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RESEARCH ARTICLE

Correlation of Bedside ICU Monitor–Derived Computerized QT and QTc Measurements with Standard 12-Lead ECG Measurements

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ABSTRACT

Objectives: Prolongation of the QT/QTc interval is associated with an increased risk of torsade de pointes. Although obtaining a standard 12-lead ECG is common for this evaluation in pediatric cardiac intensive care unit (CICU) patients, it may interrupt patient care or increase staff workload. Continuous QT/QTc measurements can be performed using bedside monitors with dedicated software in the pediatric CICU. This study aimed to evaluate the agreement between computerized QT/QTc measurements obtained from bedside monitors (three leads) and time-matched standard 12-lead ECGs.

Methods: This study was designed as a retrospective observational study. QT/QTc measurements were obtained using convenience sampling, with both ECG types recorded within ≤30 minutes of each other. Agreement between the two methods was assessed using Bland–Altman analysis.

Results: During the study period, 100 patients had both bedside monitor and 12-lead ECG measurements compared. For QT measurements, the mean bias difference was not statistically significant (β=−1.9, 95% CI=4, −11.05; p=0.6; limits of agreement [LOA]=−60, 54). For QTc measurements, the mean bias difference was also not statistically significant (β=−3.20, 95% CI=4, −11.05; p=0.6; LOA=−65, 57).

Conclusion: There was good agreement between the two methods for both QT and QTc measurements. Bedside monitor QT/QTc assessments may help identify patients at risk.

Keywords: Electrocardiography, intensive care, QTc

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Introduction

The QT interval is an important electrocardiographic parameter that encompasses the durations of ventricular depolarization and repolarization. Prolongation of the QT interval is a well-defined risk factor, particularly for torsade de pointes and sudden cardiac death.[1,2] Therefore, accurate and reliable measurement of QT and QTc in intensive care settings is critical for clinical care.

The standard 12-lead electrocardiogram (ECG) is considered the gold standard method for QT and QTc measurement.[3] However, this approach has certain limitations in intensive care settings. Recording a 12-lead ECG can interrupt patient care, require reconnection of monitor leads, and increase the workload for healthcare personnel. Particularly in pediatric intensive care patients, factors such as limited mobility, invasive catheters, and hemodynamic instability make this process even more complex.

Bedside intensive care monitors continuously record 3-lead ECG signals and, through advanced software, can automatically calculate QT and QTc measurements. This system provides continuous monitoring, reducing workload and enabling uninterrupted observation.[4,5] However, the reliability of these measurements and their concordance with standard 12-lead ECGs have been evaluated in only a limited number of studies.

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In this study, the agreement between computerized QT and QTc measurements obtained from bedside monitors used in a pediatric cardiac intensive care unit and those derived from standard 12-lead ECGs was investigated.

Methods

This study was designed as a retrospective observational investigation. Approval was obtained from the Başakşehir Çam and Sakura City Hospital Clinical Research Ethics Committee on October 22, 2025, with Decision No: 323. The study was conducted in accordance with the Declaration of Helsinki.

The study was conducted between August 1, 2024, and January 1, 2025, in the pediatric cardiac intensive care unit, including 100 patients for whom both monitor-based and standard 12-lead ECG recordings could be obtained for QT/QTc measurement. Patients of various age groups, from neonates to adolescents, were included. Patients admitted to the intensive care unit due to congenital heart disease, postoperative cardiac surgery follow-up, arrhythmia risk, or hemodynamic instability were enrolled. This study was based on routinely collected clinical and electrocardiographic data. All ECG recordings were obtained as part of standard clinical care, and no additional diagnostic or interventional procedures were performed for research purposes.

For each patient, computerized QT and QTc values obtained from bedside monitors (Philips IntelliVue MX800, 3-lead) were recorded. A standard 12-lead ECG was recorded within 30 minutes for the same patient. The electrocardiograms were acquired using a Philips PageWriter Trim II device at a paper speed of 25mm/s and an amplitude of 10mm/mV. Measurements were based on the QT and QTc values automatically calculated by the device algorithms. All QT and QTc measurements were consistently obtained from lead II (DII) using automated device algorithms. QTc values were calculated using the Bazett formula. It is acknowledged that QT/QTc measurements may vary according to the derivation used, and precordial leads such as V2–V3 may yield falsely prolonged QT measurements.

