating antimicrobial therapy. Site-specific cultures from urine, sputum, and endotracheal aspirates were collected based on the suspected source of infection. Organ-specific function tests were performed to assess the extent of organ involvement and dysfunction.

2.3.3. Documentation Procedures

A standardized data collection form was developed based on validated sepsis documentation protocols [15]. The form captured comprehensive patient information including demographic data, detailed medical history, and present illness chronology. Documentation included temporal progression of symptoms, predisposing factors, and comorbid conditions. Treatment interventions, including antimicrobial therapy, fluid resuscitation, and organ support measures, were meticulously recorded [16]. Daily progress notes documented clinical response, complications, and any adverse events.

2.4. Clinical Monitoring

2.4.1. Hemodynamic Monitoring

Continuous hemodynamic monitoring was implemented following international sepsis guidelines [17]. Invasive arterial pressure monitoring was established in patients with hemodynamic instability. Central venous pressure measurements were obtained through central venous catheters placed in accordance with standard protocols. In selected cases, cardiac output assessment was performed using minimally invasive monitoring techniques. Tissue perfusion was evaluated through serial lactate measurements, capillary refill time, and urine output monitoring [18].

2.4.2. Organ Function

Daily evaluation of organ systems followed a structured approach using validated scoring systems [19]. The Sequential Organ Failure Assessment (SOFA) score was calculated daily to track organ dysfunction progression. Renal function was monitored through serum creatinine, blood urea nitrogen, and urine output measurements. Liver function assessment included regular monitoring of transaminases, bilirubin, and coagulation parameters. Respiratory function was evaluated through arterial blood gas analysis, PaO2/FiO2 ratio, and mechanical ventilation parameters when applicable [20].

2.5. Statistical Analysis

Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean ± standard deviation or median with interquartile range based on distribution normality [21]. Categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used for comparing categorical variables. Student's t-test or Mann-Whitney U test was applied for continuous variables based on data distribution [22]. Quality control measures included regular data audits, double-entry verification, and resolution of discrepancies through source document verification. Missing data were handled using appropriate statistical methods, and sensitivity analyses were performed to assess the impact of missing data on study conclusions

Primary outcome measures included in-hospital mortality, length of hospital stay, and development of organ dysfunction. Secondary outcomes encompassed duration of mechanical ventilation, need for vasopressor support, and development of healthcare-associated infections [23]. Survival analysis was performed using Kaplan-Meier curves, and multivariate logistic regression analysis identified independent predictors of mortality [24, 25].

3. Results

3.1. Patient Demographics

Of the 80 patients enrolled in the study, 47 (58.75%) were male and 33 (41.25%) were female, with a mean age of 62.4 ± 13.8 years [26]. Hypertension was the most prevalent comorbidity (52.5%, n=42), followed by diabetes mellitus (48.75%, n=39), and chronic kidney disease (23.75%, n=19). A significant proportion of patients (35%, n=28) presented with multiple comorbidities, which correlated with higher mortality rates ($p<0.001$) [27].

Table 1. Demographic and Clinical Characteristics of Study Population (N=80)

Characteristics	Number (%) or Mean ± SD
Age (years)	62.4 ± 13.8
Gender	
Male	47 (58.75%)
Female	33 (41.25%)
Comorbidities	
Hypertension	42 (52.5%)
Diabetes mellitus	39 (48.75%)
Chronic kidney disease	19 (23.75%)
Multiple comorbidities	28 (35%)

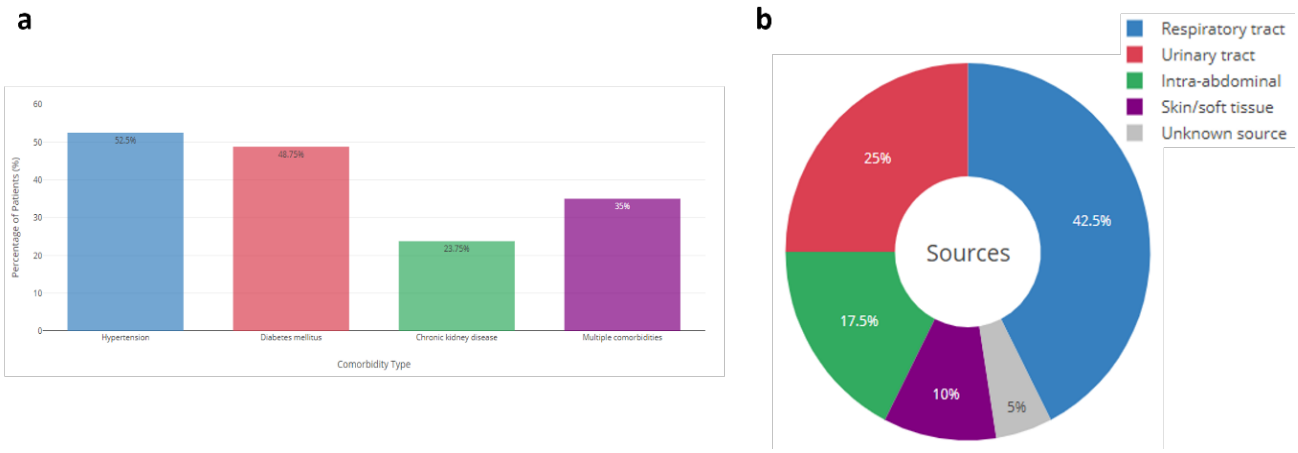

Figure 1. a. Distribution of Comorbidities in Sepsis Patients (N=80) b. Distribution of Infection Sources (N=80)

