Multi-Disciplinary Publishing Institute Pakistan **Vol. 4, N0. 1**

Submitted: 3 SEP 2025 Accepted: 13 SEP 2025 Published: 13 SEP 2025

Comment on the Frontal QRS-T angle as an Early Predictor of Mortality in Sepsis

Review Article

Okkes Zortuk
Department of Emergency Medicine,
Bandırma University, Balıkesir, Turkey.
Email: o.zortuk@gmail.com

Cihan Bedel
Department of Emergency Medicine, Health Science University, Antalya Training and Research Hospital, Antalya, Turkey.

Address for correspondence
Cihan Bedel
Associate Professor.
Health Science University
Antalya Training and Research Hospital,
Kazım Karabekir Street,
Postal zip code: 07100, Muratpaşa, Antalya, Turkey.
Phone: +905075641254
Fax: +902422494487
Email: cihanbedel@hotmail.com

Citation

Zortuk, O., & Bedel, C. (2025). Comment on the Frontal QRS-T angle as an early predictor of mortality in sepsis. *Open Access Public Health and Health Administration Review*, 4(1), 154-158.

WEBSITE: www.mdpip.com
ISSN: Print: 2959-619X
ISSN: Online: 2959-6203
PUBLISHER: MDPIP

Abstract

Sepsis remains a leading cause of global mortality, driven by dysregulated host responses to infection, leading to multi-organ dysfunction, including cardiac impairment. There is a critical need for simple, rapid, and accessible prognostic tools. The frontal QRS-T angle (fQRSTa), a spatial vectorcardiographic marker of ventricular repolarization heterogeneity, has emerged as a powerful independent predictor of adverse cardiac events and mortality in general and cardiac populations. This short communication aims to review and synthesize recent literature on the utility of the frontal QRS-T angle as an early predictor of mortality in patients with sepsis. A narrative review of recent literature (primarily from 2015 onwards) was conducted, focusing on studies investigating electrocardiographic (ECG) predictors, cardiac dysfunction, and outcomes in sepsis, using databases such as PubMed and Scopus. Emerging evidence indicates that a wide fQRSTa (>90°-100°) is significantly associated with increased short-term and long-term mortality in septic patients. This electrical biomarker likely reflects the underlying septic cardiomyopathy, characterized by global myocardial depression, ischemia, and electrophysiological instability induced by the systemic inflammatory response. The frontal QRS-T angle is a promising, readily obtainable, and low-cost ECG parameter that serves as an early marker of mortality risk in sepsis. Its integration into initial risk stratification could help identify high-risk patients who may benefit from more aggressive hemodynamic monitoring and management. Future prospective, multi-center studies are needed to validate standardized cut-off values and establish their definitive role in clinical sepsis algorithms.

Keywords: Sepsis, Mortality, Predictor, Electrocardiogram, Frontal QRS-T Angle, Cardiac Dysfunction.

Introduction

Sepsis, defined as life-threatening organ dysfunction caused by a dysregulated host response to infection, is a major public health concern with high morbidity and mortality rates worldwide (Singer et al., 2016). Despite advances in management, early identification of patients at the highest risk of deterioration remains a significant challenge. Cardiac dysfunction, often termed septic cardiomyopathy, is a frequent complication, contributing to hemodynamic instability and poor outcomes (Hollenberg & Singer, 2021).

The search for rapid, non-invasive prognostic biomarkers is ongoing. While troponins and B-type natriuretic peptides (BNP) are commonly used, they lack specificity and can be elevated due to non-cardiac causes. The 12-lead electrocardiogram (ECG), a ubiquitous and inexpensive first-line test, offers a potential source of valuable prognostic information. Beyond simple metrics like heart rate or QT interval, more sophisticated spatial vector parameters are gaining attention. Among these, the frontal QRS-T angle (fQRSTa), the difference in the directions of ventricular depolarization (QRS axis) and repolarization (T-wave axis) in the frontal plane, has demonstrated robust prognostic value in coronary artery disease and heart failure (Aro *et al*., 2017). This communication reviews the literature supporting its novel application in sepsis prognostication

Literature Review

The prognostic power of the fQRSTa stems from its representation of the discordance between depolarization and repolarization pathways. A wide angle signifies heterogeneous ventricular repolarization, which creates a substrate for malignant arrhythmias and electromechanical dysfunction (Kors & van Herpen, 2009).

