Utilisation of artificial intelligence to predict early readmission to the cardiac intensive care unit in critically ill patients

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Background: The need for cardiac intensive care unit (ICU) beds remains high in order to treat patients with severe cardiovascular diseases. Therefore, safe and timely discharge policies from the cardiac ICU to normal wards are crucial to meet the continuously increasing demand for cardiac ICU beds. ICU readmission after ICU discharge has been shown to increase mortality, hospital length of stay and costs. Artificial intelligence may provide a timely and accurate discharge decision support system for intensivists based on comprehensive, multi-dimensional ICU data.

Purpose: This is the first study to develop and validate a neuronal network, called Feedforward Neural Network (FNN), to safely discharge patients from the cardiac ICU and predict ICU readmission within 72 hours.

Methods: Adult patients who were admitted to the cardiac ICU due to a primary cardio-pulmonary admission diagnosis (such as acute myocardial infarction, cardiogenic shock or cardiac arrest) at a German tertiary care center between 2003 and 2021 were included. The dataset was split into a training and test dataset. The FNN was trained with 127 variables, including patient demographics, co-morbidities, medical diagnoses, disease acuity levels, laboratory values, vital parameters, ICU procedures and administered ICU medications. FNN was compared to the predictability of a classic logistic regression model and the Stability and Workload Index for Transfer (SWIFT) score, which is a clinical score to predict ICU readmission.

Results: 2,498 adult patients in the cardiac ICU met the inclusion criteria, out of which the FNN was trained in 1,998 (80.0%) patients and tested in 500 (20.0%) patients. The FNN had a 97.9% sensitivity, 86.9% specificity, 99.4% precision and 97.4% accuracy. FNN showed a better predictability of early ICU readmission than the logistic regression model and the SWIFT score: areas under the receiver operating characteristic (AUC ROC) curves were 90.78% vs. 71.34% vs. 71.13% (P <0.001) (Figure), respectively.

Conclusions: ICU transfer to the normal ward is considered to be a high-risk event and the vast amount of daily clinical, physiologic, laboratory and monitoring data may overwhelm critical care providers in making well informed decisions on patient discharge readiness. Artificial intelligence might be used as a sensitive, specific and accurate decision support system to help with patient discharge management and reduce ICU readmission rates.
Figure. Receiver operating characteristic (ROC) curves of feedforward neural network (solid line) and logistic regression (dashed line)