Trauma Index of Mortality: A Real-time Predictive Model for Polytrauma Patients

Adam Jennings Starr, MD; *Manjula Julka, MBA; Arun Nethi, MD; Ryan W. Fairchild, MD; Dustin B. Rinehart, MD; Hayden N. Box, MD; Caroline Park, MD; Ryan Peter Dumas, MD; Michael Cripps, MD*
Parkland Hospital, Dallas, TX, United States

Purpose: Vital signs and laboratory values are routinely used to guide clinical decision-making for polytrauma patients. These objective measures guide decisions to use damage control techniques in lieu of early definitive fracture fixation. We previously reported development of a dynamic model that captures evolving physiologic changes during a trauma patient's hospital course. We now report the results of use of the model for 1 year.

Methods: The Trauma Index of Mortality (TIM) is a machine-learning algorithm that uses electronic medical record (EMR) data to predict mortality within subsequent 48 hours of scoring during the first 3 days of hospitalization. The model updates every hour, recalculating as the patient's physiology dynamically changes in response to trauma and resuscitation. The model's development was reported previously. The algorithm was introduced into the clinical setting at our center starting August 5, 2019, and data were collected through August 4, 2020. Area under the receiver operating characteristic (ROC) curve (AUC), sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), and positive and negative likelihood ratios (LRs) were used to evaluate model performance.

Results: During the first year of clinical application, from August 5, 2019 through August 4, 2020, the model was used for 776 trauma patients who arrived at our center as Level I or II trauma activations. The last TIM score accurately predicted mortality within subsequent 48 hours of scoring in 20 of the 23 12-hour time intervals for a sensitivity of 86.9% (95% confidence interval [CI] 73%-100%). The specificity was 94.7% (95% CI 93%-96%), and the PPV was 33.3% (95% CI 21.4%-45%). The model predicted survival for 716 time intervals and was incorrect 3 times, yielding an NPV of 99.6% (95% CI 99.1%-100%). The positive LR was 16.3 (95% CI 11.6 - 23.01) and the negative LR was 0.14 (95% CI 0.07-0.21). The AUC was 0.97.

Conclusion: The primary strength of our model is its discriminative ability. It can group patients into low-risk and high-risk groups. Based on the NPV of our model, if our model predicts survival, then the risk of mortality over the subsequent 48 hours is 0.7%. However, if the model predicts mortality, then the risk mortality within the subsequent 48 hours is over 30%. By continuously adapting with the patient's physiologic response to trauma and relying on EMR data alone, the TIM overcomes many of the limitations of prior mortality risk models. It may be a useful tool to inform clinical decision-making for polytrauma patients early in their hospitalization.