Deep-learning-based artificial intelligence algorithm for detecting anemia using electrocardiogram

K.H. Jeon, J.M. Kwon, K.H. Kim, M.J. Kim, S.H. Lee, S.D. Baek, S.M. Jeung, J.S. Park, R.K. Choi, B.H. Oh

Mediplex Sejong Hospital, Incheon, Korea (Republic of)

Background: Anemia changed the morphology of electrocardiography (ECG), and researchers suggested that mismatching oxygen demand and supply in the myocardium affects the ECG

Purpose: A deep-learning-based algorithm (DLA) that enables non-invasive anemia screening from electrocardiograms (ECGs) may improve the detection of anemia.

Methods: A DLA was developed using 57,435 ECGs from 31,898 patients and was internally validated using 7,369 ECGs from 7,369 patients taken at one hospital. External validation was performed using 4,068 ECGs from 4,068 patients admitted at another hospital. Three types of DLA were developed using 12-lead ECGs to detect hemoglobin levels of 10 mg/dL or less. The DLA was built by a convolutional neural network and used 500-Hz raw ECG, age, and sex as input data.

Results: During internal and external validation, the area under the receiver operating characteristics curve (AUROC) of the DLA using a 12-lead ECG for detecting anemia was 0.941 and 0.904, respectively. Using a 90% sensitivity operating point, the specificity, negative predictive value, and positive predictive value of internal validation were 0.889, 0.998, and 0.151, respectively, and those of external validation were 0.785, 0.994, and 0.166, respectively. The predicted Hgb level based on the DLA was correlated with the actual Hgb level (r=0.891, 95% CI 0.890–0.893, P<0.0001). 57 patients of moderate to severe anemia were treated with appropriated blood transfusion and predicted DLA score of most patients who received transfusion decreased after transfusion according to increase in hemoglobin level.

Conclusion: In this study, using raw ECG data, a DLA accurately detected anemia. The application of artificial intelligence to ECGs may enable screening for anemia.
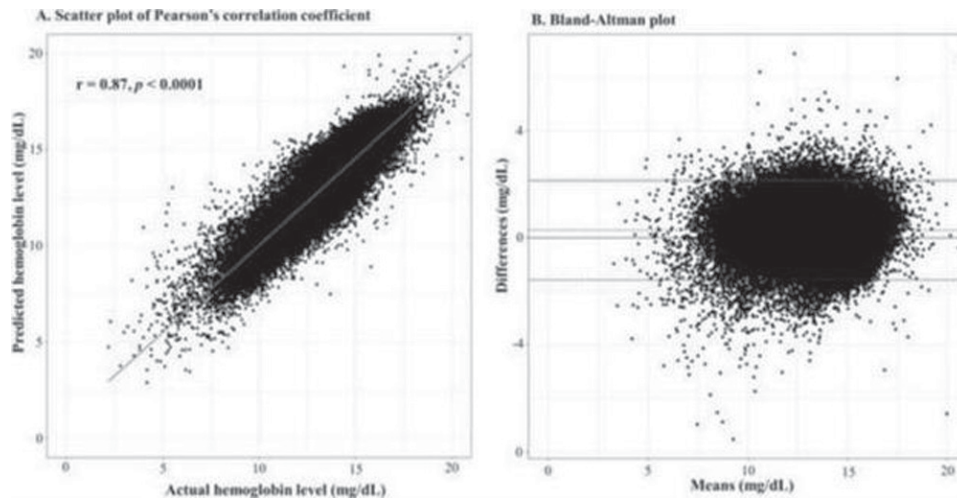
Correlation between DLA and actual Hb