Robust Detection of Wide Complex Tachyarrhythmias using Mobile Cardiac Telemetry Monitors

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OBJECTIVES

- Wide Complex Tachyarrhythmia (WCT) is a commonly observed arrhythmia in patients with heart failure.
- Automatic identification of WCT using mobile cardiac telemetry (MCT) monitors is critical for high-quality patient care due to its potentially lethal nature.
- There is very limited literature on validating an algorithm's ability to detect WCTs in near real-time in the outpatient setting.
- This study demonstrates the efficacy of the ZywieAI® algorithm in detecting episodes of sustained and/or non-sustained WCTs like ventricular tachycardia, ventricular flutter, and ventricular fibrillation.

DATASET

The ZywieAI® algorithm was evaluated by analyzing 299 WCT episodes in three public PhysioNet databases:

- MIT-BIH Arrhythmia (MITBA),
- MIT-BIH Malignant Ventricular Arrhythmia (MITMVA),
- CU Ventricular Tachyarrhythmia (CUVT).

These databases contain ECG recordings with a wide variety of PQRST morphologies and arrhythmias contaminated with noise, which make the WCT detection a challenging problem.

METHODS

- In this study, we identify an episode as WCT if the heart rate is ≥100 bpm for ≥3 consecutive beats. The reference onset-offset annotations in the databases were used to locate the WCT episodes in the recordings.
- In the ZywieAI® algorithm, we use signal processing techniques to remove artifacts in the ECG recordings and deduce fiducial points in the signal. The algorithm also identifies the ectopic beats in the recordings.
- Novel discrete features are computed from the fiducial points and ectopic beats to get a beat-level assessment in the recording. An AI-based decision classifier interprets these input features to identify a true WCT episode.
- We evaluated the performance of the algorithm both at the episode-level by analyzing how many n-beats WCT episodes are identified in each recording (where n ≥ 3) and at the recording-level.

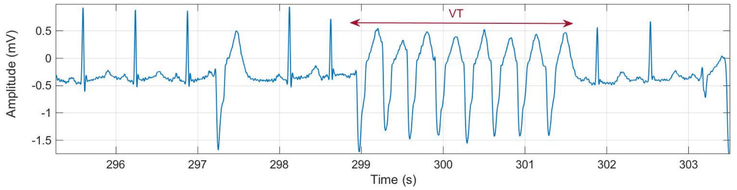

Fig. 1 An example of 8-beats VT episode in the MITBA database (recording number 205), identified by the ZywieAI® algorithm.

RESULTS

- At the recording-level, the proposed algorithm identified patients who experienced at least one episode of WCT with 100% accuracy in all three databases.
- At the individual episode-level, the algorithm had an average gross sensitivity and specificity of 94.8% and 97.6% for MITBA and 94.1% and 89.1% for MITMVA databases, respectively.
- The sensitivity of the algorithm in identifying any WCT episode with ≥10 beats was 100%, 99.8%, and 100% for MITBA, MITMVA, and CUVT databases, respectively .

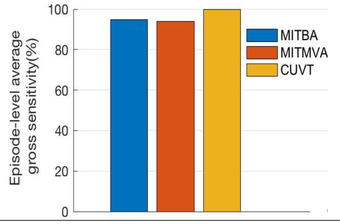

Fig. 2 Performance analysis at the episode-level. A WCT episode consists of n number of beats, where n ≥ 3.

CONCLUSIONS

- The results suggest that the ZywieAI® algorithm can robustly identify WCT episodes as short as 0.46 seconds.
- The proposed algorithm can be used to evaluate real-time ECG signals in remote cardiac monitoring studies, assisting clinicians in the timely diagnosis of patients with most lethal wide complex arrhythmias.