Using Unsupervised Machine Learning to Predict Quality of Life After Total Knee Arthroplasty

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INTRODUCTION: Many potential factors affect the quality-of-life patients after total knee arthroplasty (TKA). Up to 30% of TKA patients are unsatisfied with their outcome; however, effective strategies to alter this are lacking. We are increasingly turning to patient reported outcome measures (PROMs) to better understand how surgery affects patient quality of life from a more global perspective. Machine learning algorithms are novel tools that may help to better predict outcomes in our patients by improving stratification of poor performers. The purpose of this study was to use an unsupervised machine learning algorithm to identify patient clusters and their features that impact patient reported outcomes after total knee arthroplasty.

METHODS: Six hundred and thirty-six patients who underwent a unilateral knee arthroplasty had their data abstracted from a sing institution's database, mean age 67.25 years (SD, 8.90), 56.7% female, mean BMI 31.17 (SD, 13.1). Patient demographics and the Functional Comorbidity Index were collected alongside Patient Reported Outcome Measures Information System Global Health v1.2 (PROMIS GH) scores measured pre-operatively, and at 3-months and 1-year after total knee arthroplasty. An unsupervised machine learning algorithm (spectral clustering) was used to identify patient features impacting PROMIS GH scores at the various time points.

RESULTS: Five unique patient clusters were idenified by the spectral clustering algorithm. The clusters were distinct by age, sex and self-rated comorbidities among other features. The patient clusters were associated with predictable trends in PROMIS GH scores at the 3-month and 1-year post-op time points. Most of the improvement in quality of life was seen between the pre-operative and 3-month scores. PROMIS GH scores tended to plateau thereafter. The patients with the worst pre-operative PROMIS GH scores (cluster 5) had the most improvement after TKA, whereas patients with higher global health rating pre-op had more modest improvement (clusters 1, 2, and 3). One patient cluster (3), showed improvement between pre-op and 3-months but had a decline in their PROMIS GH scores between 3-months and 1-year. Only clusters 4 and 5 showed improvement in PROMIS GH scores that met a MCID at 1-year post op.

DISCUSSION AND CONCLUSION: Using an unsupervised machine learning algorithm, we were able to identify unique patient clusters and their features that can impact quality of life after TKA. This algorithm can be applied to other data sets or used in comparison as a baseline from which to measure the change of an intervention on this single-centre's total knee arthroplasty population. It is a positive step towards providing individually tailored precision medical care for each of our total knee arthroplasty patients.

SIGNIFICANCE/CLINICAL RELEVANCE: Results relating specific quality of life features and TKA using Machine learning can help health care providers adjust their intervention for better clinical outcomes.

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