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Prevalence and Prognostic Significance of Long QT Interval among Patients with Chest Pain: Selecting an Optimum QT Rate Correction Formula

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Abstract

Background—Little is known about the prevalence and prognostic significance of long QT interval among patients with chest pain during the acute phase of suspected cardiovascular injury.

Objectives—Our aim was to investigate the prevalence and prognostic significance of long QT interval among patients presenting to the emergency department (ED) with chest pain using an optimum QT rate correction formula.

Methods—We performed secondary analysis on data obtained from the IMMEDIATE AIM trial (N, 145). Data included 24-hour 12-lead Holter electrocardiographic recordings that were stored for offline computer analysis. The QT interval was measured automatically and rate corrected using seven QTc formulas including subject specific correction. The formula with the closer to zero absolute mean QTc/RR correlation was considered the most accurate.

Results—Linear and logarithmic subject specific QT rate correction outperformed other QTc formulas and resulted in the closest to zero absolute mean QTc/RR correlations (mean ± SD; 0.003 ± 0.002; 0.017 ± 0.016; respectively). These two formulas produced adequate correction in 100% of study participants. Other formulas (Bazett's, Fridericia's, Framingham, and Study specific) resulted in inadequate correction in 47.6 to 95.2% of study participants. Using the optimum QTc formula, linear subject specific, the prevalence of long QTc interval was 14.5%. The QTc interval did not predict mortality or hospital admission at short and long term follow-up. Only the QT/RR slope predicted mortality at 7 year follow-up (odds ratio, 2.01; 95% CI, 1.02 to 3.96; $p < 0.05$).

Conclusions—Adequate QT rate correction can only be performed using subject specific correction. Long QT interval is not uncommon among patients presenting to the ED with chest pain.

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Introduction

Ventricular repolarization duration is reflected on the body surface electrocardiogram (ECG) as the QT interval. When delayed, it is likely to increase heterogeneity of ventricular repolarization among different myocardial cells and to produce early afterdepolarizations (1). These conditions combined and accompanied by premature ventricular contractions place sufficient conditions for triggering the life threatening ventricular arrhythmia, torsade de pointes. Delayed repolarization has also been found to predict the occurrence of several adverse cardiovascular (CV) events especially in patients with acute coronary syndrome (ACS). These events include recurrent ischemia (2), ventricular arrhythmias (3), and death (2). Long QT interval in patients with ACS probably results from increased sympathetic activity when accompanied by underlying cellular damage because of ischemia (4, 5).

Despite the serious negative consequences of long QT interval, it has not been properly investigated. The majority of information comes from studies that measured the QT interval manually from a single lead with 10 second ECG during rest (3, 6–8). Recent techniques are automatic and capable of measuring the QT interval continuously using a root mean square signal that gathers ECG information from the 12 ECG leads simultaneously (9). Furthermore, almost all previous studies calculated the heart rate (HR) corrected QT interval using a single population derived formula such as Bazett's or Fridericia's. This type of QT rate correction produces misleading and random findings (10).

In a sample of patients who presented to the emergency department with chest pain and underwent 12 lead ECG monitoring over 24 hours, we aimed to determine the prevalence and prognostic significance of long QT interval using an optimum QT rate correction formula.

Methods

This was a secondary analysis of data obtained from the Ischemia Monitoring and Management in the Emergency Department in Analysis and Treatment of Acute Ischemic Myocardium (IMMEDIATE AIM) trial funded by the National Institutes of Health (RO1HL69753) (11). Data included 24-hour, 12-lead Holter with high resolution ECG acquisition signal (1000 sample/second/channel) (N, 187). Excluded from the present analysis were patients with right (n, 16) or left (n, 10) bundle branch block, atrial fibrillation (n, 8), atrial flutter (n, 1), artificial pacemakers (n, 3), or a combination of these conditions (n, 4). The total sample size for the final analysis was 145.

The QT and RR intervals were measured automatically using the software, Super ECG (Mortara Instruments, Milwaukee, WI) (9). Briefly, this software gathers information from the 12 ECG leads simultaneously to generate one root mean square ECG signal. The measured QT interval with this method will be from the earliest onset of the QRS complex in any lead to the latest T wave offset in any lead. Each measured QT interval is then matched with the preceding RR interval, the average preceding RR interval, or an RR interval that is corrected for unsteadiness in the underlying HR called the RRc. In this study, only beats within the RR range of 400 to 1500 ms were analyzed to eliminate extremes of HR and get rid of outliers.

