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# EVERYTHING THE PSYCHIATRIST NEEDS TO KNOW ABOUT ECGs

Margo Funk, MD, MA, FACLP

May 5, 2024

# DISCLOSURE

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## Margo C. Funk, MD, MA

With respect to the following presentation, there has been no relevant (direct or indirect) financial relationship between the party listed above (and/or spouse/partner) and any for-profit company which could be considered a conflict of interest.

# ACKNOWLEDGEMENTS

**Scott R. Beach, MD**

**Chris Celano, MD**

# ACKNOWLEDGEMENTS

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APA OFFICIAL ACTIONS

## APA Resource Document on QTc Prolongation and Psychotropic Medications

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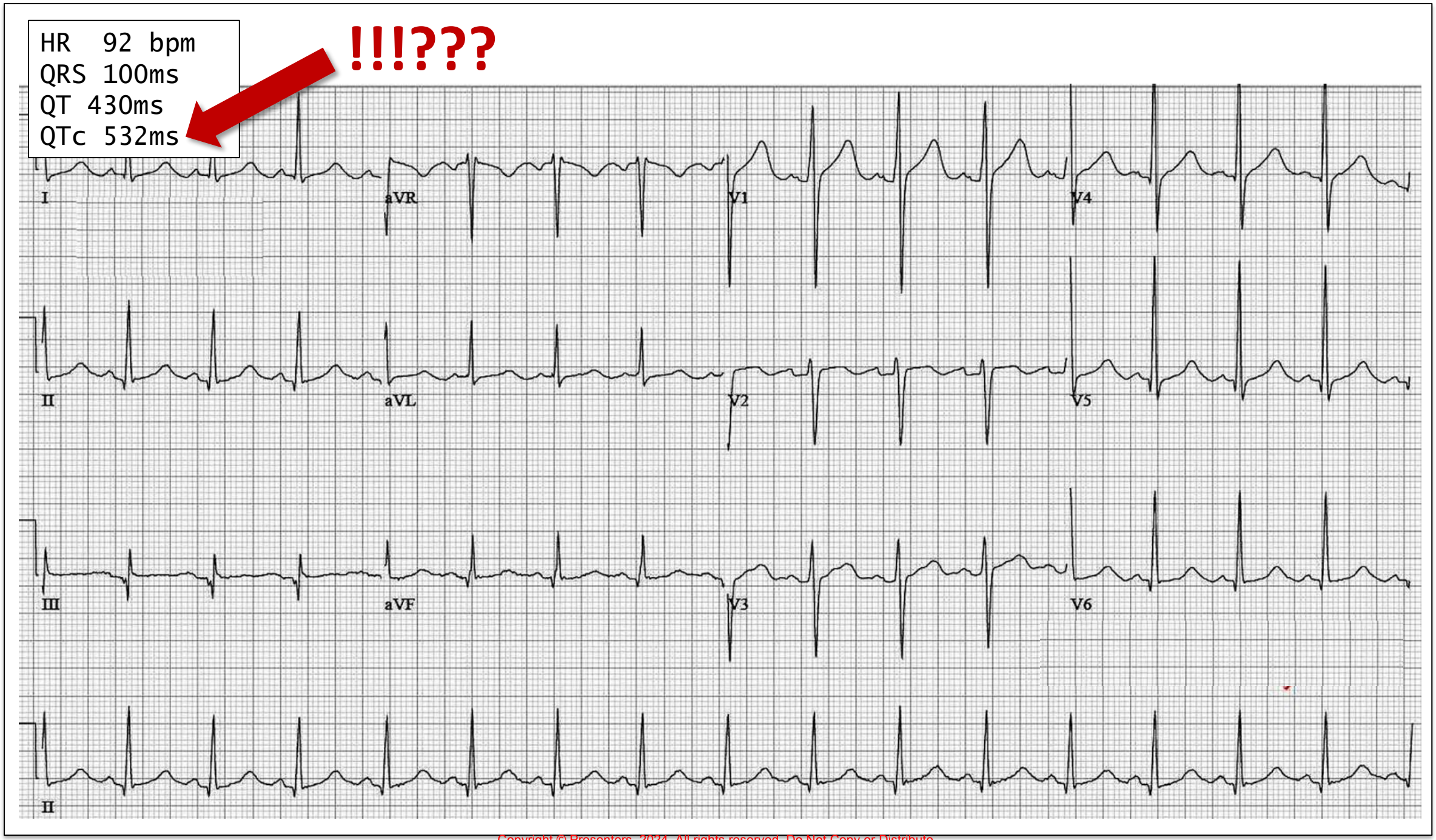
# CASE 1

27 y/o woman with history of GAD and social phobia, well controlled on citalopram 40mg po daily, presents to your outpatient clinic to establish care after relocating for her first job out of law school.

She has no significant past medical history, takes no other medications, has no family history of arrhythmia, cardiac arrest or sudden death. She has no suicide attempts, no inpatient psychiatric hospitalizations.

Your clinic just purchased an ECG machine, and the medical assistants were recently trained how to use the machine. While you believe her cardiac risk factors to be very low, since you have the resource available, you decide to obtain an ECG for the sake of completeness.



# OBJECTIVES

- Describe indications for obtaining an ECG when initiating psychiatric medications with elevated cardiac risk
- Correlate ECG waves and intervals, including the QT interval, QRS complex, and T wave, to the underlying electrophysiologic processes.
- Accurately measure the QT interval and calculate the QTc using an appropriate formula
- Describe an approach to risk-benefit assessment of starting a QTc-prolonging medication in a patient with risk factors for Torsades de Pointes.



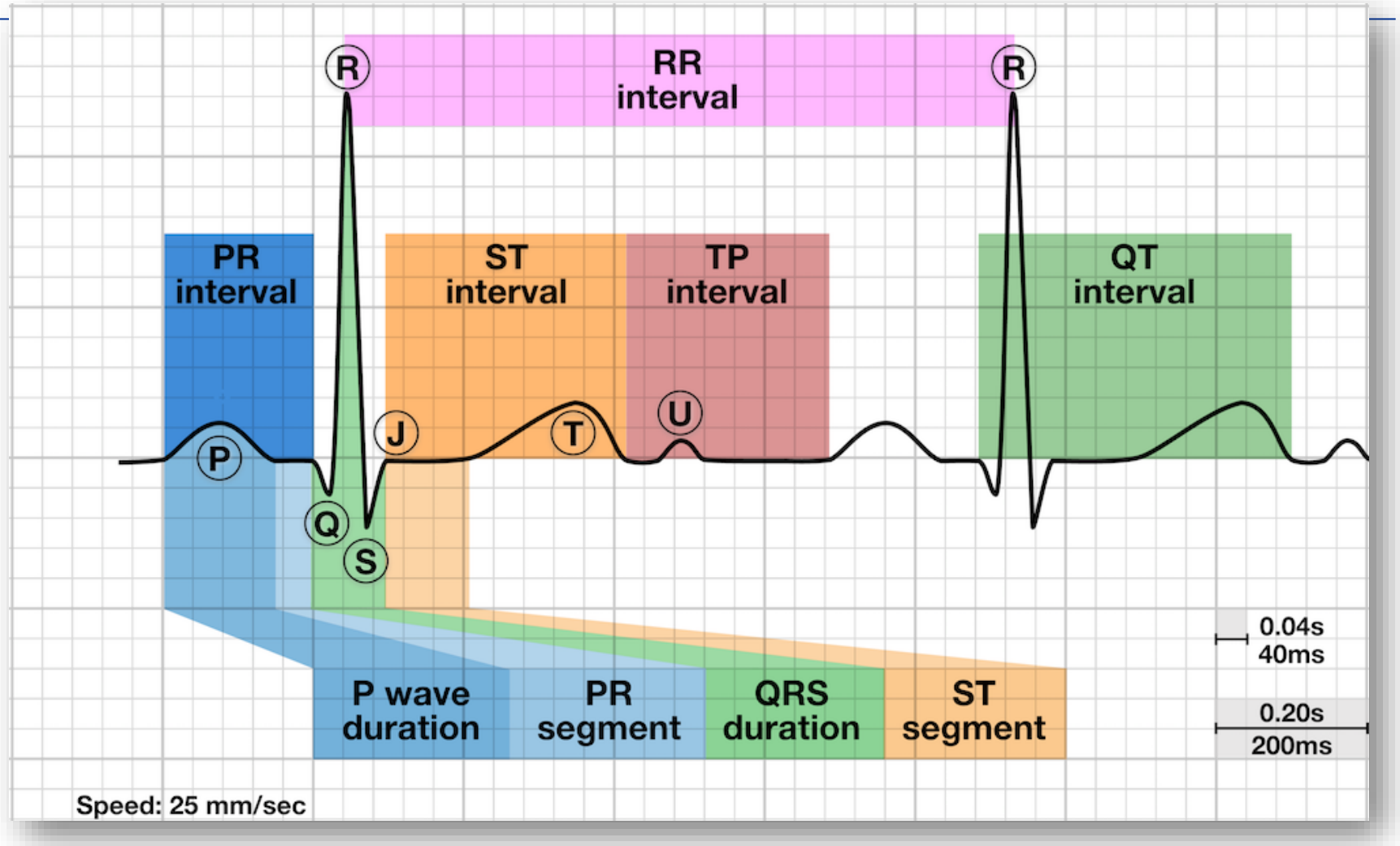


# COMPUTER-DERIVED ELECTROCARDIOGRAM

- Results differ from machine to machine
- Often are derived from “representative” or “median” complexes
- Correction method generally is the Bazett correction

**Should always be measured and interpreted by a person!**

# ECG INTERVALS




| Interval | Duration (ms) |
|---|---|
| PR | 120-200 |
| QRS | 80-100 |
| ST | 80 |
| RR | 600-1000 |







Burns and Buttner, 2022

# MEASURING HEART RATE


1. 12 lead ECG = 10 seconds
2. Count the number of beats
3. Multiply number of beats x 6 = Beats per minute

**12 Beats x 6 = 72 bpm**

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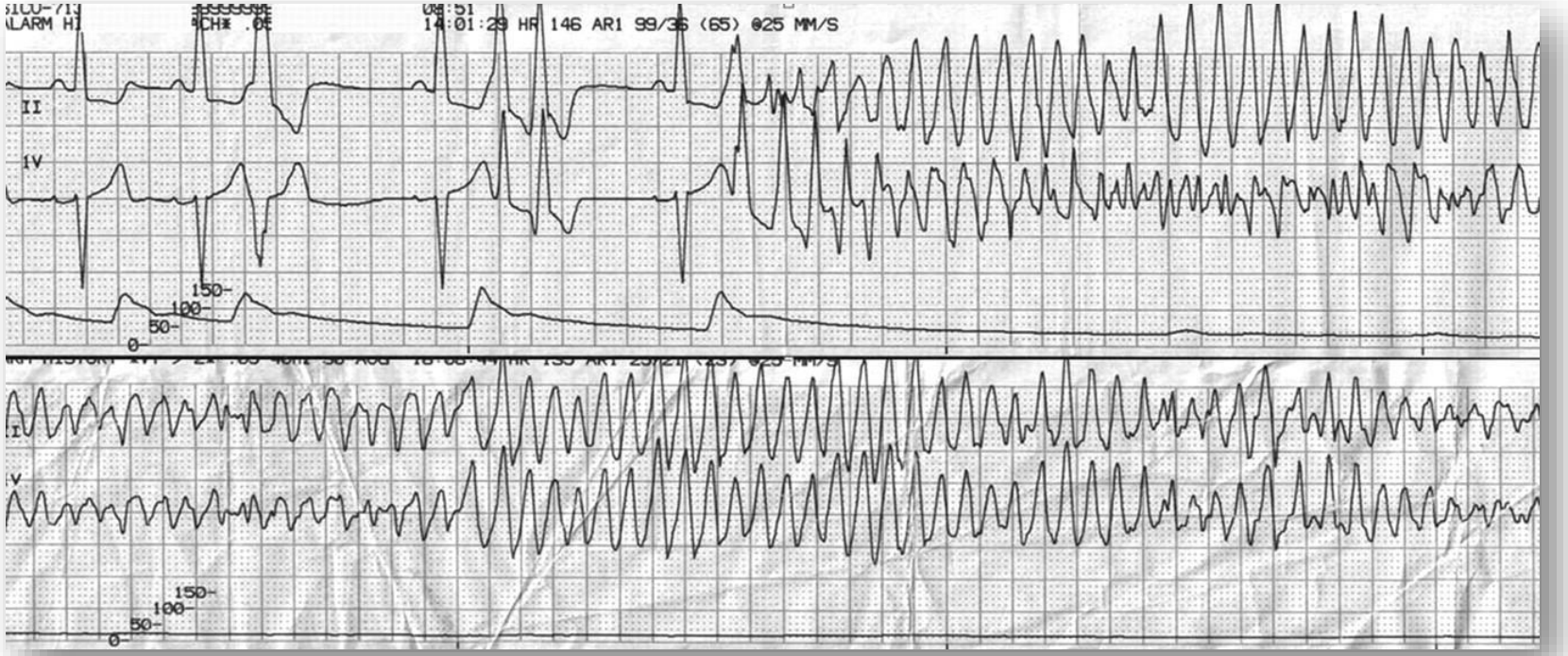
# THE CORRECTED QT INTERVAL (QTc)

# TORSADES DE POINTES (TDP)

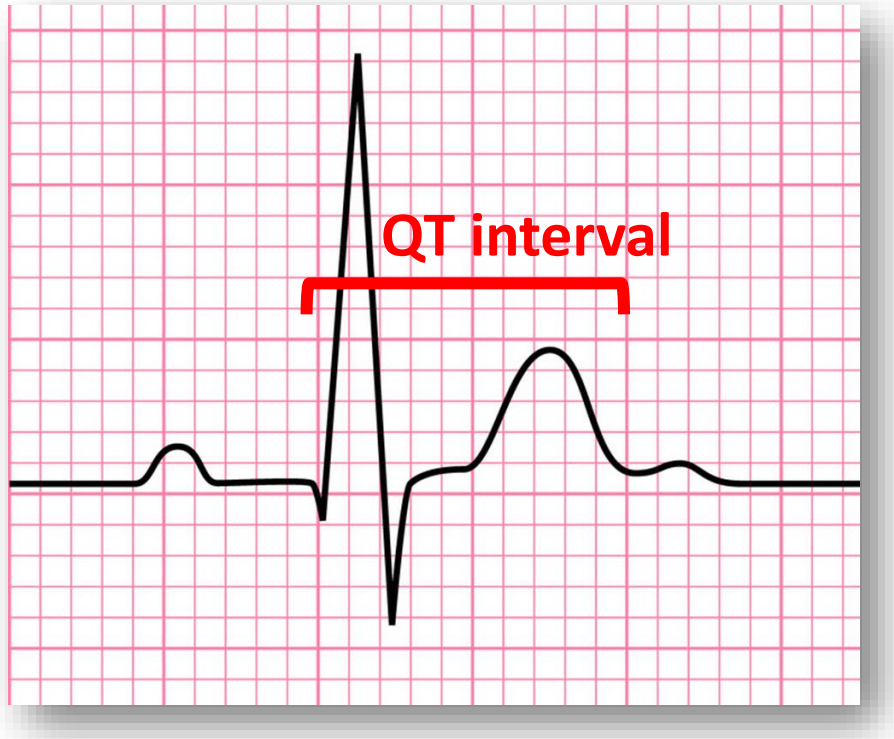
## “Twisting of the Pointes”



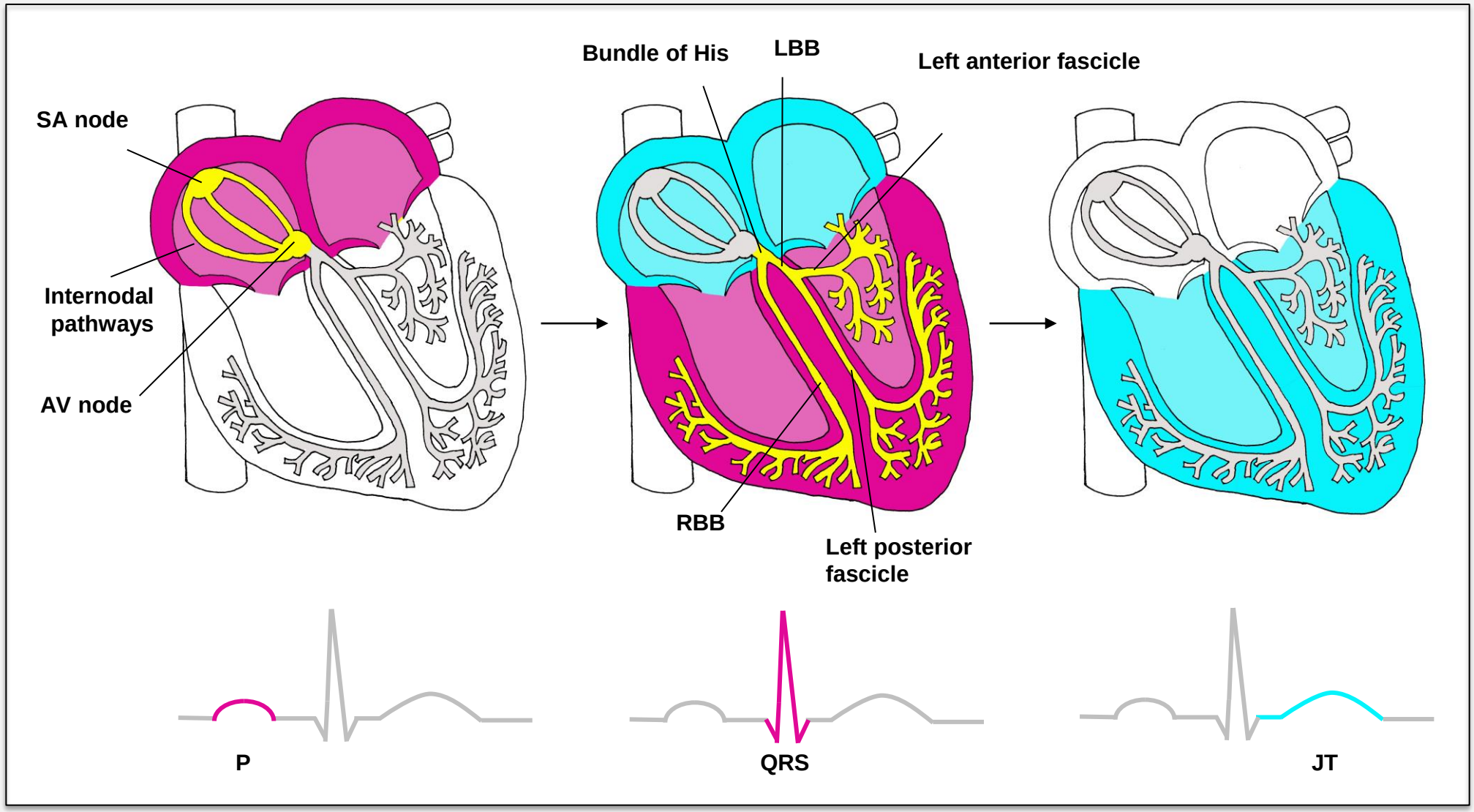

- a malignant polymorphic ventricular tachycardia
- lightheadedness, syncope, seizure-like activity, sudden cardiac death
- often an out-of-hospital event; difficult to study

# TORSADES DE POINTES (TDP) AND QTC

- Occurs in setting of congenital vs. acquired long QT syndrome
  - congenital: genetic syndromes w/characteristic QT morphology & sudden cardiac death
  - acquired: QT prolongation occurs **under certain clinical conditions**, leading to TdP
- QTc prolongation is best marker of risk



