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Machine learning model for predicting sudden cardiac death and heart failure death using 123I-metaiodobenzylguanidine

Authors:
K Nakajima¹, T Nakata², S Matsuo¹, T Doi³, A Jacobson⁴, ¹Kanazawa University Hospital - Kanazawa - Japan, ²Hakodate Goryoukaku Hospital - Hakodate - Japan, ³Teine Keijinkai Hospital - Sapporo - Japan, ⁴Diagram Consulting - Kihei - United States of America,

Topic(s):
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Background: Although I-123 meta-iodobenzylguanidine (MIBG)-based risk model has been proposed for chronic heart failure, no MIBG risk model has been established for separately predicting sudden arrhythmic events (ArE) and heart-failure death (HFD).

Purpose: The aim of this study was to create a new risk model using I-123 MIBG sympathetic imaging by incorporating machine learning (ML), an artificial intelligence (AI) technology, to predict 2-year cardiac events of ArE and HFD.

Methods: A multicenter database of heart failure from 2005 to 2016 (n=529), in which 2-year outcomes were known, was used as the training database of AI. The ArE group consisted of arrhythmic death, sudden cardiac death and appropriate therapy by implantable cardioverter defibrillator. Standardized heart-to-mediastinum ratio (HMR) to medium-medium-energy collimator condition was calculated by a planar anterior scintigram. While ML could use various training methods such as logistic, neural network, etc, the best classifier models for predicting HFD and ArE were selected. The model input was eight variables of age, sex, New York Heart Association (NYHA) functional class, left ventricular ejection fraction, ischemic etiology, HMR, and b-type natriuretic peptide (BNP) (or NT Pro BNP) and estimated glomerular filtration rate. The accuracy of the models was tested with receiver-operating characteristic (ROC) analysis. Model-based simulation of modes of events was also used to characterize the contribution of each variable. In addition to 2-year cardiac mortality risks, probabilities of ArE and HFD were separately estimated using ML-created risk models.

Results: During a two-year follow-up, 141 events (27%) consisting of ArE (n=37, 7%) and HFD (n=104, 20%) were documented. ROC AUC was 0.87 for predicting all events, and 0.91 and 0.74 for HFD and ArE, respectively. Although HFD risk strongly related to HMR positively, a non-linear (bell-shaped) relationship was found between HMR and ArE risk; namely, the most increased probability was observed in the intermediate range of HMR when NYHA class was III-IV. In patients with NYHA class I-II, however, both risks of HFD and ArE inversely related to HMR. Based on the simulated probability using multiple variables, the bell-shaped risk depended on combinations of clinical variables.

Conclusion: ML-based risk model is a new promising approach for separately predicting risks of HFD and ArE together with total risk assessment. Although the reliability of risk model is likely to depend on the size and quality of database, the new insight about the "bell-shaped" risk of fatal arrhythmic events might be obtained and further refined by the AI-based risk estimation.
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