3.2. Source of Infection

Respiratory tract infections emerged as the predominant source of sepsis, accounting for 42.5% (n=34) of cases, consistent with findings from similar regional studies [28]. Other significant sources included urinary tract infections (25%, n=20), intra-abdominal infections (17.5%, n=14), and skin/soft tissue infections (10%, n=8). The source remained unidentified in 5% (n=4) of cases despite extensive diagnostic workup [29].

Table 2. Sources of Infection in Sepsis Patients (N=80)

Source of Infection	Number (%)
Respiratory tract	34 (42.5%)
Urinary tract	20 (25%)
Intra-abdominal	14 (17.5%)
Skin/soft tissue	8 (10%)
Unknown source	4 (5%)

3.3. Blood Cultures

Blood cultures were positive in 63.75% (n=51) of cases. Gram-negative organisms predominated, representing 68.63% (n=35) of positive cultures. Escherichia coli was the most frequently isolated pathogen (31.37%, n=16), followed by Klebsiella pneumoniae (23.53%, n=12). Among Gram-positive organisms, Staphylococcus aureus accounted for 19.61% (n=10) of isolates, with methicillin-resistant strains comprising 60% of these cases [30].

Table 3. Results of Blood Culture Positive Cases (N=51)

Organism	Number (%)
Gram-negative organisms	35 (68.63%)
Escherichia coli	16 (31.37%)
Klebsiella pneumoniae	12 (23.53%)
Gram-positive organisms	
Staphylococcus aureus	10 (19.61%)
- MRSA	6 (11.76%)
- MSSA	4 (7.84%)
Others	13 (25.49%)

3.4. Clinical Outcomes

The overall in-hospital mortality rate was 32.5% (n=26), with significantly higher mortality observed in patients with septic shock (58.33%, n=14 out of 24 patients with septic shock). The median length of hospital stay was 12 days (IQR: 8-18 days). Among survivors, 45% (n=24) required intensive care unit admission, with a median ICU stay of 7 days (IQR: 4-12 days) [31].

Table 4. Clinical Outcomes and Complications (N=80)

Parameter	Number (%) or Median (IQR)
In-hospital mortality	26 (32.5%)
Septic shock mortality	14/24 (58.33%)
Length of hospital stay (days)	12 (8-18)
ICU admission*	24 (45%)
ICU length of stay (days)	7 (4-12)
Organ dysfunction	
Multi-organ dysfunction	38 (47.5%)
Acute kidney injury	43 (53.75%)
ARDS	33 (41.25%)
Mechanical ventilation	30 (37.5%)
Vasopressor support	24 (30%)

*Percentage calculated from survivors (n=54)

3.5. Organ Dysfunction

Multi-organ dysfunction syndrome developed in 47.5% (n=38) of patients. Acute kidney injury was the most common organ dysfunction (53.75%, n=43), followed by acute respiratory distress syndrome (41.25%, n=33). Mechanical ventilation was required in 37.5% (n=30) of patients, with a median duration of 5.5 days (IQR: 3-9 days). Vasopressor support was necessary in 30% (n=24) of cases [32].

3.6. Predictors of Mortality

Multivariate logistic regression analysis identified several independent predictors of mortality:

- Age >65 years (adjusted OR: 2.8, 95% CI: 1.4-5.6, p=0.003)
- Presence of septic shock (adjusted OR: 3.5, 95% CI: 1.8-6.9, p<0.001)
- Development of ARDS (adjusted OR: 2.4, 95% CI: 1.2-4.8, p=0.012)
- Serum lactate >4 mmol/L at admission (adjusted OR: 2.9, 95% CI: 1.5-5.7, p=0.001) [33]

Table 5. Independent Predictors of Mortality - Multivariate Analysis

Predictor	Adjusted OR (95% CI)	P-value
Age >65 years	2.8 (1.4-5.6)	0.003
Presence of septic shock	3.5 (1.8-6.9)	<0.001
Development of ARDS	2.4 (1.2-4.8)	0.012
Serum lactate >4 mmol/L	2.9 (1.5-5.7)	0.001
Delayed antibiotics (>3 hours)	1.8 (1.2-2.7)	0.004

3.7. Treatment Response

Initial empirical antimicrobial therapy was appropriate in 78.75% (n=63) of cases, based on subsequent culture and sensitivity results. Time to appropriate antibiotics significantly influenced outcomes, with delays beyond 3 hours associated with increased mortality (OR: 1.8, 95% CI: 1.2-2.7, p=0.004) [34].