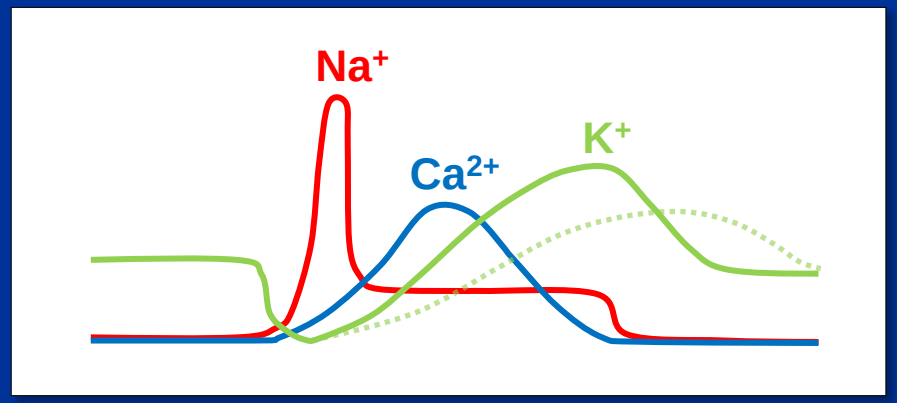
# ELECTROPHYSIOLOGY AND THE ELECTROCARDIOGRAM

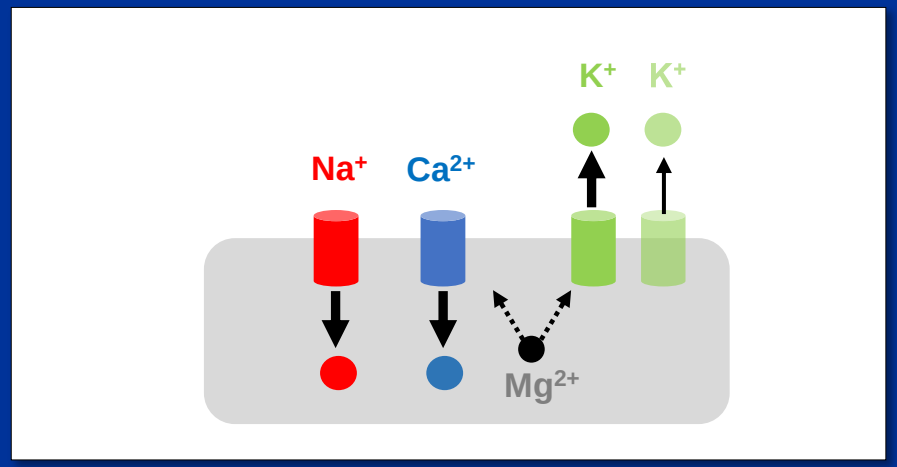



Funk et al. 2021

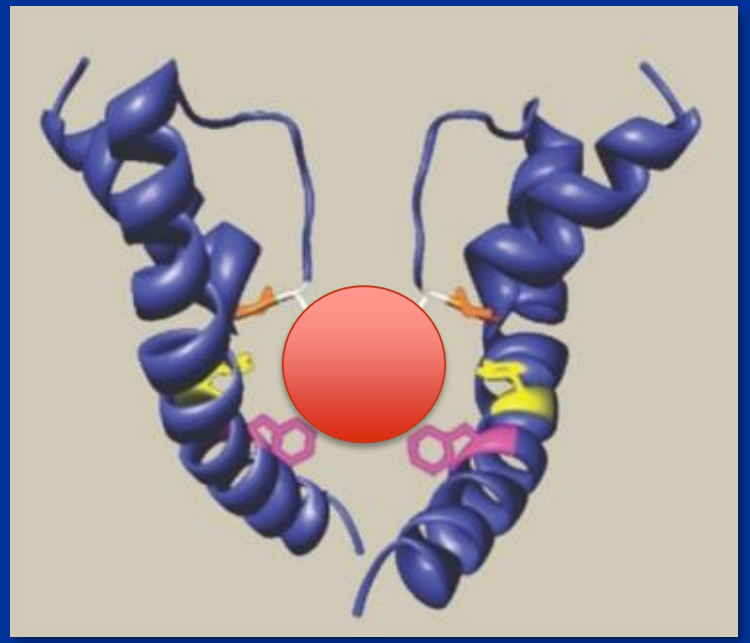
# PROLONGED REPOLARIZATION

## Cardiac Myocyte Action Potential



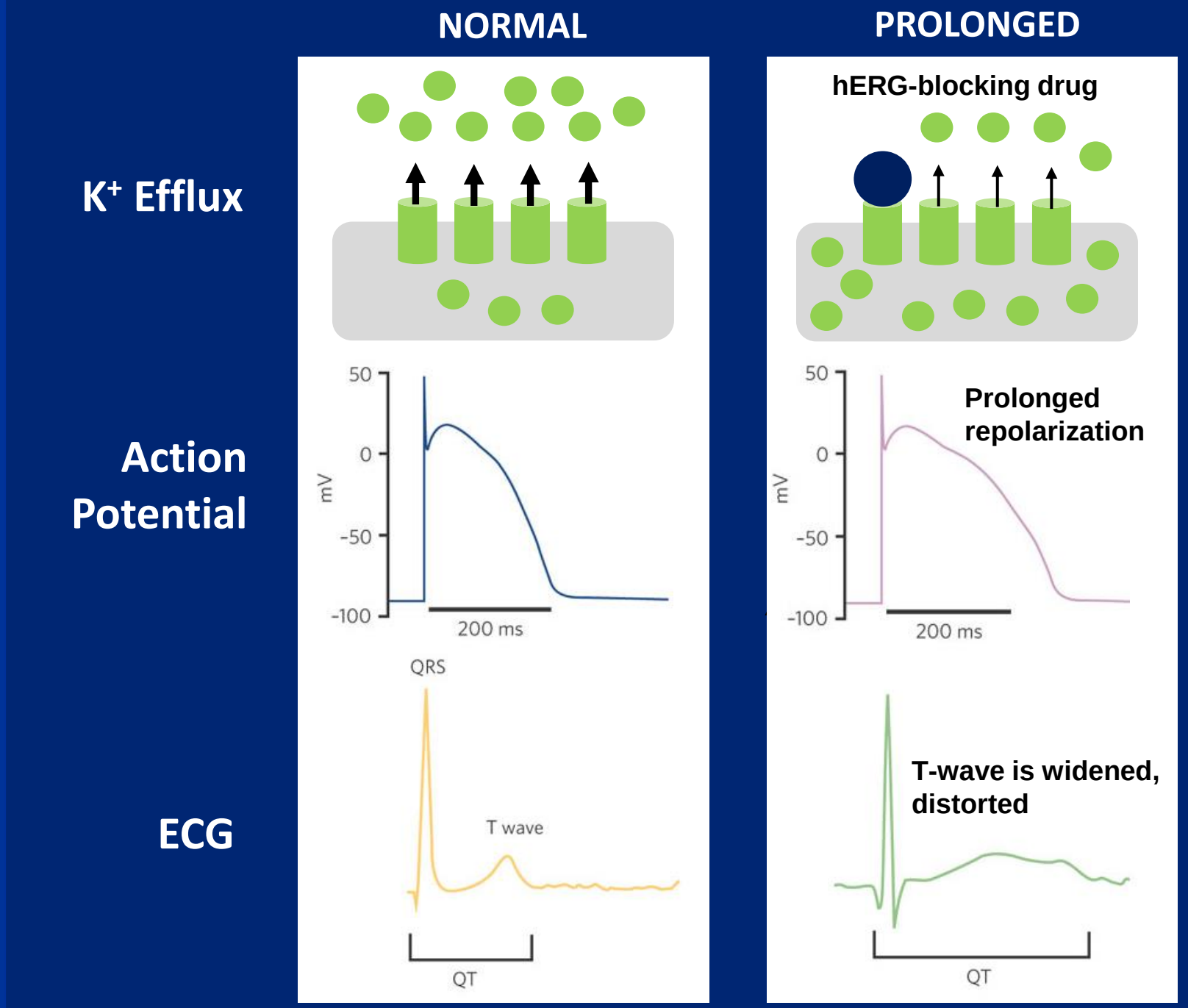




## Ikr channel – HERG
## (human ether-a-go-go related gene)



Tristani-Firouzi et al 2006, Funk et al 2020

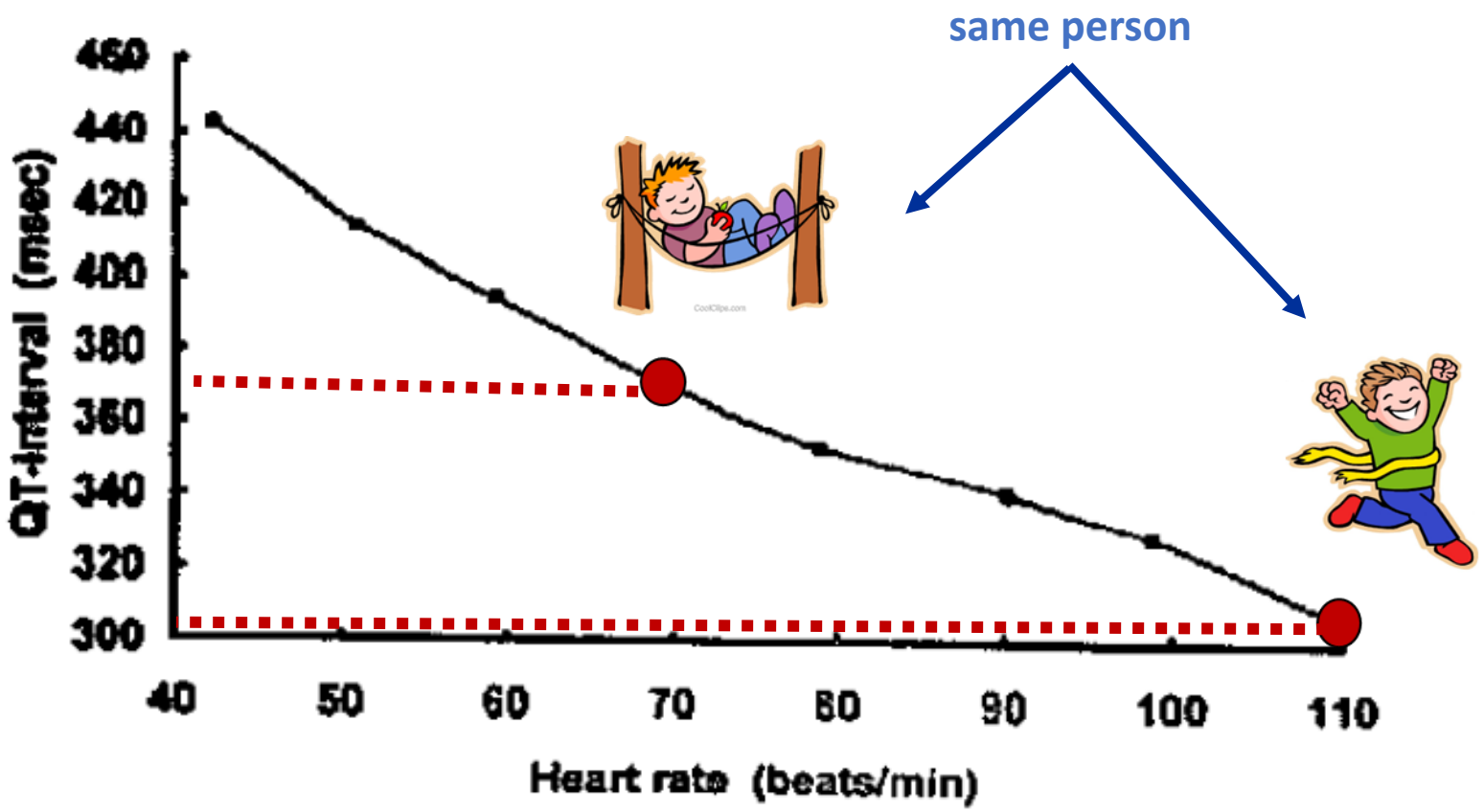
# PROLONGED REPOLARIZATION




Tristani-Firouzi et al 2006, Funk et al 2020

# QT INTERVAL IS HR DEPENDENT

- Absolute QT interval varies depending on HR
- The slower the heart rate, the longer the cycle length (duration of one beat), the longer the measured QT










J Am Coll Cardiol. 1994

# QT INTERVAL IS HR DEPENDENT



- Ventricular repolarization abnormalities do not change across HR in the same person
- We must correct the QT interval so we have a **consistent marker of risk** across all HR






J Am Coll Cardiol. 1994

# QTC CORRECTION FORMULAE

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| Method | Formula |
|---|---|
| Bazett | $QTc = QT/\sqrt{RR}$ |
| Fridericia* | $QTc = QT/\sqrt[3]{RR}$ |
| Framingham†* | $QTc = QT + 0.154\,(1000 - RR)$ |
| Hodges† | $QTc = QT + 1.75(HR - 60)$ |

†Rautaharju et al. 2009. AHA/ACC/HRS Guidelines. Recommends linear regression

*Vandenburk et al. 2016. JAHA. Recommends Fridericia or Framingham

# QTC NORMAL RANGES

| Rating | Adult Men | Adult Women |
|---|---|---|
| Normal | < 430 msec | < 450 msec |
| Borderline | 431-470 msec | 451-480 msec |
| Prolonged | > 470 msec | > 480 msec |

However, we generally become more concerned if:

- QTc > 500 msec
- QTc increases by ≥ 60 msec after medication change

*There is not an absolute QTc at which an at-risk medication cannot be prescribed

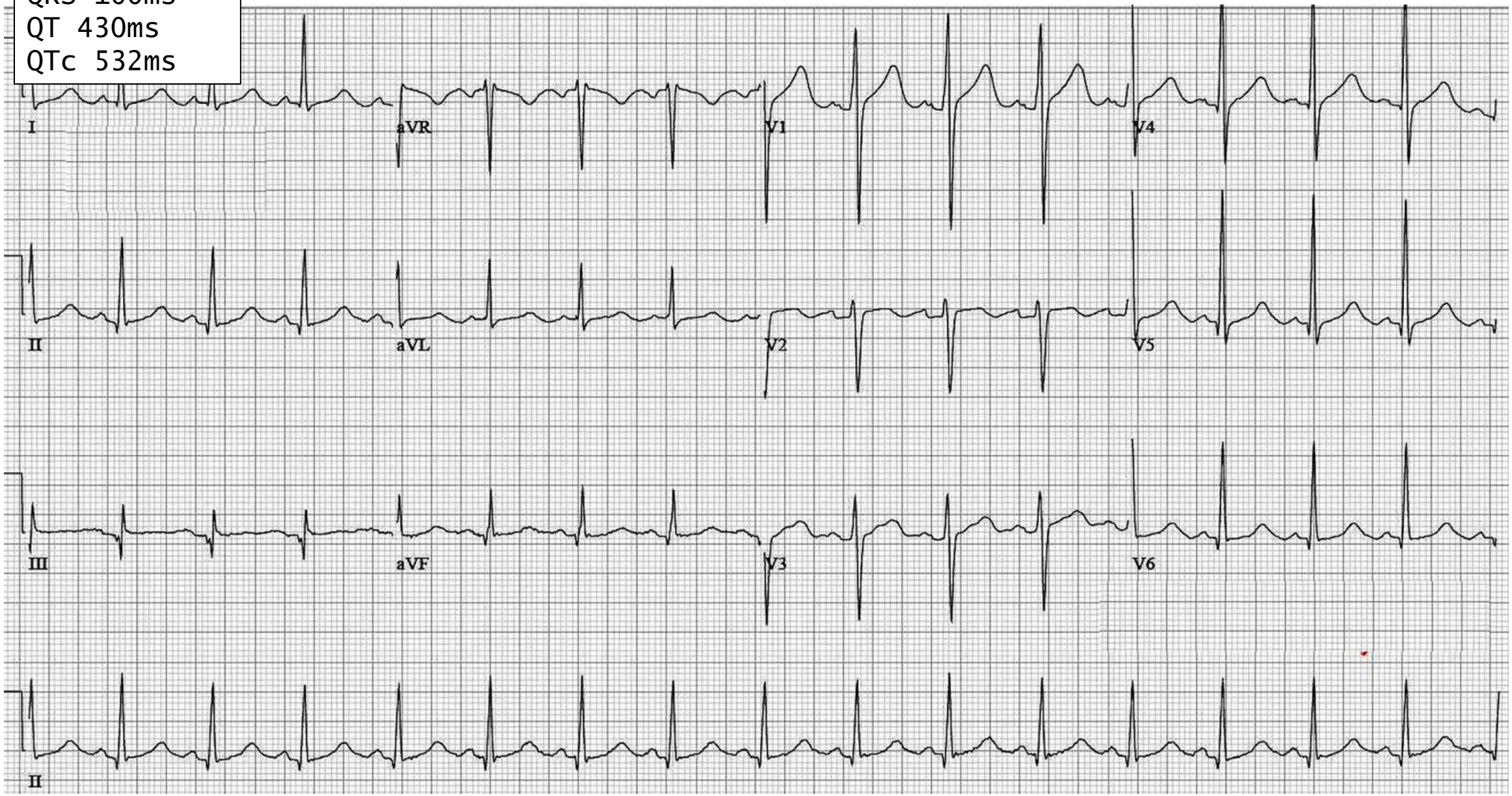




Drew 2010, Goldenberg 2006

# CASE 1

HR 92 bpm
QRS 100ms
QT 430ms
QTc 532ms



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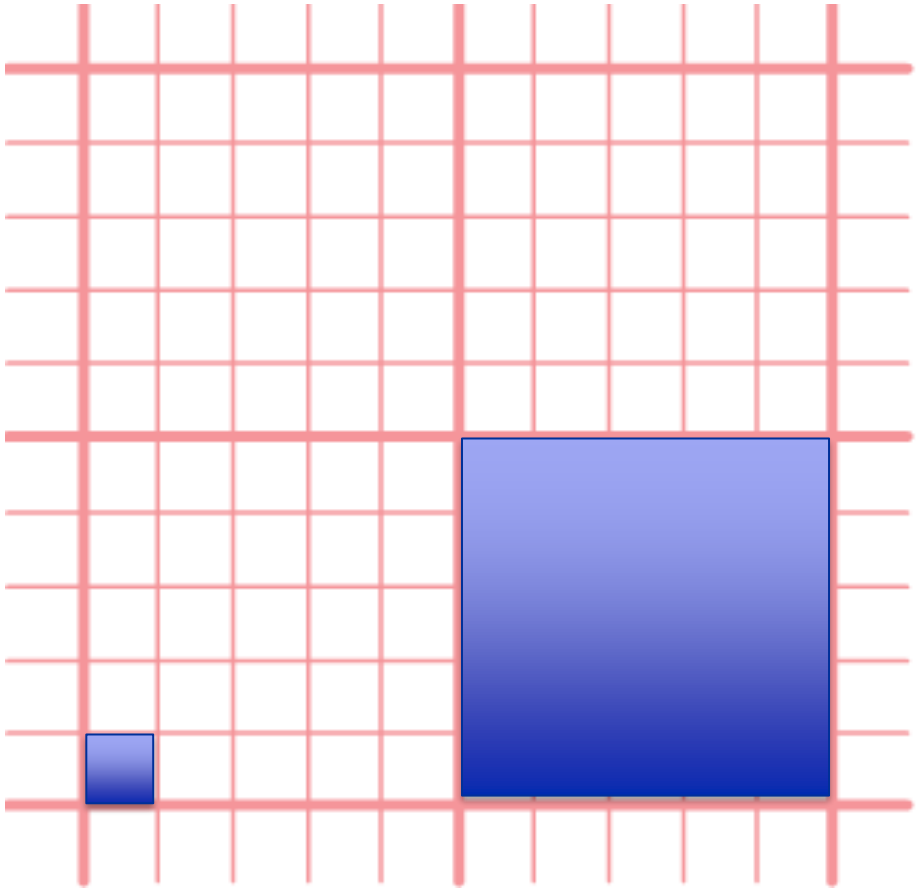
# MAKING YOUR OWN MEASUREMENTS & CALCULATIONS

