ECG restitution of the beat-to-beat QT-TQ intervals in humans. Can we begin assess arrhythmia vulnerability?

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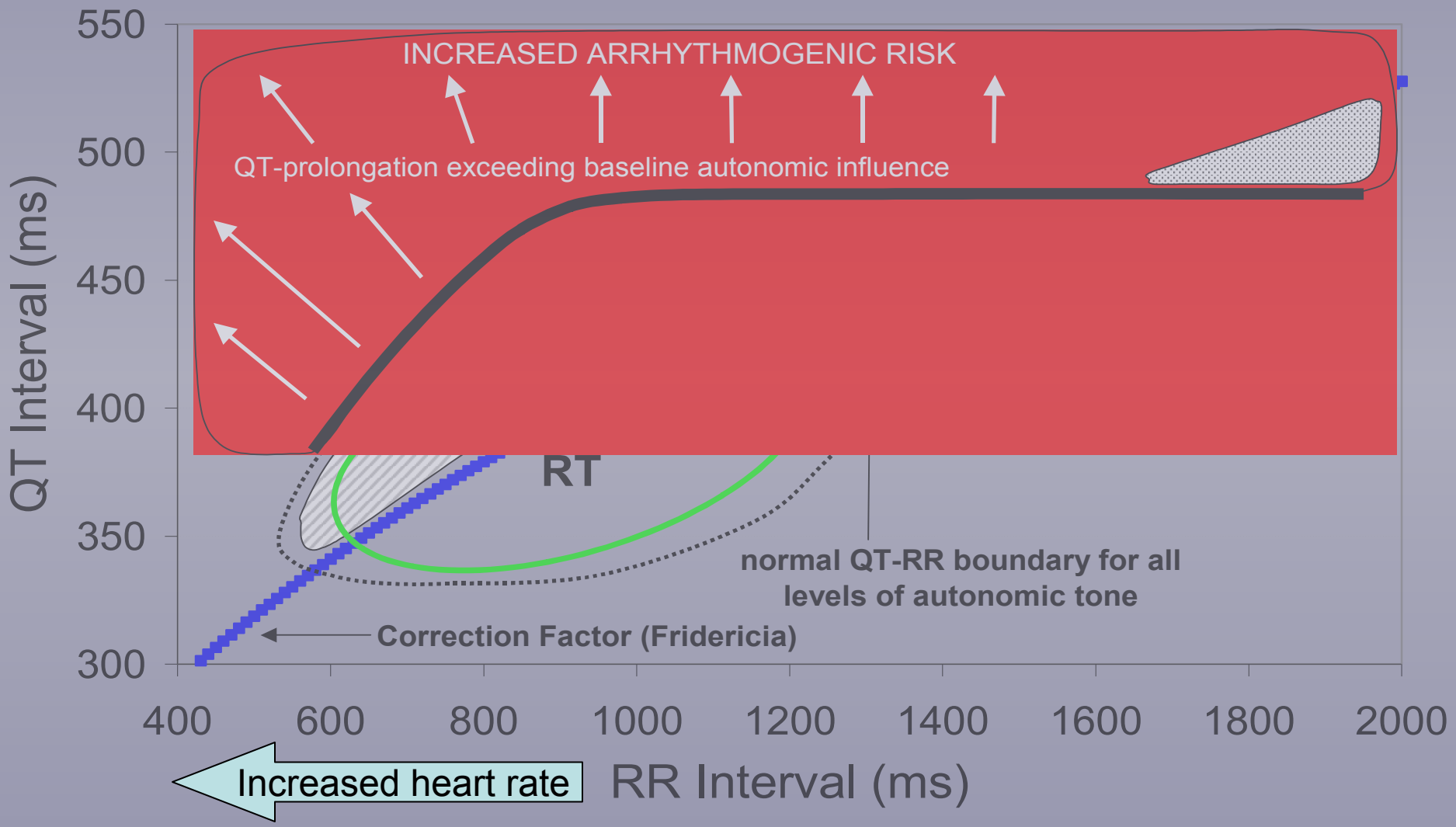
Conceptualized view of QT-RR relationship



