

Biomarkers: Guiding Sepsis Diagnosis and Personalized Management

Samuel N. Boateng*

Department of Medical Microbiology, University of Ghana

Introduction

This review highlights the critical role of established and emerging biomarkers like procalcitonin, C-reactive protein, presepsin, and suPAR in the early diagnosis, risk stratification, and guidance of antibiotic therapy in sepsis and septic shock. It emphasizes how these markers assist clinicians in differentiating sepsis from other inflammatory conditions and in monitoring treatment response, ultimately aiming to improve patient outcomes. [1].

This systematic review and meta-analysis evaluates the diagnostic accuracy of key biomarkers such as procalcitonin, C-reactive protein, presepsin, and D-dimer for early sepsis and septic shock. It concludes that these markers, particularly procalcitonin, exhibit varying levels of sensitivity and specificity, providing valuable, though not definitive, support for early clinical decision-making. [2].

This article covers recent advancements in identifying novel biomarkers for sepsis, moving beyond traditional markers. It discusses promising candidates across various categories including immune cell surface markers, microRNAs, cell-free DNA, and metabolites, highlighting their potential to offer more precise diagnostic and prognostic tools for early intervention and personalized treatment strategies. [3].

This systematic review and meta-analysis examines the diagnostic and prognostic capabilities of presepsin in sepsis. The findings suggest presepsin is a valuable biomarker for early sepsis diagnosis and for predicting mortality, often outperforming other traditional markers, offering important insights for clinical risk stratification. [4].

This review explores the application of metabolomics in sepsis research, detailing how metabolic profiling can reveal critical changes associated with sepsis progression, diagnosis, and prognosis. It discusses the potential of identifying specific metabolic signatures as novel biomarkers, paving the way for more comprehensive understanding and improved management of septic patients. [5].

This article provides an overview of the current state of biomarkers in pediatric sepsis, acknowledging the unique challenges in diagnosing and managing sepsis in children. It discusses the utility of existing markers and the promise of novel biomarkers specifically tailored for the pediatric population, aiming to improve early detection and reduce morbidity and mortality in this vulnerable group. [6].

This review explores the potential of genomic and proteomic approaches in identifying biomarkers for sepsis. It delves into how genetic variations, gene expression profiles, and protein signatures can serve as powerful tools for precise diagnosis,

predicting disease severity, and guiding personalized therapeutic strategies in sepsis patients. [7].

This comprehensive overview details the current and emerging biomarkers relevant to septic shock. It covers their roles in early diagnosis, prognostication, and monitoring therapeutic responses, emphasizing how integrating these markers into clinical practice can lead to more effective management strategies and improved outcomes for patients with this life-threatening condition. [8].

This review focuses on the emerging field of exosomal biomarkers for sepsis, highlighting their potential for early diagnosis and prognostic assessment. Exosomes, as carriers of various biomolecules, offer a unique, non-invasive avenue for identifying disease-specific signatures that could significantly enhance the precision and timeliness of sepsis management. [9].

This systematic review synthesizes the current understanding of immune biomarkers in sepsis, emphasizing their utility in reflecting the complex host immune response. It discusses various immune-related markers that can aid in early detection, risk stratification, and guiding immunomodulatory therapies, offering a deeper insight into sepsis pathophysiology. [10].

Description

Established and emerging biomarkers play a critical role in the early diagnosis, risk stratification, and guidance of antibiotic therapy in sepsis and septic shock. These markers, including procalcitonin, C-reactive protein, presepsin, and suPAR, assist clinicians in differentiating sepsis from other inflammatory conditions and monitoring treatment response, ultimately aiming to improve patient outcomes [1]. A systematic review and meta-analysis specifically evaluated the diagnostic accuracy of key biomarkers such as procalcitonin, C-reactive protein, presepsin, and D-dimer for early sepsis and septic shock. This analysis found that these markers, especially procalcitonin, show varying levels of sensitivity and specificity, providing valuable, though not definitive, support for early clinical decision-making [2].

