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## Impact of Psychotropic Medications on Electrical Cardiac Conduction in the Emergency Department: A Best Practice Review

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UNIVERSITY OF SAN DIEGO

Hahn School of Nursing and Health Science

DOCTOR OF NURSING PRACTICE PORTFOLIO

Impact of Psychotropic Medications on Electrical Cardiac Conduction in the Emergency

Department: A Best Practice Review

by

Juliann M. Hatt, BSN, RN, CEN, TCRN, MICN, PHN

A Doctor of Nursing Practice Portfolio presented to the

FACULTY OF THE HAHN SCHOOL OF NURSING AND HEALTH SCIENCE

UNIVERSITY OF SAN DIEGO

In partial fulfillment of the

requirements for the degree

DOCTOR OF NURSING PRACTICE

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### Abstract

**Background:** The effects of psychotropic drugs on cardiac repolarization have increasingly gained attention in research and clinical practice over the last 2 decades. The absolute risk of cardiac arrhythmia, such as the polymorphic ventricular tachycardia, Torsades de Pointes (TdP), is low (14 per 10,000 patients/year) and sudden cardiac death as a consequence of all cardiac arrhythmias is less frequent (Braillon et al., 2017). TdP can occur at therapeutic doses of second-generation antipsychotics and antidepressants and with a corrected Q-T (QTc) interval >500 ms. Many psychotropic medications can delay cardiac repolarization thereby producing prolonged QTc in the electrocardiogram (ECG). Emergency departments (EDs) are a frequent point of care for patients diagnosed with psychiatric medical disorders taking one or more psychotropic medications.

**Purpose of Project:** Using evidence-based practice, this project standardize the cardiac assessment of psychiatric patients in the ED who were on one or more psychotropic medications by performing a 12-lead ECG on arrival to rule out QTc prolongation, thus reducing the risk of polymorphic ventricular tachyarrhythmia.

**Outcomes:** Fifty patient-ECGs were evaluated and compared by psychotropic medication; all were within normal range. Recommend continuance of ECG protocol to assess for the possibility of QTc prolongation and to prevent its progression to TdP.

*Keywords:* Psychotropic medications, psychiatric medications, QT prolongation, QTc prolongation, 12-lead ECG, emergency department, Torsades de Pointes.

Impact of Psychotropic Medications on Electrical Cardiac  
Conduction in the Emergency Department: A Best Practice Review

**Description of the Clinical Problem**

The effect of psychotropic drugs on cardiac repolarization has increasingly gained attention in research and clinical practice over the last two decades. A prolonged QTc may in rare cases contribute to TdP emergence and, while often self-limited, could progress to ventricular fibrillation and sudden cardiac death. Of the psychotropic drugs, antipsychotics and some antidepressants have both been proven to increase QTc and are associated with TdP and sudden cardiac death.

Prior to a drug's approval, the U.S. Food and Drug Administration (FDA) requires manufacturers to perform comprehensive investigations on the medication side-effects profile to include evaluation of QT and QTc prolongation risks. The most commonly known drug-induced mechanism of QT prolongation occurs when the inward rectifier potassium ( $I_{Kr}$ ) channel of cardiomyocytes is inhibited, thus resulting in delayed cardiac action potential. First generation antipsychotics (i.e., dopamine antagonists, neuroleptics) were primarily used to treat schizophrenia and other psychotic disorders, as well as thioridazine (Mellaril, Mellaril-S), pimozide (Orap), and haloperidol (Haldol, Haldol Decanoate, Peridol) have all been found to prolong the QTc. Selective serotonin reuptake inhibitors (SSRIs) have been controversial in their effects on the QTc, leading the FDA to perform random crossover studies to compare the effects of citalopram (Celexa) to its S-isomer escitalopram (Cipralex, Lexapro), as well as to sertraline (Zoloft). Results of these case studies indicated that fluoxetine (Prozac) could protect against post-MI cardiovascular events including arrhythmias. Women demonstrated a significantly more

pronounced prolongation in the QTc interval than men; however, men typically had a longer QTc.

TdP is a potentially dangerous side effect of several psychotropic medications but is difficult to study because of its low rate of occurrence. The absolute risk of cardiac arrhythmia, such as Torsades de Pointes (TdP) is low (14 per 10,000 patients) annually, while sudden cardiac death as a consequence of all cardiac arrhythmias occurs even less frequently (Brailion et al., 2017). TdP can occur at therapeutic doses of second-generation antipsychotics and antidepressants and with a corrected QT (QTc) interval  $>500$  ms. Many psychotropic medications can delay cardiac repolarization, thereby producing a prolonged QTc in the electrocardiogram (ECG). In rare cases, a prolonged QTc may cause life-threatening polymorphic ventricular tachyarrhythmia such as TdP. TdP is often self-limited but may lead to ventricular fibrillation and sudden cardiac death.

The QT interval is a measure of combined cardiac depolarization and repolarization (Postema & Wilde, 2014). The QT interval starts with the beginning of the QRS-complex (i.e., ventricular depolarization) and ends with termination of the T-wave (i.e., ventricular repolarization). QTc prolongation is defined as  $> 450$  ms for men and  $> 470$  ms for women (Goldenberg et al, 2013). In healthy adults, a mean QTc prolongation of  $> 5$  ms due to medication is cause for concern in toxicity studies (Hasnain & Vieweg, 2014). Proven to prolong QTc and associated with TdP and sudden cardiac death are psychotropic drugs, antipsychotics, and some antidepressants. These antidepressants include the classes of conventional antipsychotics, dopamine stabilizers, serotonin antagonist/reuptake inhibitors, noradrenergic and specific serotonergic antidepressants, norepinephrine and dopamine reuptake inhibitors, selective norepinephrine reuptake inhibitors, selective serotonin reuptake inhibitors, serotonin-dopamine

antagonists, serotonin and norepinephrine reuptake inhibitors, serotonin 1A partial agonists, serotonin partial agonist reuptake inhibitors, and tricyclic/tetracyclic antidepressants. The emergency department (ED) frequently serves as a point of care for patients diagnosed with psychiatric medical disorders taking prescribed psychotropic medications.

Numerous study designs, to include meta-analyses, systematic reviews, randomized controlled studies, case-control and cross-sectional studies, have justified concerns regarding the risk of prolonged QTc, prompting regulatory agencies such as the USA Federal Drug Administration (FDA) to investigate this side effect of prescribed medications to monitor their safety. Several factors are considered when analyzing the effect of QTc prolongation, including age (< or > 60 years); sex; metabolic inhibition of another drug (e.g., CYP2C19 inhibitors) or those of who are poor CYP2C19 metabolizers; hepatic impairment; concurrent use of another QTc-prolonging drug (Hasnain et al, 2013); cardiac disease (e.g., congestive heart failure), cardiac structural or electrical abnormalities or coronary heart disease; congenital long QT syndrome (Arizona University-based Center for Education and Research on Therapeutics [AZCERT],n.d.), hypomagnesemia; and hypokalemia. AZCERT's CredibleMeds website was accessed to identify second- generation antidepressants (SGAD) and second-generation antipsychotics (SGAP) medications. Attention was focused on psychotropic medications that caused prolongation of the QT/QTc interval and sudden cardiac death; seven SGADs (i.e., citalopram, escitalopram, fluoxetine, mirtazapine, paroxetine, sertraline, venlafaxine) and nine SGAPs (i.e., amisulpride, clozapine, iloperidone, olanzapine, paliperidone, quetiapine, risperidone, sertindole, ziprasidone. Haloperidol (Haldol) is a common first-generation antipsychotic (FGAP) in use that has been found to potentiate QTc prolongation.

The American Heart Association (AHA) and the American College of Cardiology Foundation (ACCF) released a scientific statement to raise awareness among health care professionals about the risk, ECG monitoring, and management of drug-induced QT interval prolongation and TdP in hospitalized patients. This statement emphasized the importance of awareness of risk factors in order to minimize the likelihood of occurrence of drug-induced TdP (Drew et al., 2010). In a 5-year cross-sectional ECG screening in 6,790 adult psychiatric inpatients, 27.3% had abnormal ECGs, 1.6% had long QT, and 0.95% qualified as drug-induced long QT case subjects. Sudden cardiac death was recorded in five patients and TdP was recorded in seven other patients (Girardin et al., 2013).

Currently, there is a paucity of national or international guidelines or consensus documents with specific recommendations regarding ECG monitoring and screening for antidepressant and antipsychotic treatment. Existing guidance typically recommends ECG monitoring and screening before and during the start of psychotropic medicines known to cause QTc prolongation in those vulnerable to CYP2C19 inhibitors or metabolizers. The Food and Drug Administration (FDA, 2012) issued a warning about the SGAD citalopram (Celexa) and its potential risk for QTc prolongation leading to TdP at doses greater than 40 mg orally. Newer product labeling urged providers to use lower doses, to not exceed 20 mg in patients older than 60 years of age, in patients with hepatic dysfunction, those who were poor CYP219 metabolizers, and those taking concomitant CYP2C19 inhibitors. Due to this warning, the maximum dose of citalopram changed to 40 mg daily in nonelderly persons (Forest Pharmaceuticals, Inc, 2012). Antidepressant use has increased in 2017-2018 from 10.6% to 13.8% in the United States (Brody & Gu, 2020). More than 34.4 million adults took antidepressants in 2014, up from 13.4 million in 2010, and over 242 million U.S. adults filled

one or more prescriptions for psychiatric medications (Moore & Mattison, 2017). With the SARS-CoV-2 pandemic, mental health demand has increased in the United States by over 40.9% during the month of June 2020, when compared to June 2019. The impact of stay-at-home orders, social distancing, loss of employment and wages, and stresses on care providers and loved ones have contributed to a 30.9% increase in reported symptoms of anxiety and depressive disorders, a 26.3% increase in trauma or stressor-related disorders, a 13.3% increase in substance use to cope with the stress or emotions related to SARS-CoV-2, and a 10.7% increase in the admitted incidence of suicidal ideations (Czeisler et al, 2020).