# ECG BASICS

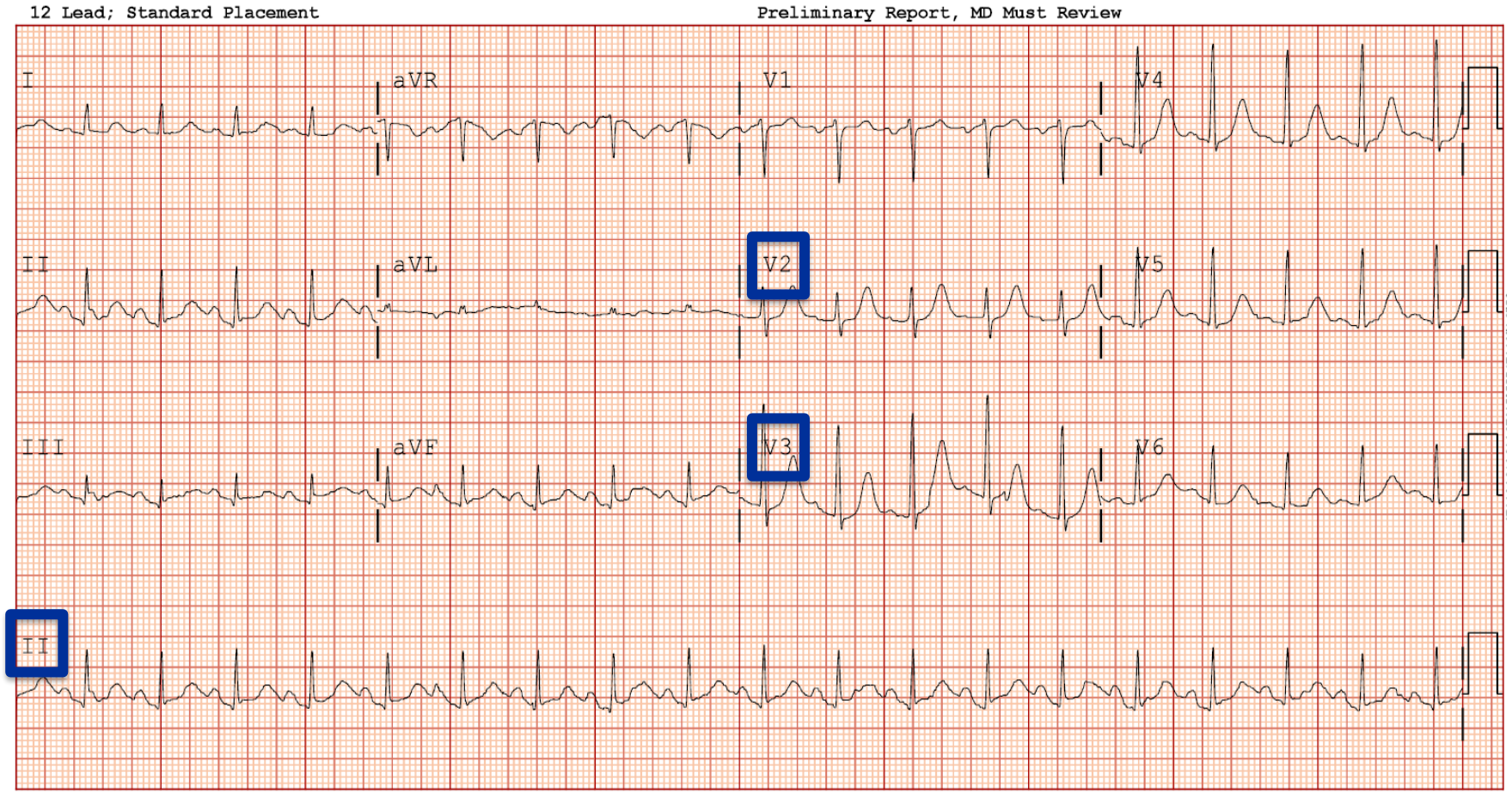


**small box = 40 msec  large box = 200 msec**

# MEASURING THE QT-INTERVAL

## Which Lead to Use?

- lead V2, V3 or II *or*
- lead where end of T-wave is easiest to discern *or*
- lead showing the longest QT










Rautaharju 2009, Isbister 2012

# MEASURING THE QT-INTERVAL

## Tangent Method

- Intersection of tangent to steepest downward slope of T-wave with isoelectric baseline



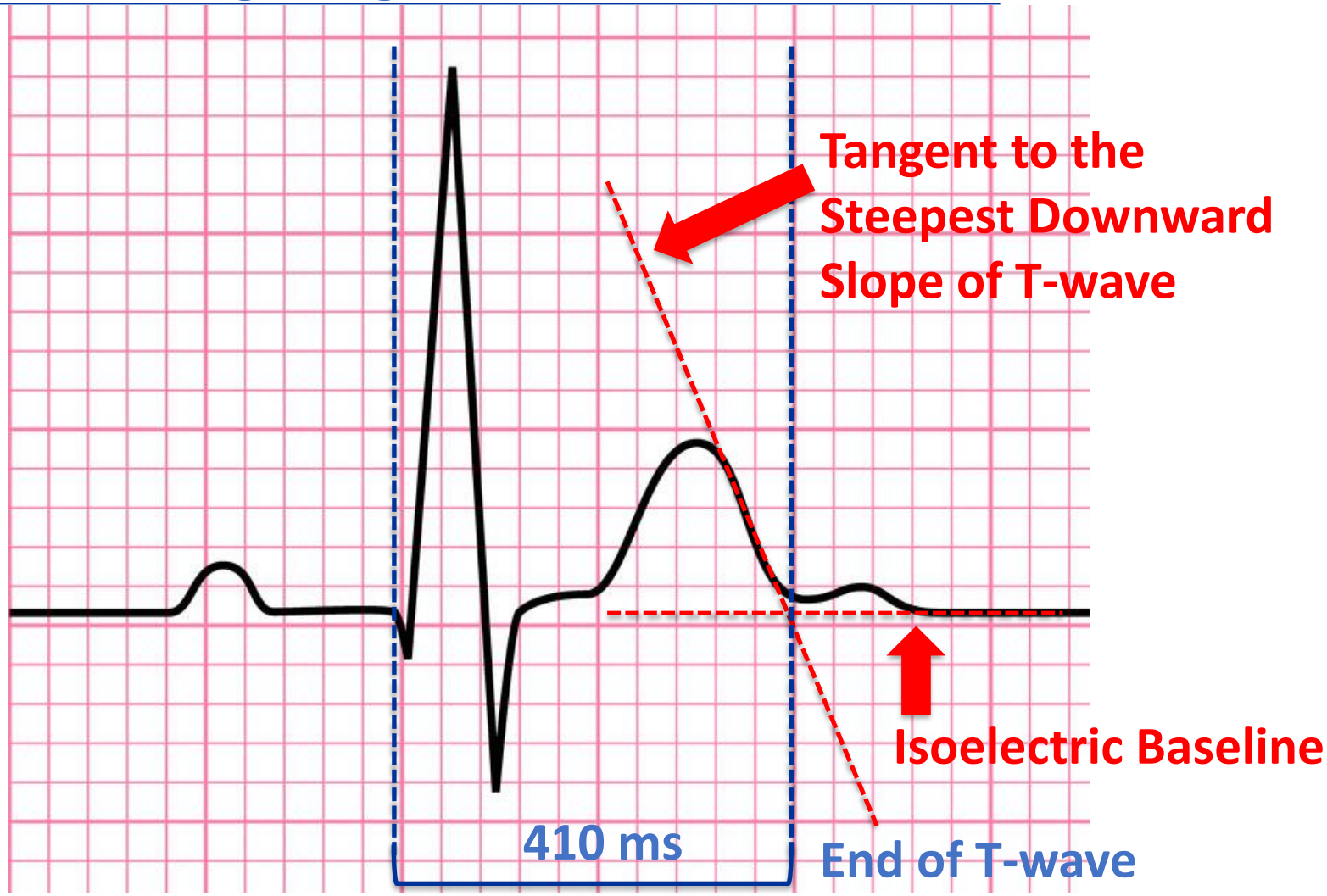




Rautaharju 2009, Isbister 2012

# TANGENT METHOD

## Beginning of Q-wave



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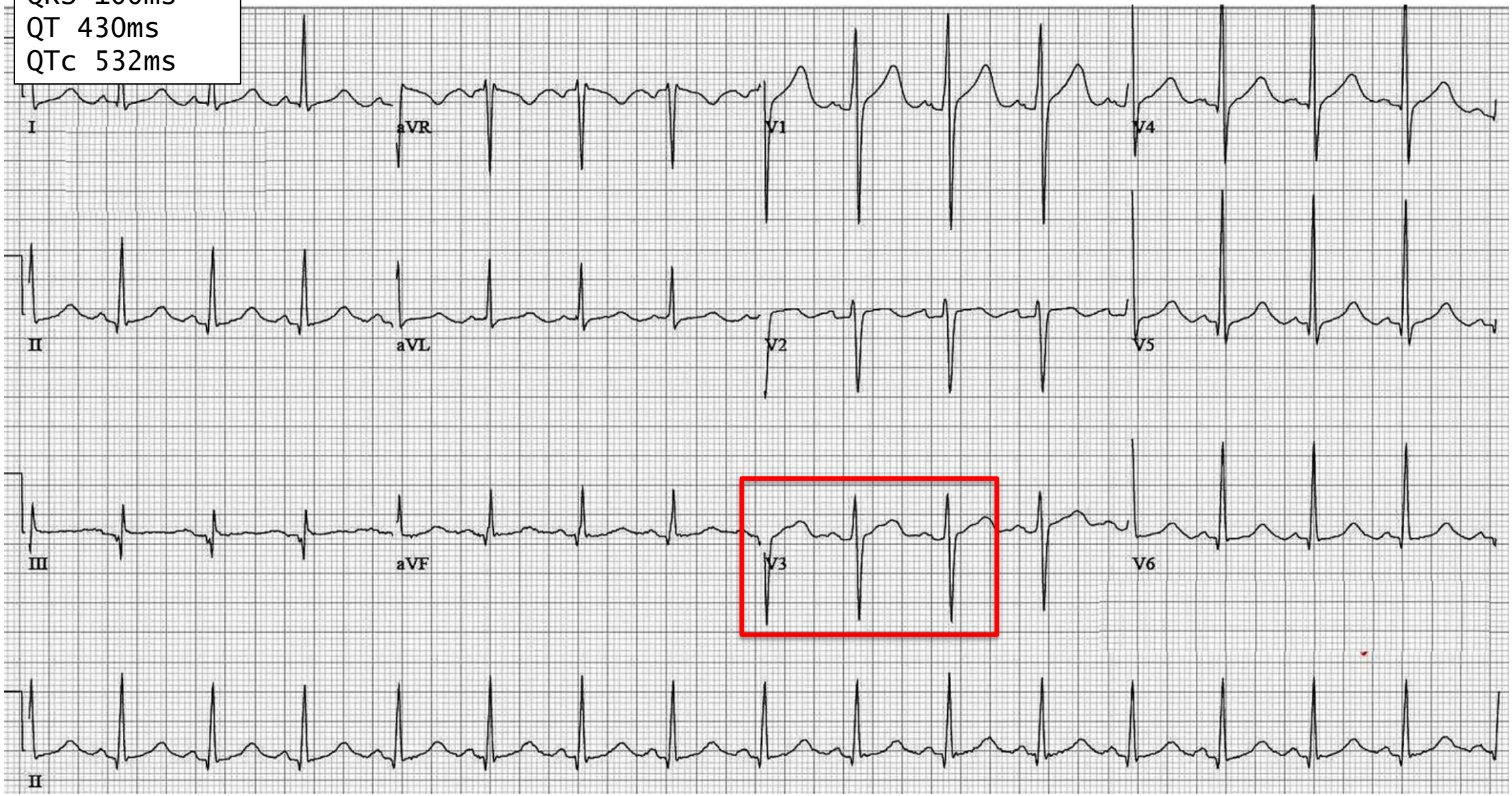
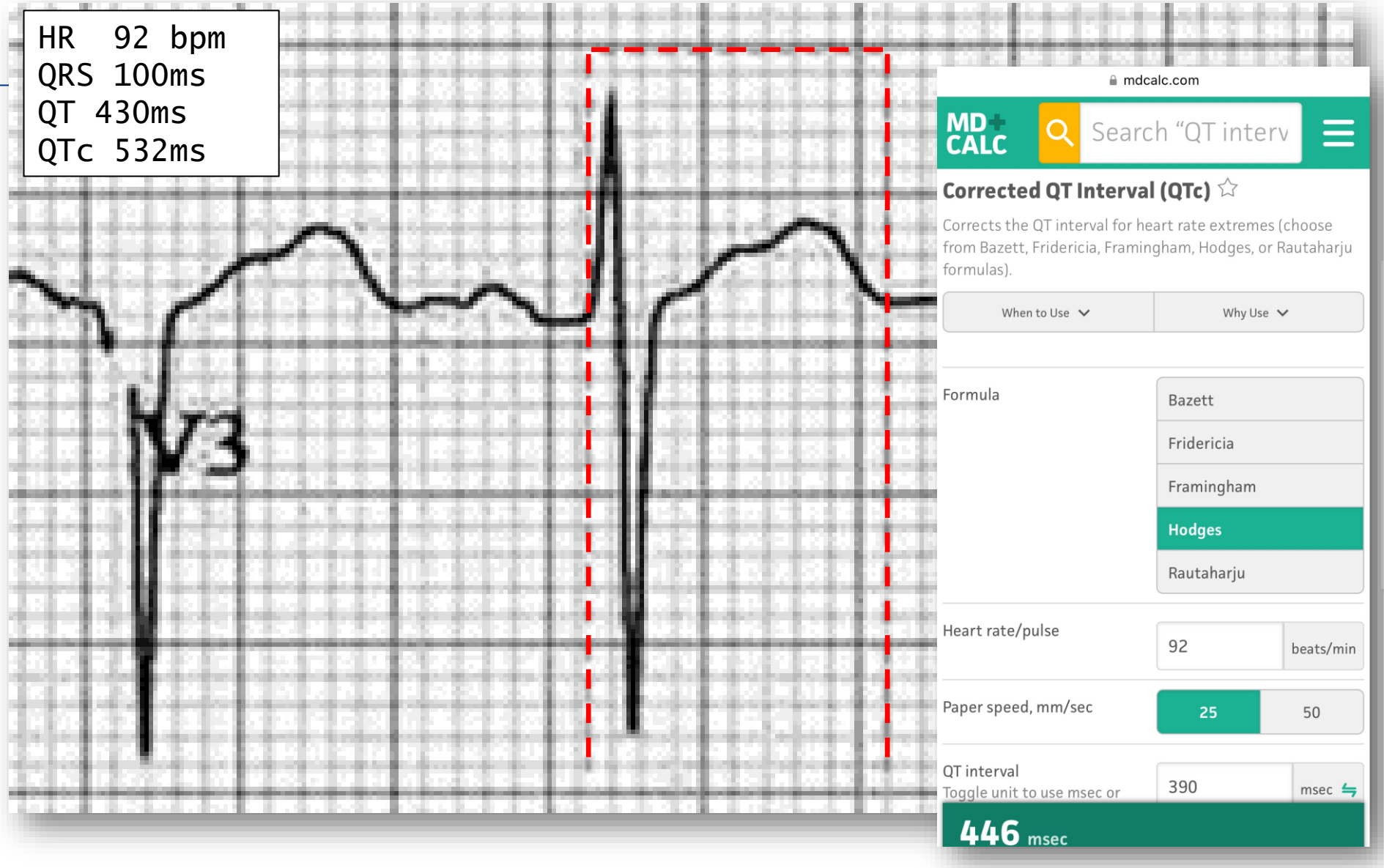


HR 92 bpm
QRS 100ms
QT 430ms
QTc 532ms

## QT = 9 boxes + 30ms = 390ms

# QT = 390 ms





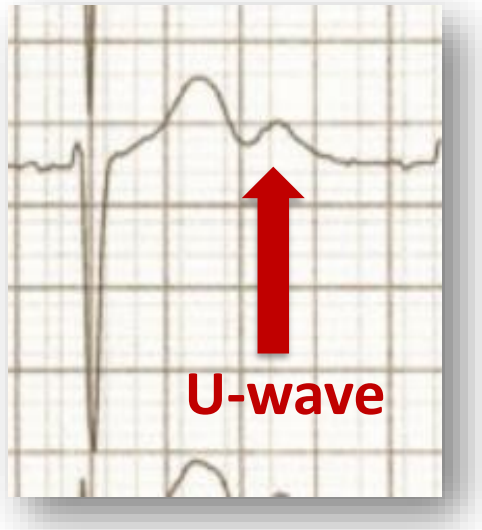


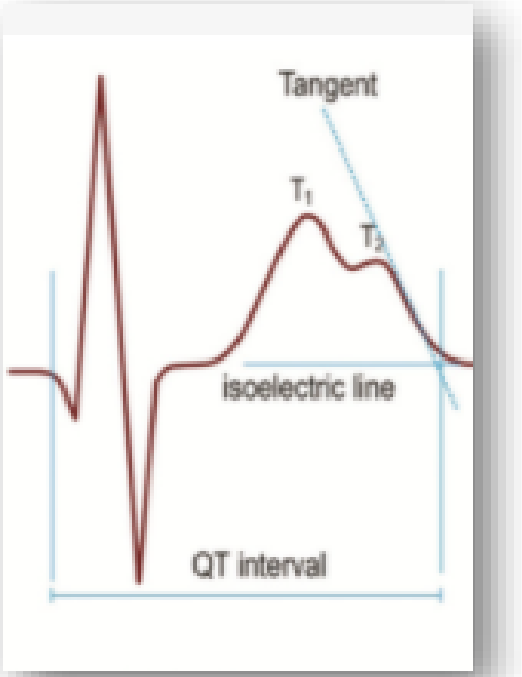
**QTc (B) = 483 ms**
**QTc (H) = 446 ms**
**QTc (Fri) = 450 ms**
**QTc (Fra) = 444 ms**

# WHAT ABOUT U-WAVES?

## ACC/AHA/HRS recommendation for U-waves superimposed on T-waves:

- If U-wave < 1/3 amplitude of T-wave either:
  - the QT should be measured in a lead without a U wave OR
  - use tangent method to steepest downward slope of T-wave
- If U-wave > 1/3 amplitude of T-wave, it is likely pathologic and should be included





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Schimpf, 2008; Rautaharju, 2009

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# RISK ASSESSMENT AND MEDICATIONS

# RISK FACTORS FOR TDP

| Non-modifiable risk factors | Modifiable risk factors |
|---|---|
| • Female sex<br>• Advanced age<br>• Metabolizer status<br>• Congenital long QT syndrome<br>• Personal history of drug-induced QTc prolongation<br>• Personal history of structural or functional cardiac disease<br>• Family history of sudden cardiac death | • Use of ≥1 QTc prolonging drug(s)<br>• Pharmacokinetic drug-drug interactions<br>• Drug toxicity<br>• Severe acute illness<br>• Bradycardia<br>• Starvation<br>• Hepatic impairment<br>• Renal impairment, hemodialysis<br>• Risk or presence of hypokalemia, hypomagnesemia or hypocalcemia |