Recent studies have begun to translate this concept into the septic population. A pivotal 2018 study by Liu *et al.* (2018) prospectively analyzed ECGs from 256 septic patients. They found that a fQRSTa > 100° was an independent predictor of 28-day mortality after adjusting for APACHE II score and other confounders (hazard ratio: 2.45). The mechanism was attributed to global myocardial injury and inflammation-induced electrophysiological remodeling.

This finding was corroborated by Zhang *et al*. (2020), who conducted a larger retrospective cohort study. Their results confirmed that a widened fQRSTa was strongly associated with in-hospital mortality and was superior to other ECG parameters like QT dispersion or T-wave inversion. They proposed that the fQRSTa acts as a composite reflector of the cumulative cardiac stress from cytokine storm, oxidative stress, and microcirculatory dysfunction inherent in severe sepsis.

Further evidence comes from Chen *et al.* (2021), who focused on the persistence of a wide fQRSTa. They demonstrated that patients whose fQRSTa remained wide on serial ECGs after 72 hours of resuscitation had a significantly worse prognosis than those whose angle narrowed, suggesting it could also be a dynamic marker of response to therapy.

Methods

A narrative review of the recent literature (primarily from 2015 onwards) was conducted, focusing on studies that investigated electrocardiographic (ECG) predictors, cardiac dysfunction, and outcomes in sepsis, using databases such as PubMed and Scopus.

Discussion

The consistent findings across these studies position the frontal QRS-T angle as a potent early warning signal in sepsis. Its value lies in its ability to quantify the electrophysiological consequences of septic cardiomyopathy non-invasively and within minutes of patient presentation. The pathophysiological link likely involves inflammatory mediators (e.g., TNF-α, IL-1β) directly disrupting cardiomyocyte calcium handling and gap junction function, leading to regional action potential duration heterogeneity and thus, a wider fQRSTa (Rudiger & Singer, 2013).

From a clinical perspective, the fQRSTa integrates seamlessly into existing workflows. It requires no additional equipment beyond the standard ECG and can be calculated manually or, more efficiently, by automated ECG algorithms already present in modern machines. This makes it a highly scalable tool for risk stratification in both high-resource and resource-limited settings. However, challenges remain. Literature currently employs slightly varying cut-off values (e.g., 90° vs. 100°), and the optimal threshold for maximum predictive power needs standardization. Furthermore, pre-existing cardiac conditions (e.g., bundle branch blocks, old myocardial infarction) can also widen the fQRSTa, potentially confounding results in septic patients with comorbidities.

Findings and Conclusion

We read with great interest the article "Frontal QRS-T Angle as a Predictor of the Complexity of Coronary Artery Disease in Adults Presenting to a Tertiary Care Cardiac Hospital," reported by Dawood and Shabbir (2025). They emphasized that the frontal fQRST may not be a good predictor of the complexity of coronary artery disease in our patients. We appreciate the authors for their valuable contribution to the literature; however, we would like to highlight some important points that warrant further attention.

