Deep Learning for Automated QTc Measurement

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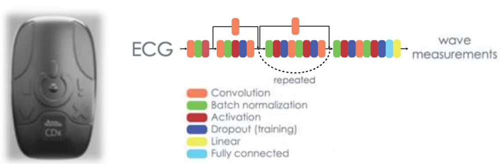
BACKGROUND

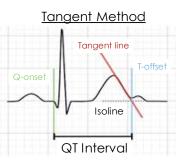
- Prolonged QT is an important ECG finding and can be related to increased risk of dangerous arrhythmias.
- Manual measurement of QT intervals is time-consuming, often relying on a small subsample of beats to represent the QT interval measurement.
- The **BeatLogic™ deep learning algorithm from Boston Scientific Cardiac Diagnostics** performs detailed analysis of every individual beat in a study, including measurement of the QT interval.
- The goal of the current analysis was to validate and **demonstrate the performance of the QT segmentation algorithm on a public database.**

METHODS

- A **deep neural network** (pre-activation residual network, 25 1D convolutional layers) was trained to identify wave onsets and offsets within individual heartbeats including the QRS onset and T offset locations used for the QT-interval.



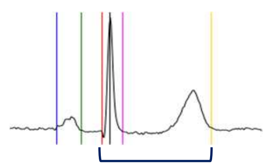
- The Framingham correction formula was used for QTc.
  QTc = QT + 0.154 * (1 – RR) - IVCD_Correction
- **Training data:** 20,080 ECG records (1-6 minutes) recorded from Boston Scientific Cardiac Diagnostics **BodyGuardian™** Heart and MINI devices were annotated and adjudicated by at least 3 certified ECG technicians. **Tangent method** was used for annotating T-wave offsets.



- The publicly available **Physionet QT database** was used to assess performance (105 files).
- **Beat-to-beat QTc error** between truth and algorithm measurements was assessed. Sensitivity (Se), Specificity (Sp), Positive Predictive Value (PPV), and Negative Predictive Value (NPV) were calculated when identifying possible **Long-QTc** (QTc > 480 msec).

RESULTS

Algorithm outputs wave measurements for each beat



QTc Error Algorithm vs Physionet Annotation	
Mean	8.0 ms
SD	38.1 ms

Identifying Long-QTc			
Se	98.8%	PPV	94.0%
Sp	75.0%	NPV	93.8%

BeatLogic™ provides accurate measurement of QT intervals over a patient's entire ECG study.

Possible Long-QT cases are identified with excellent sensitivity.

BeatLogic™ overcomes challenges of manual QT measurements on real-world ambulatory ECG data.

Learn more about BeatLogic™:

Contact the presenter: jordan.craig@cdxbsci.com

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DISCUSSION

- The **BeatLogic™** algorithm accurately measures QT intervals on every beat in a study, reporting this metric in addition to wide variety of clinically relevant beat and rhythm analyses.
- The mean error of 8.0 ms versus the Physionet QT database demonstrates **excellent performance by the algorithm**; comparable to or better than manual measurements.
- A notable amount of algorithm vs reference error in the current study may be attributed to **limitations of using the Physionet QT database** including differing approaches used for multi-channel data and apparent conflicts in QT measurement methodologies (Fig 2).

FIGURE 1

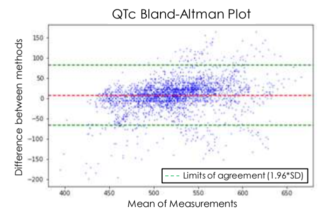


FIGURE 2

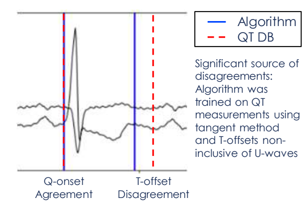
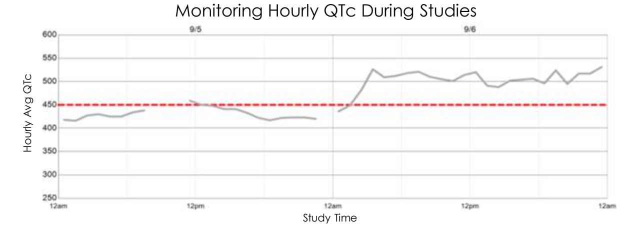


FIGURE 3



Measuring the waveforms of each beat allows for monitoring changes longitudinally, providing better context for decisions.

CONCLUSION

The BeatLogic™ algorithm enables thorough and accurate QTc measurement, providing strong performance in identifying possible Long-QTc, and overcoming limitations of small samples typically relied on during manual QT measurement.

DISCLOSURE INFORMATION

J. Craig, D. Engebretsen, M. McRoberts, & T. McClanahan are employees of Boston Scientific Corporation