According to the Centers for Disease Control and Prevention (CDC, n.d.), an estimated 50% of Americans will be diagnosed with a mental illness or disorder at some point in their lifetime. Depression is the third most common cause of hospitalizations in the United States for those aged 18 years-44 years old. For providers who prescribe the use of psychotropic medications to treat mental illness, careful consideration needs to be given to rare but serious side effects.

### **Evidence-Based Practice Model**

Across the educational pavé, numerous evidence-based practice models guide the registered nurse and advanced practice registered nurse. For this DNP project, the John Hopkins Nursing Evidence-Based Practice Model (JHNEBP) was selected to guide decision-making (Dang & Dearholt, 2017). The JHNEBP model is a three-step process that involves a cross-examination in clinical practice, searching for the best scientific evidence, then translating evidence into current practice in order to improve patient care.

### **Evidenced-Based Solutions**

Review of the literature was performed using the following search engines: CINAHL, Cochrane, Evidence-Based Medical Reviews, Google Scholar, PsycARTICLES, PsychINFO, and PubMed. Keywords utilized during initial and later searches were psychotropic medications, psychiatric medications, QT prolongation, QTc prolongation, drug-induced QT interval prolongation, 12-lead ECG, ED, ventricular dysrhythmia, polymorphic ventricular tachyarrhythmia, Torsades de Pointes, sudden cardiac death, first generation antipsychotics/antidepressants, second generation antipsychotics/antidepressants, psychiatric diagnosis, mental health in EDs. This search yielded 93 articles from the last 8 years. To narrow the search further, Medical Subject Headings (MeSH) terminology that were used included psychotropic medications, polymorphic ventricular tachyarrhythmia, ED, prolonged QTc, and 12-lead ECG, which yielded 51 results. These searches were performed multiple times between January 2020 and January 2021. A total of 22 articles were critically appraised to evaluate the proposed intervention for this manuscript. The articles were selected based on their quality, relevance to their population, and English language.

### **Purpose of the EBP Project**

The purpose of this Doctor of Nursing (DNP) project was to (a) conduct an evidence-based meta-analysis and literature reviews concerning QTc-prolongation due to psychotropic medications, (b) recommend the performance of 12-lead ECGs on persons diagnosed with a psychiatric disorder between the ages of 18 years and 65 years of age, and (c) evaluate the outcomes for patients meeting the recommended guidelines. This project's intent was to educate emergency physicians and nurses to obtain 12-lead ECGs on patients prescribed psychiatric medications and to analyze the QT and QTc prolongations due to risk factors.

### **Project Site**

This project was conducted in an ED located in Southern California. The hospital did not have a standardized protocol for patients taking psychotropic medications. Annually, the ED admitted 560 adult patients (18 years-65 years of age) who were evaluated for a psychiatric disorder, including suicidal ideations, attempts, self-harm, overdose, and assaults.

### **Project Implementation Timeline**

Development started January 2020 with the research Clinical Mentor to define the DNP project goals of analyzing and assessing QTc prolongation in patients currently prescribed with psychotropic medications. A literature review was done to obtain the most recent meta-analyses of evidence-based research on psychiatric medications with current FDA concerns for QT/QTc prolongations. The ED Physicians supported this DNP project with full collaboration as each psychiatric patient on psychotropic medications was seen, assessed, and evaluated for QTc prolongation.

Barriers to this project included the delayed from midyear to the end of the year 2020 attributable to the SARS-CoV-2 global pandemic and all of its uncertainties. One form of resistance the ED/Trauma director faced was the unforeseen pandemonium that devastated the country at a startling rate, paralyzing the project's start. Once stability was achieved, all stakeholders agreed to pursue the project in earnest. In the meantime, an education plan and protocol were developed. To monitor the outcomes of patients seen in the ED who fulfilled criteria, a data plan was devised.

### **Education Plan/Protocol**

If a patient presented to the ED and acknowledged taking a psychotropic medication, the 12-lead ECG was ordered to assess for prolonged QTc or abnormal arrhythmia. If positive, the

ED physician or registered nurse educated the patient and/or family members or contacted the psychiatrist or primary care provider.

**Data Plan/Design**

An Excel spreadsheet was created including age, sex, psychiatric diagnosis, psychotropic medication(s), QTc measured in milliseconds (ms), and cardiac rhythm.

Updated literature reviews were conducted in late 2020 while awaiting IRB review and permission to proceed was obtained in January 2021. The progress of the project is outlined in Table 1.

**Table 1***Project Development and Implementation Timeline*

Intervention/Activities	Persons Involved	Timeline
Engaged mentorship of Dr. Kelsoe at University of California, of San Diego Psychiatry and he was amenable	DNP Student Dr. John Kelsoe, MD	December 12, 2019
Proposal of DNP Practice project to Inland Valley Medical Center Emergency Department	DNP Student Jennifer Lee, MSN, RN	January 10, 2020
Clinical Stakeholders Presentation <i>scheduled</i> to present DNP Practice project	DNP Student Jennifer Lee, MSN, RN. ED Directors ED Physicians	March 30, 2020
SARS-COV-2 Global Pandemic postponement	DNP Student Jennifer Lee, MSN, RN ED Directors ED Physicians	March 19, 2020
University of California, San Diego IRB acceptance letter	DNP Student Dr. John Kelsoe, MD	September 25, 2020
Inland Valley Medical Center ED IRB acceptance letter	DNP Student Dr. Craig Owens, MD	January 13, 2021
University of San Diego IRB acceptance letter	DNP Student Michael Terry, DNP, PMHNP, FNP Joseph Burkard, DNSc, CRNA	January 13, 2021
Dissemination of final results at clinical stakeholder presentation	DNP Student Jennifer Lee, MSN, RN ED Directors ED Physicians	March 1, 2021
Final dissemination of final manuscript and poster presentation at the University of San Diego	DNP Student USD Hahn School of Graduate Nursing	March 4, 2021
Graduate	DNP Student USD Hahn School of Graduate Nursing	May 22, 2021

**Project Impact and Cost Benefit Analysis**

The average cost for a 12-lead ECG in an ED setting in the United States was estimated between \$50 - \$150. The ED where this DNP project was performed charged \$150 per 12-lead ECG. In 2017, mental and substance use disorder (MSUD) ED visits had service delivery costs

of more than \$5.6 billion; more than 7% percent of total ED-visit costs (\$76.3 billion).

According to Karaca and Moore (2020), the average cost was \$1,500 per ED visit across the 10.7 million MSUD ED visits, similar to the \$3,000 average cost for all 144.8 million ED visits.

The rate of ED visits for mental health and substance use diagnoses increased 44.1% from 2006 to 2014, to a rate of 20.3 visits per 1,000 population (Karaca & Moore, 2020).

According to the most recent census, the population in Riverside County in 2019 was 2,470,546 people (U.S. Census Bureau, 2020). At this size, it can be estimated that an average of 50,152 ED visits were for psychiatric diagnoses. Additionally, up to 27% of ED visits in the United States could be managed in the lower-cost setting of physician offices, clinics, and urgent care centers (Weinick et al, 2016). If a 12-lead ECG was performed during a psychiatric patient's visit to the ED, patients with prolonged QTc could as the result of medication be identified, preventing ED visits and managed by physician offices, clinics, and urgent care centers.

As stated above, the average cost of a 12-lead ECG at this DNP project's ED is \$150. With 50,152 psychiatric ED visits per year, the total costs for all visits is \$75,228,000. If a 12-lead ECG was running for each visit, it would cost \$7,522,800. If 27% of ED visits could be regulated by physician offices, clinics, and urgent care centers, it would prevent 13,541 yearly visits to the ED. By reducing these visits, it would save \$20,311,560 in emergency visit costs yielding a total cost avoidance to the ED of \$67,705,200. These costs do not include the human cost of deadly arrhythmias, including TdP and sudden cardiac death.

### **Project Outcome Goals**

Both short- and long-term goals were benchmarked for this project. Short-term goals were constantly re-evaluated throughout the first 4 weeks after the initiation of the clinical practice portion of the project. Consecutive assessments were discussed with the ED outcome

stakeholders. Short-term goals included determining selective psychiatric patients aged 18 years–65 years of age, those with one or more psychiatric diagnosis, and those currently prescribed and taking psychotropic medications when admitted into the ED. Once confirmation was positive in all categories, a 12-lead ECG was performed within the first 30 minutes and presented to the ED physician for reading and assessment of QT/QTc prolongation.

Long-term goals were evaluated 6 weeks following initiation of the clinical practice project and completed February 24, 2021. Long-term goals included establishing the current guidelines and recommendations from the FDA, the American Heart Association (AHA), and the American College of Cardiology Foundation (ACCF) for a QTc prolongation > 500 ms. If a patient met that criteria, the patient would be educated and contact would be made with their psychiatric provider.