Funk et al., 2020

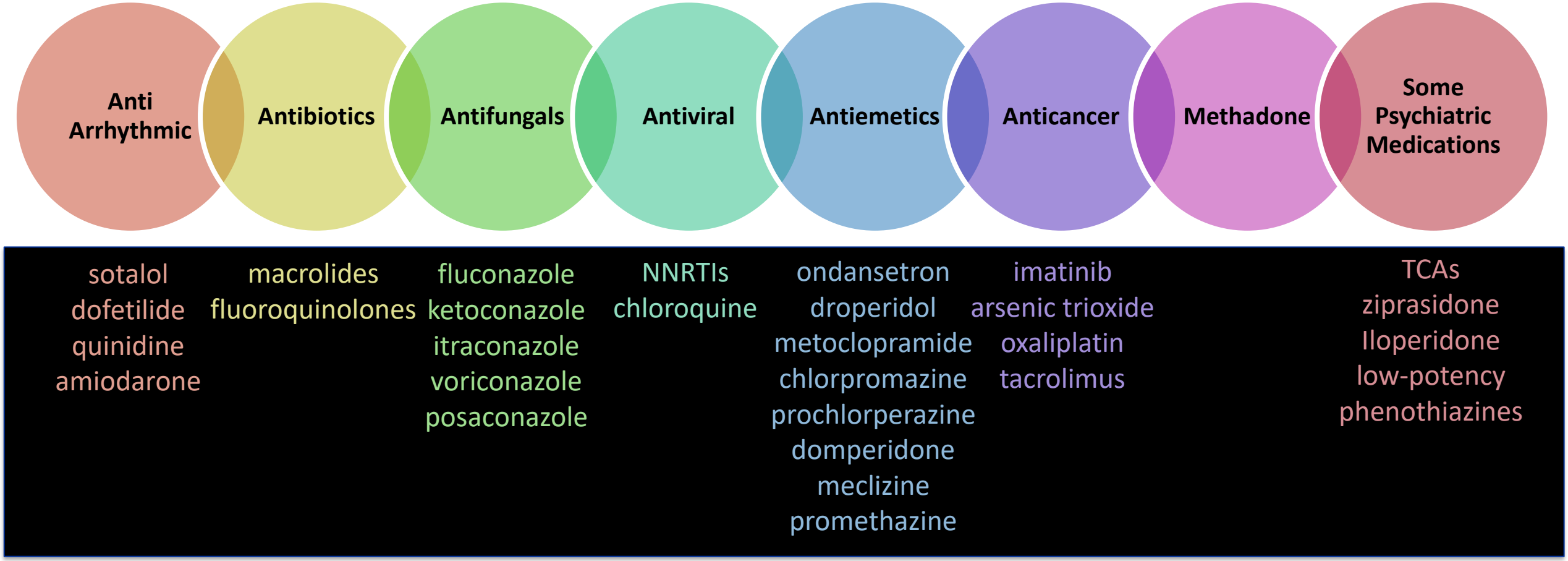
# MEDICATIONS AND RISK OF TDP

QTc prolongation is a major drug safety benchmark used by FDA and other international regulatory agencies

QTc prolongation is only a marker of risk for TdP

In the absence of other risk factors, drug-induced QTc prolongation rarely leads to TdP

# MEDICATIONS ASSOCIATED WITH PROLONGED QTC & TDP



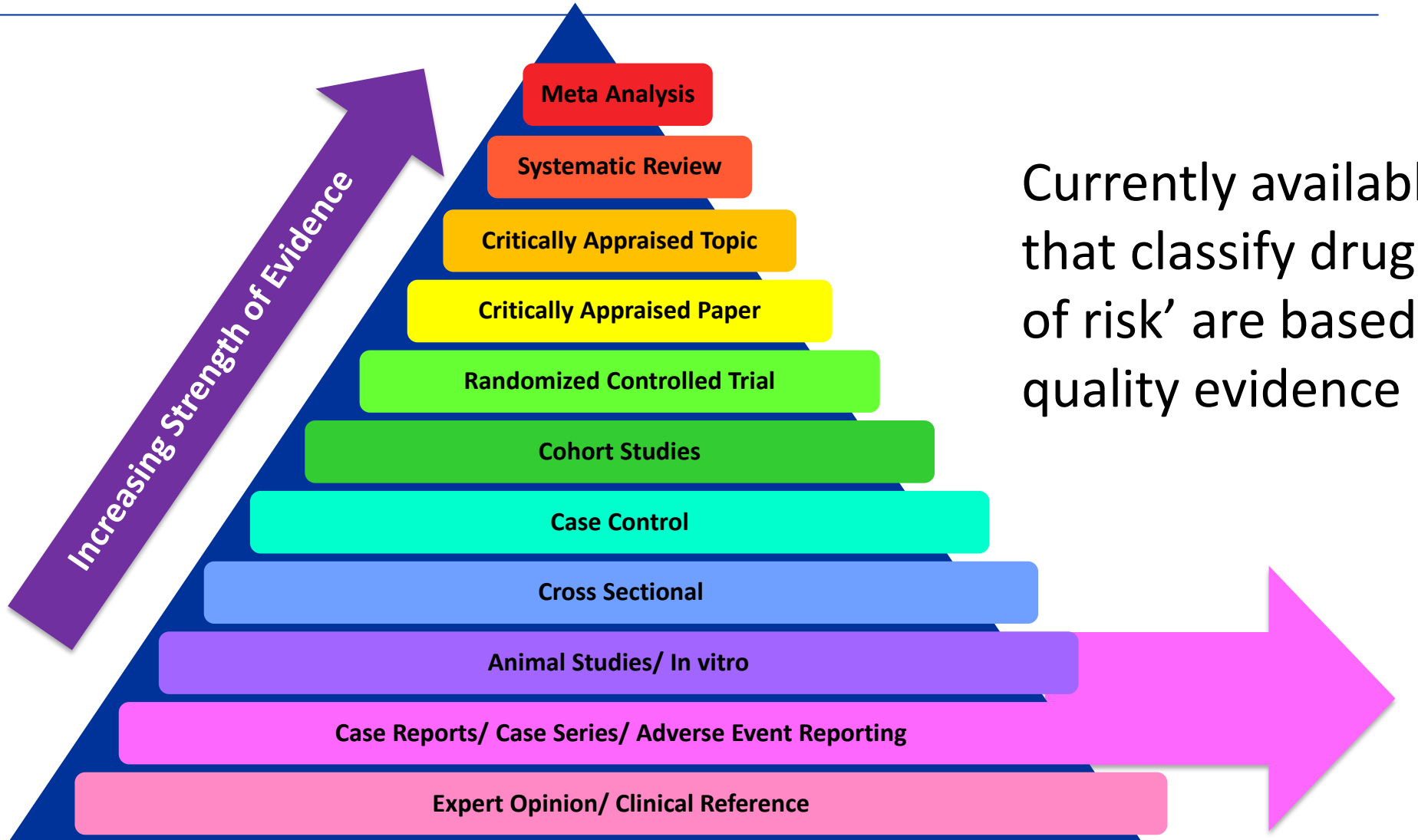







Freeman et al 2008, Tisdale et al, Tay et al 2014, Danielsson et al 2016.

# LIMITATIONS OF AVAILABLE DATA




Currently available drug registries that classify drugs according to 'level of risk' are based mostly on lower quality evidence

**QTc and Torsades Risk Drug Registries**

# LIMITATIONS OF AVAILABLE DATA

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- Study population
- Method of QTc measurement and correction
- Timing of measurement
- Medication dose
- Concomitant medications
- Reported QTc prolongation: clinically meaningful change?

# LIMITATIONS OF AVAILABLE DATA

Critical Appraisal of the Literature is Essential!

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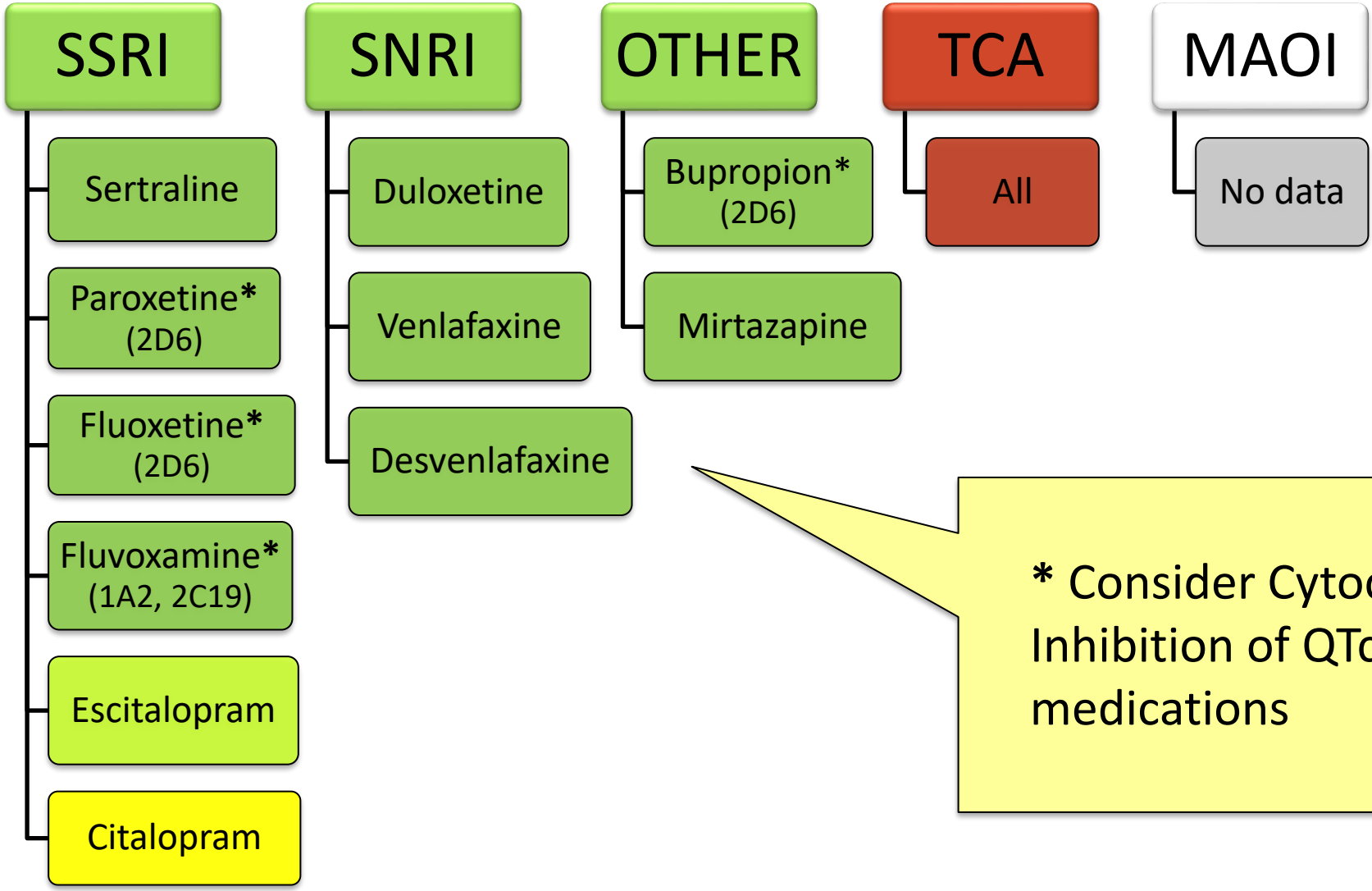
# PSYCHOTROPIC MEDICATIONS

# ANTIDEPRESSANTS




* Consider Cytochrome p450 Inhibition of QTc-prolonging medications







Funk & Bostwick 2013, Beach et al 2014, Vieweg & Wood 2004

# CITALOPRAM

**August 2011: FDA Drug Safety Communication**

- Citalopram ***should not be prescribed*** at doses > 40mg
- Citalopram should not be used at doses > 20mg in those with liver dysfunction or over age 60
- FDA asserts 60mg no more efficacious than 40mg
- Single study showing increase of 8.5 ms at 20mg and 18.5 ms at 60mg
- Similar study w/escitalopram (4.5 ms at 10mg and 10.7 ms at 30mg) but no recommendations from FDA

**March 2012: FDA Revised Recommendation**

- Citalopram ***not recommended*** at doses > 40mg
- Citalopram should be discontinued in anyone w/ QTc>500 ms




Castro et al 2013, Beach et al 2014, Drye et al 2014, Maljuric et al 2015, Girardin et al 2013, Crepeau-Gendron 2019

# Cardiac risk of using citalopram?

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All cause hospitalization and death significantly **increased** after citalopram dose reduction

No difference risk of VT/VF/sudden cardiac death vs other SSRIs

Hospitalizations for depression significantly ↑ after dose reductions

Increased prescriptions for interacting medications

More likely to be prescribed sedatives or anxiolytics

Higher healthcare utilization

# Risk of reflexively reducing citalopram dose?

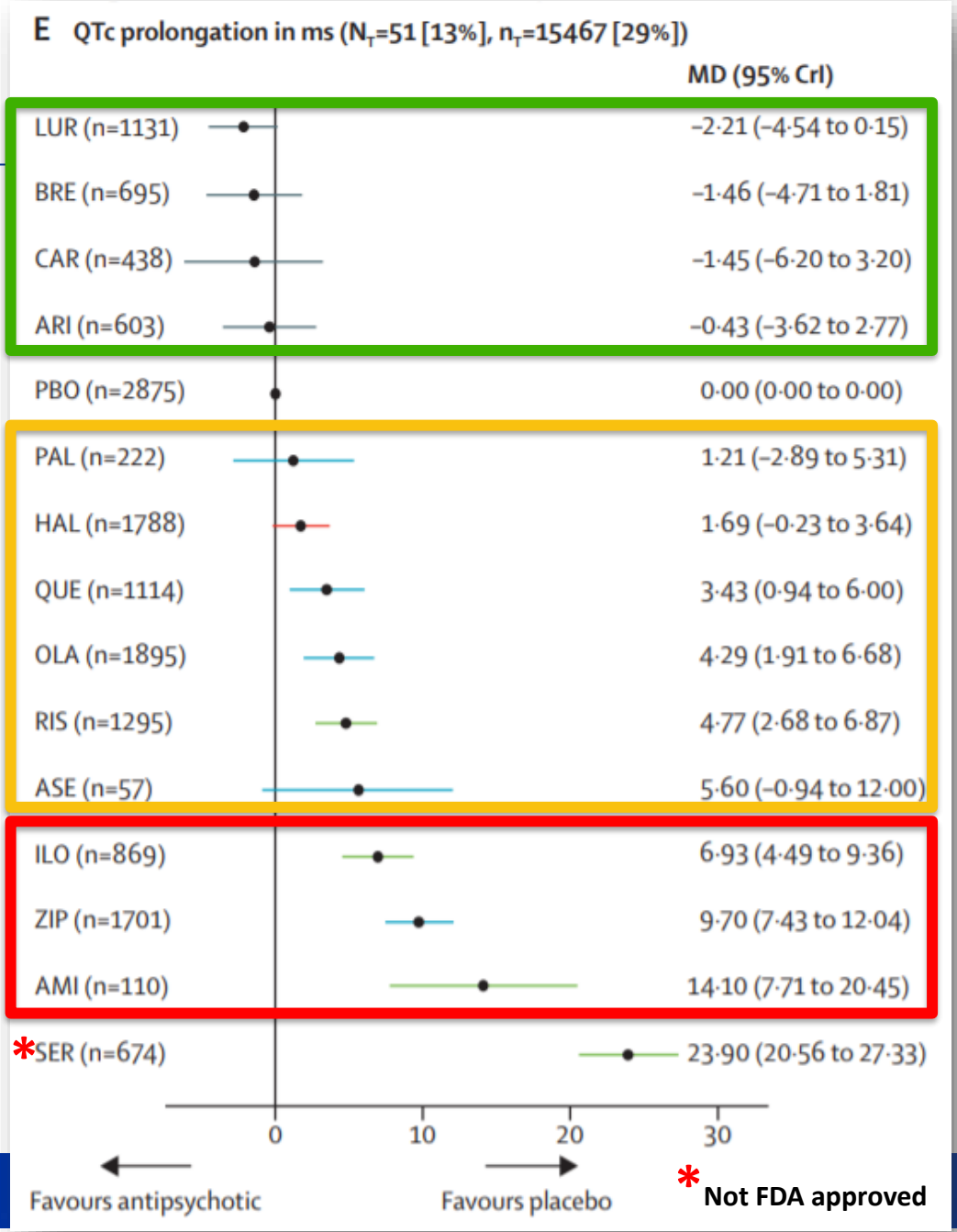
# ANTIPSYCHOTICS

## Lowest risk:
- lurasidone
- aripiprazole

## Low to Moderate risk:
- haloperidol
- quetiapine
- olanzapine
- risperidone

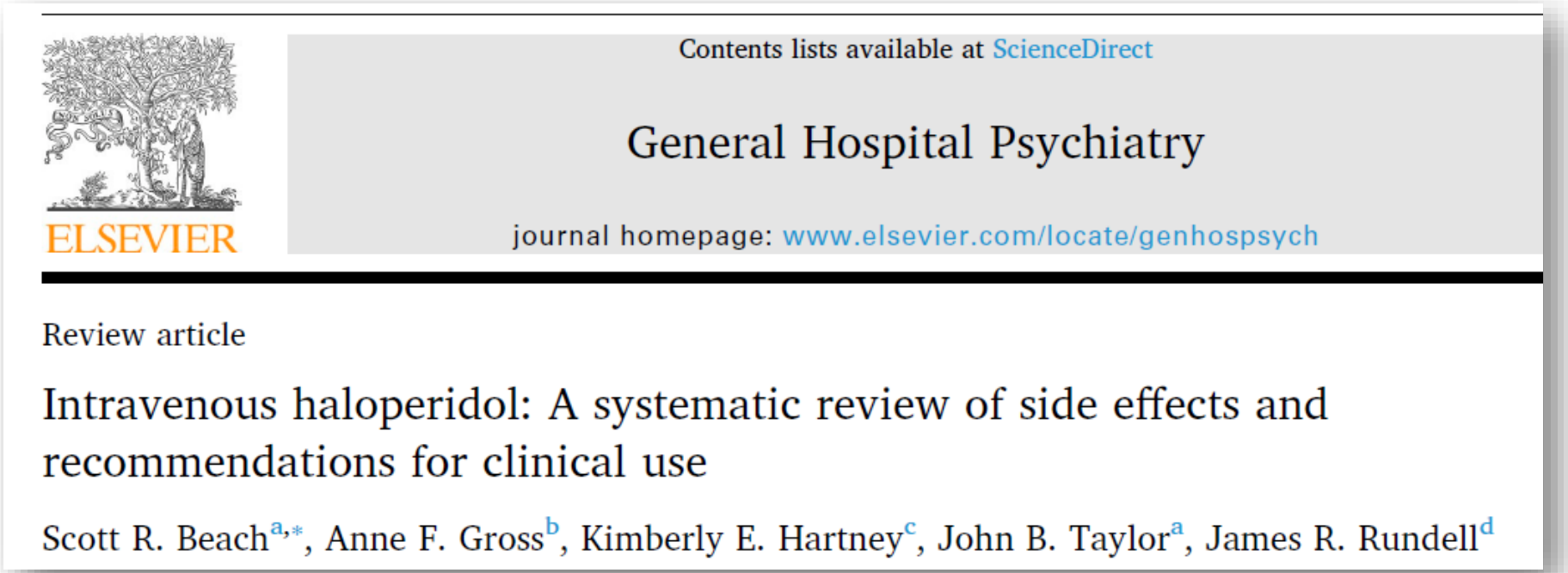
## Higher risk:
- iloperidone
- ziprasidone
- typicals (low potency phenothiazines: thioridazine, chlorpromazine, mesoridazine)

## Not enough data:
- clozapine (likely low risk)




Carra et al 2016, Leucht et al 2013, Ozeki et al 2010, Nielsen et al 2011, Huhn et al 2019

# INTRAVENOUS HALOPERIDOL



Contents lists available at ScienceDirect

General Hospital Psychiatry

journal homepage: www.elsevier.com/locate/genhospsych

Review article

Intravenous haloperidol: A systematic review of side effects and recommendations for clinical use

Scott R. Beach[a,*], Anne F. Gross[b], Kimberly E. Hartney[c], John B. Taylor[a], James R. Rundell[d]

- 2007 FDA warning suggested increased risk and recommended ECG monitoring for patients receiving IV haloperidol
- However, there is a paucity of data





Meyer-Massetti et al 2010, Carra et al 2016, Leucht et al 2013, Ozeki et al 2010, Nielsen et al 2011, Beach et al 2020

# INTRAVENOUS HALOPERIDOL

- Studies of IV haloperidol recipients have confounders
  - severe medical illness, including electrolyte disturbance
  - underlying cardiac illness
  - multiple QT-prolonging medications
- Recommendations for use in Inpatient Setting
  - Check baseline ECG and at least one follow-up
  - Consider daily ECG if other risk factors are present
  - Ensure repletion of electrolytes and minimize other risk factors
  - For QTc > 500 ms, consider continuous monitoring or alternative agents
  - Remember: the ICU is the safest place in the hospital






Beach et al 2020

# MOOD STABILIZERS - ANTIEPILEPTICS

## Do not significantly prolong QT interval

- Valproate may have some protective effects and stabilization of cardiac conduction
- There is no evidence to suggest QTc prolongation with:
  - Carbamazepine
  - Oxcarbazepine
  - Topiramate
  - Lamotrigine
  - Gabapentin

However, as these are sodium channel blockers, be aware of risk of conduction delay in patients with BBB.