There is an inverse relation between the QT interval and HR. This is especially evident when the QT interval is monitored over extended periods of time such as with 24 hour Holter monitoring. In such a circumstance, HR can vary considerably. Therefore, a QT value that is less dependent on the HR is usually calculated using one of several mathematical formulas. The resultant value is called the rate corrected QT interval or QTc. Currently there

is no perfect formula that can completely eliminate the effect of HR. For maximum precision we calculated the QTc interval using three types of QT rate correction formulas,

1. Population derived QTc formulas. The QTc interval was calculated using three existing formulas of this type; Bazett's ($QTc = QT / \sqrt{RR}$), Fridericia's ($QTc = QT / \sqrt[3]{RR}$), and Framingham's ($QTc = QT + 0.154\ (1\text{-}RR)$). Bazett's and Fridericia's belong to the mathematical expression that has the general logarithmic format, $QTc = QT/RR^{b}$, where b is the LnQT/LnRR regression line slope. On the other hand, Framingham's belongs to the mathematical expression that has the general linear format, $QTc = QT + b\ (1\text{-}RR)$, where b is the QT/RR regression line slope. Logarithmic expressions assume a non linear QT/RR pattern while linear expressions assume a linear pattern.
2. Study specific QTc formulas. The QTc interval was calculated using two formulas of this type, one belongs to the general logarithmic format and another belongs to the general linear format. The value of the slope (b) in both expressions was the average slope value derived from all study participants.
3. Subject Specific QTc formulas. As with study specific correction, the QTc interval was calculated using the general logarithmic format and the general linear format. The value of the slope (b) this time was made unique to each participant; it was derived from each participant's own data. Using this type of QT rate correction, each participant has his own unique logarithmic and linear QTc formulas.

Different QTc formulas were solved using the QT interval and the RR interval from the preceding beat so that each participant has a continuous recording for each formula (7 formulas). Both intervals were measured in seconds. The formula with the closest to zero absolute QTc/RR correlation average among all participants was selected to perform further analyses. This formula was called the optimum QTc formula. Closer to zero QTc/RR correlation suggests that this particular formula was more successful in eliminating the effect of the RR interval. This is the underlying assumption of QT rate correction. The performance of a particular QTc formula was considered adequate when the QTc/RR correlation was small (< 0.3). However, when the correlation was medium or large (≥ 0.3), the performance was considered inadequate.

The QT interval was considered long when either of the following was met:

1- The mean QTc interval calculated using the optimum QTc formula for each participant over the entire Holter recording time exceeded the upper limit of normal recommended by the American Heart Association and the American College of Cardiology (12). The upper limit of normal corresponds to values greater than the 99th percentile QTc values in males (470 ms) and in females (480 ms).

2- At least one episode of long QTc interval greater than 500 ms lasting for at least 15 minutes. This was determined by examining the QTc/Time scatter plot where QTc interval was plotted on the Y axis and Time on the X axis. Time on the X axis was divided into segments of 15 minutes corresponding to 900,000 ms. An episode of long QTc interval was identified whenever the QTc interval consistently exceeded 500 ms throughout the 15 minutes time period. However, this does not necessarily mean that all beats were greater than 500 ms.

We also calculated the QTc > 500 ms burden for the 24-hour Holter recording [(QTc > 500 ms beat count ×100) / total beat count] using only the optimum QTc formula. Adverse CV events were defined as hospital admission or seeking medical attention because of coronary artery disease, heart failure, CV thrombotic event, or arrhythmia. Adverse events also

included death of any cause during hospitalization, at 1 year follow-up, and up to 7 years of follow-up. Death was confirmed by public death records including internet accessible obituaries and the Social Security Death Index (ancestry.com, July, 2012).

Statistical analysis

The data were analyzed using SPSS for Windows version 17 (SPSS, Inc., Chicago). A $p \leq 0.05$ was considered statistically significant. Pearson's correlation was used to examine the association between two continuous variables. Binary logistic regression with the method 'enter' (all variables entered at the same time in the model) was used to examine predictors influencing the likelihood of observing adverse CV events and long mean QTc interval.

Results

Sample descriptive statistics are summarized in Table 1. Total time of Holter monitoring was 24 hours (median; interquartile range, 21 to 24).