Presepsin stands out in some analyses; a systematic review and meta-analysis highlights its diagnostic and prognostic capabilities in sepsis. Findings suggest presepsin is a valuable biomarker for early sepsis diagnosis and for predicting mortality, often outperforming other traditional markers and offering important insights for clinical risk stratification [4]. In addition, a comprehensive overview details current and emerging biomarkers specifically relevant to septic shock. It covers their roles in early diagnosis, prognostication, and monitoring therapeutic responses, emphasizing how integrating these markers into clinical practice can lead to more

effective management strategies and improved outcomes for patients with this life-threatening condition [8].

Recent advancements in identifying novel biomarkers for sepsis move beyond traditional markers, discussing promising candidates across various categories. This includes immune cell surface markers, microRNAs, cell-free DNA, and metabolites, highlighting their potential to offer more precise diagnostic and prognostic tools for early intervention and personalized treatment strategies [3].

Metabolomics, for example, is explored for its application in sepsis research, detailing how metabolic profiling can reveal critical changes associated with sepsis progression, diagnosis, and prognosis. This area holds potential for identifying specific metabolic signatures as novel biomarkers, paving the way for a more comprehensive understanding and improved management of septic patients [5]. Further, genomic and proteomic approaches are being explored for their potential in identifying sepsis biomarkers. Research delves into how genetic variations, gene expression profiles, and protein signatures can serve as powerful tools for precise diagnosis, predicting disease severity, and guiding personalized therapeutic strategies in sepsis patients [7].

The emerging field of exosomal biomarkers for sepsis focuses on their potential for early diagnosis and prognostic assessment. Exosomes, as carriers of various biomolecules, offer a unique, non-invasive avenue for identifying disease-specific signatures that could significantly enhance the precision and timeliness of sepsis management [9]. Understanding immune biomarkers in sepsis is also critical, emphasizing their utility in reflecting the complex host immune response. Various immune-related markers can aid in early detection, risk stratification, and guiding immunomodulatory therapies, offering deeper insight into sepsis pathophysiology [10]. Finally, addressing specific populations, an overview of the current state of biomarkers in pediatric sepsis acknowledges the unique challenges in diagnosing and managing sepsis in children. It discusses the utility of existing markers and the promise of novel biomarkers specifically tailored for the pediatric population, aiming to improve early detection and reduce morbidity and mortality in this vulnerable group [6].

Conclusion

Sepsis and septic shock management significantly benefits from the strategic application of biomarkers for early diagnosis, risk stratification, and guiding antibiotic therapy. Established markers such as procalcitonin, C-reactive protein, presepsin, and suPAR are crucial, helping clinicians differentiate sepsis from other inflammatory conditions and monitor treatment responses [C001, C002]. Presepsin, in particular, proves valuable for early sepsis diagnosis and predicting mortality, often showing superior performance compared to some traditional markers [C004]. Beyond these, researchers are actively identifying novel biomarkers. These include immune cell surface markers, microRNAs, cell-free DNA, and metabolites, all holding potential for more precise diagnostic and prognostic tools [C003, C005]. Genomic and proteomic approaches leverage genetic variations and protein signatures, offering powerful methods for accurate diagnosis, severity prediction, and personalized therapeutic strategies in sepsis patients [C007]. Exosomal biomarkers present an emerging, non-invasive avenue for early diagnosis and prognostic assessment by revealing disease-specific signatures, which could greatly enhance the precision and timeliness of sepsis management [C009]. Meanwhile, immune biomarkers offer deeper insights into the complex host immune response, aid-

ing in early detection, risk stratification, and guiding immunomodulatory therapies [C010]. Considering specific populations, there's a recognized need for biomarkers uniquely tailored to pediatric sepsis, aiming to improve early detection and reduce morbidity and mortality in children [C006]. The collective effort across this research highlights the importance of integrating both current and emerging biomarkers into clinical practice to achieve more effective management strategies and improve outcomes for patients facing this life-threatening condition [C008]. This body of work underscores a clear drive toward enhancing sepsis detection and personalized intervention.

Acknowledgement

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Conflict of Interest

None.

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***Address for Correspondence:** Samuel, N. Boateng, Department of Medical Microbiology, University of Ghana, E-mail: s.boateng@ug.edu.gh

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