Development of a Dynamic Risk Assessment Instrument to Assess Candidacy for Outpatient Hip or Knee Arthroplasty Based on Machine Learning Techniques

Tony Sicheng Shen, Matthew A Wickersham, Nicholas Bartelo, Scott Michael Lavalva, Olivier Elemento, Mathias P G Bostrom[1], Edwin P Su[1], Michael P Ast[1]
[1]Hospital For Special Surgery

INTRODUCTION: Patient selection is critical to the safety of ambulatory hip or knee arthroplasty. Those selected for outpatient arthroplasty should be at minimal risk of requiring a hospital-based intervention postoperatively. Using a machine learning approach, we developed a risk assessment instrument that identifies patients who are at higher risk of requiring inpatient postoperative care based on their preoperative characteristics.

METHODS: We reviewed 17,792 patients who underwent a primary total hip (THA) or total knee arthroplasty ((TKA) between 2016-2019 using an institutional electronic health record. These patients were divided into a group which required a hospital-based intervention (HBI) during their postoperative admission (n=12,820) and those who did not (n=4,972). HBIs included abnormal vital signs, abnormal laboratory testing requiring monitoring or intervention, blood transfusion, urinary retention requiring catheterization, uncontrolled nausea, and uncontrolled pain requiring intravenous breakthrough medication. Using 64 patient characteristics, we applied supervised computational learning models to predict the risk for HBI. This model was adapted into a risk assessment instrument using SHAP values, allowing for a determination of HBI risk using routinely obtained preoperative variables.

RESULTS: The area under the receiver operating curve (AUROC) for the best performing computational model was 0.969 for predicting HBI. The predictive capability of this model far exceeds current clinical selection criteria, which carries an AUROC of 0.666. Clinical variables that are routinely available on preoperative examinations were adapted into a web-based risk assessment instrument that determines a patient's risk for HBI based on data from the computational model.

DISCUSSION AND CONCLUSION: The use of machine learning combined with the development of a dynamic risk assessment instrument represents an objective, data-driven approach to identifying candidates who are safe for ambulatory hip or knee arthroplasty.