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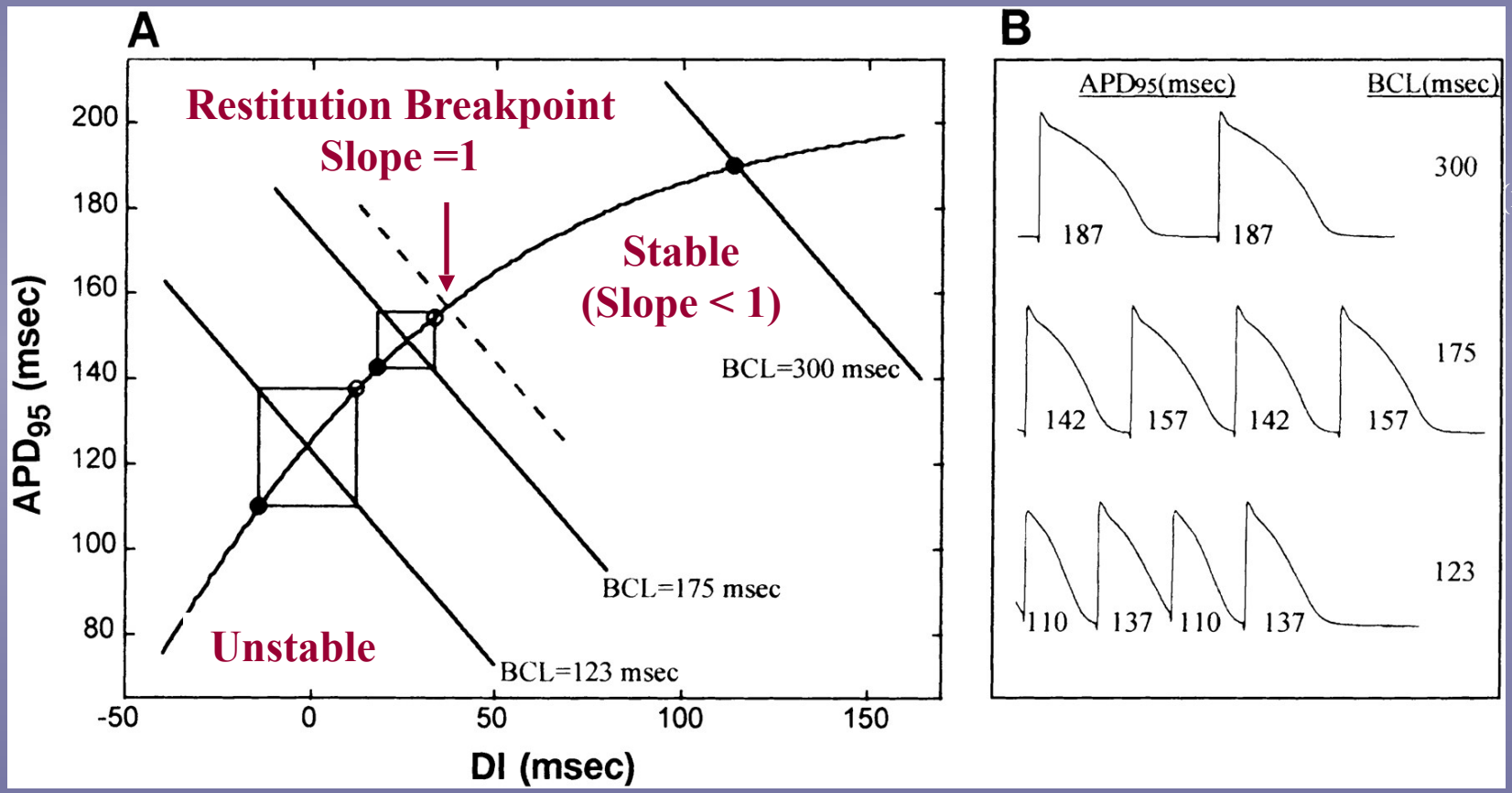
ECG Restitution

- Ability of the heart to recover from one beat to the next.
- Examines the relationship between action potential duration (QT interval) and diastolic interval (TQ interval) through the ECG.
- Replaces the traditional invasive electrophysiology procedure
- As QT/TQ ratio increases between beats this may be associated with increase arrhythmia vulnerability due to re-entry