#### **Process Indicator Data Monitoring**

The first process indicators used to translate this current evidence into practice took the form of education workshops for ED staff on the rationale and importance of detecting a prolonged QT/QTc of those at moderate and high risk. The impact of patient/family and ED staff education on psychotropic medications was the focus of this evidence-based project. Essential follow up consisted of viewing identified patient data. Obtaining ED staff feedback was important to maintain best practice and retention of daily goals. Bi-weekly in-person meetings with staff were maintained in order to be attentive to their concerns, questions, observations, and commentary.

#### **Outcome Indicator Data Monitoring**

The outcome indicator used to translate this current evidence into clinical practice was evaluating the number of patients aged 18 years–65 years of age with one or more psychiatric

diagnoses and taking one or more psychotropic medications. An average number of 10 patients per week are admitted into the ED for drug or alcohol-induced overdose, suicidal ideation or suicide attempt, self-harming behaviors, or brought in by law enforcement under California's Welfare and Institution Code 5150 for detention of a mentally disordered persons for evaluation. Outcome data were collected biweekly.

### **Results**

Results were analyzed for process and outcome indicator data by assessing the average number of weekly patients meeting the specific criteria for a total of 50 patients. While this project primarily focused on medication statistics, the traits related to gender and age were deemed important to capture. The conclusions resulted from calculations and graphing in Excel.

Psychiatric medications were considered for their potential to cause prolongation of the QT/QTc interval and sudden cardiac death; those not meeting this stipulation were not included. The seven SGADs and nine SGAPs) were examined (AZCERT, 2013). The cardiac rhythm on the ECG was analyzed and documented as displaying sinus bradycardia (n7), regular sinus rhythm (n17), sinus tachycardia (n24), atrial fibrillation with rapid ventricular response (n1), or regular sinus rhythm with sinus arrhythmia (n1). Table 2 displays the raw data collected on Day 1 of admission to the ED.

**Table 2**

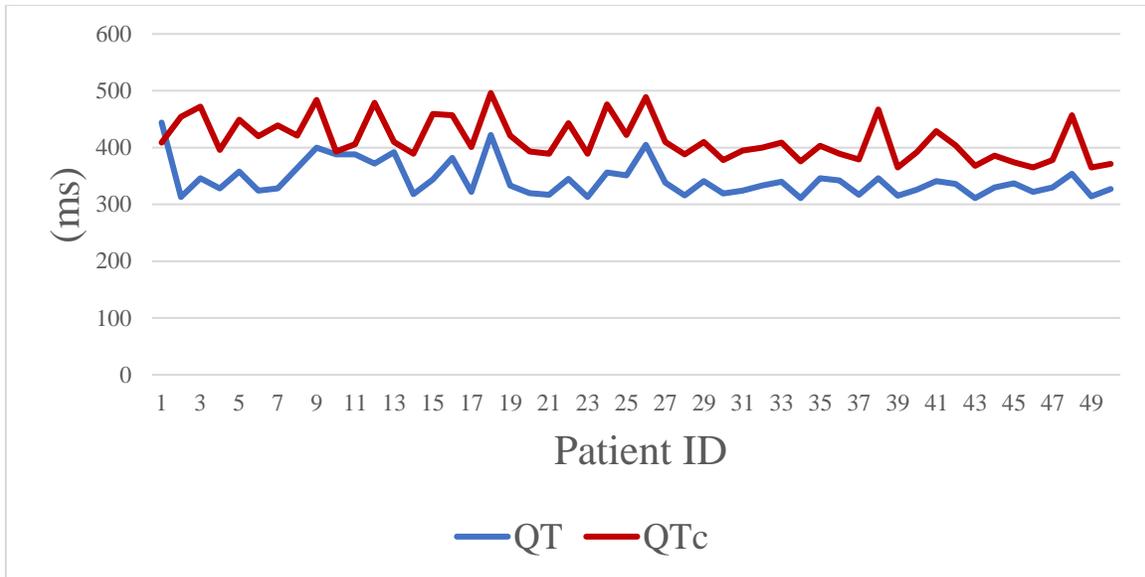
*Raw Data*

Subject	QT (ms)	QTc (ms)	Age	Gender	Diagnoses	Medications	Rhythm
1	444	409	65	F	GAD, MDD, SA/SI	Abilify, Alprazolam	Sinus Brady
2	313	454	59	M	GAD, MDD	Citalopram	Atrial Fibrillation RVR
3	346	472	23	F	ADHD, GAD, MDD, PTSD, Substance Use	Adderall, Buspirone, Klonopin	Sinus Tach
4	328	396	38	M	Schizoaffective, Substance Use	Clonidine, Seroquel, Wellbutrin, Zyprexa	Sinus
5	358	449	22	F	Asthma, PTSD, SA/SI, TBI	Ativan, Duloxetine, Keppra	Sinus
6	324	420	58	M	GAD, MDD, PTSD, SA/SI	Escitalopram, Gabapentin	Sinus Tach
7	328	439	49	M	GAD, MDD	Gabapentin, Lyrica, Paxil	Sinus Tach
8	364	421	18	M	OD, SA/SI, Schizophrenia	Haldol, Quetiapine	Sinus Tach
9	400	484	55	F	GAD, SA/SI	Gabapentin, Hydroxyzine	Sinus
10	388	393	32	F	GAD, MDD, PTSD, SA/SI	Citalopram	Sinus w/ Sinus Arrhythmia
11	388	406	20	M	Schizophrenia, Substance Use	Lithium, Olanzapine, Risperdone	Sinus Tach
12	372	479	20	F	Bipolar w/ mania, SA, Substance Use	Lithium, Paroxetine	Sinus Tach
13	392	410	39	M	Bipolar, Depression, PTSD	Gabapentin, Lithium, Risperdal	Sinus Tach
14	318	389	25	M	Bipolar, OD, SA	Depakote, Haldol, Lithium	Sinus Tach
15	344	459	62	F	Schizoaffective	Escitalopram, Lithium	Sinus Tach
16	382	457	18	F	Bipolar, Depression, PTSD	Alprazolam, Fluoxetine	Sinus
17	322	401	31	M	MDD, SA, Substance use	Gabapentin, Lexapro	Sinus
18	422	496	63	F	GAD, MDD, SA/SI	Abilify, Escitalopram	Sinus Brady
19	333	421	44	M	MDD, SA/SI, PTSD	Escitalopram	Sinus Tach
20	320	393	29	M	Alcohol Use, Schizophrenia, Substance Use	Alprazolam, Risperdone	Sinus Tach
21	317	389	38	F	Bipolar, OD, SA/SI	Bupropion, Fluoxetine	Sinus
22	345	443	53	F	Bipolar w/ mania, SA, Substance Use	Lithium, Quetiapine	Sinus Tach
23	313	389	22	M	Alcohol Use, Schizoaffective, Substance Use	Risperdone	Sinus Tach
24	356	476	59	M	GAD, MDD, PTSD, SA/SI	Escitalopram, Gabapentin	Sinus Brady
25	351	422	47	M	Alcohol Use, MDD, SA/SI, PTSD	Gabapentin, Escitalopram	Sinus
26	405	489	56	F	GAD, MDD, SA/SI	Citalopram	Sinus
27	338	410	41	F	Alcohol Use, GAD, MDD	Fluoxetine	Sinus Brady
28	316	388	23	F	MDD, SA/SI, Substance Use	Sertraline	Sinus
29	341	410	35	F	Bipolar w Mania, OD, Panic, SA/SI	Alprazolam, Lamotrigine	Sinus Tach
30	319	378	18	M	Alcohol Use, Schizophrenia, Substance Use	Clozapine, Risperdone	Sinus Tach
31	324	395	21	F	Bipolar, Depression, PTSD	Duloxetine, Risperdone	Sinus
32	333	400	25	M	Alcohol Use, Schizoaffective, Substance Use	Haloperidol, Lamotrigine	Sinus Tach
33	340	409	33	M	GAD, MDD	Escitalopram	Sinus
34	311	376	28	F	GAD, MDD, SA/SI	Sertraline, Gabapentin	Sinus
35	346	403	54	M	PTSD	Escitalopram	Sinus
36	342	389	45	F	MDD, SA, Substance Use	Paroxetine	Sinus
37	317	379	21	M	GAD, Substance Use	Sertraline	Sinus Tach
38	346	467	65	M	MDD, PTSD, SA/SI, Substance Use	Fluoxetine	Sinus Brady
39	315	365	18	M	Alcohol Use, Schizophrenia, Substance Use	Risperdone	Sinus Tach
40	326	392	18	M	PTSD, Substance Use	Venlafaxine	Sinus Tach
41	341	429	58	M	Alcohol Use, Schizoaffective, Substance Use	Haldol, Quetiapine	Sinus Tach
42	336	404	39	F	Bipolar, OD, SA/SI	Lithium	Sinus
43	311	368	20	F	MDD, Schizoaffective, Substance Use	Thioridazine, Valproate	Sinus Tach
44	330	386	27	M	MDD, SA, Substance use	Duloxetine	Sinus
45	337	374	22	F	GAD, MDD, PTSD, SA/SI	Paroxetine	Sinus Tach
46	322	365	29	F	Bipolar w Mania, OD, Panic, SA/SI	Lurasidone, Valproate	Sinus Tach
47	330	378	35	F	Alcohol Use, GAD, MDD, SA/SI	Escitalopram, Gabapentin	Sinus Brady
48	354	457	64	M	GAD, MDD, PTSD, SA/SI	Gabapentin, Venlafaxine	Sinus Brady
49	314	365	21	M	ADHD, Alcohol Use	Adderall	Sinus Tach
50	327	371	27	M	Bipolar, OD, SA/SI	Risperdone, Paroxetine	Sinus

For most of the sample, their QT and QTc measurements had largely parallel trendlines. The space between each trendlines averaged to be 70.5ms; the difference between the QTc average of 414.28ms and the QT average of 343.78ms (Figure 1).

