Development of a Predictive Model for 90-Day Postoperative Periprosthetic Fracture Following Primary Total Hip Arthroplasty

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INTRODUCTION: Periprosthetic fractures (PPFx) represent a significant complication after primary total hip arthroplasty (THA). Reliable risk assessment tools are essential for predicting PPFx and improving patient care. This study aims to evaluate different machine learning models to create a predictive model using the Elixhauser Comorbidity Index for PPFx risk stratification following primary THA.

METHODS:
We analyzed data from 792,602 patients who underwent primary elective THA, sourced from the National Readmissions Database (2016-2020). The dataset was divided into a training set (80%) and a testing set (20%). Four machine learning models were utilized to predict PPFx: logistic regression, gradient boosting (GBM), neural networks (NN), and random forests (RF). The independent variables included the 31 Elixhauser comorbidities, along with age and gender. The best model's coefficients were normalized to a scale of -5 to 5 for risk stratification. The final predictive model was then applied to the entire dataset.

RESULTS: GBM emerged as the most effective model for predicting PPFx, with an AUC of 0.785. The other models performed as follows: NN (AUC 0.780), logistic regression (AUC 0.765), and RF (AUC 0.756). Using the GBM coefficients, patients were assigned risk scores and categorized into risk groups: low risk (score <10), moderate risk (10-14), high risk (15-19), and very high risk (20+). Patients in the moderate-risk category had a 3.28-fold increased risk of PPFx compared to those in the low-risk category. High-risk patients had a 10.22-fold increase, and very high-risk patients had a 15.80-fold increase in PPFx risk.

DISCUSSION AND CONCLUSION: Periprosthetic fractures are a critical challenge post-THA, necessitating effective risk stratification tools for better patient management. This study utilized the variables found within the Elixhauser Comorbidity Index to develop a model that accurately predicts 90-day PPFx risk, aiding clinical decision-making and improving patient outcomes.

Periprosthetic Fracture 90-Day Risk

Risk Group	OR	95% Lower CI	95% Upper CI	P
Low Risk	1.00			
Moderate Risk	3.28	2.11	3.58	<0.001
High Risk	10.22	5.33	11.27	<0.001
Very High Risk	15.80	14.40	17.34	<0.001

Odds Ratio