Predicting Mortality After Trauma Using Electronic Medical Record Data: A Retrospective Analysis at a Level-I Trauma Center

Ryan W. Fairchild, MD*; Hayden N. Box, MD; John David Watkins, MS; Arun Nethi; Dustin B. Rinehart, MD; Michael Cripps, MD; Manjula Julka, MBA, MD; Adam Jennings Starr, MD*
UT Southwestern Medical Center/Parkland Hospital, 75235, TX, United States

Purpose: The timing of fracture fixation in polytraumatized patients has been an evolving concept. Conventional methods to determine patient stability and resuscitation status rely on a subjective interpretation of vital signs and laboratory values, with the intent of guiding clinical decision-making and the decision to use damage control versus early definitive fixation principles. Prior multivariate models have tried to use this physiologic data to predict mortality risk and therefore guide treatment, but due to a number of limitations, they have not proven clinically useful. The purpose of our study was to use electronic medical record (EMR) data and machine learning techniques to develop an automated algorithm that predicts 48-hour mortality in polytraumatized patients during the first 72 hours of their hospitalization.

Methods: The PolyTrauma Early Mortality Model (PTEMM) is a machine learning algorithm that uses EMR data to predict 48-hour mortality during the first 72 hours of hospitalization. The model updates every 12 hours, evolving with the patient's physiologic response to trauma and ongoing resuscitation. The model was developed and trained on 4567 hospitalized polytrauma patient encounters from 2009-2014 and was tested on 484 encounters from 2015-2016. Area under the receiver operating characteristic curve (ROC), sensitivity, specificity, positive (PPV) and negative predictive value (NPV), and positive and negative likelihood ratios (LRs) were used to evaluate model performance.

Results: The PTEMM accurately predicted 52 of the 56 12-hour time intervals within 48 hours of mortality, for a sensitivity of 92.8% (95% confidence interval [CI] 82.7%-98.0%). The specificity was 92.2% (95% CI 90.8%-93.6%), and the PPV was 31.7% (95% CI 27.7%-36.0%). The model predicted survival for 1342 time intervals and was incorrect 4 times, yielding an NPV of 99.7% (95% CI 99.2%-99.9%). The positive LR was 12.0 (95% CI 9.9-14.6), and the negative LR was 0.08 (95% CI 0.03-0.20). The area under the ROC curve was 0.96 (95% CI 0.94-0.97). Model performance was stable over the first 72 hours of hospitalization.

Conclusion: Prior mortality risk models have provided only a vague, static prediction of in-hospital mortality that is impractical to use in the clinical setting. By relying only on EMR data to provide an automated risk that evolves with the patient's physiologic response to trauma, the PTEMM overcomes many of the limitations of prior models. The PTEMM provides the clinician with a more clearly defined description of mortality risk and therefore may prove to be a useful tool to augment clinical decision-making for polytrauma patients early in their hospitalization.

See the meeting app for complete listing of authors' disclosure information.