Statistical Analysis

The primary aim was to assess agreement between two measurement methods; therefore, Bland–Altman analysis was selected as the principal statistical approach.

Agreement between the obtained QT and QTc values was evaluated using Bland–Altman analysis. Continuous variables were expressed as mean±standard deviation (SD), and categorical variables as percentages (%). Statistical analysis was performed using SPSS version 26.0. A p-value<0.05 was considered statistically significant.

Results

A total of 100 simultaneous recordings from 100 patients were analyzed during the study period. The mean age of patients was 6±2.4 months, and 58% were male. Of the cases, 70% were postoperative congenital heart surgery patients, 10% were monitored for suspected arrhythmia, and 20% were admitted for other cardiac reasons (Table 1).

The mean bias difference between QT values obtained from the bedside monitor and those from the standard 12-lead ECG was −1.9ms (95% CI: −11.05 to +4; p=0.6). According to the Bland–Altman analysis, the limits of agreement (LOA) ranged from −60 to +54ms (Fig. 1).

For QTc values, the mean bias difference was −3.20ms (95% CI: −11.05 to +4; p=0.6). The LOA limits ranged from −65 to +57ms (Fig. 2).

A strong correlation was observed between the measurements (r=0.89, p<0.001).

Discussion

In this study, we evaluated the agreement between computerized QT and QTc measurements obtained from bedside monitors used in a high-volume pediatric cardiac intensive care unit and those obtained from standard 12-lead ECGs. The most significant finding of this study is that bedside monitors used in the pediatric cardiac ICU showed high agreement with the standard 12-lead ECG for QT and QTc measurements. The statistically insignificant bias difference supports the reliability of monitor-based measurements.

Studies conducted in adult patient populations have shown that monitor-based QT/QTc measurements exhibit variable levels of accuracy.[6,7] In a study by Calvo-Ayala et al.[8] involving 43 intensive care patients, QTc determination by telemetry had poor agreement and moderate correlation with electrocardiography. However, telemetry had an acceptable area under the curve in ROC analysis, with tolerable sensitivity and specificity depending on the cutoff used to define prolonged QT. Correlation between the 2 methods was only moderate (r=0.6, p<0.001).

Table 1. Patient demographics

Characteristic	n	%
Total number of patients	100	100
Age (mean±SD) (months)	6±2.4	-
Gender (Male)	58	58
Gender (Female)	42	42
Diagnosis: Congenital heart disease	80	80
Diagnosis: Other	20	20

SD: Standard deviation.

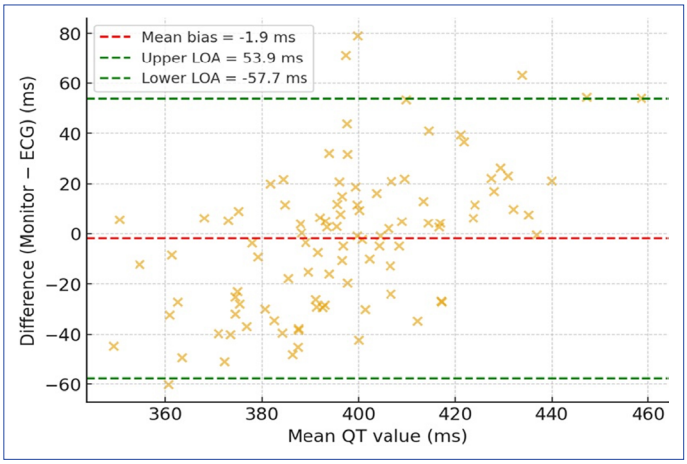


Figure 1. Bland–Altman plot for QT measurements comparing bedside monitor (3-lead) with standard 12-lead ECG. The dashed red line indicates the mean bias (-1.9 ms), and dashed green lines indicate the limits of agreement (-57.7 to +53.9 ms).