Table 2 presents the mean QTc/RR correlation of all study participants for different QTc formulas. This value emphasizes the direction of the QTc/RR relation, that is, over or under estimation of the QT interval. A positive sign indicates under estimation of the QT interval with increasing HR (↓ RR) while a negative sign indicates over estimation of the QT interval with increasing HR. Nevertheless, using the mean QTc/RR correlation for estimating the true magnitude, on average, of this correlation is not accurate. This is because positive and negative values tend to cancel each other when calculating the mean value. Importantly, the magnitude of the correlation should not be affected by the sign. Therefore, we are also reporting in the same table the mean value of the absolute QTc/RR correlation. It is this value that was used to judge the adequacy of QT rate correction by different formulas.

Table 2 shows large mean absolute QTc/RR correlation when Bazett's formula was used for QT rate correction. The mean absolute correlation was medium using Fridericia's, Framingham's, and study specific QT rate correction. However, subject specific QTc correction resulted in almost zero mean absolute QTc/RR correlations. Therefore, among these formulas only subject specific correction resulted in adequate QT rate correction. In fact, subject specific correction completely eliminated the RR interval effect on the QT interval. Linear subject specific correction outperformed logarithmic subject specific correction. Nevertheless, the difference in mean absolute QTc/RR correlation was small, approximately 0.01. To the contrary, with study specific correction, the logarithmic expression outperformed the linear expression but again the difference was small, approximately 0.03. In this study, the QT/RR regression line pattern was linear in 91% of the study participants.

The difference in QT rate correction between study specific formulas and population derived formulas (Fridericia's and Framingham's), excluding Bazett's, was not enormous as one would expect (Table 2). The maximum difference in mean absolute QTc/RR correlation between using either one was 0.112, which is the difference between using logarithmic study specific correction and Framingham's. Referring to the same table, subject specific correction resulted in adequate correction among all study participants, 100% of the time. Other formulas, excluding Bazett's, resulted in adequate correction in 32.4 to 52.4% of study participants. Bazett's formula produced adequate correction in less than 5% of study participants.

Comparing different QTc formulas to the optimal formula (linear subject specific) resulted in a QTc difference of less than 17 ms on average (Table 3). This difference was less than 8 ms excluding Bazett's formula which resulted in the maximum QTc difference. The QTc

difference between using linear subject specific correction and Bazett's formula exceeded 20 ms in 42 participants (29%). A QTc difference greater than 20 ms occurred in less than 12 participants using other formulas, excluding the logarithmic subject specific correction. Logarithmic subject specific correction resulted in zero participants with a QTc difference exceeding 20 ms. A QTc difference greater than 20 ms is of concern because a difference of this magnitude increases substantially the proarrhythmic risk associated with long QTc interval (13).

The time duration, prevalence of long mean QTc interval, and QTc > 500 ms burden were different based on the QTc formula being used (Table 4). Other QTc indices calculated only using the linear subject specific formula were prevalence of mean QTc > 500 ms (8, 5.5%) and number of participants who had at least one episode of long QTc interval greater than 500 ms lasting for at least 15 minutes (19, 13.1%). None of these indices (regardless of the QTc formula being used) predicted any of the adverse CV events reported in Table 1. Only the QT/RR slope predicted mortality at 7 year follow-up. The odds ratio (OR) for mortality at 7 year follow-up for each 0.1 unit increase in the QT/RR slope was 2.01 (95% CI, 1.02 to 3.96, $p < 0.05$). The overall prevalence of long QT interval using either definition (mean or episode) was 14.5% (21 participants).

Univariate predictors of long mean QTc interval calculated using linear subject specific correction are presented in Table 5. With multivariate analysis, however, only the QT/RR slope and having a history of old MI predicted long mean QTc interval. The overall multivariate model was statistically significant (X, 35.07; df, 5; $p < 0.0001$) and showed a god fit (Hosmer and Lemeshow X, 6.06; df, 8; p, 0.64). The model explained between 22.4 (Cox and Snell R squared) and 43.8% (Nagelkerke R square) of the total variance and correctly classified 91.3% of cases.

Discussion

This is the first study to examine the prevalence and time duration of long QT interval among patients presenting to the emergency department with chest pain. For maximum precision, the prevalence of long QT interval was calculated using the optimum QT rate correction formula, linear subject specific. This formula was selected after statistically comparing seven different QTc formulas. In this study, we monitored the QT interval continuously for 24 hours. Twenty-four hour continuous monitoring is likely to be more reliable and accurate compared with a single 10-second ECG recording.

