

Using Machine-Learning to Decode Postoperative Hip Mortality Trends: Actionable Insights from an Extensive Clinical Dataset

Christopher Q. Lin, MS¹, Christopher A. Jin, BS¹, David Ivanov, MD¹, Christian A. Gonzalez, BS¹, Michael J. Gardner, MD¹
¹Stanford Hospitals and Clinics, Stanford, CA, USA
cqclin@stanford.edu

Disclosures: None

INTRODUCTION: Hip fractures are a significant health concern. They represent one of the most dangerous sequelae of falls, often leading to substantial declines in functional capacity and independence. Despite advances in surgical techniques and perioperative management, postoperative mortality remains a pressing concern. Recent studies have reported that approximately 5-12% of patients expire within 30 days of surgical intervention [1], highlighting the critical need for precise identification and modification of significant preoperative risk factors and tailored interventions in the postoperative period. A comprehensive understanding of these factors is crucial for optimizing patient care, guiding clinical decision-making, improving prognostic accuracy and risk assessment, and developing targeted interventions to improve postoperative outcomes.

METHODS: Data from hip fracture patients from the 2016 to 2020 American College of Surgeons National Surgical Quality Improvement Program (NSQIP) was used. We utilized a penalized regression approach employing the Least Absolute Shrinkage and Selection Operator (LASSO) [2]. LASSO minimizes coefficients of variables that do not contribute substantially to model performance, effectively driving them toward zero. We applied the LASSO algorithm with a 70-30 training-test split to identify the most pertinent predictors in the training dataset regarding a primary mortality outcome within 30 days following the operation. Two LASSO logistic regression models were developed, the first of which incorporated only preoperative clinical factors, while the latter incorporated both preoperative and postoperative clinical factors. Subsequently, we evaluated the performance of the resulting models on the validation set, assessing their predictive accuracy and generalizability via an area under the receiver operating characteristic (ROC) curve.

RESULTS SECTION: A total of 107,660 patients were included in our study cohort. Following LASSO analysis, the first model contained 68 relevant postoperative factors were identified to have a positive or negative predictive effect on 30-day mortality following surgery. 16 postoperative factors were also modeled using LASSO, resulting in a second model totaling 84 factors. As measured by LASSO Coefficient, the strongest preoperative clinical factors associated with 30-day mortality included presence of ascites (1.28), disseminated cancer (1.14), mechanical ventilation (0.75), low functional health status (0.63, 0.37), male sex (0.54), septic shock (0.53), age (0.49), sepsis (0.37), CHF (0.37), and history of COPD (0.27). Postoperative factors most associated with 30-day mortality included postoperative delirium (0.66) and postoperative pressure sore (0.13). The usage of mobility aids (-1.52) in addition to postoperative bone protection medication (-0.85) were strongly associated with 30-day survival. Our first model utilizing preoperative factors alone possessed an AUC of 0.80, while the combined preoperative and postoperative factors model possessed an AUC of 0.83 (Figure 1).

DISCUSSION: Advances in statistical modeling have provided various tools that allow clinicians to stratify risk in operative candidates. Using LASSO, we identified many additional clinical factors that had an effect on postoperative mortality than previously reported. Notably, it was found that not all comorbidities prior to surgery were equally associated with postoperative mortality, and that smoking status, preoperative renal failure, and diabetes showed very weak associations with 30-day mortality. Our model also showed that the usage of regional (-0.73) or local anesthetic (-0.83) was a stronger predictor of 30-day survival as compared to general or spinal anesthetic, emphasizing that the means of anesthesia remain important in maximizing outcomes. The major postoperative factor found to have an association on 30-day mortality was the presence of postoperative delirium (0.66). Targeted interventions at preventing the onset of delirium should be considered for high-risk postoperative hip patients in preventing mortality, who already possess limited mobility. Mortality was negatively correlated with the use of a mobility aid following surgery (-1.6) and the prescription of postoperative antiresorptive medication (-0.90), indicating that emphasizing the usage of a mobility aid to promote early ambulation postoperatively may promote better outcomes in hip fracture patients. In conjunction with prescription of bone protection medication, these postoperative interventions show utility in preventing 30-day mortality.

SIGNIFICANCE/CLINICAL RELEVANCE: (1-2 sentences): We present two LASSO regression models; the first of which can be applied prior to surgery using only preoperative factors, and the latter which can be applied as intraoperative and postoperative factors become available to predict 30-day mortality and identify relevant clinical factors associated with mortality.

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IMAGES AND TABLES:

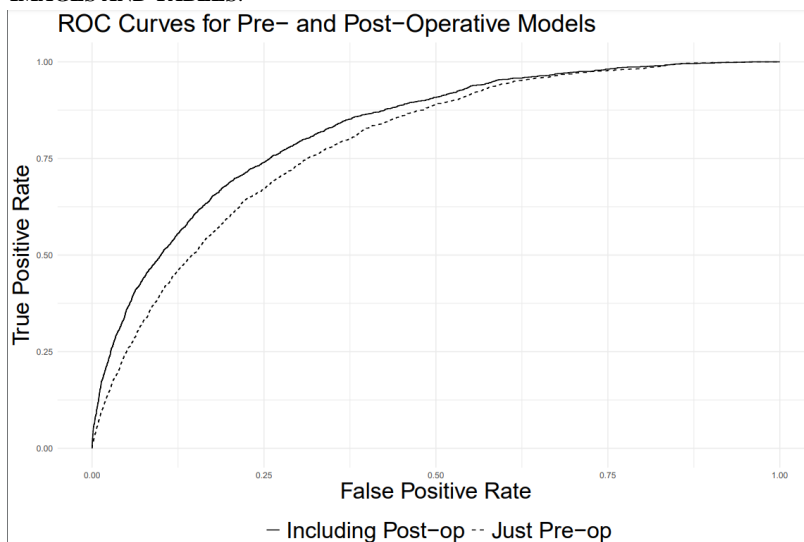


Figure 1. Comparison of return operator curves for preoperative only and preoperative and postoperative combined factors for predicting 30-day mortality after hip fracture.