ECG: Electrocardiogram; LOA: Limits of agreement.

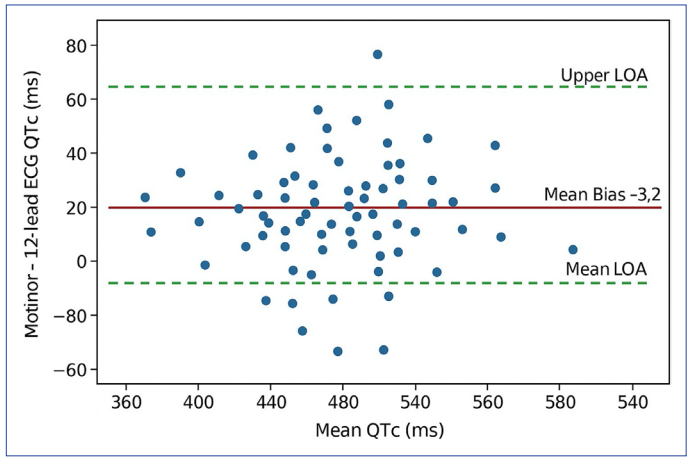


Figure 2. Bland–Altman plot for QTc measurements comparing bedside monitor (3-lead) with standard 12-lead ECG. The solid line indicates the mean bias (-3.2 ms), and dashed lines indicate the limits of agreement (-65 to +57 ms).

ECG: Electrocardiogram; LOA: Limits of agreement.

However, data for pediatric populations remain quite limited. Our study is significant as it demonstrates a comparable level of reliability in children.

Most patients in pediatric intensive care units are monitored post-cardiac surgery or due to congenital heart disease. QT/QTc prolongation is common in these patients due to electrolyte imbalances, pharmacological treatments (e.g., antiarrhythmics, antibiotics), or hypoxia. Reliable monitor-based measurements may contribute to the early detection of sudden QT prolongations and to the prevention of potential torsade de pointes attacks through continuous monitoring.[5–9]

Bedside monitors offer several advantages, including performing measurements without interrupting patient care, reducing the workload of intensive care personnel, enabling continuous, real-time QT/QTc monitoring in high-risk patients, and allowing rapid assessment before or after initiation of drug therapy. Similar advantages have been highlighted in the literature.[9,10] We observed comparable findings in our study.

The mean bias differences for QT and QTc in our study were also not statistically significant. These findings are consistent with those reported by Murray et al.[10] in 2025. Their study included 120 patients, of whom 60 (50%) had available 12-lead ECGs for comparison. The mean bias difference for QT measurements was not statistically significant (β=-2.47, 95% CI: −11.05 to +5.50; p=0.44; limits of agreement [LOA]=−64.37 to 59.44). Similarly, the bias difference for QTc was not statistically significant (β=-3.20, 95% CI: -11.05 to +5.50; p=0.44; LOA=−67.43 to 61.03). The bias differences in both our study and that of Murray et al.[10] were clinically insignificant.

Limitations

The main limitations of this study are its single-center, retrospective design, which limits generalizability, and its exclusive reliance on automated device-based calculations for QT/QTc measurements without including manual assessments. Additionally, the lack of correlation analysis with clinical outcomes (e.g., arrhythmia development and mortality) is another limitation. Focusing on a pediatric population and comparing measurements within the same time frame are notable strengths of the study.

Conclusion

In conclusion, computerized QT and QTc measurements obtained from bedside intensive care monitors show high agreement with standard 12-lead ECG measurements. This method can serve as a practical tool in pediatric cardiac intensive care units, enhancing patient safety and facilitating clinical workflow.

Disclosures

Ethics Committee Approval: The study was approved by the Başakşehir Çam and Sakura City Hospital Clinical Research Ethics Committee (no: 323, date: 22/10/2025).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest Statement: The authors declare that there is no conflict of interest.

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