Kurt et al 2009, Kwan et al 2004, Dixon et al 2008, Saetre et al 2009, Chen et al 2012

# MOOD STABILIZERS - LITHIUM

## ? Lithium's effects on QT remain uncertain

- Only a few small studies
- No QTc prolongation within the therapeutic range of 0.6-1.2 mEq/L
- Increasing serum lithium concentrations correlated w/ QTc prolongation
- QTc increases are modest and may not be clinically significant

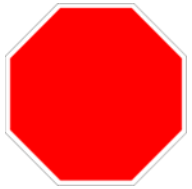






Reilly 2000, Hsu 2005, Mamiya 2005, Chen 2020

# METHADONE



- Prolongs the QTc and is in **highest risk categories for TdP**
- Potent inhibitor of hERG IKr channels
- **2006: FDA issued black box warning:**

**"cases of QT interval prolongation and serious arrhythmia (TdP) have been observed during treatment with methadone"**

**Important to balance risk of TdP and risk of death from OUD!**





Romero 2016, Martell 2005, Eap 2007, Fanoe 2007, Cruciani 2005, Maremani 2005, Peles 2006, Katchman 2002

# METHADONE SAFETY GUIDELINES

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**Risk Factors**

- Older Age
- Female Sex
- Functional structural heart dz
- Prior QTc prolongation or TdP
- Prior arrhythmia
- Prior cardiac arrest
- Family history arrhythmia, cardiac arrest, sudden cardiac death
- Hypokalemia
- Hypocalcemia
- Hypomagnesemia
- Bradycardia
- Renal Dysfunction
- Hemodialysis
- Liver Dysfunction
- Impaired drug metabolism
- Drug-Drug interactions
- Taking one or more QTc-prolonging drugs

## Methadone Safety Guidelines

**American Pain Society and Heart Rhythm Society, 2014**

**Baseline ECG**

| **Obtain If:** | **Consider Obtaining If:** |
|---|---|
| • Risk Factors for TdP<br>• Prior ECG with QTc > 450ms | • No risk factors for QTc prolongation/ TdP |

**ECG Contingencies**

| **Consider Alternatives** when baseline QTc > 450ms <500ms | **Recommend Against Use** when baseline QTc > 500ms |
|---|---|

**Considerations for All Patients**

| **Evaluate and correct reversible causes QTc prolongation before initiation** | **Balance risk of TdP with risk of untreated Opioid Use Disorder** |
|---|---|

Adapted from Chou R. et al., 2014

# BUPRENORPHINE

Safer alternative to methadone

- Does not prolong the QT interval or have an association with TdP
- One hundred times less potent of an hERG IKr inhibitor than methadone





Katchman 2002, Ilback 2008, Baker 2006, Demarie 2011, Wedam 2007, Kao 2015, Fareed 2013, Hanon 2010, Ancherson 2009, Stallvik 2013, Athanasos 2008, Esses 2008

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# CONSIDERATIONS FOR ECG MONITORING

# CONSIDERATIONS FOR WHEN TO ORDER AN ECG

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## If using a prior ECG…

- No more than one month prior to the decision point
- Without substantial changes in medications, electrolytes, or cardiovascular status

## If in resource-poor areas…

- Practitioners should not let the absence of an ECG preclude the prescription of a psychiatric medication
- If an ECG machine is available, practitioners of any medical specialty should be comfortable with QTc measurement, calculation and documentation

# CONSIDERATIONS FOR WHEN TO ORDER AN ECG

## Who can interpret an ECG?

- In settings where clinicians do not have access to a cardiology overread, clinicians of any medical specialty should feel comfortable with the measurement, calculation and documentation of the QTc interval





Funk et al., 2020; Funk et al., 2021

# WHEN TO OBTAIN AN OUTPATIENT ECG?

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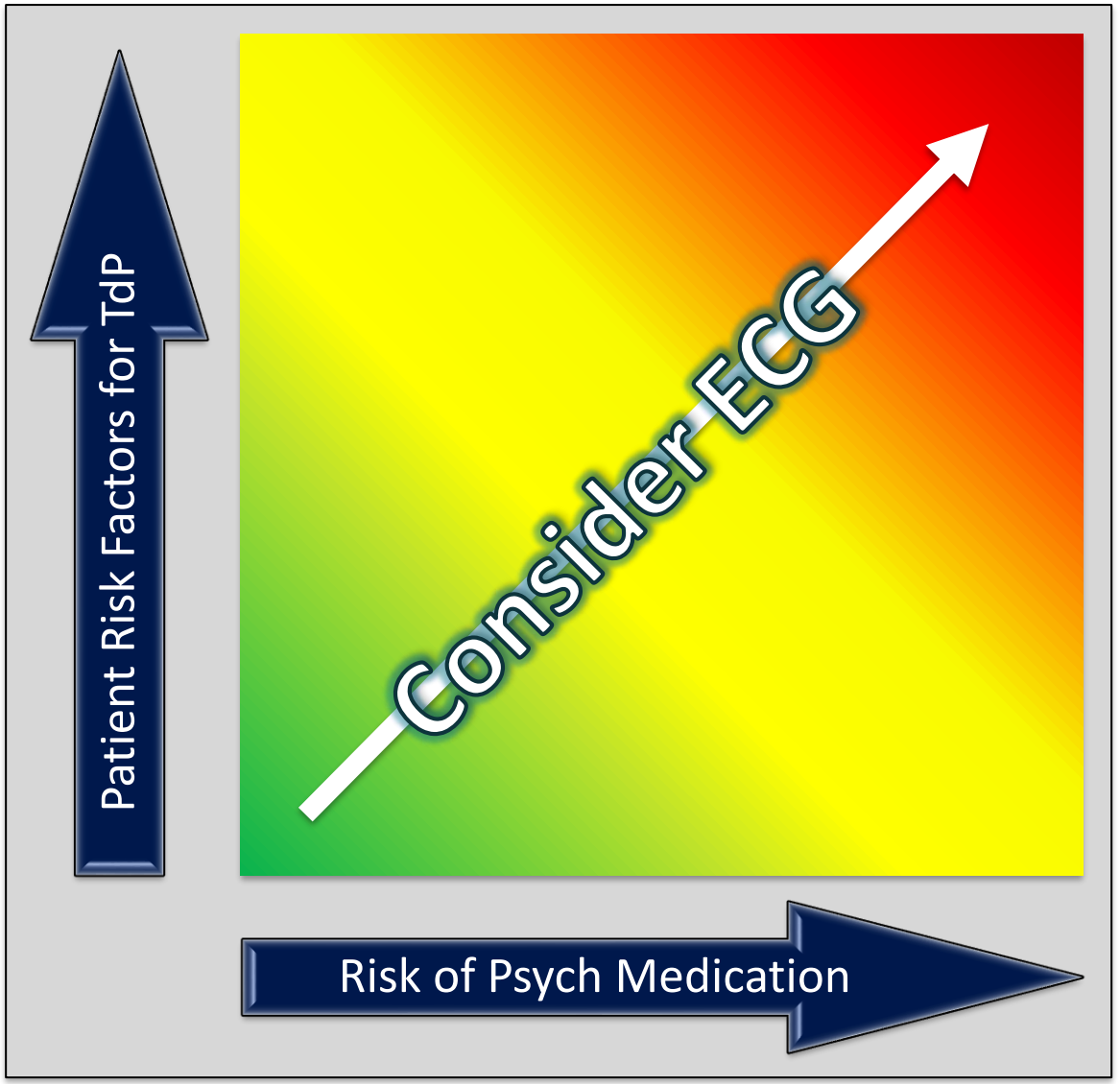
## Non-Modifiable Risk Factors For TdP

- Older Age
- Female Sex
- Functional structural heart disease
- Prior QTc prolongation or TdP
- Prior arrhythmia
- Prior cardiac arrest
- Family history arrhythmia, cardiac arrest, sudden cardiac death

## Modifiable Risk Factors For TdP

- Hypokalemia
- Hypocalcemia
- Hypomagnesemia
- Bradycardia
- Renal Dysfunction
- Hemodialysis
- Liver Dysfunction
- Impaired drug metabolism
- Drug-Drug interactions
- Taking one or more QTc-prolonging drugs




## Low Risk Medications

- Most SSRIs & SNRIs
- Benzodiazepines
- Valproic Acid
- Buprenorphine
- Aripiprazole
- Lurasidone

## Moderate Risk Medications

- Citalopram
- Quetiapine, Risperidone, Olanzapine, Haloperidol
- Trazodone

## High Risk Medication

- Methadone
- Ziprasidone
- Iloperidone
- Low -Potency Phenothiazines
- Tricyclic Antidepressants

# CONSIDERATIONS FOR OUTPATIENT ECG MONITORING

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## When to Obtain Baseline ECG?

**No ECG Needed**

No risk factors for TdP **AND**
Not prescribing High-Risk Drug

**Obtain ECG**

Multiple Risk Factors
for TdP **AND** Any Drug

**Obtain ECG**

No Risk Factors for TdP
**AND** High-Risk Drug

**Obtain ECG AND Consider Consulting Existing Cardiologist**

Risk Factors for TdP **AND** High-Risk Drug

## Interpreting Baseline and Drug Steady State ECG

**Proceed with Medication**

QTc < 500ms **AND**
No increase of QTc by ≥ 60ms

**Proceed w/ Caution: Careful Risk-Benefit Analysis**

QTc > 500ms **OR** Increase of QTc ≥ 60ms

## When to Consult Cardiology?

**Cardiology Consultation**

High-Risk Drug **AND**
QTc > 500ms **OR** Increase QTc ≥ 60ms

**Immediate Cardiology (ER)**

Cardiac symptoms
(dizziness, syncope, palpitations)

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# ROLE OF PACEMAKERS AND DEFIBRILLATORS

# CASE 2

44 y/o man with a family history of cardiac arrest in his grandfather, father, and paternal aunt, tests positive for a genetic cardiomyopathy with high risk for sudden cardiac death. He has never had any arrhythmias or cardiac symptoms. He is implanted with a subcutaneous Implantable Cardioverter Defibrillator (ICD) for primary prevention.

His past medical and psychiatric history is notable for hyperlipidemia, recurrent sinus infections, and depression. He takes simvastatin, escitalopram, and is frequently prescribed a Z-pack (azithromycin) by his PCP.

He develops a viral GI illness with multiple days of vomiting and diarrhea, not able to keep anything down. He presents to the ED for dehydration where his QTc(H) is 522ms, K+ is 2.7. The ED resident orders zofran for nausea. When another ED resident questions this decision due to Torsades risk, the first resident says “Don’t worry about it. He has an ICD.”

**Should they worry about it?**

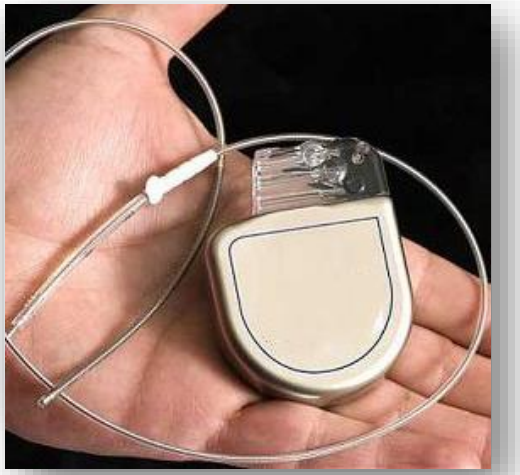
# INDICATIONS FOR ICD IMPLANTATION

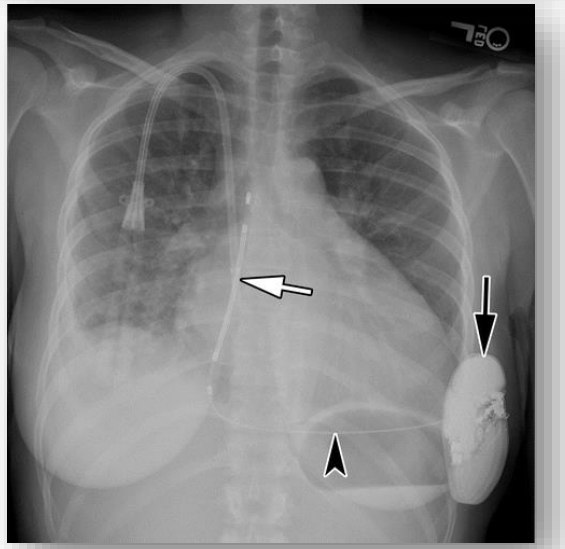
## Primary Prevention:

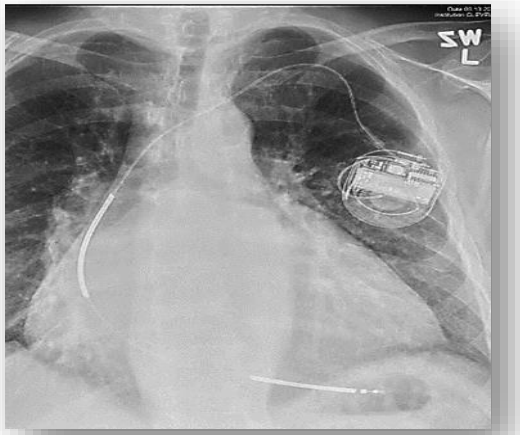
- CAD + Heart failure LVEF ≤ 35%
- Dilated Cardiomyopathy
- Certain Pathogenic Gene Mutations
- Arrhythmogenic RV Cardiomyopathy
- Congenital Long QT Syndrome
- Asymptomatic QTc > 500ms during β-Blocker
- Brugada syndrome + symptoms/ inducible AF

## Secondary Prevention:

- VF sudden cardiac arrest
- sustained VT
- Hemodynamically not-tolerated VT







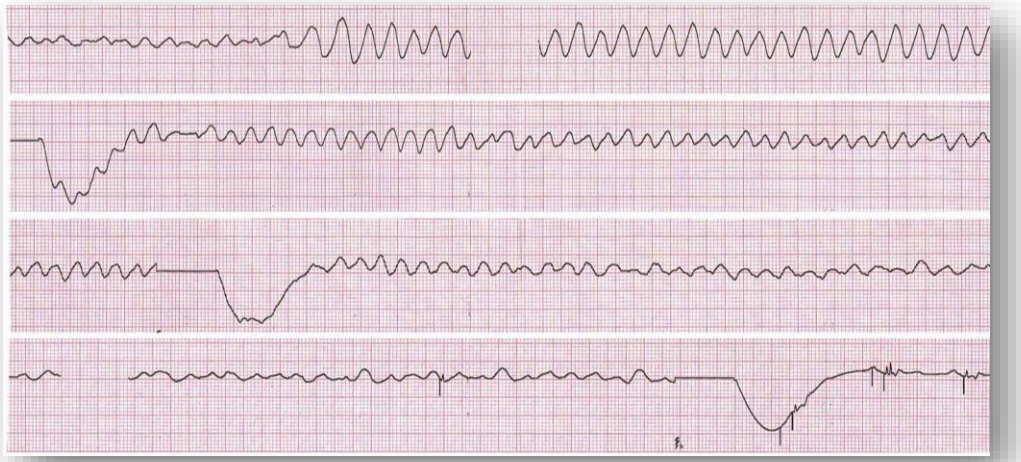


Al-Khatib. ACC/AHA/HRS 2017 Guidelines for Management of Patients with ventricular arrhythmias and the prevention of SCD.

