

Creation of a Mobile-based Application to Assess Risk of Psychiatric Medications in the Setting of Prolonged QTc Interval.



Patrick Ying MD, Allison B. Deutch MD, Mark Abrams DO, S. Alex Sidelnik MD and Rachel A Caravella MD
NYU Grossman School of Medicine, Department of Psychiatry

Department of Psychiatry
Division of Consultation-Liaison Psychiatry

BACKGROUND

Consultation-Liaison (CL) psychiatrists frequently provide consultation for patients prescribed psychotropic medications who have complex cardiopulmonary disease, including a prolonged QTc interval which can indicate an increased risk for fatal ventricular arrhythmias like torsades de pointes. CL Psychiatrists must weigh the risk of using psychotropic medications which can further prolong QTc against the risk of allowing acute agitation to go untreated, particularly during behavioral emergencies.

In these circumstances, the literature suggests using EKG parameters not routinely available on automated EKG interpretations, such as the Hodges formula for correcting QT for heart rate (HR) (QTc-Hodges), and methods to correct for wide QRS complexes. QTc –Hodges has been suggested as an alternative to the Bazett formula used in automated EKG interpretations which overcorrects the QT interval in tachycardic patients (Beach, 2018). Wide QRS complexes, occurring as a result of ventricular conduction defects or ventricular pacing, “artificially” prolong the QT interval, without representing a true abnormality in repolarization and risk of torsades de pointes. Methods to correct QTc in the presence of a wide QRS interval include: JT prolongation index (JT_i) (Salik & Muskin, 2013); JTc interval with Hodges correction; Bogossian method; and, Rautaharju method. (Funk, et al 2021). While these are complex calculations (Table 1), to date, there have been no online or application based calculators for clinicians to use these methods at point-of-care.

OBJECTIVE & METHOD

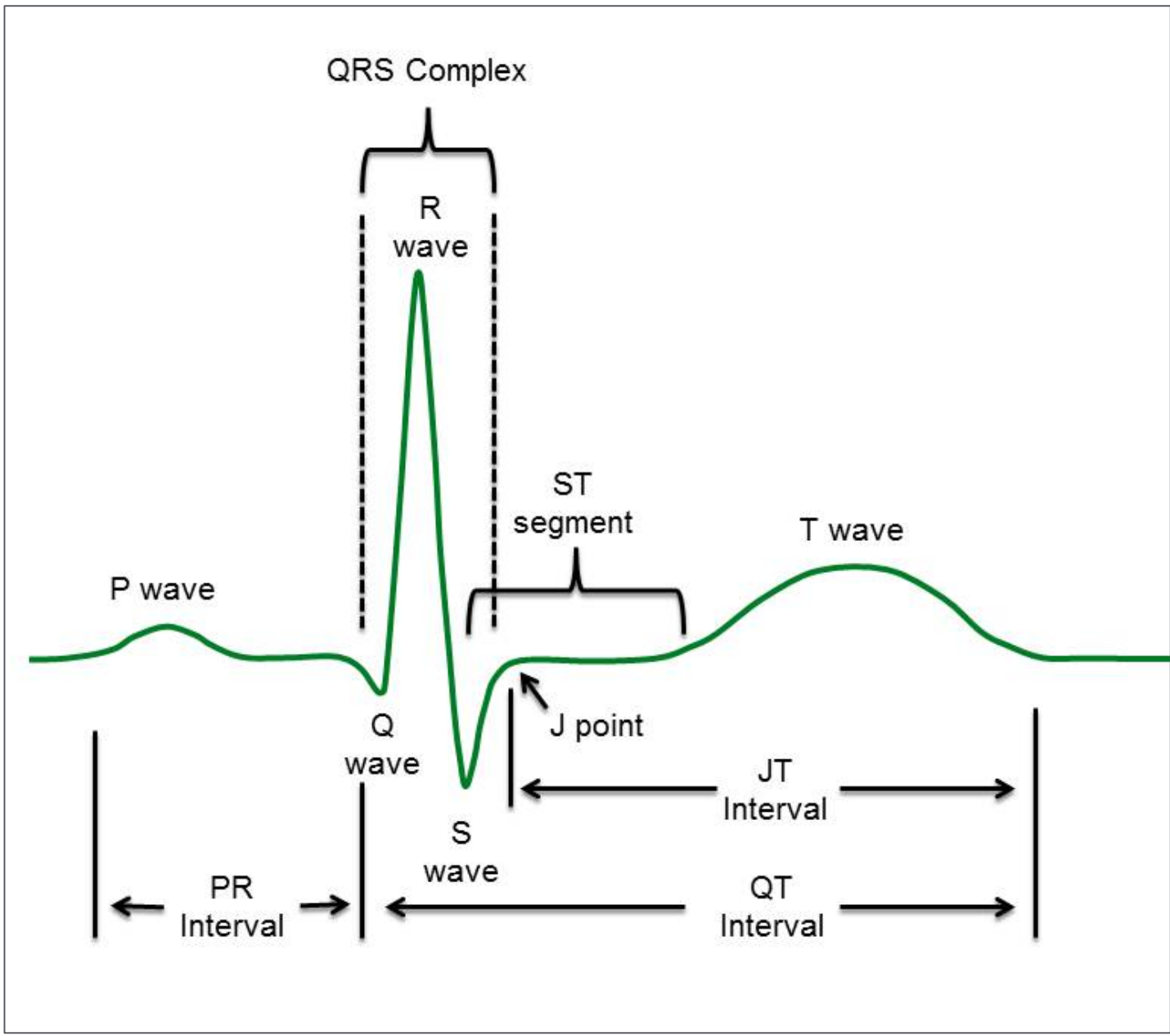
Objective: We created an online calculator, optimized for smartphones, that allows for these calculations to be readily performed at the bedside. Three clinical scenarios derived from clinical experience are shown to demonstrate the utility of this new mobile tool.