**Figure 1**

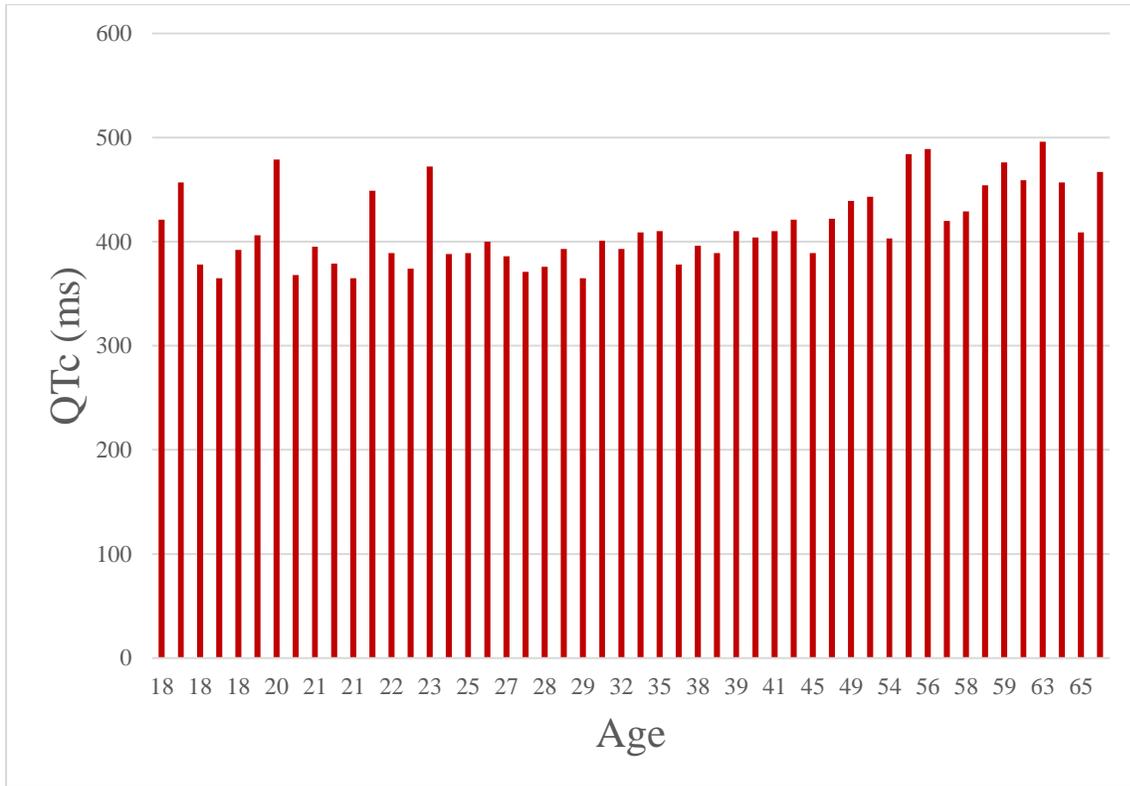
*QT and QTc Measurements for All Patients*



The ages of the patients ranged from 18 years-65 years of age. There did not appear to be any relationship between age and QTc measurements based on the distribution (Figure 2). The uniformity of the data was a positive sign as there was no skewing nor evident trends due to age.

**Figure 2**

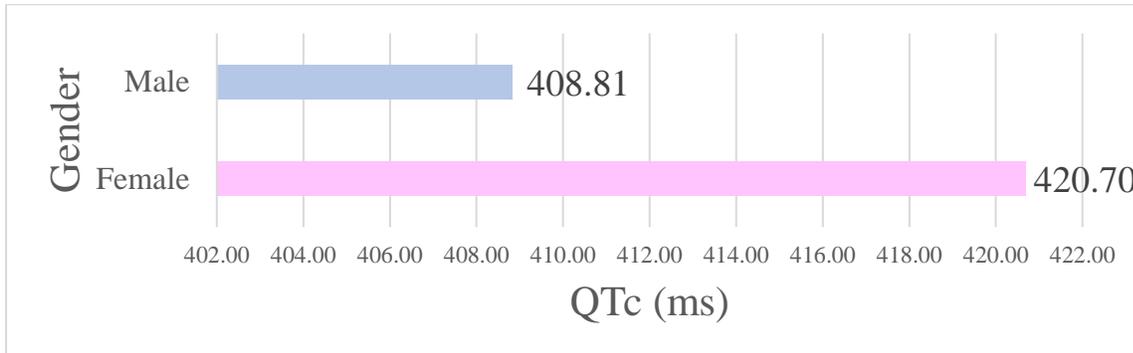
*QTc Measurements by Age*



Of the 50 patients, 23 were female and 27 were male. When compared, females had a slightly longer average QTc (420.70 ms) compared to the males (408.81 ms); however, current literature indicates that males may have longer QT/QTc without the influence of psychiatric medication.

**Figure 3**

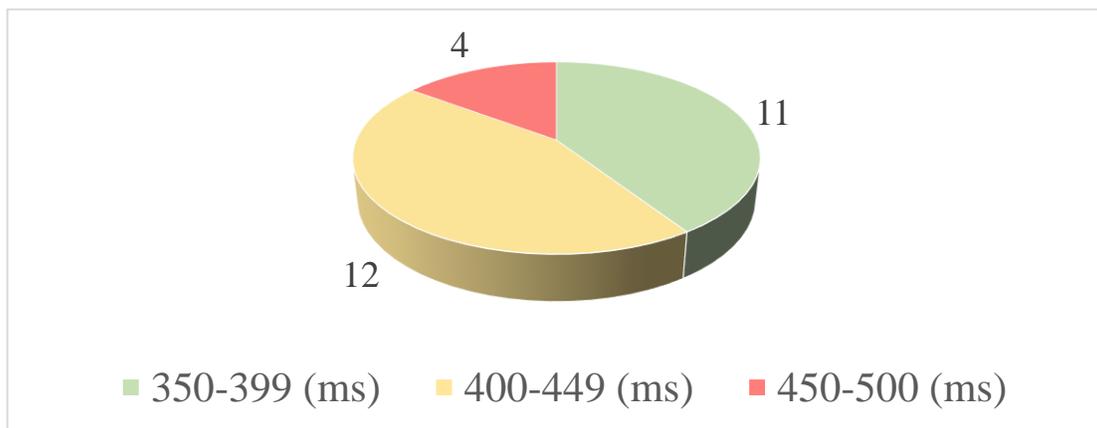
*Average QTc Based on Gender*

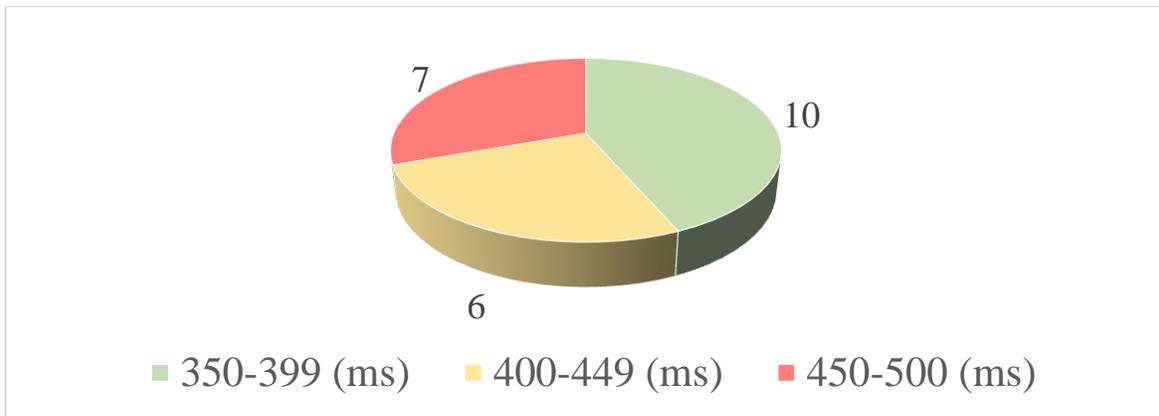


This introduces the first limitation to the modest data pool, for as previously stated, males genetically have longer baseline QTc measurements than females. If this project were repeated or expanded, a more robust sample might reveal true differences between the prolongations of males and females. By analyzing each gender separately, the project’s findings would likely be explained by pre-existing differences. Males and females appeared to have similar numbers in the 350-399ms range, but male patients were more likely to be in the 400-449ms range.

