Addressing the Challenge of Spine Patient Triage: Development of a Simple Algorithm for Identification of Potential Surgical Candidates

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INTRODUCTION: In the majority of patients suffering from spine conditions, axial and radicular symptoms resolve approximately 2 to 12 weeks after onset without surgical intervention. Therefore, utilizing spine surgeons to manage the subset of patients potentially requiring surgery is the most efficient resource allocation strategy. Unfortunately, initial triage of patients to the most appropriate provider on the spine care team remains a challenge in practice, leading to inefficient care, increased cost, and patient frustration. While prior studies have attempted to identify which patients will fail nonsurgical treatment and ultimately require surgery, many rely on information that cannot be known at the time of initial appointment scheduling. Others have developed models that can inform triage decisions, but the complexity of the models generated makes implementation into practice challenging. The purpose of this study was to develop a simple algorithm for identifying patients most likely to require surgical management of spine conditions that could be used to appropriately triage this population to spine surgeons.

METHODS:

A retrospective review of 5,886 consecutive new patients presenting to a single multidisciplinary spine clinic from March 2021 to September 2022 was performed. All patients seen by spine service providers, including orthopaedic spine surgeons, surgical physician assistants, nonsurgical nurse practitioners, and physiatrists were included. No other exclusion criteria were applied. The primary outcome of interest was whether a patient underwent spine surgery during the study period.

Sixty-four independent variables were recorded from data collected during patient intake and the first clinical visit. Independent variables included demographics, social vulnerability index scores, spine condition type, symptom duration, type, and location, prior treatments and medications used, patient goals, and responses to the PROMIS Physical Function, Global Health, Pain Interference, and Pain Intensity questionnaires. Chi-square and independent samples t-tests were performed to compare the characteristics of patients who did and did not undergo surgery during the study period. A gradient boosted model was generated to identify the independent variables most associated with undergoing spine surgery. This approach was used for initial variable screening given the large number of potentially interrelated independent variables being assessed. The 5 most important variables were then entered into a multiple logistic regression model. The model's accuracy in identifying surgical patients was assessed by the area under the curve (AUC) of the receiver operating characteristics (ROC) curve. To simplify the model into a usable decision support tool, positive responses to each independent variable were assigned a weight based on the odds ratios from the multivariable model, resulting in potential scores ranging from 0-11.2, with higher scores indicating increased likelihood of surgery. The 75th percentile score was selected as the threshold for identifying patients most likely to require surgery. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the model's ability to accurately predict which patients would undergo surgery was then assessed. Statistical significance was assessed at p<0.05.

RESULTS:

Overall, 440/5,886 (7.5%) patients underwent spine surgery during the study period. In comparison to patients managed nonsurgically, surgical patients were older, more likely to be male, and more likely to be white. Further, surgical patients were more likely to have lumbar pathology, have used non-opioid and opioid pain medicines, have a history of spine injections, and a history of prior spine surgery. Finally, surgical patients were more likely to have greater radicular than axial symptoms, less likely to have primarily axial symptoms, more likely to be interested in learning about injections and surgery, and had more severe disease burden across all patient-reported outcome measures. All reported trends were significant at p<0.05. In the gradient boosted model, the following variables were identified as the top 5 predictors of spine surgery, presented in descending order of importance: patient goal of interest in learning about spine surgery, history of spine injections, difficulty walking a mile, radicular symptoms greater than axial symptoms, and increased age (converted to age>60 for further analysis).

When entered into a multivariable logistic regression model each of these variables were confirmed to be independently associated with undergoing spine surgery (all p<0.001). The AUC of the model was 0.752, indicating strong predictive accuracy. The odds ratios from the model were then used to score patients for creation of the decision support tool. Positive responses to a patient goal of interest in learning about spine surgery, history of spine injections, difficulty walking a mile, radicular symptoms greater than axial symptoms, and age >60 were assigned values of 3.3, 2.0, 1.9, 2.3, and 1.7, respectively. The average resulting score for the population was 2.9 ± 2.4. The 75th percentile cutoff, indicating the patients most likely to require surgery, was 4.0. In the resulting confusion matrix treating patients with scores ≥4 as predicted spine surgeries, sensitivity was 60.0%, specificity was 76.6%, PPV was 17.2%, and NPV was 96.0%, and an AUC of 0.683 was achieved.

DISCUSSION AND CONCLUSION:
Identification of patients who will ultimately require spine surgery remains challenging based on the heterogeneous nature of spine conditions. However, a simple 5-question algorithm incorporating patient demographics, symptoms, treatment history, physical function, and patient goals may improve practices' ability to identify potential surgical candidates prior to their first visit. Prospective application and evaluation of the algorithm to evaluate whether it improves the triage of appropriate patients to spine surgeons is warranted.