Machine Learning Model for the Prediction of 90-Day Unplanned Readmissions after Revision Total Joint Arthroplasty
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INTRODUCTION: Although hip and knee total joint arthroplasty (TJA) continues to be one of the most successful surgical interventions in medicine, unplanned hospital readmissions have been reported to occur in as many as 20% of patients. Statistical models to preoperatively predict patients’ risk of readmission and major complications after total joint arthroplasty (TJA) may aid in improving perioperative optimization. In addition, accurate statistical models associating patient factors with outcomes are essential for risk adjusting outcome-based performance measures and reimbursement programs. Although risk models for TJA exist, machine learning models such as artificial neural networks (ANNs) are valuable tools for analyzing and interpreting large and complex datasets. In this study, we sought to create a prediction calculator based on artificial neural networks to determine the expected 90-day readmission rates after total hip arthroplasty (THA).

METHODS: A single-institution database consisting of 4,302 consecutive revision THAs was utilized in our artificial neural networks model. Of these, 3,657 (85%) and 645 (15%) patients were used for training and validation of the ANN model, respectively. The predictive variables used included sex, age, diabetes, smoking status, body mass index (BMI), American Association of Anesthesiologist (ASA) score, revision etiology, and prior revision history. The models were used to predict the probability of unplanned readmission within 90 days of discharge for revision TJA. A graphical representation of the ANN model is shown in Figure 1. The area under curve (AUC), via receiver operating characteristic (ROC) analysis, was used as an accuracy metric.

RESULTS: In the validation phase, for predicting 90-day unplanned readmissions after revision TJA, the model had an AUC of 0.74 (95% CI: 0.70-0.79; Accuracy:71.32%). The optimal cutoff point (probability) was 0.65, which had a sensitivity of 0.60 and a specificity of 0.76. Additionally, at this cutoff point the positive and negative predictive values were 0.55 and 0.80, respectively. The ASA score, BMI, and sex – in that order – were the strongest predictors of 90-day readmissions after revision TJA, while prior revision history was the weakest predictor.

DISCUSSION AND CONCLUSION: This study established and internally cross-validated a novel artificial neural network based predictive model of 90-day readmissions after revision THA. Our machine learning algorithm demonstrated a high construct validity, reliability, and responsiveness predicting 90-day readmission following revision THA. This is of clinical importance as unplanned hospital readmissions have been reported to occur in as many as 20% of patients, thereby placing an enormous burden on both patient’s health and healthcare system.