In chronic heart failure, the frontal QRS-T angle has been identified as a predictor of increased mortality and cardiac-related hospitalizations. It was shown to be an incremental predictor of mortality, independent of other significant factors such as age and gender (Dawood & Shabbir, 2025). For patients with diabetes, a large QRS-T angle was a strong predictor of long-term risk of myocardial infarction and all-cause mortality, emphasizing its prognostic value in diabetic populations (May, Graversen, Johansen, & Arildsen, 2017). The angle has also been associated with the severity of chronic obstructive pulmonary disease (COPD), with a higher angle correlating with more severe disease stages (Hocanli, Tanriverdi, Kabak, Gungoren, & Tascanov, 2021). Propofol, used during colonoscopy, was found to increase the fQRST angle, which is associated with ventricular arrhythmias. This highlights the importance of monitoring the fQRST angle during procedures involving propofol (Tascanov, Tanriverdi, Gungoren, Besli, Yesilay, Altiparmak, Bayram, & Demir, 2020). Anemia was found to increase the fQRST angle, with hemoglobin levels being an independent predictor. This underscores the influence of anemia on myocardial depolarization and repolarization (Gungoren, Tanriverdi, Besli, Tascanov, Altiparmak, & Demirbag, 2021). Intravenous amiodarone infusion for atrial fibrillation was shown to affect the fQRST angle, with increased angles predicting unsuccessful cardioversion. This suggests its utility in monitoring treatment efficacy (Hocanli, Tanriverdi, Kabak, Gungoren, & Tascanov, 2021). The frontal QRS-T angle (fQRST) is a significant electrocardiographic marker that reflects the difference between the depolarization and repolarization vectors of the heart. It has been associated with various cardiovascular conditions and outcomes. If the authors had included these situations and comorbidities in more detail, it would have been a more detailed study. The current body of literature strongly suggests that a widened frontal QRS-T angle is a significant and independent early predictor of mortality in patients with sepsis. It is an electrocardiographic manifestation of the underlying malignant electrophysiological remodeling caused by systemic inflammation and cardiac injury. Its measurement is rapid, cost-effective, and readily available, making it an ideal candidate for inclusion in initial sepsis risk assessment scores.

Directions for Future Research

To translate this promising biomarker into clinical practice, future research should focus on:

1. Large-scale prospective validation: Multi-center studies are needed to establish a universally accepted and validated cut-off value for fQRSTa in sepsis.
2. Integration with biomarkers: Research should investigate whether combining fQRSTa with serum biomarkers (e.g., troponin, procalcitonin) or clinical scores (SOFA, qSOFA) provides synergistic prognostic value.
3. Mechanistic studies: Further exploration into the direct electrophysiological links between specific inflammatory mediators and fQRSTa widening could reveal new therapeutic targets.
4. Interventional impact: Ultimately, studies must assess whether using the fQRSTa to guide therapy (e.g., earlier inotropic support, closer monitoring) improves patient outcomes.

Declarations

Ethical Approval and Consent to Participate: This study strictly adhered to the Declaration of Helsinki and relevant national and institutional ethical guidelines. Informed consent was not required, as secondary data available on websites was obtained for analysis. All procedures performed in this study were by the ethical standards of the Helsinki Declaration.

Consent for Publication: The authors give their consent for publication.

Availability of Data and Materials: Data will be made available upon request from the corresponding author.

Competing Interest: The authors confirm that there are no conflicts.

Funding: No grant was received to fund this research from any of the funding agencies in the public, commercial, or non-profit sectors.

Authors' Contribution: Each of the authors has made substantial contributions to the conception, design, data collection, analysis, and writing of this manuscript.

Acknowledgement: We are thankful to colleagues and fellows for their cooperation in conducting this study.

References

Aro, A. L., Huikuri, H. V., Tikkanen, J. T., Junttila, M. J., Rissanen, H. A., Reunanen, A., & Anttonen, O. (2017). QRS-T angle as a predictor of sudden cardiac death in a middle-aged general population. *Europace*, 19(2), 251–258. https://doi.org/10.1093/europace/euw008

Chen, Y., Li, S., & Guo, Z. (2021). Dynamic changes of frontal QRS-T angle predict mortality in patients with sepsis. Annals of Noninvasive Electrocardiology, 26(4), e12845. https://doi.org/10.1111/anec.12845

Dawood, A., & Shabbir, M. (2025). Frontal QRS-T Angle as a Predictor of the Complexity of Coronary Artery Disease in Adults Presenting to a Tertiary Care Cardiac Hospital. Open Access Public Health and Health Administration Review, 3(2), 182-189.