Effects of heart rate on restitution and alternans



Human HR

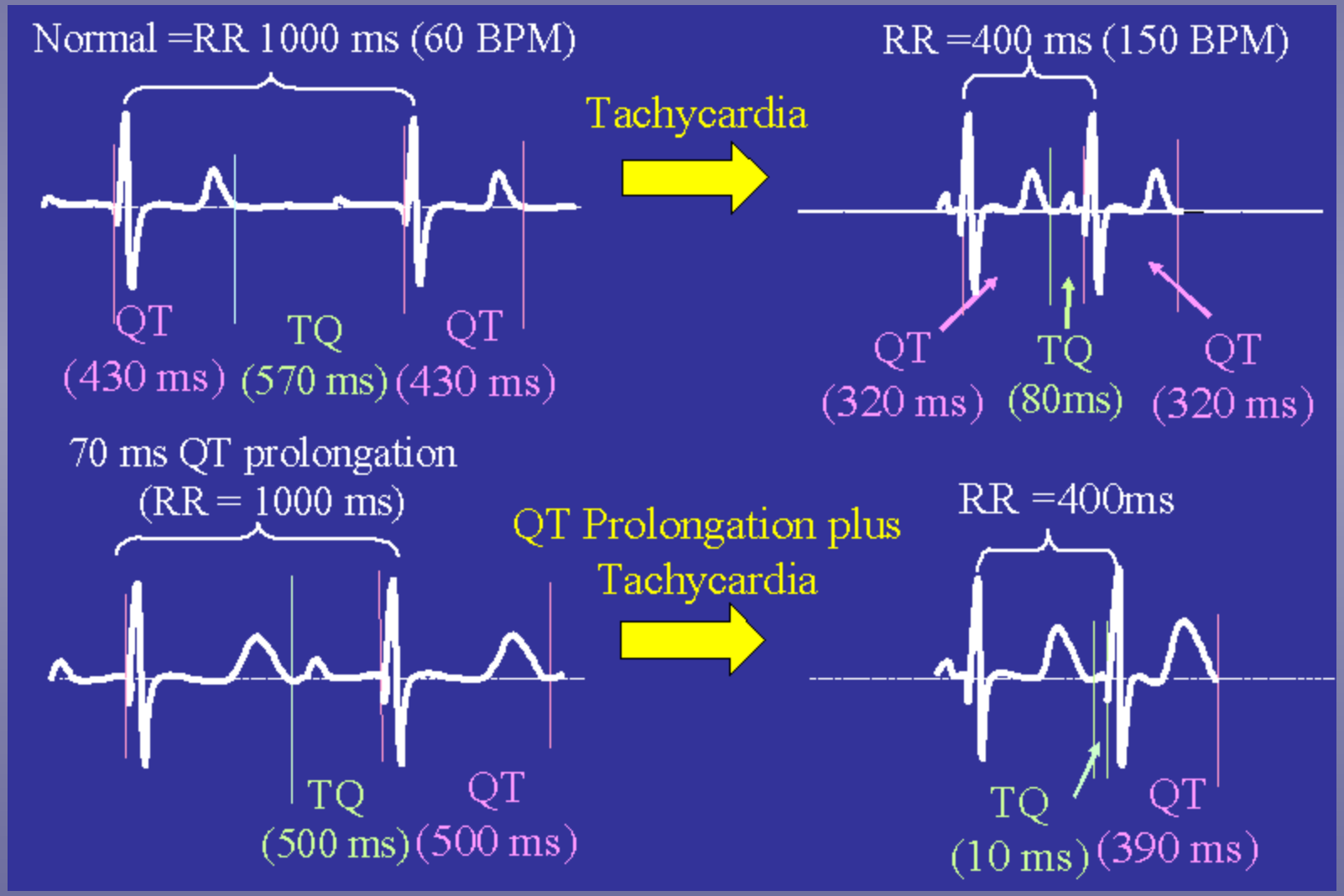
70 BPM (normal resting)

110 BPM

180 BPM

Am J Physiol 275 (Heart Circ Physiol. 44): H1635-1642, 1998

QT prolongation during tachycardia dramatically impairs restitution (increase QT/TQ ratio >1)



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Methods in normals and TdP

- Sequential beat-to-beat analyses of QT, TQ, and RR
- 22.5-hour Holter on 3 successive days
- Baseline, 160 (n= 38) or 320 (n=19) mg oral Sotalol