Subject specific correction almost completely eliminated the RR effect on the QT interval and resulted in adequate correction in 100% of the study participants. In contrast, Bazett's formula exerted only minimal control on the RR interval and resulted in inadequate correction in more than 95% of the study participants. Interestingly, the difference in correction adequacy between population derived and study specific formulas was not large as one would expect. However, this difference is considerable given that slight changes in the QTc interval can make a difference between low risk and substantial risk of developing life threatening ventricular arrhythmias (13).

These findings indicate that subject specific correction is the only type of correction that adequately corrects the QT interval for rate. This is consistent with previous research (14). The QT/RR relation is highly individualized and thus only an individualized correction approach can mathematically express it (15). Our findings also showed inadequate correction using the other types of QT rate correction on average. Current practice standards (12, 16) and regulatory guidelines (13) still advocate the use of some of these formulas,

specifically Framingham's and Fridericia's. Giving the mounting evidence against their use, it might be appropriate now to revise these guidelines.

More than being inaccurate, using the other formulas compared to subject specific correction resulted in a QTc difference greater than 20 ms in 6 to 29% of the study participants. This indicates that further caution is needed when the concern is a QTc difference less than 20 ms or when the underlying HR is unsteady. HR unsteadiness will likely increase the QTc difference (17, 18).

The use of subject specific QT rate correction in hospital settings would be feasible with a software upgrade in patient monitoring equipment. The technology and equipment necessary for continuous monitoring are already in place. Calculating the QTc interval using subject specific correction would require computer measurement of an adequate number of QT-RR beat history for at least 2 minutes. To deal with the resultant delay during this initial measurement period, the monitoring device could in the meanwhile calculate the QTc interval using one of the population derived formulas, preferably Fridericia's, and display the message 'Processing… preliminary QTc = 420 ms,' for example. Two minutes of QT-RR beat history are adequate for the average individual and are likely to produce a QT/RR slope (*b*) value with a high level of statistical confidence (two tailed type 1 error < 0.05 and statistical power ≥ 0.8). However, when the QT/RR slope is extremely low, an extended period of monitoring is required. The required monitoring time might be as long as 25 minutes when the QT/RR slope is ≤ 0.02. This is likely to occur in some individuals (see the range values for the QT/RR slope reported in Table 1). In addition to the absolute QT/RR slope value, the required monitoring time is affected by the QT and RR intervals variability (standard deviation), shape of the QT/RR regression line (linear vs. nonlinear), underlying HR, and whether the HR is steady or unsteady. All these factors would need to be accounted for in the upgraded software.

The prevalence of long QTc interval was 14.5% calculated using the optimum QT rate correction formula, linear subject specific. This includes participants with long mean QTc values and participants with at least one episode of long QTc interval consistently exceeding 500 ms for at least 15 minutes. Nearly 6% of the study participants had a mean QTc longer than 500 ms. On average, the QTc > 500 ms burden was approximately 5%. These findings indicate that long QTc interval is not uncommon among patients presenting to the emergency department with chest pain. This was the first study to examine these indices during the acute phase of suspected CV injury where repolarization abnormalities are expected to be greater and more pronounced. Previous research in patients with ACS carried out later during hospital stay reported varying estimations of long QTc interval ranging between 19% and 60% (6, 19, 20). In addition to other limitations, however, almost all these studies used inaccurate formulas to calculate the QTc interval such as Bazett's and Fridericia's.

Regardless of the QT rate correction formula, QTc indices did not predict any of the adverse events reported in this study. Only the QT/RR slope predicted mortality at 7 year follow-up. This indicates that using the QTc interval as a prediction tool primarily for mortality and hospital admission at short and long term follow-up might not be appropriate. Evidence on the prediction power of long QTc interval is confusing with some studies providing supporting evidence (2, 21) and others providing opposing evidence (3, 6). All these studies are with serious limitations related to QT measurement and rate correction.

The factors we found to predict long mean QTc interval can all be linked to structural changes in the myocardium. The clearest example is having a history of old MI which increases the odds of having a long mean QTc interval by almost 12 folds, controlling for

other variables in the model. This finding is congruent with the existing notion that long QTc interval is unlikely to occur without an underlying structural damage affecting ion channels. Sympathetic hyperactivity, for example, cannot by itself make the QTc interval longer (4). This finding indicates that the QT interval needs to be carefully monitored in such patients.

