Near Perfect Prediction of Mortality 24-Hours in Advance in a Cardiovascular Intensive Care Unit Using Artificial Intelligence

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Abstract

Introduction

Artificial intelligence (AI) may be able to predict mortality in a cardiovascular intensive care unit (CVICU). This study evaluated the prognostic utility of AI using continuous vital sign and laboratory data in a CVICU to predict mortality up to 24 hours before death.

Methods

Continuous physiological data and 393 serial laboratory parameters were collected from patients admitted to a single-center CVICU between January 28, 2021 and November 30, 2023. Primary outcome was CVICU all-cause mortality. A customized neural network was trained to predict mortality from 48 hours of sensor data and 24 hours of laboratory data; data within 15 minutes of death was excluded. Summary statistics were fed into a pre-processing pipeline and the neural network. The model was used to predict if a subject would have mortality at 15-minutes, 6-hours, 12-hours, and 24-hours before death. The models were assessed using area under the receiver operating curve (AUC) on stratified holdout sets across 50 iterations.

Results

A total of 2,845 CVICU patients were identified, 214 mortalities and 2,631 survivors.

The model obtained exceptional performance at each pre-mortality time: AUC 0.974±.017 (15 minutes); 0.961±.018 (6 hour); 0.950±.023 (12 hour); and 0.939±.022 (24 hour). Predictors of mortality included lactate, oxygen saturation, systolic blood pressure, central venous pressure, ventilation rate, mean arterial blood pressure, and arterial blood gas values.

Conclusion

A low parameter neural network can achieve unprecedented AUC for detection of CVICU mortality as early as 24-hours pre-mortality. This is readily deployable and may have important implications in patient care.

Table 1: Top features and associated weights for mortality prediction

Feature	**Classification Weight**
Lactate (increasing)	0.241
Oxygen saturation (5^{th} quantile) (decreasing)	0.232
Systolic Blood Pressure (5^{th} quantile) (decreasing)	0.188
Central Venous Pressure (increasing)	0.185

Ventilation Rate (increasing)	0.183
Mean Arterial Pressure (5th quantile) (decreasing)	0.176
Bicarbonate (decrerasing)	0.173
Mean arterial pressure (25th quantile) (decreasing)	0.164
Systolic blood pressure (25th quantile) (decreasing)	0.162

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