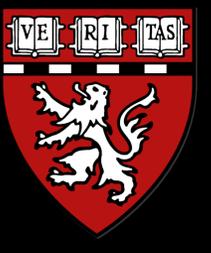# You Do the Math! QT-Prolonging Medications in the Context of Falsely QT-Prolonging Cardiac Pacemaker, Presented in Two Cases

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Background and Introduction

Ventricular pacing by a cardiac pacemaker results in artificial widening of the QRS complex caused by myocyte-to-myocyte propagation of the electrical current, which results in slowing of depolarization (but not repolarization) when compared to a healthy non-paced heart[1,2]. Because QT-interval appears prolonged (and the QTc is correspondingly prolonged), clinicians may be reluctant to prescribe QT-prolonging medications to patients with cardiac pacemakers, due to concern for the risk of potentially fatal arrhythmias / torsades de pointes[3]. Herein we present two cases illustrating this phenomenon, of patients with cardiac pacemakers and QTc >540ms who were initially denied QT-prolonging (but clinically useful) psychiatric medications. In both cases, consult-liaison psychiatrists assisted the patient's medicine teams in re-calculating the QTc, demonstrating normal QTc when accounting for pacemaker, and allowing the patient to resume their psychiatric medications. In such cases, the JT-interval and JTc may further provide useful information to guide clinical decision making[4].

Purpose

To present two cases demonstrating the correction of QT-interval and JT-interval in patients with prolonged QT in the setting of cardiac pacemaker and taking QT-prolonging psychiatric medications.

Patient 1, Mr. L

Initial Presentation and History, Patient 1:
Mr. L is an 80 yo gentleman with past medical history significant for COPD, CAD s/p multiple PCI, HFpEF, AF (on anticoagulation), HTN, T2DM, hypothyroidism, MDD, BPH, urinary retention, GERD, heart block, CKD (stg 4), chronic neck and back pain, Parsonage Turner syndrome, who was admitted to the WX MICU in setting of hypoxic respiratory failure and sepsis due to PNA, complicated by AKI on CKD and metabolic encephalopathy. Psychiatry was consulted due to worsening restlessness and agitation in the ICU, manifesting as loud outbursts of yelling; the primary team requested assistance in selecting a psychotropic medication, given his EKG findings.
Recent EKG findings reviewed at consultation:
Instrument measured QT = 544ms
Instrument calculated QTc = 547ms

Patient 2, Mr. C

Initial Presentation and History:
Mr. C. is an 87 year old male veteran with past history of anxiety, major depressive disorder, unspecified neurocognitive disorder, and a complex medical history including CAD, diastolic heart failure, orthostatic hypotension, lumbar spinal stenosis, RA, OA, glucocorticoid deficiency on hydrocortisone, pacemaker, GERD, BPH, chronic GI issues (without clear explanation) for which he was on long term metaclopramide therapy. He was admitted from the WX ED for agitation and HI noted by staff at his rehabilitation center. Psychiatry was consulted for SI/HI statements, and medication recommendations in the setting of prolonged QTc on EKG.
He was previously treated with Quetiapine 25-50mg QD.
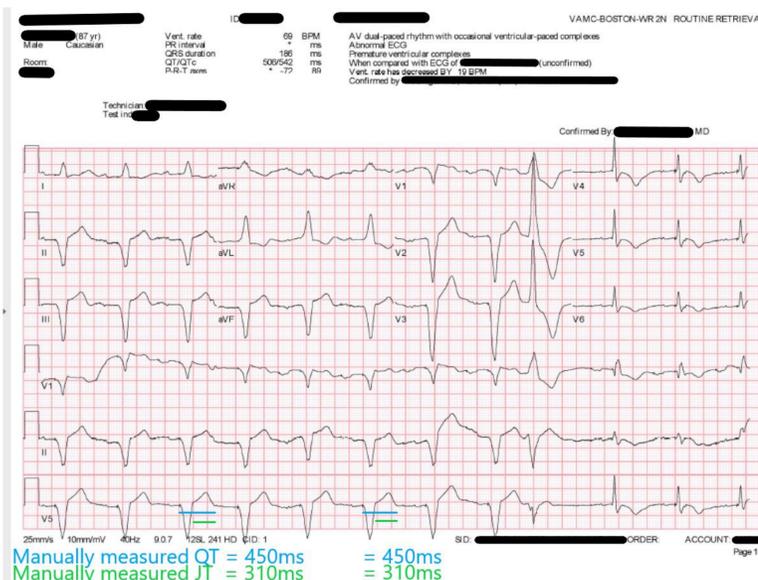Recent EKG findings at consultation:
Instrument measured QT = 506ms
Instrument calculated QTc = 542ms