To acknowledge some of the limitations in this study, there were fewer males than females. Males have shorter QT interval than females. Furthermore, long QTc interval calculated with subject specific correction was defined using the same cut points used to define long QTc interval calculated using Bazett's formula. We do not know if this was accurate. We think that new limits need to be specifically set to define long QTc interval calculated with subject specific correction. One more limitation is that there were 14.5% of the study participants taking beta blocker therapy. Beta blockers affect the QT interval tending to underestimate its prediction power and prevalence of long QT interval. However, we analyzed the data excluding participants taking beta blockers and the sample estimates were similar. There were only one major difference; heart size on X ray no longer predicted long mean QTc interval with univariate analysis.

Another possible limitation is not accounting for QT hysteresis. QT hysteresis or the delayed QT interval adaptation to sudden alterations in the RR interval makes matching the QT interval to its theoretical RR interval predecessor a challenge. This is always a concern when the underlying HR is unsteady. In such a circumstance, the coming QT interval might not be a good match with the immediately preceding RR interval and therefore render the calculated QTc interval inaccurate. On average, full adaptation of the QT interval requires more than 112 seconds (22). However, this is very unlikely affected our findings giving that the prevalence of long QT interval was determined using a mean QTc value over 24 hours in addition to an episode of consistently long QTc interval for at least 15 minutes. Furthermore, the QTc interval for the further analyses we carried out was calculated using subject specific correction. Subject specific correction resulted in almost zero QTc/RR correlation which necessarily means that the effect of the underlying HR regardless of how much it was variable on the QTc interval was also almost zero.

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Table 1

Sample descriptive statistics (N, 145).

	Mean ± SD (Range)
Age (years)	62.92 ± 13.94 (30 to 93)
Mean RR (ms)	899.52 ± 148.20 (595.59 to 1328.88)
Mean QT (ms)	422.26 ± 39.88 (325.23 to 542.77)
QT/RR slope (linear)	0.121 ± 0.056 (0.019 to 0.349)
QT/RR slope (log)	0.244 ± 0.10 (0.041 to 0.57)
	n (%)
Gender	
Male	61 (42.1%)
Female	84 (57.9%)
ACS	41 (28.3%)
ST elevation MI	5 (3.4%)
Non ST elevation MI	7 (4.8%)
Unstable angina	29 (20%)
History	
MI	40 (27.6%)
Angina	36 (24.8%)
CABG	15 (10.3%)
PCI	26 (17.9%)
Beta blockers	21 (14.5%)
Adverse Cardiovascular Events	
Hospital admission	111 (76.6%)
Mortality during hospital admission	4 (2.8%)
Hospital admission at 1 year follow-up	45 (40.5%)
Mortality at 1 year follow-up	10 (8.6%)
Mortality at 7 year follow-up	32 (22.1%)
Any adverse cardiovascular event	121 (83.4%)

ACS, acute coronary syndrome; CABG, coronary artery bypass graft; linear, linear QT/RR regression line pattern; log, logarithmic QT/RR regression line pattern; MI, myocardial infarction; ms, millisecond; PCI, percutaneous coronary intervention; QTc, QT interval corrected for heart rate.

Table 2

Adequacy of QT rate correction by different QTc formulas (N, 145).

	QTc/RR correlation			Absolute QTc/RR correlation			
QTc formula	**Mean**	**SD**	**Range**	**Mean**	**SD**	**Range**	**Adequate correction, n (%)**
Bazett	−0.714	0.205	−0.962 to 0.233	0.720	0.183	0.070 to 0.962	7 (4.8%)
Fridericia	−0.344	0.356	−0.945 to 0.659	0.432	0.242	0.014 to 0.945	47 (32.4%)
Framingham	−0.295	0.417	−0.962 to 0.753	0.442	0.254	0.001 to 0.962	49 (33.8%)
Study specific (log)	−0.023	0.401	−0.912 to 0.789	0.330	0.227	0.000 to 0.912	76 (52.4%)
Study specific (linear)	−0.058	0.433	−0.936 to 0.808	0.362	0.244	0.006 to 0.936	64 (44.1%)
Subject specific (log)	0.004	0.023	−0.055 to 0.072	0.017	0.016	0.000 to 0.072	145 (100%)
Subject specific (linear)	0.000	0.003	−0.008 to 0.010	0.003	0.002	0.000 to 0.010	145 (100%)

linear, linear QT/RR regression line pattern; log, logarithmic QT/RR regression line pattern; QT, QT interval; QTc, QT interval corrected for heart rate; RR, RR interval; SD, standard deviation.

