Deep Neural Network Trained on Surface ECG Improves Diagnostic Accuracy of Prior Myocardial Infarction Over Q Wave Analysis.

Yildirim O, Baloglu UB, Talo M, Tung JS, Kang G, Tooley J, Alhusseini MI, Baykaner T, Wang PJ, Perez M, Tereshchenko L, Narayan SM, Rogers AJ

[1] Munzur University, Turkey, [2] University of Bristol, United Kingdom, [3] Firat University, Turkey, [4] Stanford University, [5] Oregon Health Science Institute, Portland, OR

Background:

Clinical screening of myocardial infarction (MI) is important for preventative treatment and risk stratification for cardiology practice. Many of these events may be silent (without clinical symptoms) but have the same impact on health. Current detection by ECG Q-wave analysis is quick and inexpensive but has poor accuracy for assessing prior MI.

Objective:

To evaluate the ability of a deep neural network (DNN) trained on the surface ECG to identify patients with clinical history of myocardial infarction.

Methods:

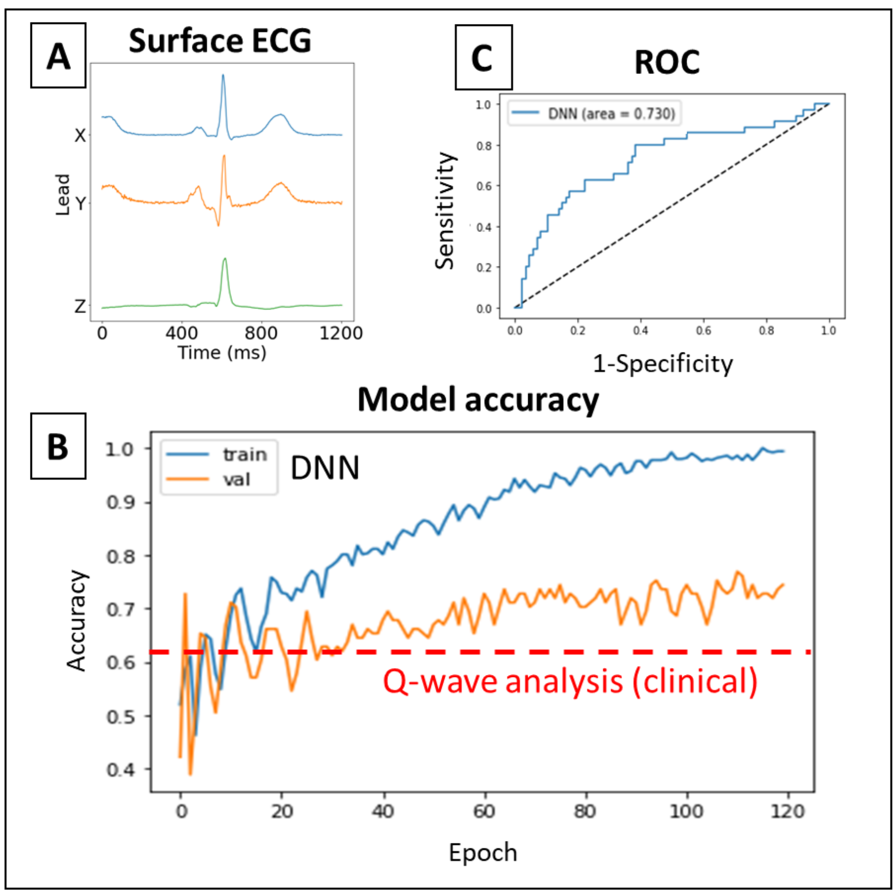
We assessed 608 well-characterized patients (61.4 ± 14.5 years, 31.2% female) at 2 academic centers. From one 12-lead ECG, median beats were calculated in 3 orthogonal planes (X, Y, Z; **[A]**) and used to train a DNN to identify a history of prior myocardial infarction. Accuracy was compared to manual assessment of pathologic Q waves, defined as a deflection > 25% of the subsequent R wave, >40ms in width, and > 0.2mV amplitude in 1 of 3 ECG planes.

Results:

Of 608 patients, 175 had history of MI (28.7%). The DNN outperformed the accuracy of pathologic Q waves. In training, DNN converged to >98% accuracy and in testing, its accuracy was 71 ± 5% **[B]** (k=5-fold cross validation). This outperformed the 62% accuracy of pathologic Q waves in this study (red dotted line, Fig. B). In the validation cohort, DNN provided an area under the receiver operating characteristics curve of 0.730 **[C]**.

Conclusion:

Deep learning of a 12-lead ECG can identify features of prior myocardial injury more accurately than clinical Q-wave analysis. Such a platform could be used for frequent screening of interval MI events. In attempting to improve these results further, studies should explain what inputs weighted DNN decisions, and identify those that reflect abnormalities detectable clinically or on imaging.



[A] shows representative input 3-lead ECG for patient with history of myocardial infarction and Q wave present on the Y axis. A deep neural network was trained on these 3D ECGs over 120 epochs resulting in validation and training accuracy curves (orange, blue). This is shown relative to manual ECG classification accuracy (red dotted) **[B]**. Continuous probabilities predicted by the neural network are used to construct an ROC curve for detecting history of MI **[C]**.