**Figure 4**

*QTc Distribution Among Male Patients*



**Figure 5***QTc Distribution Among Female Patients*

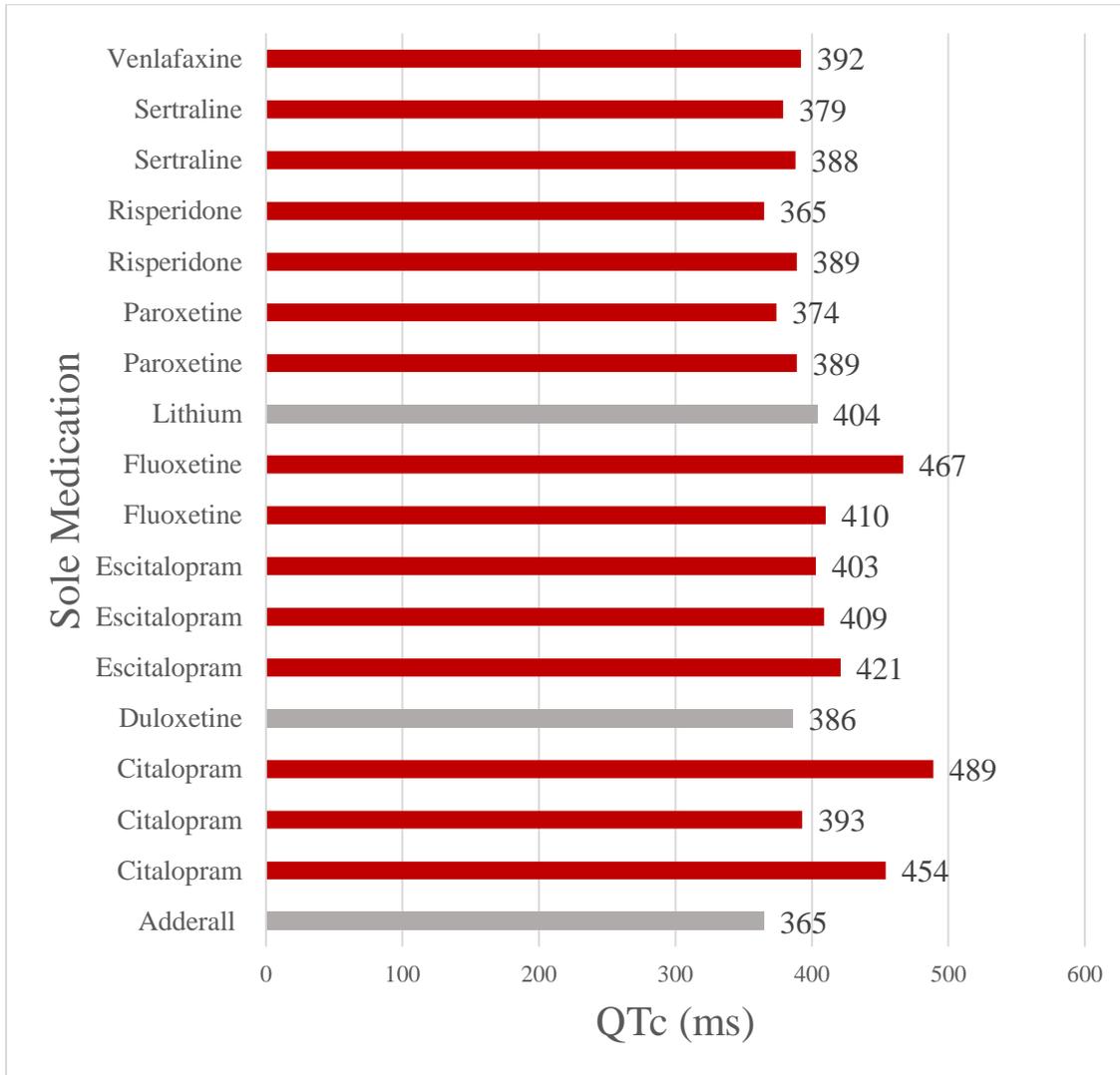
The exact capture of patient diagnoses in relation to their potential for cardiac conduction abnormalities did not have a significant role on the relationships between psychotropic medications and the patient population's QTc measurements. Data were collected in an ED setting and therefore the noting of cardiac rhythms and various diagnoses are standard when performing an EKG.

The psychotropic medications were grouped into two categories: second-generation antipsychotics and second-generation antidepressants. The antipsychotic medications considered were Risperidone (dopamine, serotonin, norepinephrine receptor antagonist [DSN-RAn]/serotonin-dopamine antagonist), Quetiapine (dopamine, serotonin multimodal [DS-MM], serotonin-dopamine antagonist), Thioridazine (dopamine and serotonin receptor antagonist/dopamine 2 antagonist), and Haldol (dopamine receptor antagonist [D-RAn]/dopamine 2 antagonist). The second-generation antidepressants noted were Citalopram (serotonin reuptake inhibitor [S-RI]/selective serotonin reuptake inhibitor [SSRI]), Escitalopram (serotonin reuptake inhibitor [S-RI]/selective serotonin reuptake inhibitor [SSRI]), Fluoxetine (serotonin reuptake inhibitor [S-RI]/selective serotonin reuptake inhibitor [SSRI]), Sertraline

(serotonin reuptake inhibitor [S-RI]/selective serotonin reuptake inhibitor [SSRI]), Paroxetine (serotonin reuptake inhibitor [S-RI]/selective serotonin reuptake inhibitor [SSRI]), and Venlafaxine (serotonin and norepinephrine reuptake inhibitor [SN-RI]/dual serotonin and norepinephrine reuptake inhibitor [SNRI]). While more than half of the sample was prescribed more than one medication, 18 patients were taking one medication; 15 of those were taking a sole antidepressant. No patient taking a medication of interest was exclusively on an antipsychotic. The graph below displays the three patients with a corresponding drop from 18- to 15- (gray bars) in order to maintain the attention on the medications of focus. The highest QTc measurements were taking Citalopram (489ms) and Fluoxetine (467ms). The lowest QTc measurement came from one patient taking Risperidone (365ms). As expected, Citalopram has been identified as the antidepressant with the most profound effect for increasing QTc. The Fluoxetine patient was 41 years of age; an ideal patient to be monitored in primary care yearly. The patient on Risperidone was one of the youngest at age 18 years. Risperidone is one of the nine second generation antipsychotics on the list for prolonged QTc measurements. Neither of the two patients on Risperidone had high QTc measurements. These findings cannot be generalized due to the small sample size.

**Figure 6**

*QTc Measurements Taken for Patients Taking a Single Medication*

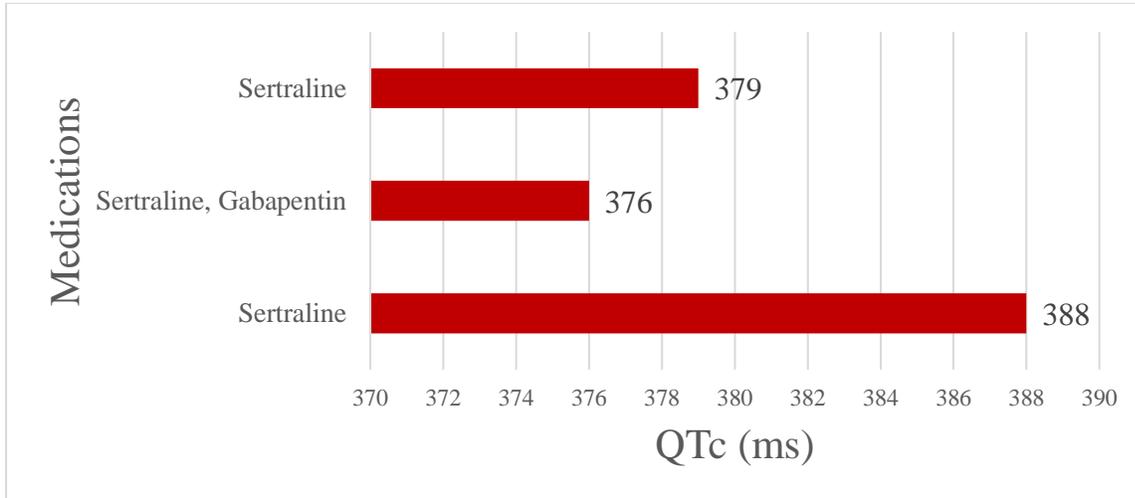


The intention of this project was rule out QTc prolongation with each medication; however, most patients were on two or more medications. For side-by-side comparisons, those on more than one medication appear multiple times; therefore, the number of patients represented in the graphs outnumber the number of patients in the sample.

When examining the SGADs, Sertraline had the shortest average QTc length at 381ms. Of the second-generation antidepressant medications, Sertraline is considered one of the safer psychiatric medications.

**Figure 7**

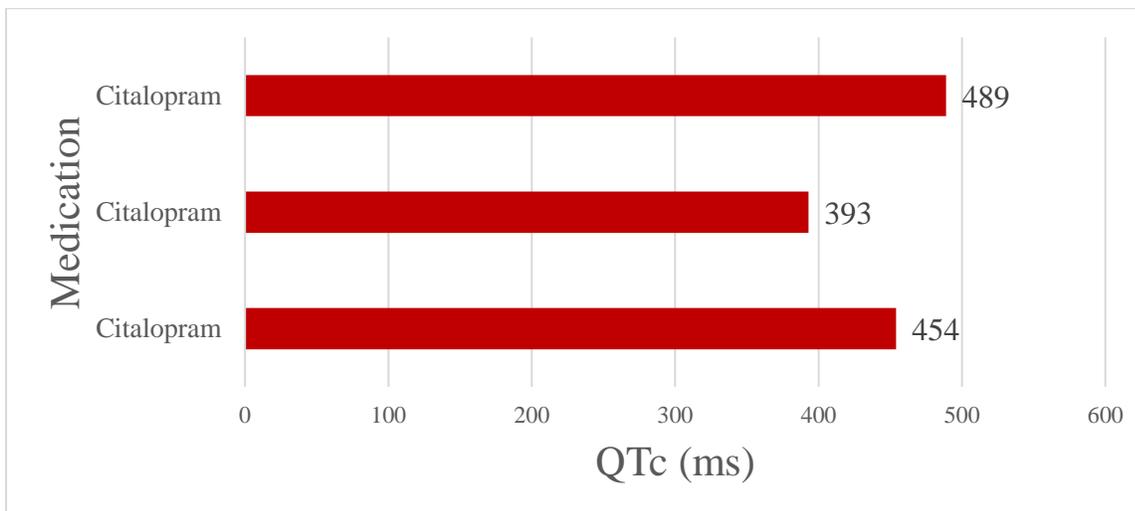
*QTc Measurements for Sertraline*



Citalopram had the longest average QTc length at 445.33ms and was the longest average QTc length of all the medications of focus for this project.

