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EARLY RECOGNITION AND BIOMARKER-GUIDED MANAGEMENT OF SEPSIS IN RESOURCE-LIMITED INTENSIVE CARE UNITS: A NARRATIVE REVIEW

General Medicine

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ABSTRACT

Background: Sepsis remains one of the leading causes of mortality in intensive care units (ICUs) worldwide, particularly in low- and middle-income countries (LMICs). Delayed clinical recognition, inappropriate antimicrobial use, and limited critical care resources contribute significantly to poor outcomes. **Objective:** This narrative review evaluates current evidence regarding early recognition tools, standardized protocols, and biomarker-guided management strategies for sepsis in resource-limited settings. **Methodology:** Databases including PubMed, Scopus, Embase, and the Cochrane Library were reviewed for studies published in English between January 2015 and April 2026. Explicit inclusion and exclusion criteria were implemented to evaluate clinical trials, observational cohorts, meta-analyses, and global guidelines**.** **Discussion:** Biomarkers such as serum lactate, procalcitonin (PCT), and C-reactive protein (CRP) enhance clinical recognition frameworks and antibiotic stewardship. Incorporating point-of-care assays and simplified, resource-adapted sepsis bundles helps mitigate systemic infrastructural constraints. **Conclusion:** Early diagnosis combined with structured, biomarker-guided protocolization significantly reduces mortality, ICU stay, and antimicrobial misuse. Streamlined integration of these frameworks is vital for resource-limited settings.

KEYWORDS

Sepsis; Biomarkers; Procalcitonin; Lactate; SOFA; Intensive Care; Resource-Limited Settings.

1. INTRODUCTION

Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection. Despite historic advances in critical care medicine and international guidelines, sepsis continues to carry high mortality. In India, delayed presentation, limited intensive care infrastructure, and overcrowded emergency departments worsen prognosis. Delayed recognition, inappropriate antimicrobial use, and limited critical care resources contribute significantly to poor outcomes. Early identification using bedside tools and biomarkers has become increasingly important. This review discusses the diagnostic utility, therapeutic implications, and implementation challenges of biomarker-guided sepsis management in resource-limited settings.

2. METHODOLOGY

A comprehensive literature search was conducted using online databases including PubMed, Scopus, Embase, and the Cochrane Library using the keywords 'sepsis', 'biomarkers', 'procalcitonin', 'lactate', 'SOFA', 'qSOFA', and 'resource-limited ICU'. The review evaluated literature including randomized controlled trials, observational studies, meta-analyses, and international guidelines published in English between January 2015 and April 2026.

2.1 Document Selection Criteria

To maintain rigorous standards suitable for a Scopus-indexed review, specific eligibility criteria were strictly applied to the literature:

- **Inclusion Criteria:** Articles published in English between January 2015 and April 2026; studies assessing biomarkers (procalcitonin, lactate, C-reactive protein, presepsin, interleukin-6); trials or cohorts tracking scoring systems (SOFA, qSOFA); and literature evaluating management strategies (fluid resuscitation, broad-spectrum antibiotics, balanced crystalloids, norepinephrine) or challenges specific to resource-limited ICU settings.
- **Exclusion Criteria:** Studies published before January 2015 or after April 2026; non-English literature; publications lacking focus on the core biomarkers or clinical scoring systems mentioned; and studies conducted entirely outside the scope of intensive care units or resource-limited settings.

3. Clinical Recognition of Sepsis

Rapid identification of sepsis is critical. The SOFA score remains the gold standard for organ dysfunction assessment, while qSOFA provides rapid bedside screening. Tachypnea, altered mentation, and hypotension remain major warning signs. Serial assessment improves predictive accuracy.

4. Role of Biomarkers

Biomarkers provide essential physiological insights to complement clinical scores:

- **Serum Lactate:** Remains the most widely used prognostic marker. Elevated lactate correlates with tissue hypoperfusion and mortality.
- **Procalcitonin:** Useful for differentiating bacterial infections and guiding antibiotic de-escalation; limited by cost.
- **CRP:** Remains widely available but has low specificity as an inflammatory marker.
- **Presepsin and Interleukin-6:** Emerging markers showing promise but limited by cost and availability.

Table 1. Biomarkers Used in Sepsis (Comparison of Common Sepsis Biomarkers)

Biomarker	Clinical Utility	Limitation
Lactate	Perfusion marker	Non-specific
Procalcitonin	Bacterial infection marker	Cost
CRP	Inflammatory marker	Low specificity
Presepsin	Early sepsis detection	Limited availability

5. Management Strategies

Early administration of broad-spectrum antibiotics, aggressive fluid resuscitation, and vasopressor support remain cornerstones of management. Biomarker-guided antibiotic stewardship helps reduce unnecessary antibiotic exposure. Balanced crystalloids are preferred over normal saline in septic shock. Norepinephrine remains the first-line vasopressor.

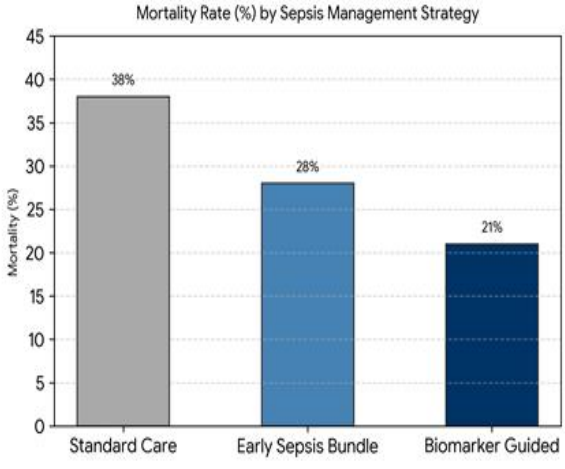

Figure 1. Mortality Reduction with Early Sepsis Management (Categorical Distribution)

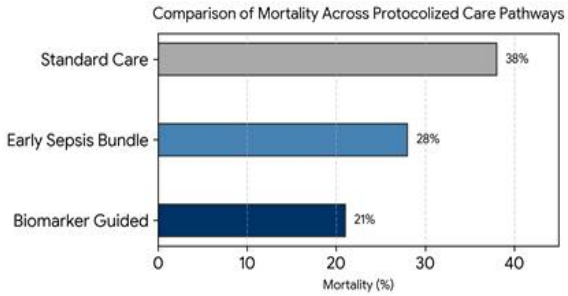

Figure 2. Impact of Sepsis Pathways on Mortality Outcomes (Horizontal Trajectory)

6. Challenges in Resource-Limited Settings

Overcrowded emergency departments, delayed microbiological diagnosis, lack of intensivists, and financial constraints limit implementation of sepsis bundles. Point-of-care lactate measurement and simplified sepsis protocols can improve feasibility.

7. Future Directions

Artificial intelligence-assisted screening systems, low-cost biomarker assays, and tele-ICU support may improve early recognition and outcomes in developing nations.

8. CONCLUSION

Early recognition and biomarker-guided management significantly improve sepsis outcomes. Integration of affordable biomarkers with standardized sepsis protocols is essential for resource-limited settings such as India. Biomarker-guided therapy improves outcomes and should be incorporated into resource-adapted sepsis bundles.

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