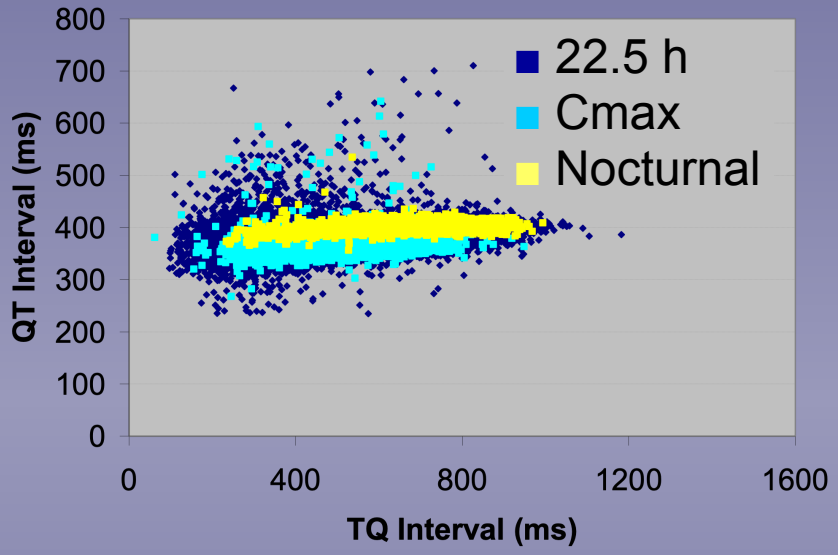
TdP Case Study

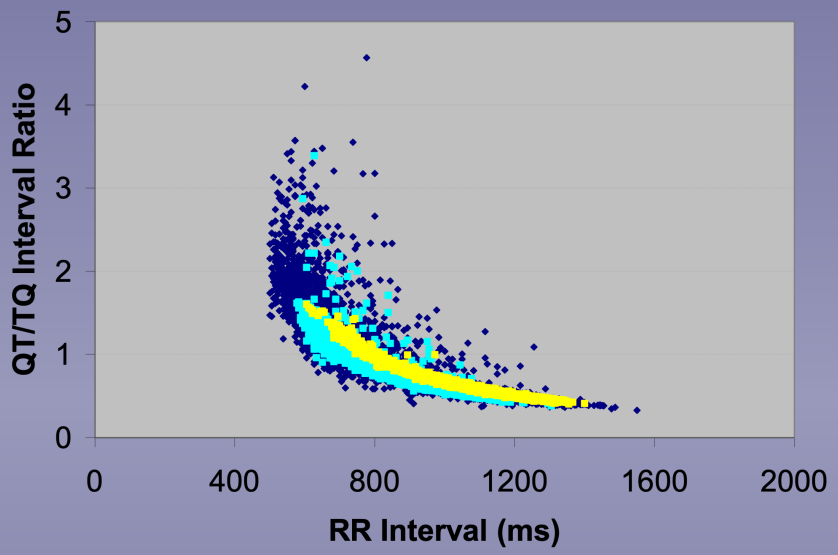
- 66 yo female CAD: Holter after sotalol (2 mg/kg, iv) prior to TdP

Restitution Parameters

- **Lower TQ 5th quantile**: boundary of lower 5% of beats
- **% Beats with QT/TQ > 1:** Reflects relative time spent in on steep portion of restitution relationship
- **Upper 98% quantile of QT/TQ ratio**: reflects degree and magnitude of steepness in restitution relationship for beats that may pose the greatest risk