EKG, patient 1: Mr. L
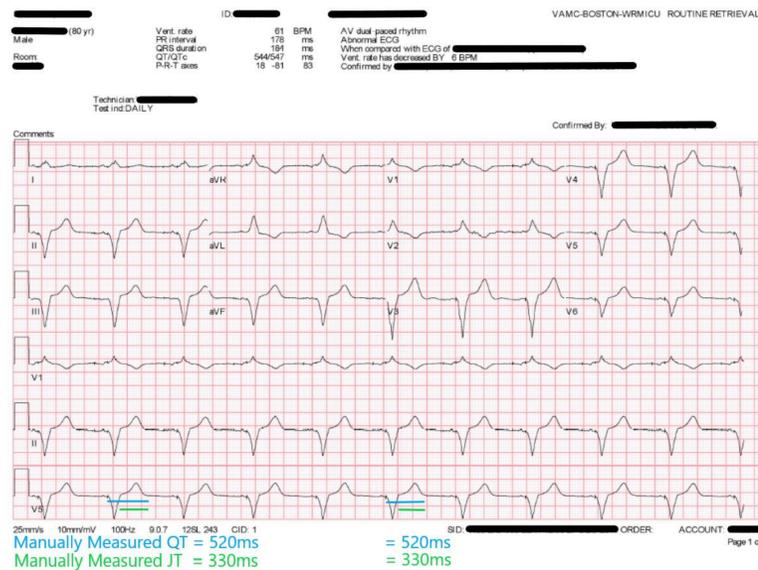
Manual Measurement of QT, JT, QRS, and RR, Patient 1 (Mr. L):
QT: 520ms, JT: 330ms,
QRS: 200ms, RR: 0.960s

EKG, patient 2: Mr. C

Manual Measurement of QT, JT, QRS, and RR, Patient 2 (Mr. C):
QT: 450ms, JT: 310ms,
QRS: 160ms, RR: 0.810s

Manual Measurement of QT and JT

A set of EKG calipers and EKG ruler were used to measure QT and JT-intervals, RR-intervals, and QRS complex durations by hand. In both cases the original measurements were verified with the attending of record at the time the patient was seen. Our measurements were consistent with the original measurements. QRS widening was corrected by subtracting 100mg. Fridericia's formula was used for calculation of both QTc and JTc; ideal JTc range = 310-340ms, and 370ms is considered upper limit of normal[3,4].

Manual Calculation of QTc and JTc

Using Fridericia's Formula, corrected for cardiac pacemaker:
$$QTc = ((QT)-(QRS-100))/(RRs^{1/3})$$
And
$$JTc = (JT) / (RRs^{1/3})$$

Manual Calculation of QTc and JTc, Patient 1 (Mr. L):
$QTc = ((520)-(200-100))/((0.960)^{1/3})$
$= ((520-100)/(0.98648)) = (420/0.98648)$
QTc = **426**
and
$JTc = (330)/(0.960^{1/3}) = (330)/(0.98648)$
JTc = **335**

Manual Calculation of QTc and JTc, Patient 2 (Mr. C):
$QTc = ((450)-(160-100))/(0.810^{1/3})$
$= ((450-60)/(0.93217)) = (390/0.93217)$
QTc = **418**
and
$JTc = (310)/(0.810^{1/3}) = (310)/(0.93217)$
JTc = **332**

QTc and JTc to Guide Clinical Decision-Making

For both Patient 1 and Patient 2, the QTc and JTc when calculated manually were found to be non-concerning, and psychiatric medications (including those which prolong QT) could be continued.

Discussion

Cardiac pacemakers falsely prolong QT and can result in clinical concern for the use of QT-prolonging medications, including many psychiatric medications. Here we presented two cases in which the QT was falsely prolonged. We demonstrated the manual measurement of QT-interval and JT-interval, and manually calculated QTc and JTc, demonstrating that doing so can resolve clinical concern for prolonged QT in some patients with cardiac pacemakers, and thereby improve care for these patients.

References

1: Beach, SR, et al. QTc Prolongation, Torsades de Pointes, and Psychotropic Medications. Psychosomatics. 2013; 54: 1-13.
2: Chiladakis, JA, et al. Facilitating assessment of QT interval duration during ventricular pacing. Europace. 2013; 15: 907-914.
3: Crow, RS, et al. Prognostic Significance of Corrected QT and Corrected JT Interval for Incident Coronary Heart Disease in a General Population Sample Stratified by Presence of Absence of Wide QRS Complex. Circulation. 2003; 108: 1985-1989.
4: Bogmolman, A, et al. 2013. Protected from Torsades de Pointes? What Psychiatrists Need to Know About Pacemakers and Defibrillators. Psychosomatics. 2013; 54: 407-417.

Acknowledgements