# IMPLANTED CARDIOVERTER-DEFIBRILLATOR (ICD)

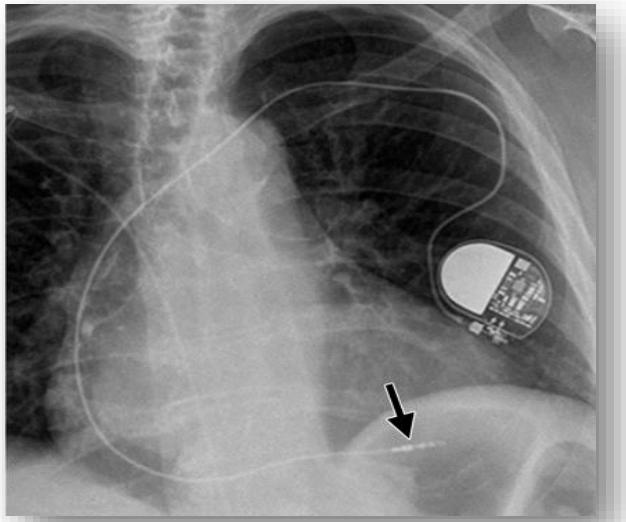
## ICDs can readily terminate most VT/VF effectively, but…

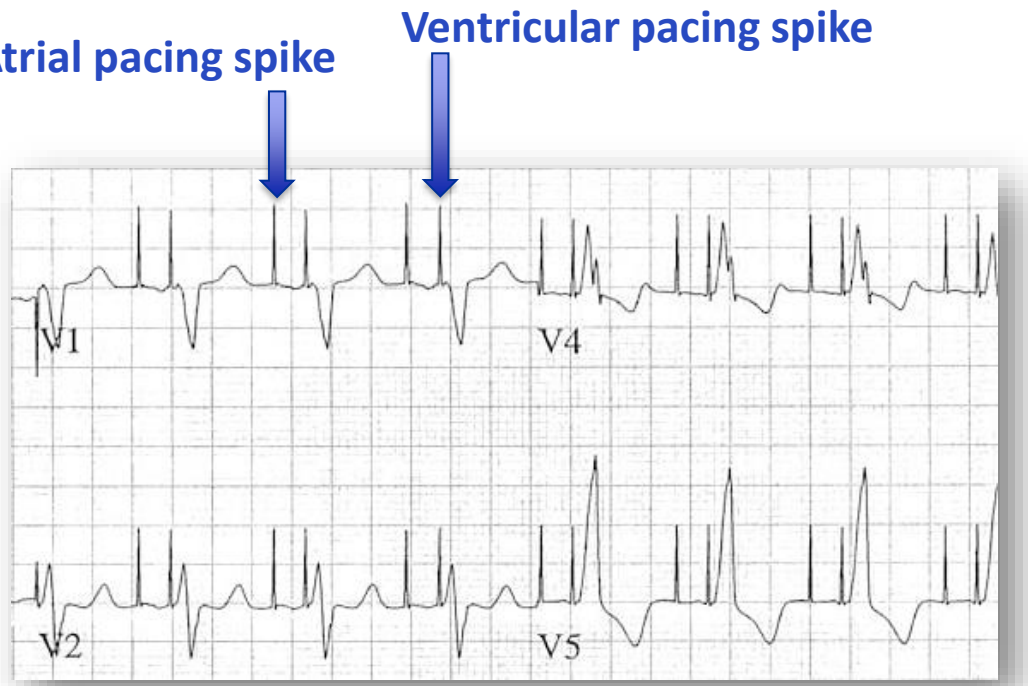
- Even appropriate shocks are independently associated with increased risks of death and worsening heart failure
- Some VT will recur if substrates are unchanged, despite “successful” shocks
- ICD “storms” are common, which lead to significant psychological morbidity



# PERMANENT PACEMAKER (PPM)

**Indication:** treatment of brady-arrhythmias
**Goal:** to sustain adequate HR for daily activity
**How does it work?** Paces the heart if the HR drops below the pacing threshold (usually 30-40 bpm)








Aguilera AL, Volokhina YV, Fisher KL. Radiographics. 2011

# PERMANENT PACEMAKER (PPM)

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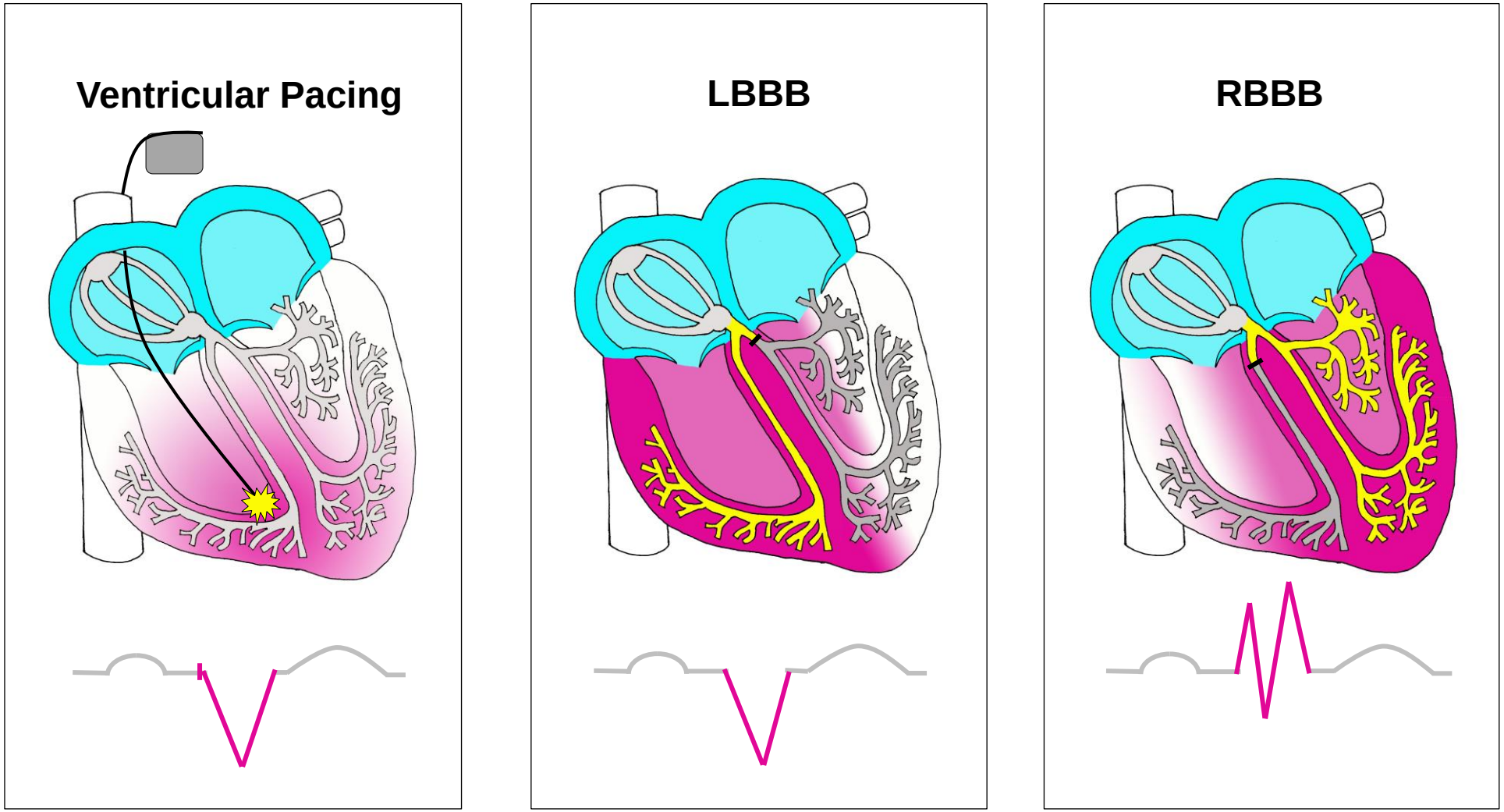
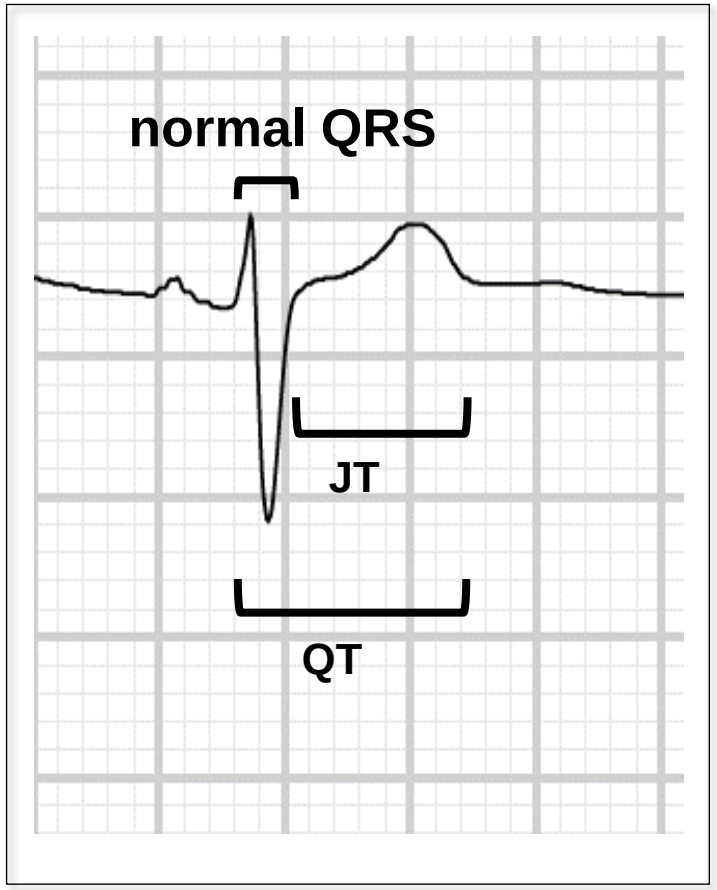
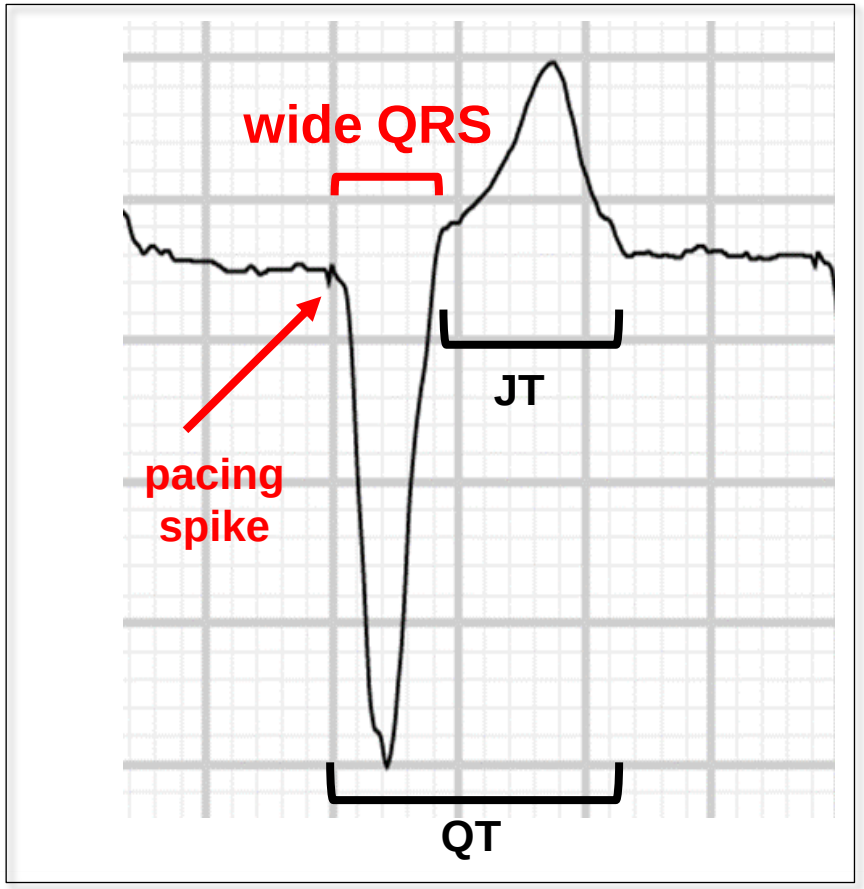



Funk et al 2021

# WIDE QRS: VENTRICULAR PACING OR BBB




**Widening of QRS leads to prolongation of QTc without perturbation of repolarization**



Funk et al 2021

# CASE 3

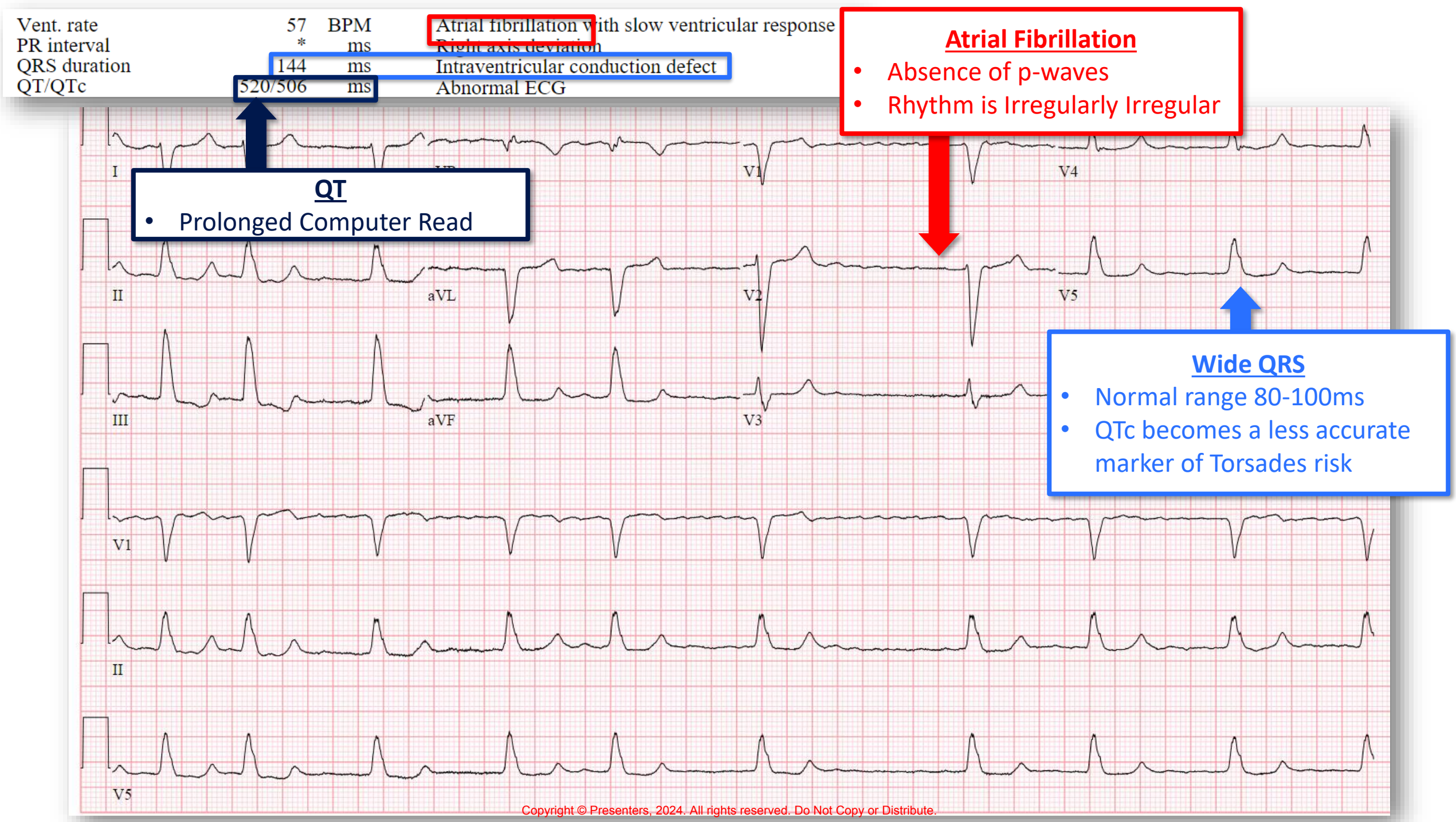
A 63 y/o woman with MDD and GAD presents for a new patient evaluation in your outpatient psychiatry clinic. Past medical history notable for:

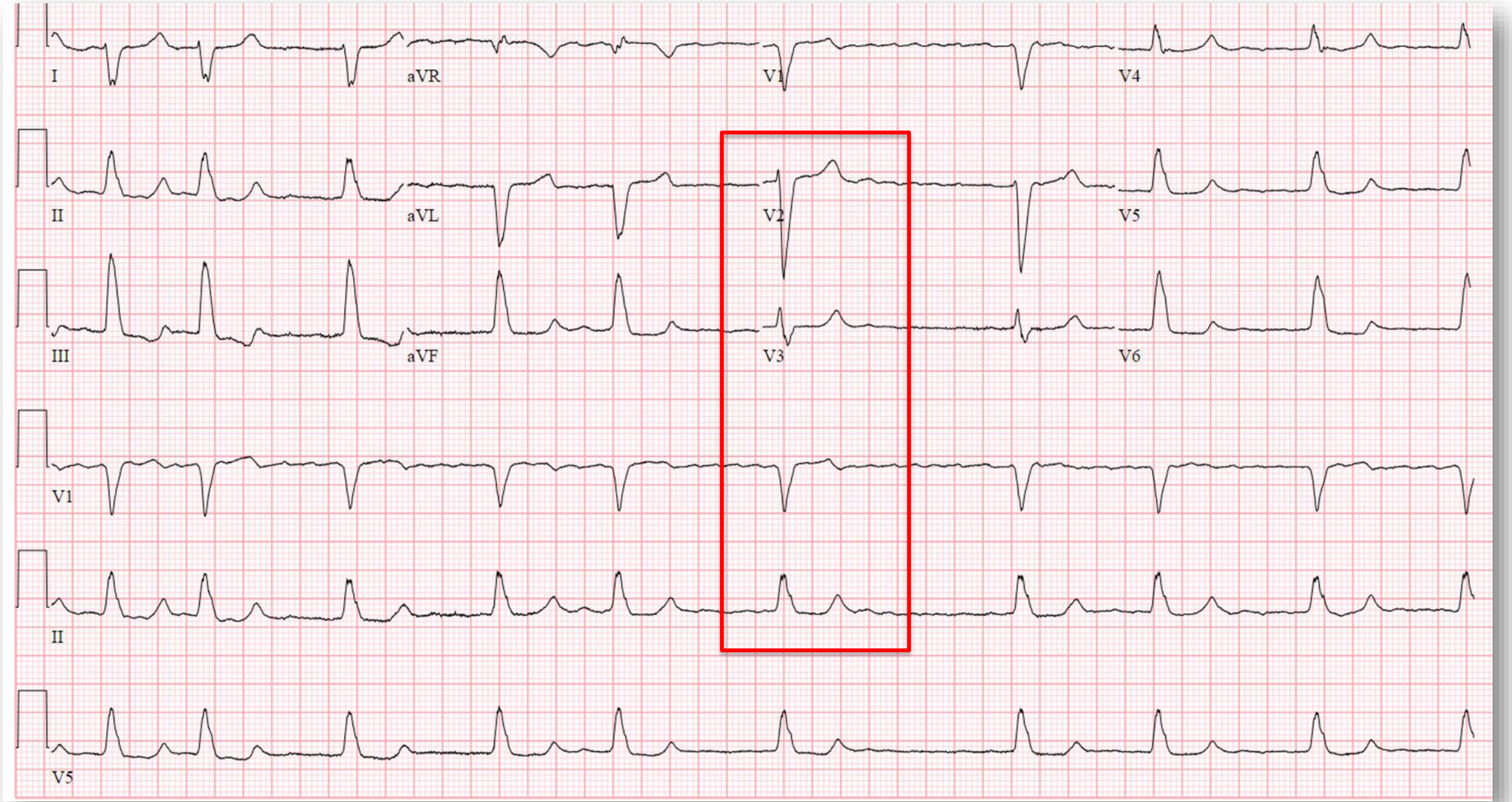
- rheumatic fever, c/b mitral & aortic valve stenosis
- s/p mitral and aortic valve replacement
- HFpEF
- atrial fibrillation on amiodarone and warfarin
- right bundle branch block
- obesity
- other meds: furosemide

She has suffered from terrible depression since the death of her sister by suicide 9 months ago. + low mood, anhedonia, passive thoughts of death, amotivation, hopelessness, & extreme guilt. Feels paralyzed by worry, can't tolerate being around people. Has daily panic attacks.