Baseline in normals volunteers

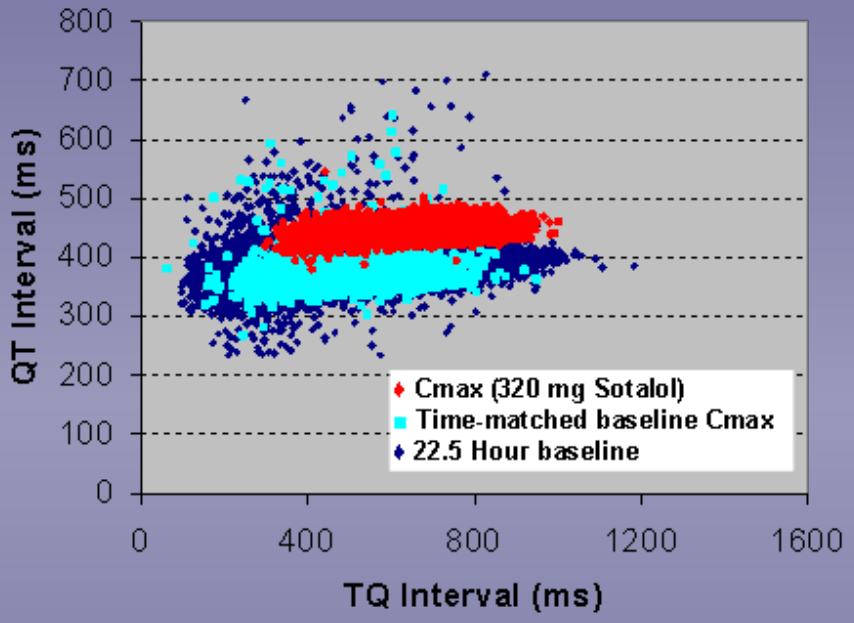


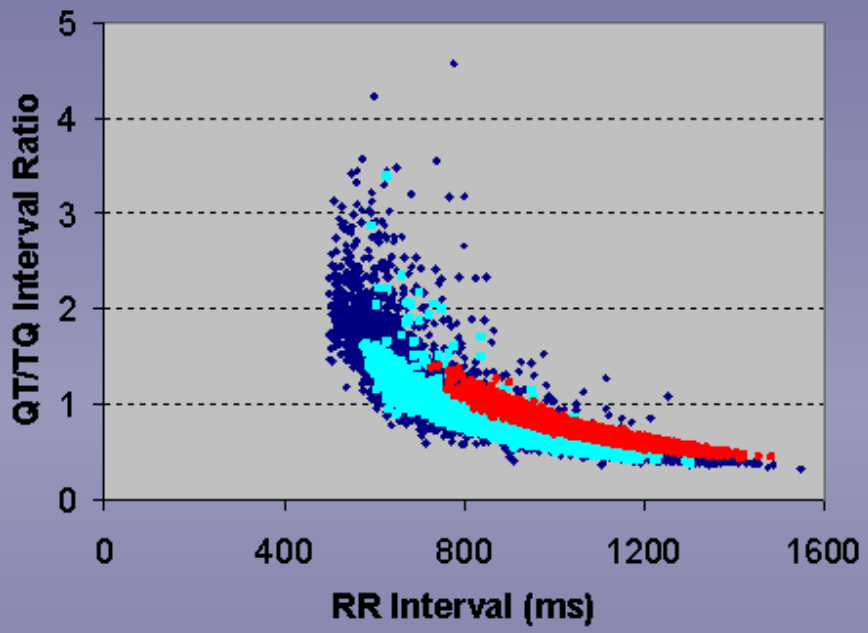


Parameters	Baseline Assessment Periods (98% Confidence Bounds)		
	22.5 Hours	Cmax (Hours 2-4)	Nocturnal (Hours 19-21)
RR interval (ms)	828 (794-858)	827 (794-866)	994 (947-1050)#
QT interval (ms)	375 (366-383)	373 (364-382)	411 (401-420)#
QTc interval (Bazett)	412 (405-420)	409 (401-418)	413 (405-422)
TQ interval (ms)	456 (422-481)	456 (425-488)	586 (538-629)#
$TQmin_{5th\ quantile}$ (ms)	270 (252-287)	298 (279-321)	404 (369-442)#
%(QT/TQ ratio) > 1	25 (18-34)	20 (13-32)	6 (4-9)#
$(QT/TQ\ ratio)_{max\ 98\%\ quantile}$	1.52 (1.43-1.62)	1.41 (1.31-1.50)	1.23 (1.13-1.34)#

Annals of Noninvasive Electrocardiology 12(4): 1-11 (2007)

