

Predicting Prolonged Hospital Stay following Hip Dysplasia Surgery in the Pediatric Population Using an Artificial Neural Network to Identify the Most Important Variables

Theodore Quan¹, Philip M Parel, Amil Raj Agarwal, Alex Gu², Melina Recarey, Rachel Ranson³, Avilash Das, Brock Knapp, Sean Tabaie

¹George Washington University, ²George Washington University School of Medicine An, ³NYU Langone Orthopedic Hospital

INTRODUCTION: Pediatric patients diagnosed with developmental dysplasia of the hip (DDH) can be managed conservatively or surgically. Early detection can facilitate conservative treatment with harnesses, whereas patients who present with DDH after 6 months of age or who fail conservative management may need surgical treatment. Understanding patient risk factors is important to optimize patient outcomes following surgical treatment for hip dysplasia. The goal for legislation and hospitals has been to maximize outcomes while also reducing costs. Minimizing extended length of hospital stay following surgical procedures reduces costs and can also potentially improve the patients' quality of life and satisfaction. Therefore, it is important to determine patient variables associated with length of stay. Artificial neural networks (ANNs) are computational models that change based on the input and output of data. The purpose of this study was to develop and utilize an ANN model to determine the most important non-modifiable and modifiable factors which can predispose patients to require a prolonged hospital stay following hip dysplasia surgery.

METHODS: From 2012-2019, the National Surgical Quality Improvement Program Pediatric database was used to identify pediatric patients who underwent surgical treatment for hip dysplasia. In total, 25 demographic, comorbidity, preoperative, and intraoperative variables were analyzed in this study. Chi-squared tests and analysis of variance were performed to compare the various variables between the cohort of patients who had an extended length of hospital stay and those who had a normal length of stay. Extended length of stay was defined as more than 7 days based on prior studies. Variables that were statistically significant, with a p-value < 0.05, were inputted into the ANN model. The ANN module of Statistical Package for Social Sciences was used for analysis.

RESULTS: In total, 10,816 patients were analyzed in the study, of which 594 (5.5%) had a prolonged hospital stay. The ANN reached a Receiver Operating Characteristic (ROC) Area-Under-the-Curve (AUC) of 0.841, which is considered to be excellent accuracy (Figure 1). It was found that 15 out of the 25 variables analyzed were important to predict prolonged hospital stay. The five most important variables which helped to predict extended length of stay following hip dysplasia surgery were operative time (increased; importance = 0.223), body mass index (decreased; importance = 0.158), age (older; importance = 0.101), preoperative international normalized ratio (INR) (increased; importance = 0.096), and cardiac comorbidities (presence of cardiac comorbidities; importance = 0.077) (Figure 2).

DISCUSSION AND CONCLUSION: The present study used an ANN model and identified several significant factors which can help predict patients requiring an extended length of hospital stay following surgical treatment for hip dysplasia, including operative time, body mass index, age, preoperative INR, and cardiac comorbidities. Clinicians should be aware of these important variables and explore reductions to length of stay through preoperative patient optimization. Specifically, several of these factors, such as INR, can be evaluated preoperatively through laboratory tests and medically managed prior to the surgery. Evaluating factors that impact patients' length of hospital stay can help optimize costs, and our study demonstrated that ANN modeling represents a novel and unique approach to determine which modifiable and non-modifiable factors can assist in predicting length of stay following hip dysplasia surgery.

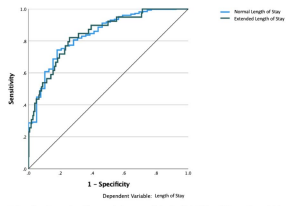


Figure 1. Receiver Operating Characteristic curve of the Artificial Neural Network model in predicting Extended Length of Hospital Stay

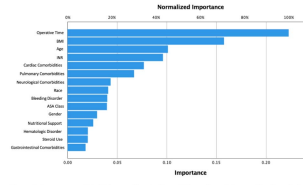


Figure 2. Importance of Variables used by the Neural Network model to predict Extended Length of Hospital Stay