

## Early Detection of QT Interval Prolongation from the ECG Database System

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### Abstract and Objective

To prevent unexpected sudden cardiac patient death due to drug-induced Long QT syndrome (LQTS), we seek to build a computerized early detection and warning system of QTc interval increase tendency. We built an ECG database system that holds the digital waveform data and related information of the ECGs performed in out hospital, and developed an experimental detection system of QTc increase tendency. Despite the several problems about the accuracy of detection, we succeeded in extracting a patient who seemed to be drug-induced LQTS. A combination of such a detection system with more accuracy and drug prescription database would contribute to the early detection of drug-induced LQTS.

**Keywords:** long QT syndrome, early detection, ECG database

### Introduction

Long QT syndrome (LQTS) is one of the critical diseases which can increase a risk for sudden cardiac death. Especially drug-induced LQTS should be distinguished because even non-cardiac disease patient can develop it. For the prevention of sudden cardiac patient death due to drug-induced LQTS, it is quite important that the attending physician notices as early as possible that the patient's QTc interval is increasing. Therefore, it might be clinically useful if a computerized early detection and warning of QTc interval prolongation would become possible. The purpose of this study is to find a method to detect an increase tendency of the QTc interval using an ECG database system as early as possible before the QTc interval is prolonged so much that the diagnostic criteria of LQTS is met.

### Methods

The ECG database system used in this study holds the digital waveform data and related information (includes measurement data) of the 12-lead resting ECGs performed at the Tokyo University Hospital between Mar. 13th and Jul. 18th, 2012 (16647 ECGs, 12026 patients). We investigated the diagnostic criteria of LQTS used in clinical settings, the algorithms of QTc prolongation diagnosis used by recent electrocardiographs, and the ICH guidance for clinical evaluation of QT/QTc interval prolongation and proarrhythmic potential for non-antiarrhythmic drugs (the ICH E14 guideline). Based on the findings, we developed a detection system of QTc increase tendency that extracts the patients whose QTc interval increases by more than designated quantity or ratio compared to the first QTc interval. We set the detecting threshold at 60 msec and carried out the extraction.

### Results and Conclusion

Using the detection system, 2,755 patients were found to have ECG examinations more than once, and 57 patients showed the QTc interval increase of over 60 msec compared to their own first QTc interval. However, by inspecting manually the ECG interpretation of electrocardiographs and physician's diagnosis, 95% of the extracted patients proved pseudo-positive. The reasons are as follows : (1) difficulty in precise measurement of QT interval due to the ECG waveform abnormality (15 patients), (2) overcorrection of QT interval on tachycardia due to the Bazett's formula (31 patients), (3) QT interval prolongation by the mechanism other than the abnormal prolongation of ventricular repolarization (8 patients). After the exclusion of these pseudo-positive cases by changing the QT correction formula of the detection system (for the case 2. From Bazett to Framingham) and manually referring to physician's ECG diagnosis (for the case 1 and 3), we investigated the clinical records about the rest 3 patients, and found that all of them were positive cases, one of which seemed to be drug-induced LQTS. The results of our study suggest that the LQTS can be detected at an early stage by automatically extracting the patients whose QTc interval shows increase tendency over time to some extent from the ECG database. The measurement of QT/QTc interval by electrocardiographs has several problems about the accuracy, thereby our system extracts many pseudo-positive cases. Although a part of such cases can be excluded automatically by changing the QT correction formula, many of them needs manual exclusion. To improve our system, we are trying an experimental PC software, which measures all the QT interval of all the beats in all the leads recorded in a MFER-format ECG waveform file. It might enable to estimate automatically the measurement accuracy through the dispersion of the measured values (for the case 1). The exclusion of the case 3 might be performed automatically by using other parameter (i.e. JT interval), or setting the upper limit of the QRS duration. Cooperation of such a detection system and drug prescription database would help a physician notice early the symptoms of critical adverse effect of the medicines which his patient is taking, change the prescription, and prevent the patient's sudden death.

### References

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