**Figure 8**

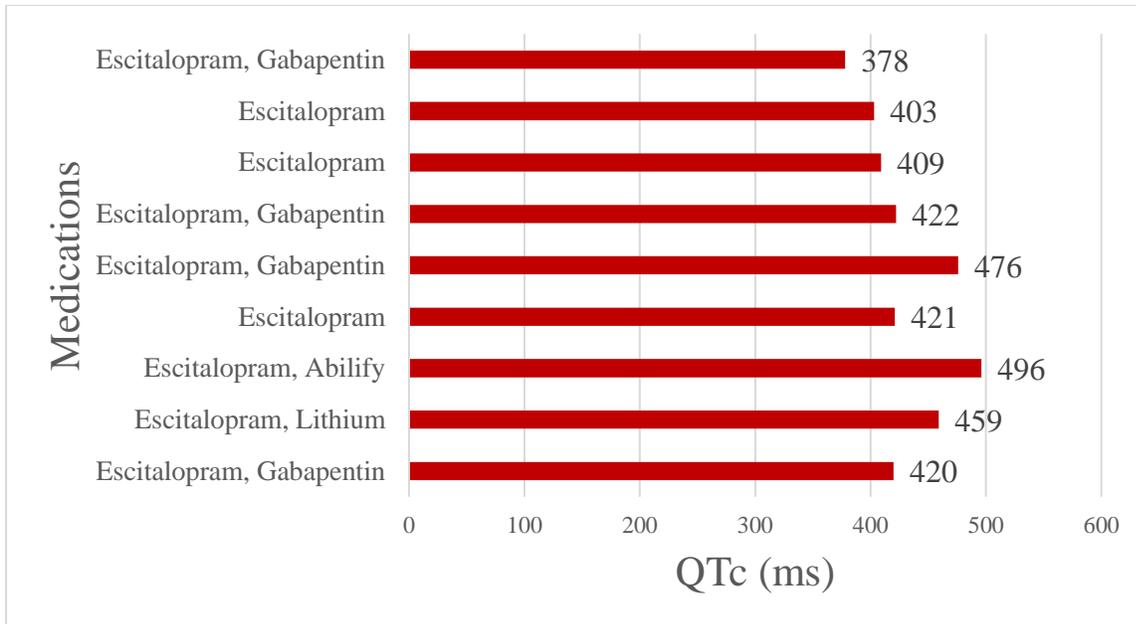
*QTc Measurements for Citalopram*



With the exception of Escitalopram, Citalopram appeared to have the longest QTc lengths; however, QTc length with Escitalopram were nearly as long at 431.56ms, followed by Quetiapine and Fluoxetine with average lengths of 431ms and 430.75, respectively.

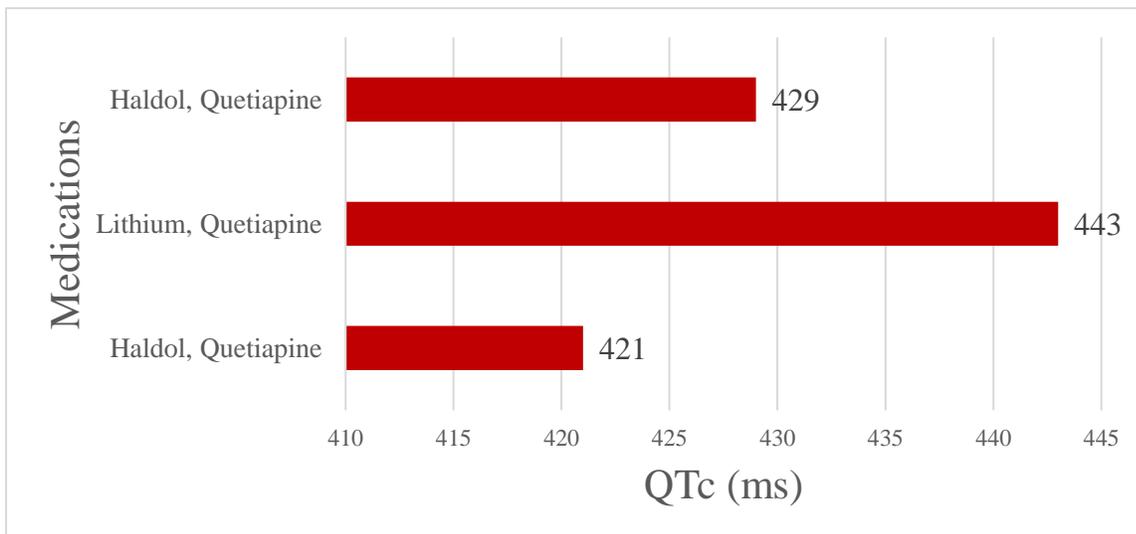
**Figure 9**

*QTc Measurements for Escitalopram*



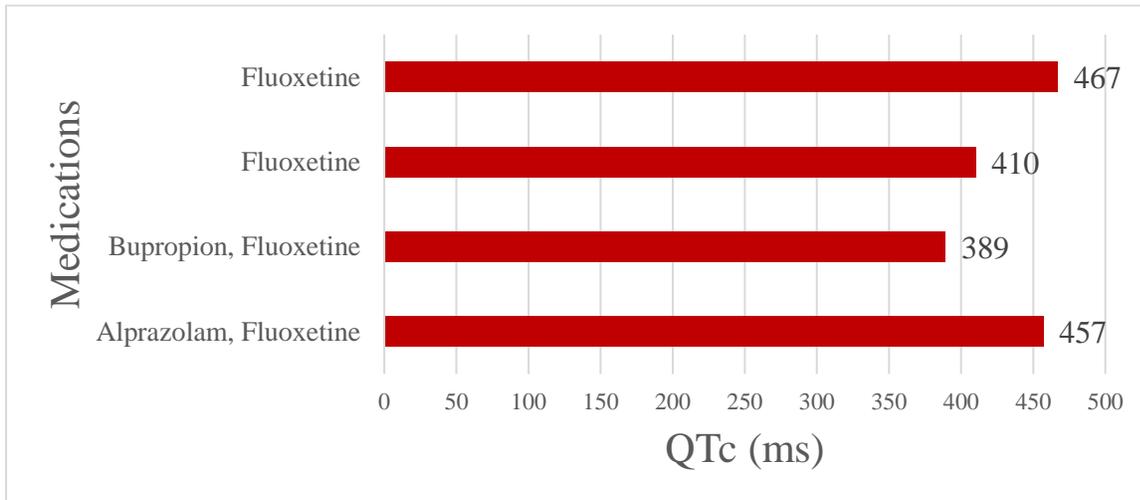
**Figure 10**

*QTc Measurements for Quetiapine*



**Figure 11**

*QTc Measurements for Fluoxetine*



This EBP project’s limited data might suggest that Escitalopram is riskier when compared to Citalopram, which contrasts with published data. Larger EBP projects or formal research studies with an adequately powered sample size would likely confirm what is known in the literature.

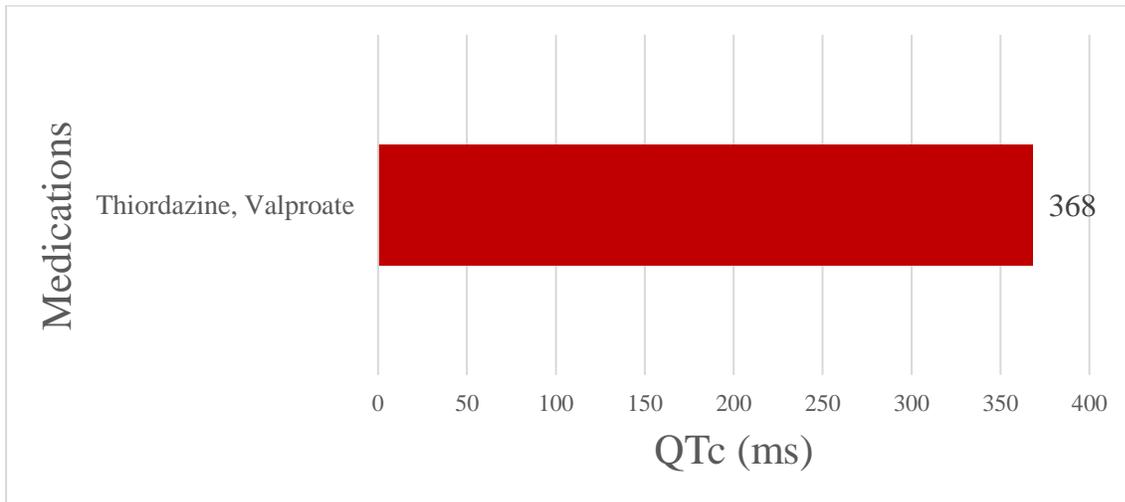
Three of the 50 patients were on Citalopram; however, nine of the patients are taking Escitalopram. Conceivably, the small number of patients taking Citalopram have skewed the data for patients taking Citalopram. The average QTc length for Quetiapine should have been on the higher end of the spectrum but was not in this limited sample. Furthermore, Fluoxetine’s resultant trailing of Quetiapine’s results was consistent with published data reflecting slightly lower QTc elongations.