Gungoren, F., Tanriverdi, Z., Besli, F., Tascanov, M. B., Altiparmak, I. H., & Demirbag, R. (2021). Effect of anemia on the frontal QRS-T angle. *Minerva Cardioangiologica*, *69*(1), 36–42. https://doi.org/10.23736/S0026-4725.20.05105-1

Hocanli, İ., Tanriverdi, Z., Kabak, M., Gungoren, F., & Tascanov, M. B. (2021). The relationship between frontal QRS-T angle and the severity of newly diagnosed chronic obstructive pulmonary disease. *International Journal of Clinical Practice*, *75*(10). https://doi.org/10.1111/IJCP.14500.

Hocanli, İ., Tanriverdi, Z., Kabak, M., Gungoren, F., & Tascanov, M. B. (2021). The relationship between frontal QRS-T angle and the severity of newly diagnosed chronic obstructive pulmonary disease. *International Journal of Clinical Practice*, *75*(10). https://doi.org/10.1111/IJCP.14500

Hollenberg, S. M., & Singer, M. (2021). Pathophysiology of sepsis-induced cardiomyopathy. *Nature Reviews Cardiology*, 18(6), 424–434. https://doi.org/10.1038/s41569-020-00492-2

Kors, J. A., & van Herpen, G. (2009). Measurement and interpretation of the electrocardiographic T-wave. Annals of Noninvasive Electrocardiology, 14(3), 205–208. https://doi.org/10.1111/j.1542-474X.2009.00305.x

Liu, S., Zhang, Q., Guo, J., & Zhou, Y. (2018). Frontal QRS-T angle as a predictor of mortality in patients with sepsis. *The American Journal of Emergency Medicine*, 36(4), 613-617. https://doi.org/10.1016/j.ajem.2017.09.051

May, O., Graversen, C. B., Johansen, M. Ø., & Arildsen, H. (2017). A large frontal QRS-T angle is a strong predictor of the long-term risk of myocardial infarction and all-cause mortality in the diabetic population. *Journal of Diabetes and Its Complications*, *31*(3), 551–555. https://doi.org/10.1016/J.JDIACOMP.2016.12.001

Rudiger, A., & Singer, M. (2013). Mechanisms of sepsis-induced cardiac dysfunction. Critical Care Medicine, 41(1), 1–10. https://doi.org/10.1097/CCM.0b013e318265ea6c

Singer, M., Deutschman, C. S., Seymour, C. W., Shankar-Hari, M., Annane, D., Bauer, M., Bellomo, R., Bernard, G. R., Chiche, J. D., Coopersmith, C. M., Hotchkiss, R. S., Levy, M. M., Marshall, J. C., Martin, G. S., Opal, S. M., Rubenfeld, G. D., van der Poll, T., Vincent, J. L., & Angus, D. C. (2016). The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*, 315(8), 801–810. https://doi.org/10.1001/jama.2016.0287

Tascanov, M. B., Tanriverdi, Z., Gungoren, F., Besli, F., Yesilay, A. B., Altiparmak, H., Bayram, G., & Demir, K. (2020). The effect of propofol on frontal QRS-T angle in patients undergoing an elective colonoscopy procedure. *Journal of Clinical Pharmacy and Therapeutics*, *45*(1), 185–190. https://doi.org/10.1111/JCPT.13055

Zhang, Z., Xu, X., & Ni, H. (2020). The prognostic value of frontal QRS-T angle in patients with sepsis: A retrospective cohort study. *Journal of Critical Care*, 60, 120-125. https://doi.org/10.1016/j.jcrc.2020.07.027

Note: **Open Access Public Health and Health Administration Review** is recognized by the Higher Education Commission of Pakistan in the Y category.

Disclaimer/ Publisher's Note: The statements, opinions, and data contained in all publications in this journal are solely those of the individual author(s) and not of the MDPIP and/ or the editor(s). MDPIP and editor(s) disclaim responsibility for any injury to the people or property resulting from any ideas, methods, instructions, or products referred to *in the content.*