Methods: Using the Calconic online interactive calculator platform, we created an online calculator that provides the CL psychiatrist with methods to correct the QT for both HR and wide QRS, if applicable, at point-of-care. Although the calculator is optimized for mobile devices, it can be accessed by any web browser (tinyurl.com/QTCCAL).

App Design: The user inputs QT interval, QRS interval and HR in the app. The app will calculate QTc-Hodges, and indicate when the QRS interval is prolonged. In the setting of prolonged QRS interval, the app will display four methods for correcting wide QRS interval, the JT prolongation index, the JTc with Hodges correction, the Bogossian QTc correction with Hodges, and the Rautaharju QTc correction (see Table 1).

TABLE 1: Methods for correcting wide QRS (Salik & Muskin, 2013; Funk et, al 2021)

JT Prolongation Index (JT _i)
JT= QT- QRS JT _i = JT (HR + 100)/518 Prolonged > 112
JTc with Hodges Correction
JT = QT-QRS JTc (Hodges) = JT + 1.75(HR – 60) Upper limit of normal >355 msec (M); >372 msec (F)
Bogossian (Simplified) with Hodges Correction
QTc = (QT – 0.5*QRS) + 1.75(HR – 60) Upper limit of normal >450 msec (M); >460 msec (F)
Rautaharju Formula
QTc = QT – 155*(RR – 1) – 0.93*(QRS – 139) + k k = -22ms, (M); -34ms, (F) Upper limit of normal >450 msec (M); >460 msec (F)



Graphic from wikitox.org

APP DEMO: QTc & Wide QRS Correction

App address:
tinyurl.com/QTCCAL

USER INPUTS DATA:

QTc Calculator - Hodges and Wide QRS correction

The Hodges correction is more accurate than Bazett, especially at lower and higher heart rates.

In cases of widened QRS (>120 msec) such as from bundle branch block or ventricular pacing, the calculator will suggest methods to correct for the widened QRS interval.

QT interval

470 msec

QRS interval

194 msec

Heart Rate

90 BPM

APP will first calculate QTc Hodges

QTc (Hodges)= QT + 1.75(HR-60)

523 msec

QTc (Hodges)

QRS interval prolonged!

If the QRS interval is >120msec, the following measures are thought to be more useful in determining risk of arrhythmia.

Wide QRS corrections - check box to calculate

☒ JT prolongation index

☒ JTc + Hodges Correction

☒ Bogossian Formula + Hodges Correction

☒ Rautaharju Formula

If QRS prolonged, APP will alert user and offer 4 alternatives to correct for wide QRS complex.

