Development of a Predictive Model for 90-Day Postoperative Joint Infection Following Primary Total Hip Arthroplasty

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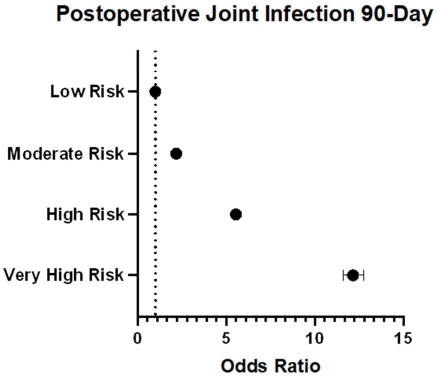
INTRODUCTION: Postoperative joint infection (PJI) is a serious complication that can occur following primary total hip arthroplasty (THA). Although relatively rare, with an incidence of 2%, it can have devastating consequences. Hence, it is essential to have validated risk assessment tools to predict the likelihood of PJI in THA patients. This study aims to compare various machine learning models to develop a predictive model using the Elixhauser Comorbidity Index for PJI risk stratification following primary THA.

METHODS: We identified 792,602 patients who underwent primary elective THA from the National Readmissions Database for the years 2016-2020 using ICD-10 codes. The dataset was divided into a training set (80%) and a testing set (20%). Four machine learning models—logistic regression, gradient boosting (GBM), neural networks (NN), and random forests (RF)—were used to predict PJI. Independent variables included the 31 Elixhauser comorbidities, as well as patient age and gender. The best-performing model's coefficients were normalized to a scale of -5 to 5, allowing for patient stratification by risk score. The final predictive model was then applied to the entire patient cohort.

RESULTS: Logistic regression proved to be the most effective model for predicting PJI, with an AUC of 0.741, followed by NN (AUC 0.721), GBM (AUC 0.733), and RF (AUC 0.704). Using the logistic regression model, patients were assigned risk scores and categorized into risk groups: low risk (score <5), moderate risk (6-10), high risk (11-15), and very high risk (16+). Patients in the moderate-risk category had a 2.18 times higher risk of PJI ($p<0.001$) compared to those in the low-risk category. High-risk patients had a 5.54 times greater risk ($p<0.001$), while very high-risk patients had a 12.14 times greater risk ($p<0.001$) than those in the low-risk category.

DISCUSSION AND CONCLUSION: PJI remains a critical challenge following primary THA, and effective risk stratification tools are vital for improving patient outcomes. This study demonstrates the use of the Elixhauser Comorbidity Index in developing a predictive model that can identify patients at risk for 90-day PJI, aiding in clinical decision-making and risk management.



	OR	95% Lower CI	95% Upper CI	*P*
Low Risk	1.00			
Moderate Risk	2.18	2.11	2.24	**<0.001**
High Risk	5.54	5.33	5.77	**<0.001**
Very High Risk	12.14	11.59	12.72	**<0.001**