Torsades or Not to Torsades?
Do You Know the QT on the QT Interval?
Class Code 143A

Presented By:
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Director The Center of Excellence in Education
Director of HERO
What is This?
What About This One?
And Finally This One!
The Big Three

- Polymorphic ventricular tachycardia (PVT) is a form of ventricular tachycardia in which there are multiple ventricular foci with the resultant QRS complexes varying in amplitude, axis and duration. The commonest cause of PVT is myocardial ischemia.

- Torsades de pointes is a specific form of polymorphic ventricular tachycardia occurring in the context of QT prolongation; it has a characteristic morphology in which the QRS complexes “twist” around the isoelectric line.

- Bidirectional VT is another type of polymorphic VT, most commonly associated with digoxin toxicity.
How to Recognize Digoxin Toxicity: Common Symptoms and Signs

Common arrhythmias associated with digoxin toxicity

Bradycardia

Paroxysmal atrial tachycardia with block

Bidirectional ventricular tachycardia

Regularization of atrial fibrillation
What is the QT Interval?

- Measure from beginning of the QRS complex to the end of the T wave
- QT interval < 0.50 sec.
QT Interval

- Indirect measure of the time between ventricular repolarization and depolarization.

- Varies with heart rate
  - Lengthens with bradycardia
  - Shortens with tachycardia
Anything that causes the cell to remain positive inside longer than normal delays its repolarization back to the resting state.

This prolongs repolarization and the QT interval

- Drugs that block potassium channels: some antiarrhythmics or antidepressants
- Genetic abnormalities of the potassium channel
- Genetic abnormalities of the sodium channel (think Brugada Syndrome)
And More....

- Class 1A antiarrhythmics
- Most class III antiarrhythmics
- Tricyclic antidepressants
- Some antibiotics: erythromycin, clindamycin, Bactrim
- Liquid protein diets
- Hypomagnesemia, hypocalcemia, hypokalemia
- Mitral valve prolapse
A prolonged QT reflects prolonged myocyte repolarization due to ion channel malfunction.

This prolonged repolarization period also gives rise to early after-depolarizations (EADs).

EADs may manifest on the ECG as tall U waves; if these reach threshold amplitude they may manifest as premature ventricular contractions (PVCs).

TdP is initiated when a PVC occurs during the preceding T wave, known as ‘R on T’ phenomenon.

The onset of TdP is preceded by a sequence of short-long-short R-R intervals, so called “pause dependent” TdP, with longer pauses associated with faster runs of TdP.
Why We Worry About Prolonged Repolarization

- Patient can develop early after depolarizations
  - Unequal repolarization is a set up for reentrant arrhythmias
  - Both acquired and congenital Torsades de Pointes are thought to be due to EADs
About the QT Interval

- QT interval is heart rate dependent
  - Shortens at fast heart rates (short R-R interval)
  - Lengthens at slow heart rates (long R-R interval)

- Measurement must be corrected for heart rate
  - Bazett formula often used for correction

\[
QT_c = \frac{QT}{\sqrt{R-R}}
\]

All measurements in seconds
Measuring the QT

**Measured QT**

\[ \text{QTc} = \frac{\text{QT}}{\sqrt{R-R}} \]

Measurements in seconds

**HR: 70**

\[ 0.84 \text{ sec} \sqrt{0.9165} \]

\[ \frac{0.43}{0.9165} = 0.469 \]

**HR: 36**

\[ 1.52 \text{ sec} \sqrt{1.232} \]

\[ \frac{0.80}{1.232} = 0.649 \]
Normal QTc Intervals:

- Quick way < .45 in men, < .46 in women
- Or, remember that a QTc of 500 ms (.50 sec) or more is dangerously prolonged.

<table>
<thead>
<tr>
<th></th>
<th>1 - 15 years</th>
<th>Adult Males</th>
<th>Adult Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;440 ms</td>
<td>&lt;430 ms</td>
<td>&lt;450 ms</td>
</tr>
<tr>
<td></td>
<td>&lt;.44 sec</td>
<td>&lt;.43 sec</td>
<td>&lt;.45 sec</td>
</tr>
<tr>
<td>Borderline</td>
<td>440-460 ms</td>
<td>430-450 ms</td>
<td>450-470 ms</td>
</tr>
<tr>
<td></td>
<td>.44-.46 sec</td>
<td>.43-.45 sec</td>
<td>.45-.47 sec</td>
</tr>
<tr>
<td>Prolonged</td>
<td>&gt;460 ms</td>
<td>&gt;450 ms</td>
<td>&gt;470 ms</td>
</tr>
<tr>
<td></td>
<td>&gt;.46 sec</td>
<td>&gt;.45 sec</td>
<td>&gt;.47 sec</td>
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Accuracy Matters: Identifying the End of the T Wave
Skill Building: U Waves: Include or Not?

**Recommendation:**
- If U wave occurs after T wave ends don’t include it
- If U wave interrupts T wave, include it
Pop Quiz!
QRS Width

- QRS represents ventricular depolarization
  - QRS width represents intraventricular conduction time
  - A wide QRS will increase the QT interval but does not mean that repolarization time is prolonged

This QRS is .16 sec wide.
The measured QT = .51 sec. The QTc = .452 sec
Why Worry About Long QT Intervals?