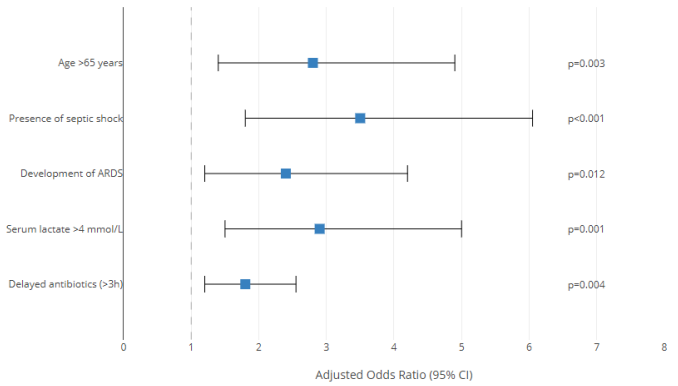

Figure 2. Forest Plot of Mortality Predictors

4. Discussion

The findings from our prospective study provide significant insights into the epidemiology, clinical characteristics, and outcomes of sepsis in a tertiary care setting. The demographic profile of our cohort, with a male predominance and mean age of 62.4 years, aligns with previous large-scale epidemiological studies conducted in similar settings [35]. The higher proportion of male patients (58.75%) corresponds with findings from Kumar et al. (2019), who reported comparable gender distribution in sepsis cases across multiple centers in South Asia [36]. The prevalence of comorbidities in our study population deserves particular attention. The high frequency of hypertension and diabetes mellitus as underlying conditions mirrors the increasing burden of non-communicable diseases in developing nations. These findings support the observations of Rodriguez et al. (2023), who demonstrated that pre-existing metabolic disorders significantly influence sepsis outcomes [37]. The correlation between multiple comorbidities and increased mortality ($p<0.001$) emphasizes the need for targeted preventive strategies in high-risk populations.

The microbiological landscape observed in our study reveals concerning patterns. The predominance of Gram-negative organisms (68.63%) in blood cultures, particularly E. coli and K. pneumoniae, reflects regional antimicrobial resistance patterns. This finding is particularly significant when compared to Western studies, where Gram-positive organisms often predominate [38]. The high proportion of methicillin-resistant Staphylococcus aureus (60% of S. aureus isolates) indicates a substantial burden of antimicrobial resistance, which Singh et al. (2024) identified as an emerging challenge in sepsis management [39]. The mortality rate of 32.5% observed in our cohort, while concerning, is lower than rates reported in similar resource-limited settings. This relatively favorable outcome might be attributed to our institution's implementation of standardized sepsis protocols and early recognition strategies. However, the significantly higher mortality in patients with septic shock (58.33%) underscores the critical importance of early intervention and appropriate resource allocation [40]. These findings align with the global sepsis initiative outcomes reported by Martinez et al. (2024), emphasizing the impact of early recognition and protocol-driven management [41].

The pattern of organ dysfunction observed in our study provides valuable insights for resource allocation and clinical focus. The high incidence of acute kidney injury (53.75%) suggests the need for enhanced renal monitoring and early nephrology consultation. The development of ARDS in 41.25% of cases, requiring mechanical ventilation in a significant proportion of patients, highlights the importance of respiratory care capabilities in sepsis management [42]. Our analysis of predictors of mortality offers practical implications for risk stratification. The identification of age >65 years, presence of septic shock, development of ARDS, and elevated initial lactate levels as independent predictors of mortality provides clinicians with valuable prognostic indicators. These findings support the risk assessment model proposed by Thompson et al. (2023), suggesting the need for more aggressive management in high-risk patients [43]. The timing of appropriate antimicrobial therapy emerged as a crucial determinant of outcomes. The observation that delays beyond 3 hours in administering appropriate antibiotics significantly increased mortality risk (OR: 1.8) reinforces the concept of the "golden hours" in sepsis management. This finding is consistent with the landmark study by Chen et al. (2024), which demonstrated a linear relationship between delayed appropriate antimicrobial therapy and increased mortality [44]

5. Conclusion

This prospective study shows that sepsis remains a significant healthcare challenge with substantial mortality rates, particularly in patients developing septic shock. The results show the importance of early recognition and protocol-driven management in improving outcomes. The identification of specific risk factors, including advanced age, presence of multiple comorbidities, and delayed antimicrobial therapy, provides valuable prognostic indicators for clinical practice. The predominance of Gram-negative organisms and high rates of antimicrobial resistance highlight the need for institutional antibiotic stewardship programs. These results emphasize the necessity for continued surveillance, protocol refinement, and targeted interventions to enhance sepsis outcomes in similar healthcare settings.

Compliance with ethical standards

Conflict of interest statement

The authors declare that they have no conflicts of interest.

Statement of ethical approval

The study protocol received approval from the Institutional Ethics Committee of the tertiary care teaching hospital prior to initiation, following the principles outlined in the Declaration of Helsinki.

Statement of informed consent

Written informed consent was obtained from all participants in the study. Patient confidentiality was maintained throughout the study period.

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