Escitalopram was the most common of the focus medications ( $N = 9$ ). This particular drug is a commonly prescribed psychotropic medication. The second most common focus medication was Risperidone ( $N = 7$ ). While Escitalopram is a common antidepressant,

Risperidone is a common SGAP. Compared to the other psychotropic medications, the average QTc for Risperidone was in the lower range at 385.29ms.

**Figure 12**

*QTc Measurements for Thioridazine*

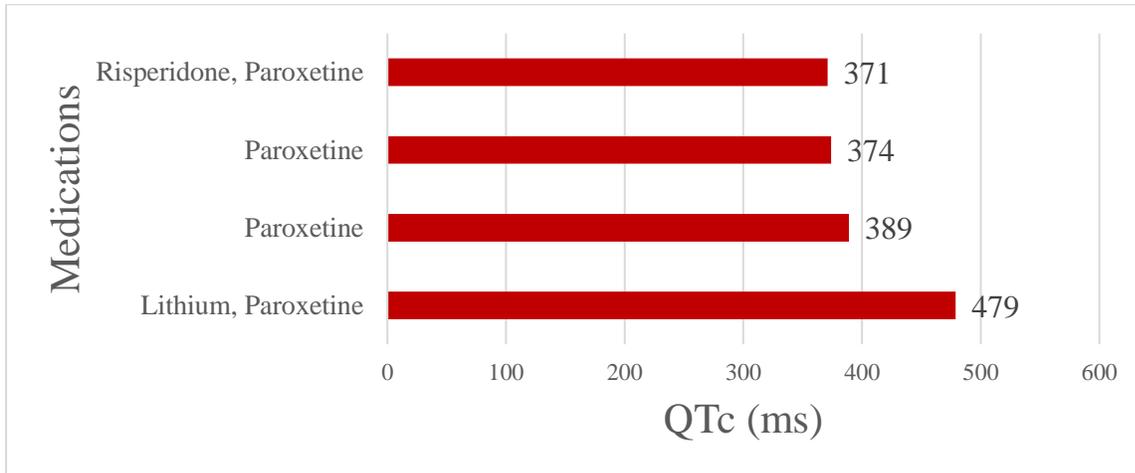


The antipsychotic medication Thioridazine has the shortest average QTc elongation in this project at 368ms. When given in the appropriate dose, Thioridazine should not cause any lengthening of the QTc. As only one patient is taking Thioridazine, the assumption is that this patient was on a proper dose.

The three remaining medications (i.e., Paroxetine, Haldol, Venlafaxine) revealed QTc lengths in the middle range of all observations.

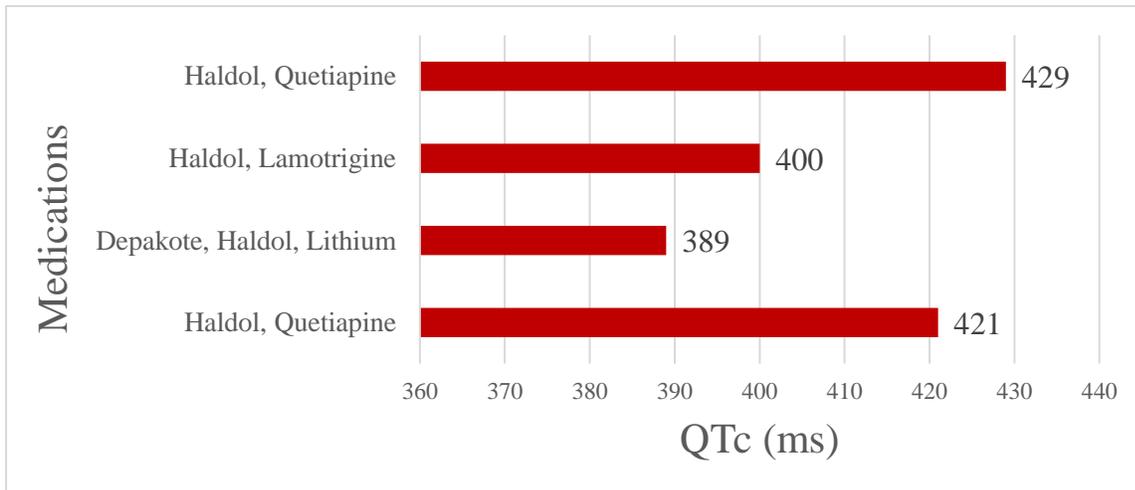
**Figure 13**

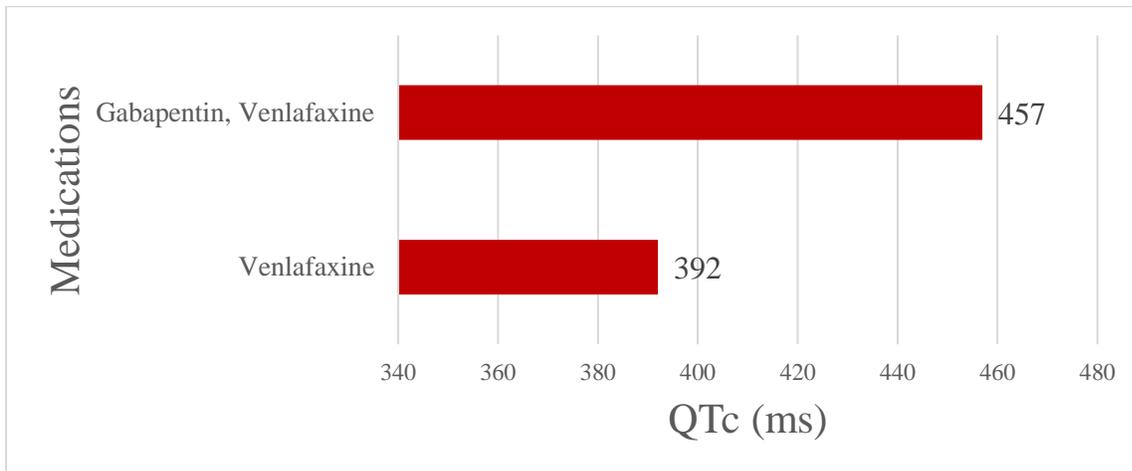
*QTc Measurements for Paroxetine*



**Figure 14**

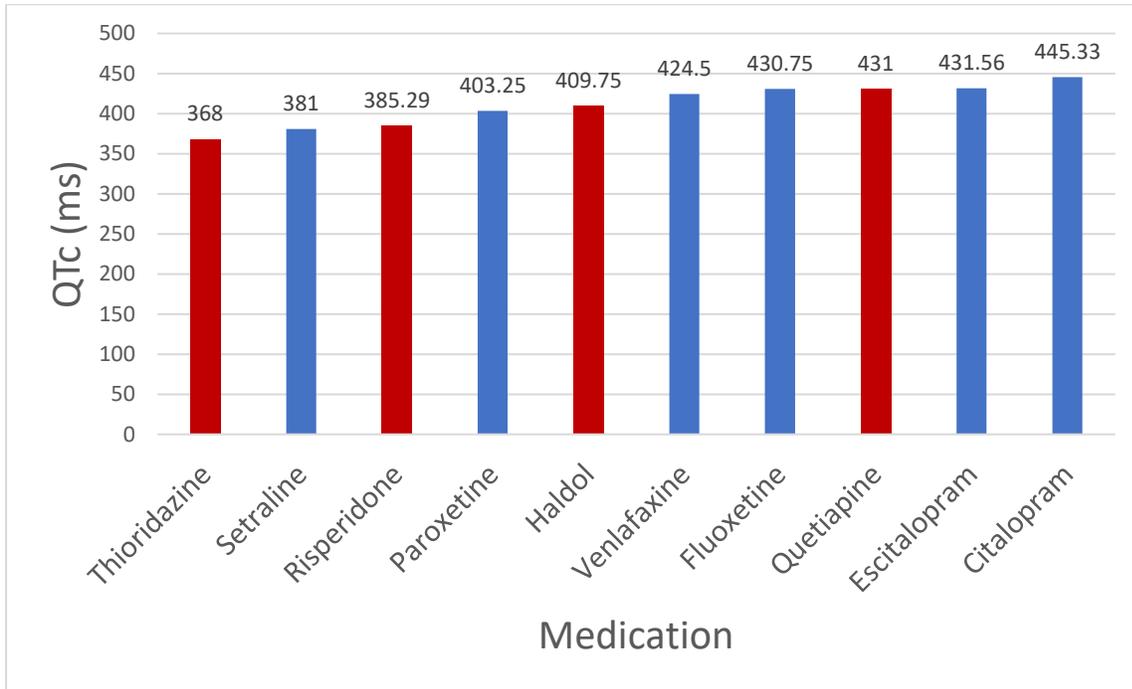
*QTc Measurements for Haldol*



**Figure 15***QTc Measurements for Venlafaxine*

As these three medications are not on the low end of the spectrum, caution should be taken when prescribing and their potential effect on QTc should not be discounted.