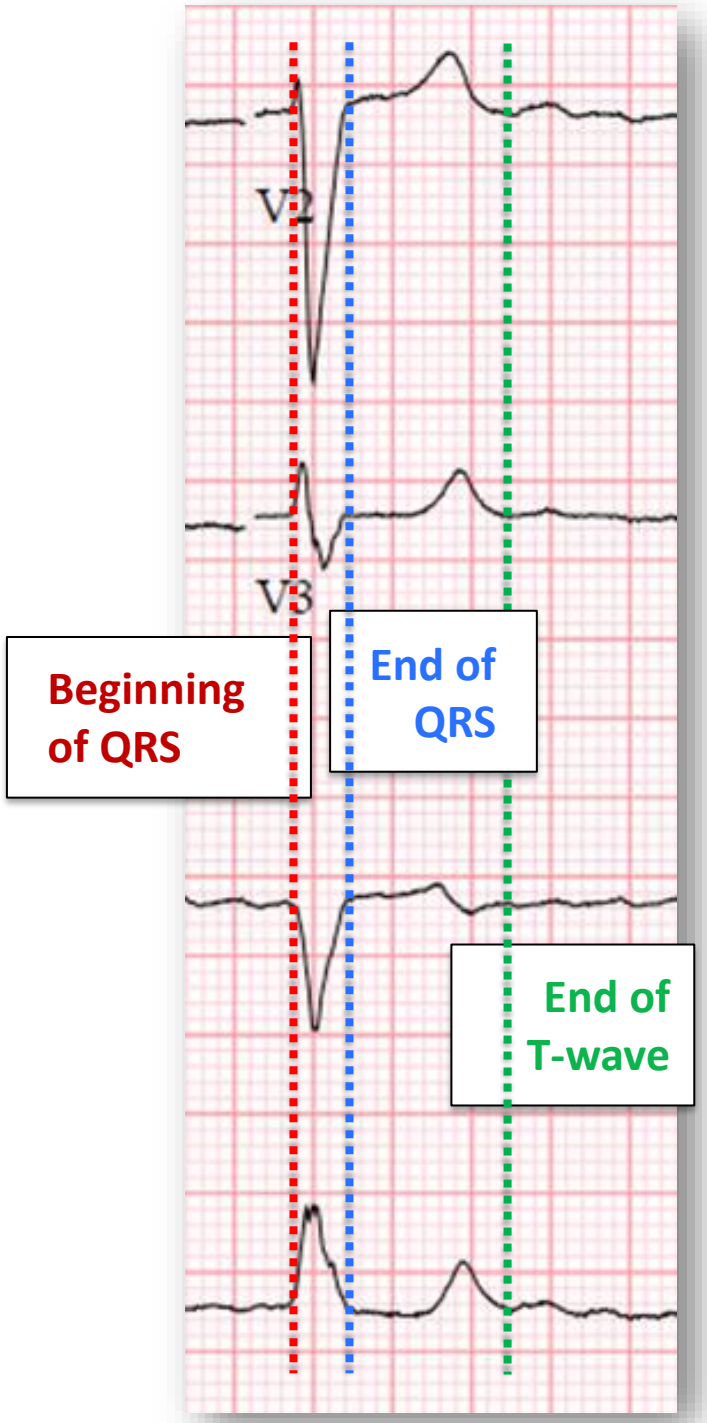
Two of her 8 other siblings also ended their lives by suicide. She has had a trials of mirtazapine (oversedation, no mood improvement), and bupropion (worsened her anxiety).

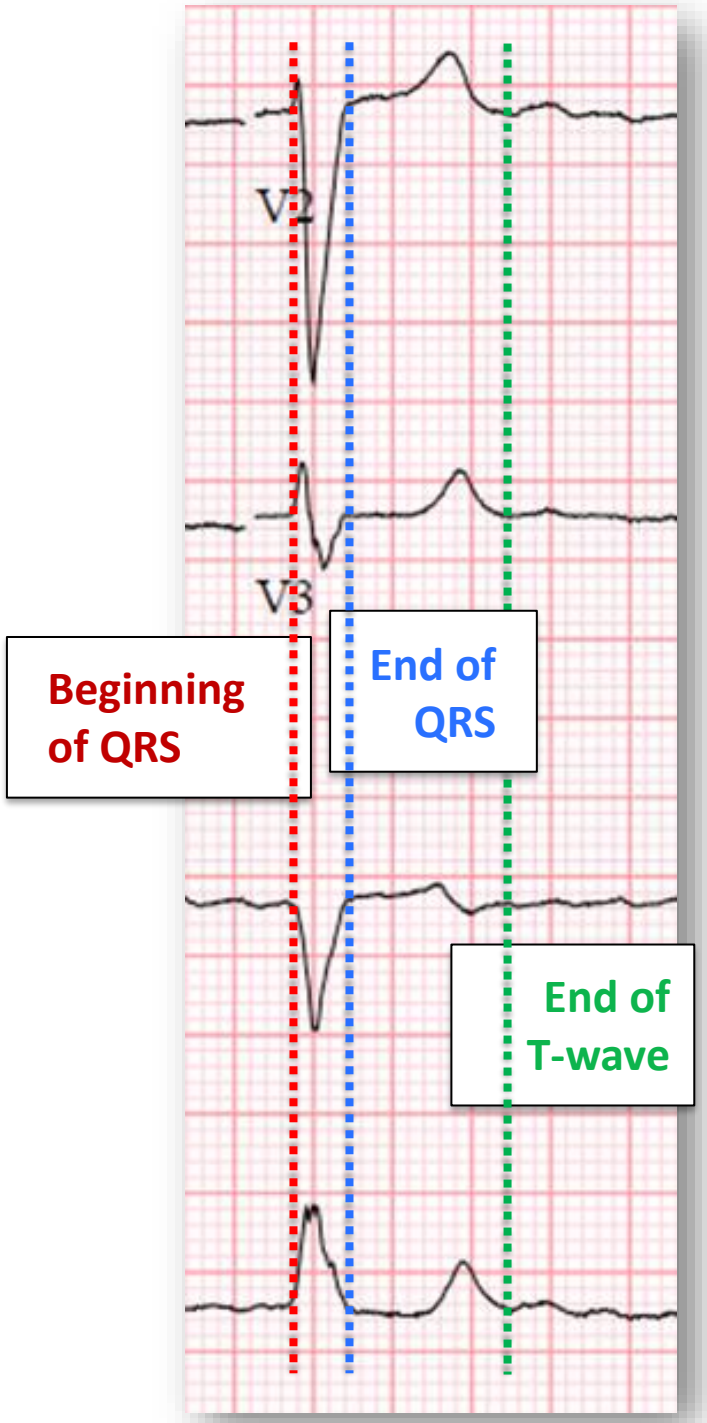
She has never had a trial of an SSRI.

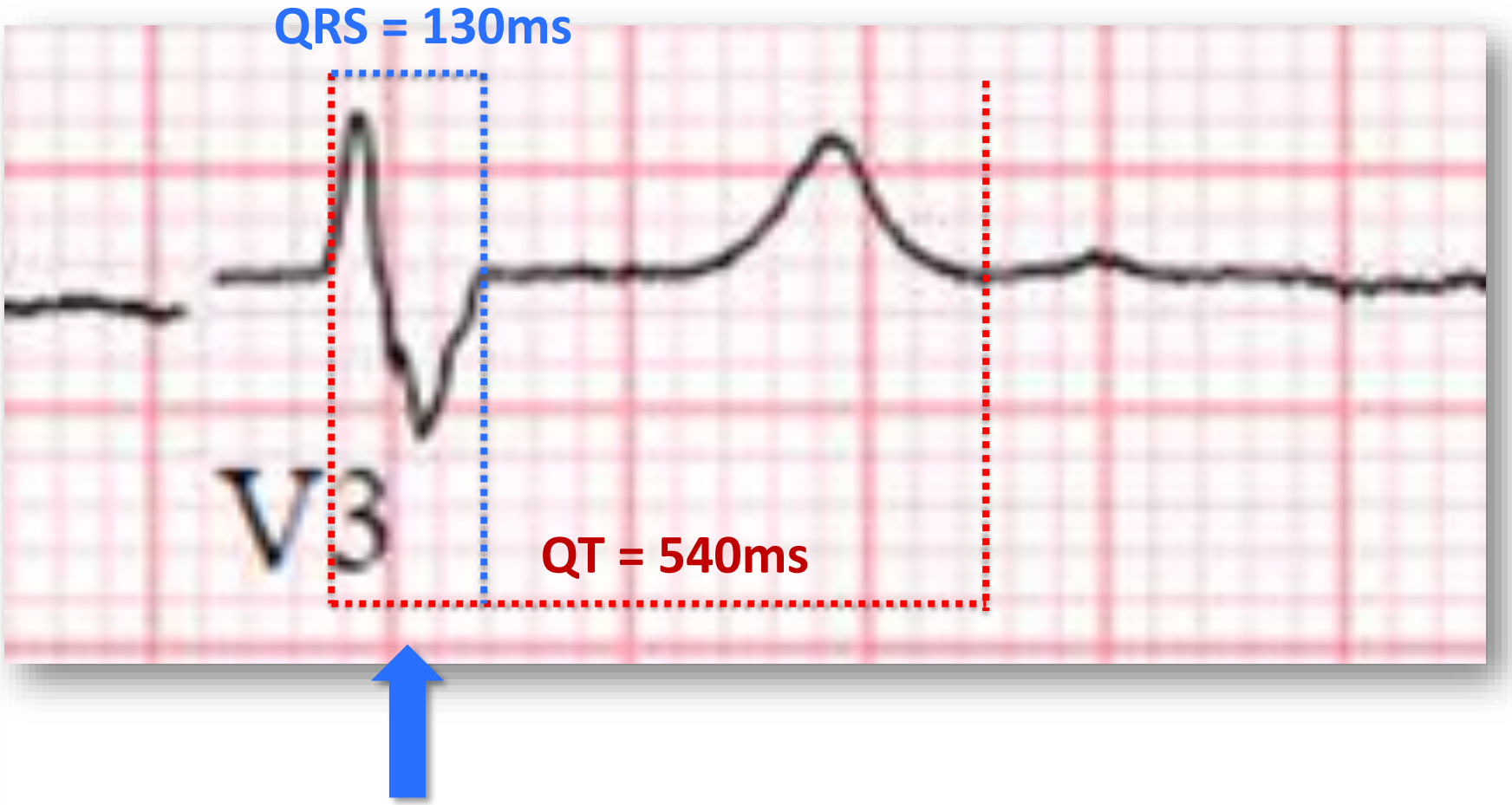




# What is the QT interval?

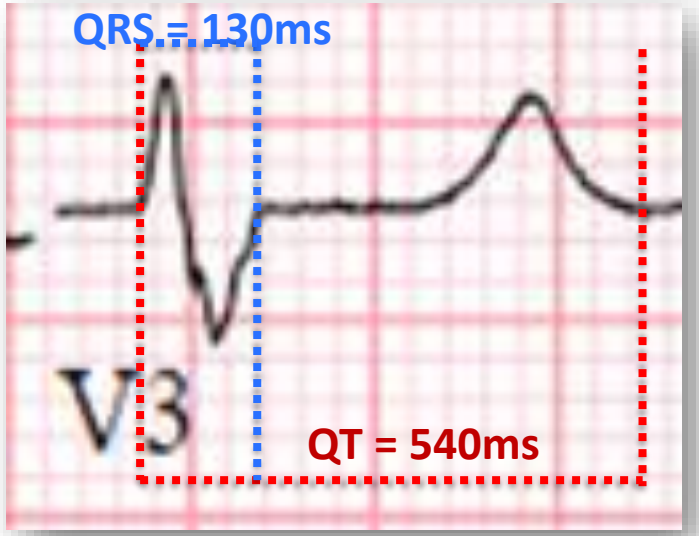



**Widening of QRS leads to prolongation of QTc without perturbation of repolarization**

# CORRECTING FOR WIDE QRS




## STEP 1: Obtain ECG Measurements (QT, QRS, RR/HR)

QRS complex ≥ 110ms?

YES

130ms

NO

## STEP 2: Select Wide QRS Correction Method

BOGOSSIAN SIMPLIFIED
**QTm = QT – 0.5*QRS**

JT INTERVAL
**JT = QT – QRS**

QTm = QT modified for wide QRS

**QTm = 540 – 0.5*130 = 475ms**

**JT = 540 – 130 = 410ms**

## STEP 3: Select Heart Rate Correction Method

HODGES
**QTc = QTm + 1.75 (HR – 60)**

FRIDERICIA
**QTc = QTm/ $\sqrt[3]{RR}$**

JTc: substitute JT for QTm

**QTc = 475ms + 1.75 (57 – 60) = 470ms**

**JTc = 410ms + 1.75 (57 – 60) = 405ms**

## QTc and JTc Upper Limits of Normal

QTc
**500 ms**

JTc
**men 355 ms**
**women 372 ms**

**QTc = 470ms** ✓

**JTc = 405ms** ⛔

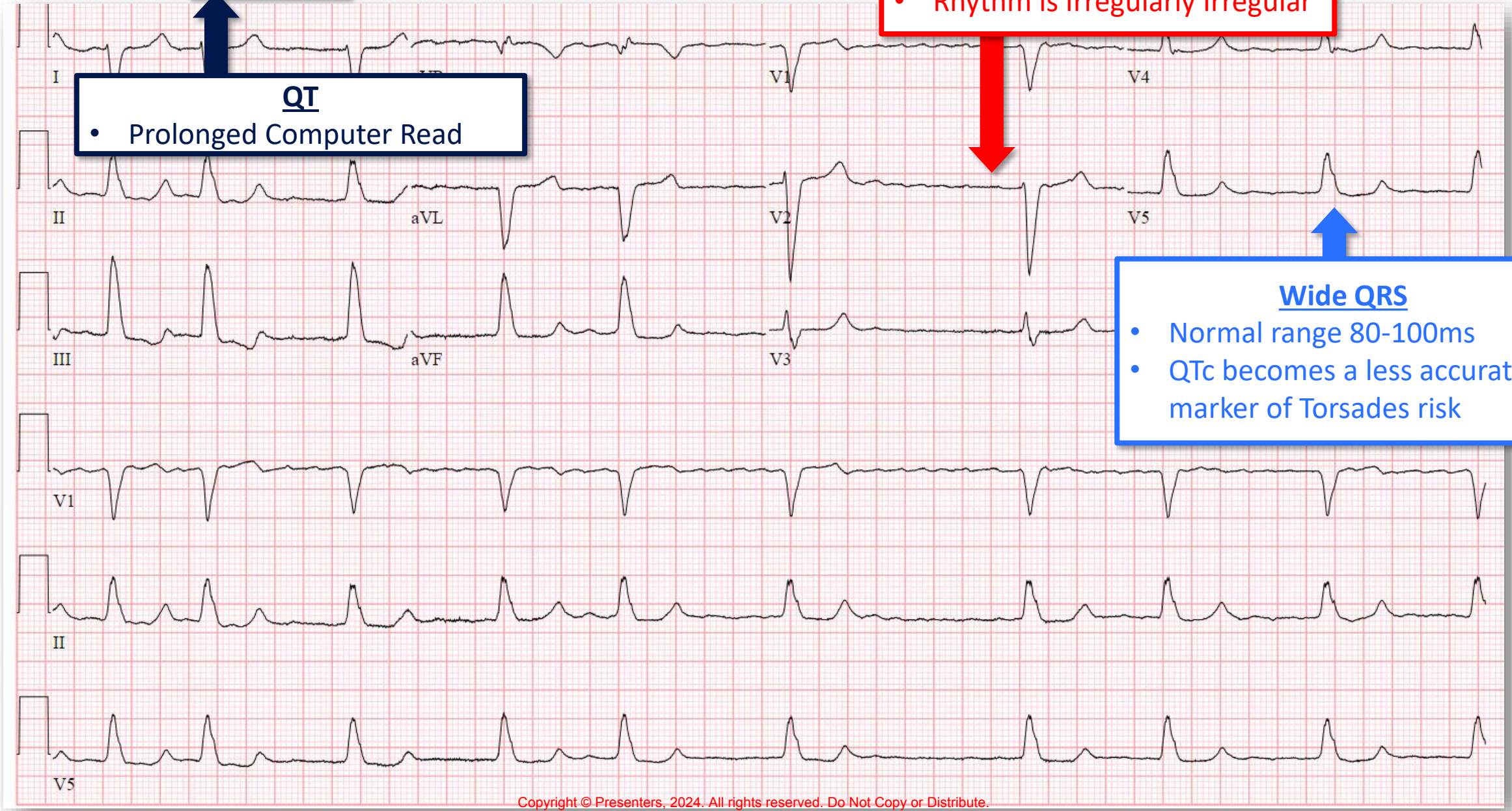






Funk et al, 2021

| | | | |
|---|---|---|---|
| Vent. rate | 57 | BPM | Atrial fibrillation with slow ventricular response |
| PR interval | * | ms | Right axis deviation |
| QRS duration | 144 | ms | Intraventricular conduction defect |
| QT/QTc | 520/506 | ms | Abnormal ECG |




**Atrial Fibrillation**

- Absence of p-waves
- Rhythm is Irregularly Irregular

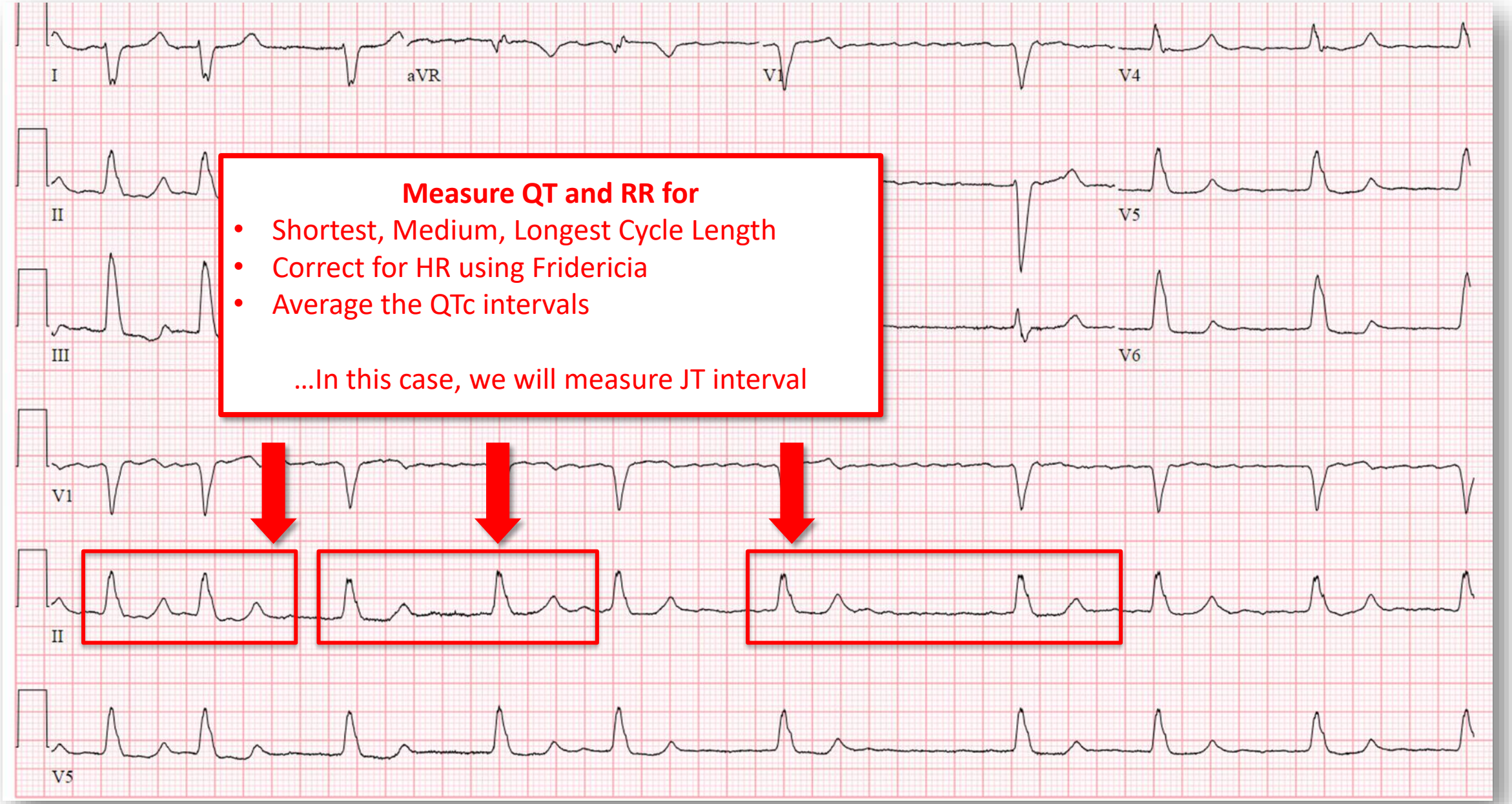
**QT**

- Prolonged Computer Read

**Wide QRS**

- Normal range 80-100ms
- QTc becomes a less accurate marker of Torsades risk

# QTC IN ATRIAL FIBRILLATION




**Measure QT and RR for**

- Shortest, Medium, Longest Cycle Length
- Correct for HR using Fridericia
- Average the QTc intervals