Sotalol improves restitution despite QT prolongation



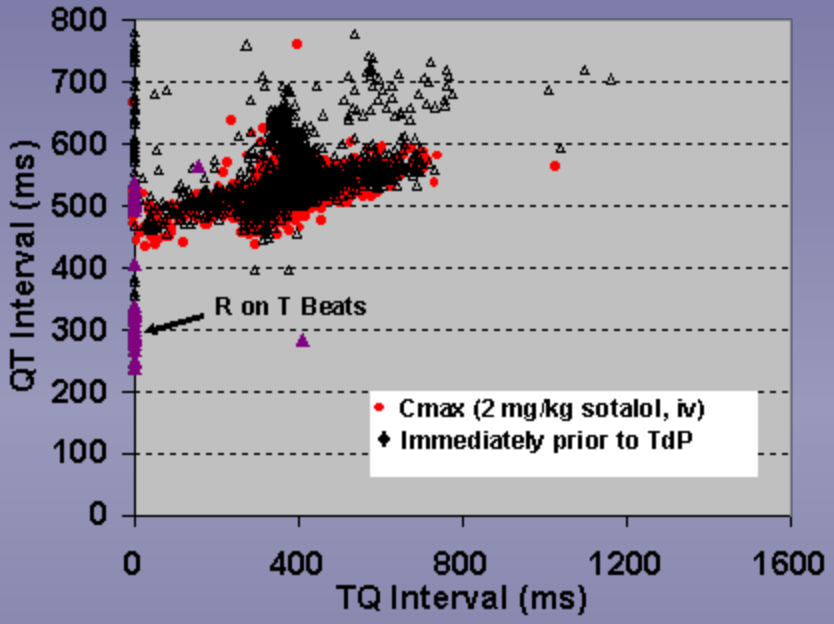


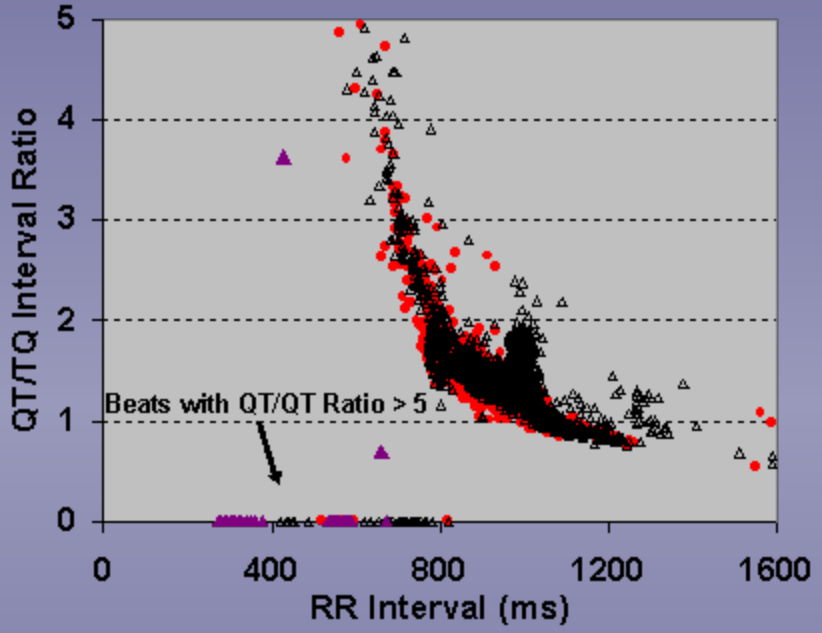
Comparison of Cmax period to time-matched baseline

RR: ↑ 235 ms
QT: ↑ 101 ms
TQ: ↑ 134 ms
QTc: ↑ 52 ms

TQ 5th Quantile: ↑ 115 ms
QT/TQ 98th Quant: ↓ 15%
%QT/TQ beats >1: ↓ 30%

Restitution is impaired prior to TdP





Comparison to Cmax period from normals

RR: ↓ 172 ms
QT: ↑ 53 ms
TQ: ↓ 225 ms
QTc: ↑ 95 ms

TQ 5th Quantile: ↓ 126 ms
QT/TQ 98th Quant: ↑ 58%
%QT/TQ beats >1: ↑ 722%

ECG Restitution Summary

- Can be obtained through digitized Holter recordings
- May be used to assess changes in autonomic state in conjunction with QT prolongation
- If boundaries can be defined, could delineate normal from abnormal repolarization status.

Other Contributors

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