Which Patients are at High Risk for Transfusion after Posterior Spinal Fusion for Idiopathic Scoliosis?: A Machine Learning Predictive Model

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INTRODUCTION:

Posterior spinal fusion (PSF) for idiopathic scoliosis can lead to significant blood loss and may necessitate allogenic blood transfusion. The purpose of this study is to identify risk factors for blood transfusion after PSF for idiopathic scoliosis. We hypothesize perioperative risk factors can be used to create a predictive model associated with 30-day blood transfusion risk after posterior spinal fusion for adolescent idiopathic scoliosis.

METHODS:

The Pediatric National Surgical Quality Improvement Program (NSQIP) dataset from 2016 to 2022 was queried. The main participant use file was combined with specialty scoliosis datasets from 2016 to 2022. Patients identified as having idiopathic scoliosis by participating institutions, undergoing PSF were included. The following factors were included in a multivariable regression analysis: age in years, gender (female/male), number of levels fused (<6, 6-12, >12 levels), total operative time, the use of cell saver, bleeding/heme disorders, the use of intraoperative antifibrinolytics, height at surgery in inches, and weight at surgery in pounds. A multilevel perceptron neural network was used to create a predictive model for allogenic blood transfusions after PSF for AIS, with 70% of the data being used to train the model and 30% of the data used to test the model.

RESULTS:

There were 18,633 patients included in this study. Of these patients, 1,855 (10%) required an allogenic blood transfusion within the 30-day perioperative period. Female sex, a greater number of levels fused, a higher total operation time, cell saver not being used, intraoperative antifibrinolytics not being used, shorter height, and lesser weight were all associated with a higher risk of transfusion (p<0.05 for all). The multivariable logistic regression model can be found in Figure 1a. Age and bleeding/heme disorders were not associated with perioperative allogenic blood transfusion. A multilayer perceptron neural network with 90% accuracy in predicting allogenic blood transfusions was created, with relative importances of independent variables being found in Table 1.

DISCUSSION AND CONCLUSION:

Allogenic blood transfusions were necessary after one in every ten posterior spinal fusions for scoliosis. This study identified several risk factors for allogenic blood transfusion during the 30-day perioperative period in healthy patients undergoing posterior spinal fusion for adolescent idiopathic scoliosis and created a model utilizing machine learning that predicted allogenic blood transfusions with 90% accuracy. This machine learning model can be used for anticipatory guidance for transfusion, resource allocation and shared decision making.

Figure 1a. A multivariable logistic regression model for intraoperative or postoperative allogenic blood transfusion after posterior spinal fusion for adolescent idiopathic scoliosis.

	OR	Lower	Upper	Sig
Age in years	0.998	0.968	1.030	0.916
Female gender	1.408	1.209	1.640	**<0.001**
Levels fused (<6 levels)	4.078	2.963	5.612	**<0.001**
6-12 levels				**<0.001**
>12 levels	2.183	1.596	2.987	**<0.001**
Total operative time	1.006	1.005	1.006	**<0.001**
Use of cell saver	0.789	0.707	0.880	**<0.001**
Blood/heme disorder	1.379	0.944	2.012	0.096
Intraoperative antifibrinolytics	0.836	0.7	0.997	**0.047**
Height at Surgery in inches	0.988	0.986	0.990	**<0.001**
Weight at Surgery in pounds	0.948	0.933	0.964	**<0.001**
Constant	1.066			0.900

Figure 1b. Relative importance of variables in 90% predictive multilayer perceptron neural network for predicting allogenic blood transfusions after posterior spinal fusion for adolescent idiopathic scoliosis.

Normalized importance of independent variables in predicting allogenic blood transfusion after posterior spinal fusion for adolescent idiopathic scoliosis