- Long QT Syndrome (LQTS) is a disorder of myocardial repolarization characterized by a prolonged QT interval on the EKG.

- Two major types:
  - Acquired
  - Congenital

- Patients with either type are at risk for developing Torsades de pointes.
### Types of LQTS

<table>
<thead>
<tr>
<th>Acquired</th>
<th>Congenital</th>
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</thead>
<tbody>
<tr>
<td>¤ Drugs (most drugs that cause LQTS block K+ channels)</td>
<td>¤ Hereditary</td>
</tr>
<tr>
<td>¤ Electrolyte imbalances (hypokalemia, hypomagnesemia)</td>
<td>¤ Due to mutations of genes that control ion channels on cardiac cell membrane: K+, Na+</td>
</tr>
<tr>
<td>¤ Anorexia</td>
<td></td>
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<tr>
<td>¤ Bradycardia</td>
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Features of LQTS

<table>
<thead>
<tr>
<th>Acquired</th>
<th>Congenital</th>
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</thead>
<tbody>
<tr>
<td>Pause-dependent or bradycardia dependent</td>
<td>R on T wave without preceding change in RR intervals</td>
</tr>
<tr>
<td>Initiated by short-long R-R interval</td>
<td>Often follow sudden adrenergic surge (exercise, loud noise)</td>
</tr>
<tr>
<td>Short bursts or can degenerated into VF</td>
<td>Short bursts or can degenerate into VF</td>
</tr>
</tbody>
</table>
Why is This Torsades de Pointes?
Something to Think About!

“All Torsades is polymorphic VT but not all polymorphic VT is Torsades!”

- **Torsades vs Polymorphic VT**
- QT interval
  - Normal (PVT) versus prolonged (TdP)
- Onset
  - Following a pause versus “R on T” without a change in preceding cycle length (TdP)
Distinguishing TdP from PVT or VF

QT = .30
QTc = .394

Not Torsades!
Torsades or Not?

QT = 800 ms

Not Torsades!

QT = .36
QTc = .46

Torsades!
Signs of Impending TdP

PVC’s & couplets

QTc = 730 ms

T Wave Alternans
Same patient one hour later...
Nursing Responsibilities

- Monitor QT interval for patients identified at high risk
  - Patients on medications known to prolong QT interval
    - Quinidine, procainaminde, disopyraminde, sotalol, dofetilide, ibutilide
  - Patients who overdose on potentially prodysrhythmic medications
  - New onset bradycardia
  - Severe hypokalemia or hypomagnesemia

AACN Dysrhythmia/ST Monitoring Practice Alert
Treatment

- Emergency:
  - IV magnesium
  - Defibrillation
  - Overdrive pacing

- Long Term:
  - Monitor QT interval
  - DC or monitor drug dose if QT $\geq$ 500 sec
What should you do if TdP becomes sustained?

Defibrillate!
**Adult Tachycardia** (With Pulse)

1. Assess appropriateness for clinical condition. Heart rate typically ≥150/min if tachyarrhythmia.

2. **Identify and treat underlying cause**
   - Maintain patent airway; assist breathing as necessary
   - Oxygen (if hypoxemic)
   - Cardiac monitor to identify rhythm; monitor blood pressure and oximetry

3. **Persistent tachyarrhythmia causing:**
   - Hypotension?
   - Acutely altered mental status?
   - Signs of shock?
   - Ischemic chest discomfort?
   - Acute heart failure?

4. **Synchronized cardioversion**
   - Consider sedation
   - If regular narrow complex, consider adenosine

5. **Wide QRS? ≥0.12 second**
   - Yes: Proceed to step 4
   - No: Proceed to step 6

6. **IV access and 12-lead ECG if available**
   - Consider adenosine only if regular and monomorphic
   - Consider antiarrhythmic infusion
   - Consider expert consultation

7. **IV access and 12-lead ECG if available**
   - Vagal maneuvers
   - Adenosine (if regular)
   - 2:1 atrioventricular block if present

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**Doses/Details**

**Synchronized Cardioversion**
- Initial recommended doses:
  - Narrow regular: 50-100 J
  - Narrow irregular: 120-200 J biphasic or 200 J monophasic
  - Wide regular: 100 J
  - Wide irregular: defibrillation dose (NOT synchronized)

**Adenosine IV Dose:**
- First dose: 6 mg rapid IV push; follow with NS flush.
- Second dose: 12 mg if required.

**Antiarrhythmic Infusions for Stable Wide-QRS Tachycardia**

**Procainamide IV Dose:**
- 20-50 mg/min until arrhythmia suppressed, hypotension ensues, QRS duration increases >50%, or maximum dose 17 mg/kg given.
- Maintenance infusion: 1-4 mg/min.
- Avoid if prolonged QT or CHF.

**Amiodarone IV Dose:**
- First dose: 150 mg over 10 minutes.
- Repeat as needed if VT recurs.
- Follow by maintenance infusion of 1 mg/min for first 6 hours.

**Sotalol IV Dose:**
- 150 mg over 10 minutes, then 2 mg/min IV drip.
AND THE ANSWER IS.....

\[
QTC = \frac{0.32}{0.6324} = QTC \ .506!
\]

Special thanks to Carol Jacobson and David Parish
Thank you for attending!

Class code 143A
12 Lead EKG of a 56-year-old white female with a potassium of 2.4 and a magnesium of 1.6 mg