In summary, the 10 medications examined in this EBP project included four antipsychotic medications and six antidepressant medications. Altogether, their for average QTc prolongations from least to greatest were: Thioridazine, Sertraline, Risperidone, Paroxetine, Haldol, Venlafaxine, Fluoxetine, Quetiapine, Escitalopram, and Citalopram (Figure 16). Both antipsychotic and antidepressant medications were dispersed throughout the sample and the range of QTc lengths was 77.33ms (Range: Citalopram = 445.33ms, Thioridazine = 368ms). Therefore, this small group were not likely to be reaching alarming QTc levels. Furthermore, the spectrum of QTc levels for all the individuals was between the mid 300s to the mid 400s; acceptable QTc levels. This group provided the spectrum of ages (18 years-65 years of age) with a balanced gender distribution.

**Figure 16***Average QTc Based on Medication*

### Discussion and Sustainability

The implementation of this EBP project improved ED staff knowledge on the importance of assessing and the analyzing the effects of second-generation antipsychotics and antidepressants for rare cases where the QTc interval is greater than 500 ms. Many psychotropic medications can delay cardiac repolarization thereby producing prolonged QTc and raising the possibility of life-threatening progression to TdP, ventricular fibrillation, or sudden cardiac death.

Barriers impeded successful implementation of this project:

1. In a high-volume ED, physicians did not consistently order the 12-lead ECG.
2. Patients might not have been forthcoming with their psychotropic medications or neglected to report them thinking they were unrelated to their chief complaint.
3. The time and cost for an ECG.

4. Lack of follow up or perceived risk of litigation for neglecting to interpret an ECG not ordered by the physician could have complicated data collection.
5. Patients perceived as violent and non-compliant might not be able to undergo an ECG, even if they were undergoing a cardiac event.
6. With the time constraints of a busy ED, provider and staff perception of the need for the education department could have affected compliance.

To sustain this project, another DNP student at the University of San Diego Hahn School of Nursing could adopt this as their own EBP project. That student would need an emergency medicine background, be familiar with cardiac rhythms and ECG interpretation, and possess an understanding of the neurochemistry underlying psychotropic medications. As an alternative, an ED-based project champion could maintain the project and conduct education sessions for new ED staff.

### **Implications for Practice**

Healthy People 2030 included mental health with 15 baseline objectives focused on the prevention, screening, assessment, and treatment of mental disorders and behavioral conditions (Office of Disease Prevention and Health Promotion, n.d.). While the needed attention given to mental health concerns in the United States continues to grow, specialty providers must also consider the cardiac health implications of their psychiatric patients. The ED's role is pivotal in the assessment of psychiatric patients that may have an undiagnosed QT/QTc prolongation attributed to their psychotropic medications.

### **Conclusion**

Advanced practice nurses are positioned to understand the complexity of mental health care and emergency medicine. This EBP project supported existing evidence, but the findings

from a small patient sample are not generalizable. Continued sustainability of this project would yield a larger sample over time to understand the characteristics of each of these medications in the local population of ED patients. Goals of this project were to raise awareness in ED providers to evaluate QTc measurements of their patients on psychotropic medications and to standardize the use of 12-lead ECGs as part of the intake process.

### References

Arizona University-based Center for Education and Research on Therapeutics (AZCERT). (n.d.).

*CredibleMeds: Resources for everyone*. Retrieved January 29, 2021, from

<http://www.crediblemeds.org/everyone/>

Brailon, A. (2018). Comment on: “Limited evidence for risk factors for proarrhythmia and

sudden cardiac death in patients using antidepressants: Dutch consensus on ECG

monitoring”. *Drug Safety*, 41(12), 1415-1416. [https://doi.org/10.1007/s40264-018-0714-](https://doi.org/10.1007/s40264-018-0714-7)

[7](https://doi.org/10.1007/s40264-018-0714-7)

Brody, D., & Gu, Q. (2020). *Antidepressant use among adults: United States, 2015–2018*

[NCHS Data Brief 337]. <https://www.cdc.gov/nchs/data/databriefs/db377-H.pdf>

Centers for Disease Control and Prevention. (n.d.). Mental health: *Data and publications*.

Retrieved January 25, 2021, from

[https://www.cdc.gov/mentalhealth/data\\_publications/index.htm](https://www.cdc.gov/mentalhealth/data_publications/index.htm)

Czeisler, M. É., Lane, R. I., Petrosky, E., Wiley, J. F., Christensen, A., Njai, R., Weaver, M. D.,

Robbins, R., Facer-Childs, E. R., Barger, L. K., Czeisler, C. A., Howard, M. D., &

Rajaratnam, S. M. W. (2020). Mental health, substance use, and suicidal ideation during the COVID-19 pandemic – United States, June 24–30, 2020. *Morbidity and Mortality*

*Weekly Report*, 69(2), 1049-1057. <http://doi.org/10.15585/mmwr.mm6932a1>

Dang, D., & Dearholt, S. L. (2017). *Johns Hopkins nursing evidence-based practice: Model and*

*guidelines* (3rd ed). Sigma Theta Tau International

Drew, B. J., Ackerman, M. J., Funk, M., Gibler, W. B., Kligfield, P., Menon, V., Philippides, G.

J., Roden, D. M., & Zareba, W. (2010). Prevention of torsade de pointes in hospital

settings: A scientific statement from the American Heart Association and the American

- College of Cardiology Foundation. *Journal of the American College of Cardiology*, 55(9), 934-947. <https://doi.org/10.1016/j.jacc.2010.01.001>
- Forest Pharmaceuticals, Inc. (2012). *Celexa (citalopram)* [package insert].
- Girardin, F. R., Gex-Fabry, M., Berney, P., Shah, D., Gaspoz, J.-M., & Dayer, P. (2013). Drug-induced long QT in adult psychiatric inpatients: The 5-year cross-sectional ECG screening outcome in psychiatry study. *American Journal of Psychiatry*, 170(12), 1468-1476. <https://doi.org/10.1176/appi.ajp.2013.12060860>
- Goldenberg, I., Mathew, J., Moss, A. J., McNitt, S., Peterson, D. R., Zareba, W., Benjorin, J., Zhang, L., Vincent, G. M., Andrews, M. L., Robinson, J. L., & Morray, B. (2006). Corrected QT variability in serial electrocardiograms in long QT syndrome. *Journal of the American College of Cardiology*, 48(5), 1047-1052. <https://doi.org/10.1016/j.jacc.2006.06.033>
- Hasnain, M., & Vieweg, W. V. R. (2014). QTc interval prolongation and torsade de pointes associated with second-generation antipsychotics and antidepressants: A comprehensive review. *CNS Drugs*, 28(10), 887-920. <https://doi.org/10.1007/s40263-014-0196-9>
- Hasnain, M., Vieweg, W. V. R., Howland, R. H., Kogut, C., Crouse, E. L., Koneru, J. N., Hancox, J. C., Digby, G. C., Baranchuk, A., Deshmukh, A., & Pandurangi, A. K. (2013). Quetiapine, QTc interval prolongation, and torsade de pointes: A review of case reports. *Therapeutic Advances in Psychopharmacology*, 4(3), 130-138. <https://doi.org/10.1177/2045125313510194>
- Karaca, Z., & Moore, B. J. (2020). *Costs of emergency department visits for mental and substance use disorders in the United States, 2017*. <https://hcup->

[us.ahrq.gov/reports/statbriefs/sb257-ED-Costs-Mental-Substance-Use-Disorders-2017.pdf](https://www.ahrq.gov/reports/statbriefs/sb257-ED-Costs-Mental-Substance-Use-Disorders-2017.pdf)

Moore, T. J., & Mattison, D. R. (2017). Adult utilization of psychiatric drugs and differences by sex, age, and race. *JAMA Internal Medicine*, 177(2), 274-275.

<https://doi.org/10.1001/jamainternmed.2016.7507>

Office of Disease Prevention and Health Promotion. (n.d.). *Healthy People 2030; Mental health and mental disorders*. <https://health.gov/healthypeople/objectives-and-data/browse-objectives/mental-health-and-mental-disorders>

Postema, P. G., & Wilde, A. A. M. (2014). The measurement of the QT interval. *Current Cardiology Reviews*, 10(3), 287-294.

<https://doi.org/10.2174/1573403x10666140514103612>

U.S. Census Bureau. (2020). *QuickFacts Riverside County, California and QuickFacts San Diego County, California*. Retrieved January 25, 2021, from

<https://www.census.gov/quickfacts/riversidecountycalifornia> and

<https://www.census.gov/quickfacts/sandiegocountycalifornia>

U.S. Food & Drug Administration. (2012). FDA Drug Safety Communication: Revised recommendations for Celexa (citalopram hydrobromide) related to a potential risk of abnormal heart rhythms with high doses. Retrieved January 15, 2021, from

<https://www.fda.gov/drugs/drug-safety-and-availability/fda-drug-safety-communication-revised-recommendations-celexa-citalopram-hydrobromide-related>

Weinick, R. M., Burns, R. M., & Mehrotra A. (2010). Many emergency department visits could be managed at urgent care centers and retail clinic. *Health Affairs*, 29(9), 1630-1636.

<https://doi.org/10.1377/hlthaff.2009.0748>