Table 3

Absolute mean QTc difference between using linear subject specific (LSS) QT rate correction and other QTc formulas.

Comparison	Mean difference (ms)	SD	Range	QTc difference > 20 ms, n (%)
Mean LSS vs. mean Bazett's	16.38	13.30	0.02 to 63.07	42 (29%)
Mean LSS vs. mean Fridericia's	7.32	7.70	0.00 to 37.54	11 (7.6%)
Mean LSS vs. mean Framingham's	7.52	7.89	0.00 to 45.88	9 (6.2%)
Mean LSS vs. mean Study specific (log)	6.51	8.97	0.00 to 49.95	9 (6.2%)
Mean LSS vs. mean Study specific (linear)	6.66	8.89	0.00 to 53.65	9 (6.2%)
Mean LSS vs. mean Subject specific (log)	1.64	2.05	0.02 to 12.27	0 (0.0%)

linear, linear QT/RR regression line pattern; log, logarithmic QT/RR regression line pattern; ms, millisecond; QTc, QT interval corrected for heart rate; SD, standard deviation.

Table 4

Time duration, prevalence of long mean QTc interval, and QTc > 500 ms burden using different QTc formulas.

QTc formula	Mean QTc (ms) Mean ± SD (range)	Long Mean QTc [Male / Female] n, %	QTc > 500 ms Burden (%) Mean ± SD (range)
Bazett	447.31 ± 30.26 (381.56 to 550.98)	19 (13.1%) [7 (4.8%) / 12 (8.3%)]	8.22 ± 20.66 (0.00 to 99.80)
Fridericia	438.23 ± 29.37 (386.79 to 548.08)	14 (9.7%) [6 (4.1%) / 8 (5.5%)]	4.77 ± 16.92 (0.00 to 99.80)
Framingham	436.50 ± 28.37 (384.42 to 547.00)	13 (9%) [5 (3.4%) / 8 (5.5%)]	4.08 ± 16.11 (0.00 to 99.80)
Study specific (log)	433.69 ± 30.90 (369.25 to 546.60)	14 (9.7%) [6 (4.1%) / 8 (5.5%)]	4.28 ± 16.21 (0.00 to 99.60)
Study specific (linear)	433.45 ± 29.72 (374.19 to 546.10)	13 (9%) [5 (3.4%) / 8 (5.5%)]	3.83 ± 15.60 (0.00 to 99.40)
Subject specific (log)	435.66 ± 33.74 (373.10 to 553.26)	17 (11.7%) [8 (5.5%) / 9 (6.2%)]	5.16 ± 19.12 (0.00 to 99.80)
Subject specific (linear)	436.61 ± 33.33 (372.02 to 555.83)	17 (11.7%) [8 (5.5%) / 9 (6.2%)]	5.09 ± 19.11 (0.00 to 99.7)

linear, linear QT/RR regression line pattern; log, logarithmic QT/RR regression line pattern; ms, millisecond; QTc, QT interval corrected for heart rate; SD, standard deviation.

Table 5

Predictors of long mean QTc (n, 138).

Predictors	Univariate			Multivariate		
	B	S.E.	OR (95% CI)	B	S.E.	OR (95% CI)
Acute MI (yes, no)	1.529	0.678	4.62 (1.22 to 17.45) *	1.291	1.013	3.64 (0.50 to 26.50)
Old MI (yes, no)	1.824	0.550	6.20 (2.12 to 18.20) ***	2.464	0.819	11.75 (2.36 to 58.49) **
QT/RR slope [a]	1.675	0.466	5.34 (2.14 to 13.31) ***	1.790	0.630	5.99 (1.74 to 20.58) **
Heart size on X ray (normal, enlarged)	1.723	0.574	5.60 (1.82 to 17.26) **	0.824	0.770	2.28 (0.50 to 10.31)
T wave inversion (yes, no)	1.979	0.562	7.24 (2.40 to 21.80) ***	0.801	0.834	2.23 (0.43 to 11.43)

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

[a] QT/RR slope multiplied by 10 so that ORs are interpreted for each 0.1 unit increase in the QT/RR slope.

B, b- weight of multiple regression (logistic); CI, confidence interval; MI, myocardial infarction; OR, odds ratio; QT, QT interval; QTc, QT interval corrected for heart rate; RR, RR interval; S.E., standard error.