JT prolongation index (>112 increased risk for TdP)

101

JTc + Hodges (limit >355 for men, >372 for women)

329 msec

Bogossian Formula + Hodges

426 msec

Rautaharju Formula - women

437 msec

Rautaharju Formula - men

449 msec

The app will calculate the user's choices for correction of the wide QRS.

CASE 1

54-year old man w/ psychiatric history of opioid use disorder on methadone maintenance x 20 yrs, PMH Hepatitis C, admitted for knee surgery.

Consult Question: Can the surgical team continue methadone post-op with QTc-Bazett=509 msec on admission EKG?

EKG:
Ventricular Rate: 83 BPM
QRS Duration: 88 msec
Q-T Interval: 434 msec
QTc (Bazett): 509 msec
Normal Sinus Rhythm

App Output:

- QTc-Bazett overestimates the QTc interval at the heart rate of 83 BPM.
- The app recalculates the QTc interval using the Hodges correction, at 474 msec, which is below the 500 msec threshold associated with a significant increased risk of torsades de pointes.

CL Recommendation:

- Continue methadone. Risk of relapse > risk of medication,
- Frequent QTc monitoring
- Keep Magnesium > 2 and Potassium > 4

Case Conclusion:

- The patient proceeded to surgery and was subsequently discharged without incident.

CASE 2

63 year old man with a history of coronary artery disease (CAD), unipolar depression and generalized anxiety disorder, admitted for heart failure exacerbation.

Consult Question: Can the medicine team safely restart home regimen of citalopram 40mg and aripiprazole 5mg given worsening depressive illness in setting of heart failure and admission EKG with QTc (Bazett) = 582 msec?

EKG:
Ventricular Rate: 90 BPM
QRS Duration: 194 msec
Q-T Interval: 470 msec
QTc (Bazett): 582 msec
Right bundle branch block

App Output: (Please see APP Demo)

- QTc Hodges is prolonged at 523 msec
- The app identifies a widened QRS complex that artificially prolongs the QTc interval and offers 4 methods of correction of the wide QRS
- JT index is 101, (< 112, not prolonged)
- JTc with Hodges correction is 329 msec
- Bogossian QTc with Hodges correction is 426 msec
- Rautaharju QTc correction (men) is 449 msec
- These values are not associated with increased risk of torsades de pointes.

CL Recommendation

- Continue aripiprazole, however, given FDA warning on citalopram with regard to QTc prolongation, switch to escitalopram

Case Conclusion

- The patient tolerated the switch to escitalopram without symptomatic relapse

CASE 3

77 year old woman with past history significant for dementia, coronary artery disease s/p CABG, peripheral vascular disease, admitted for worsening left foot pain in the setting of osteomyelitis. Behavioral Emergency Response Team activated for severe agitation.

Consult Question: What medications for agitation can be safely given in the context of delirium and prolonged QTc interval?

EKG:
Ventricular Rate: 80 BPM
QRS Duration: 130 msec
Q-T Interval: 540 msec
QTc (Bazett): 624 msec
Right bundle branch block

App Output:

- QTc-Hodges is prolonged at 575 msec
- The app identifies a widened QRS complex that artificially prolongs the QTc interval and offers 4 methods of correction of the wide QRS
- JT index is 142 (>112 prolonged)
- JTc with Hodges correction is 445 (limit for women is 372 msec
- Bogossian QTc with Hodges correction is 510 msec
- Rautaharju QTc correction (women) is 553 msec
- These values are associated with increased risk of torsades de pointes.

CL Recommendation

- Avoid using antipsychotic medication, utilize valproate 250mg IV for agitation

Case Conclusion:

- The patient was successfully deescalated.

CONCLUSION:

The interactive online calculator is an effective, point-of-care tool to assist CL psychiatrists in risk-risk decisions regarding the use of psychiatric medications in medically ill patients.

REFERENCES

Salik J and Muskin PR, Psychosomatics. Sep-Oct 2013; 54(5):502.
Beach SR, et al. Psychosomatics. Mar-Apr 2018; 59(2):105-122.
Funk MC, et al, J Acad Consult Liaison Psychiatry. 2021 Sep-Oct;62(5):501-510.