…In this case, we will measure JT interval

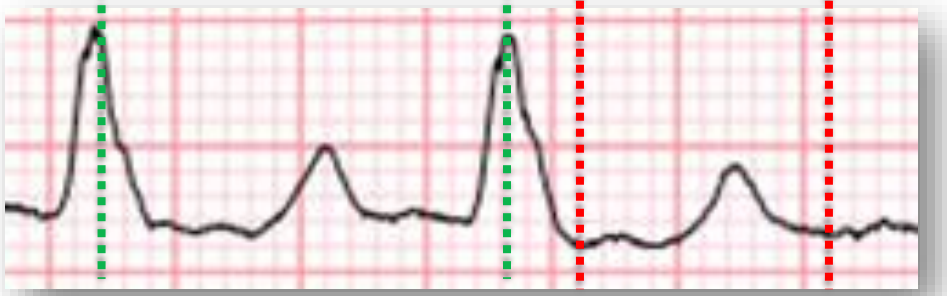
# QTC IN ATRIAL FIBRILLATION

$$\frac{(JTc_1 + JTc_2 + JTc_3)}{3} = JTc_{mean}$$

$$\frac{(464 + 373 + 296)}{3} = 378ms$$

JT= 400ms

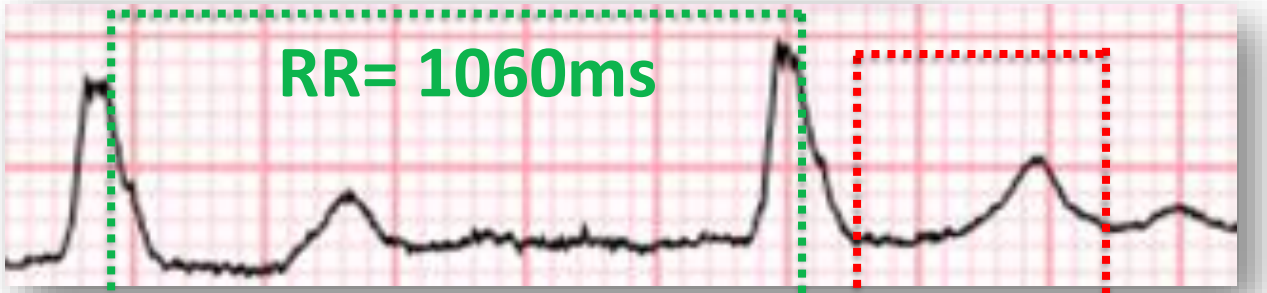
RR= 640ms



$JTc_1$ (Frid)= 464ms

JT= 380ms

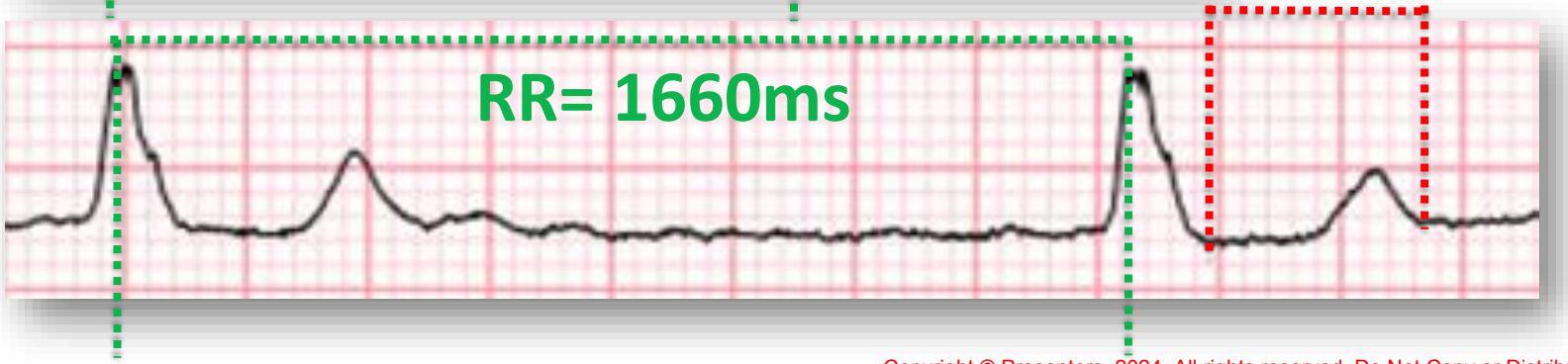
RR= 1060ms



$JTc_2$ (Frid)= 373ms

JT= 350ms

RR= 1660ms



$JTc_3$ (Frid)= 296ms

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- right bundle branch block
- obesity
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She has suffered from terrible depression since the death of her sister by suicide 9 months ago. + low mood, anhedonia, passive thoughts of death, amotivation, hopelessness, & extreme guilt. Feels paralyzed by worry, can't tolerate being around people. Has daily panic attacks.

Two of her 8 other siblings also ended their lives by suicide. She has had a trials of mirtazapine (oversedation, no mood improvement), and bupropion (worsened her anxiety).

She has never had a trial of an SSRI. **Her JTc is 378ms (upper limit of normal in women = 372ms).**

## Will you prescribe an SSRI?

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# RISK STRATIFICATION & MITIGATION

# TYPES OF RISK MITIGATION

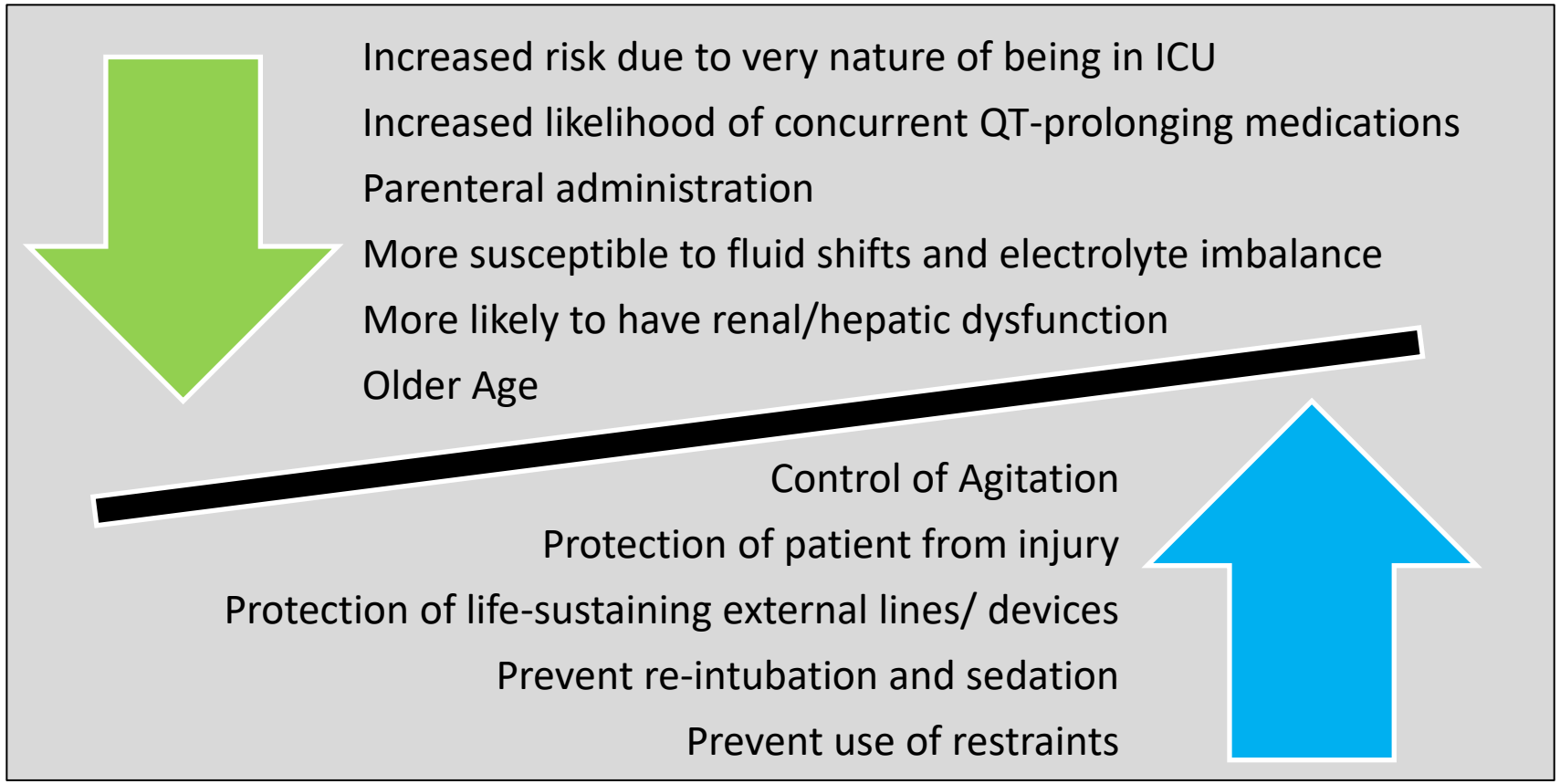
- Comfort measuring QTc and knowing when to adjust your approach (e.g. wide QRS from pacing or BBB)
- How and when to monitor
- Choice of medication
- Involve the other experts
- Interventions for high-risk situations

# RISK:BENEFIT ANALYSIS

## To Prescribe or Not to Prescribe?

# RISK STRATIFICATION & MITIGATION

## Risk-Benefit Analysis: ICU



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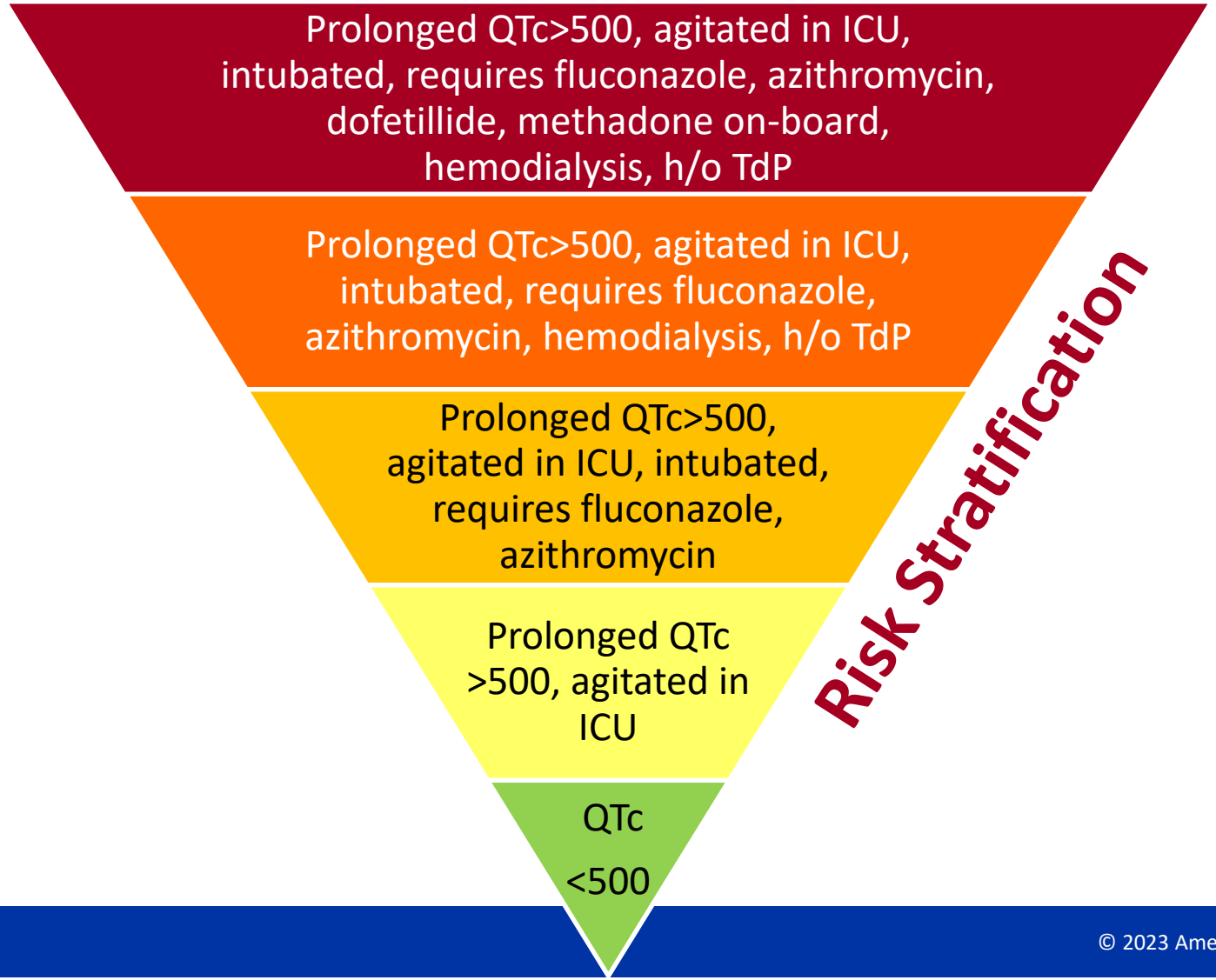
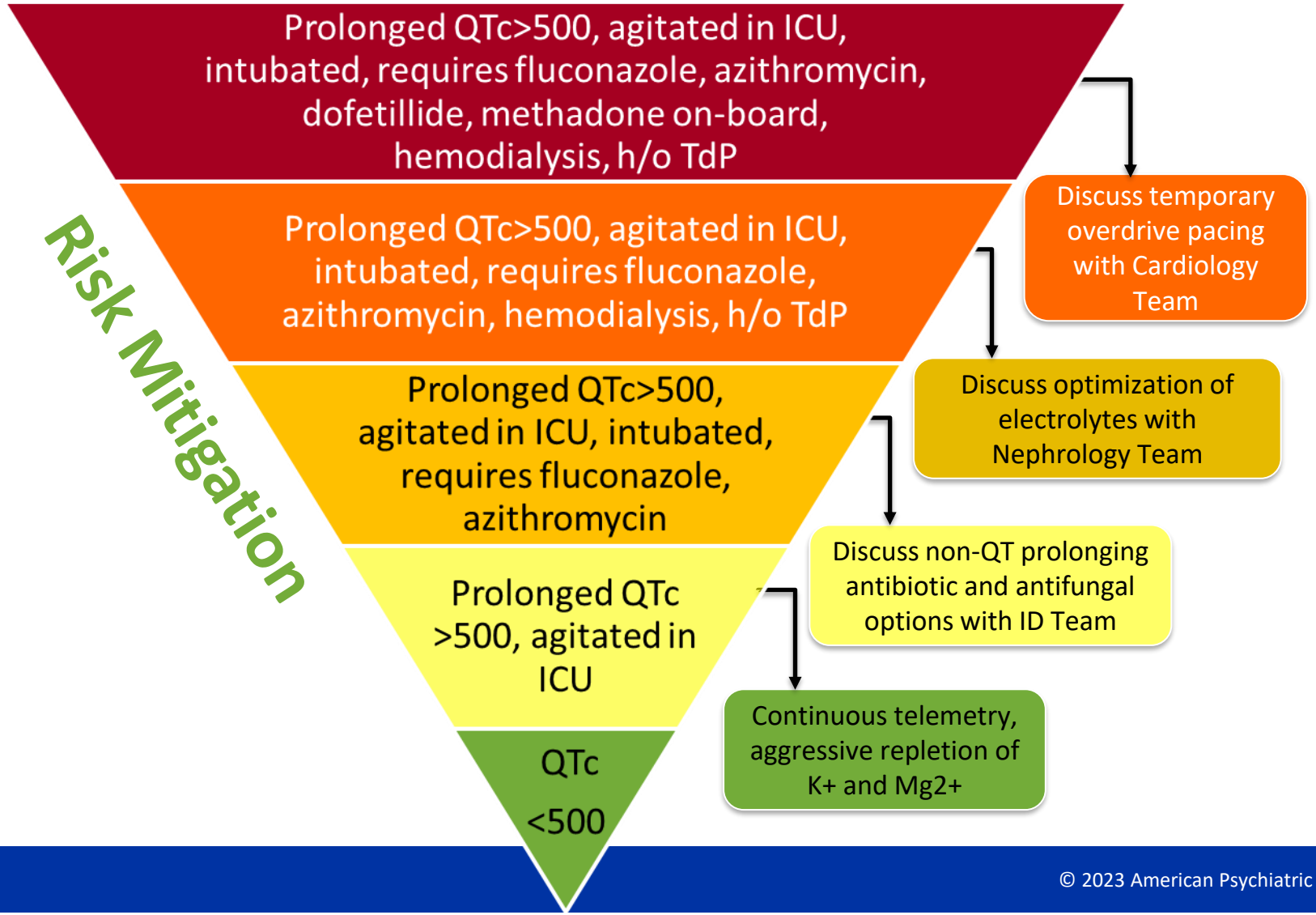


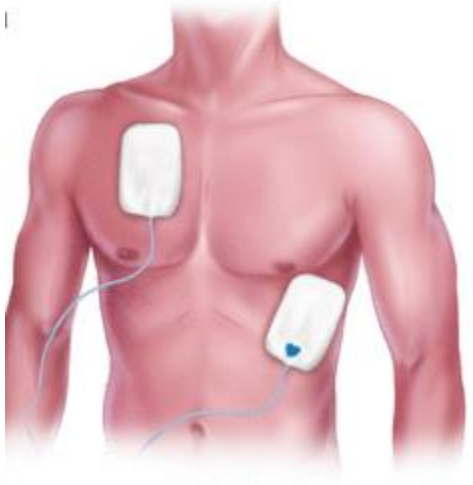
# RISK STRATIFICATION & MITIGATION



# HIGH-RISK MITIGATION STRATEGIES

## Cardiac Overdrive Pacing

- In high-risk cases with severe bradycardia
- Overdrive pacing > 70 bpm can mitigate risk of early-after-depolarizations that can lead to a reentrant rhythm
- All cardiac implanted electronic devices (e.g. pacemakers, ICDs) have capability for overdrive pacing
- Pacing thresholds usually set to HR 40-50 to preserve battery-life and ventricular strain, HOWEVER pacing rates can be increased in high-risk patients
- Alternatively may consider temporary transvenous pacing or “chemical” overdrive pacing with isoproterenol (less common)









Pinski et al., 2002 Lankipalli et al., 2005

# HIGH-RISK MITIGATION STRATEGIES:

## Hemodialysis

- Sudden cardiac death (SCD) is leading cause of death in hemodialysis
- QTc prolongation very common in hemodialysis patients
- Contradicting studies regarding impact of dialysate electrolyte concentrations and serum-to-dialysate gradient measures on QTc
- Goal K+ in HD patients is 5.1
- **Work closely with nephrology in high-risk patients on HD**





Kim et al., 2019, Predictors of Arrhythmic and Cardiovascular Risk in ESRD, BMC Nephrology

# TAKE-HOME POINTS

- Do your own QT measurement and HR correction
- “Bazett is Bad” (all other HR correction formulae are fine)
- Correct the QT for a wide QRS – JTc is easy to do!
- 500ms is not an absolute QTc cut-off
- Must consider risk of Torsades vs. benefits of medication in context of patient goals

# QUESTIONS?

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