Title: Machine Learning Predictors of Extended Length of Stay in Pediatric DDH Surgery

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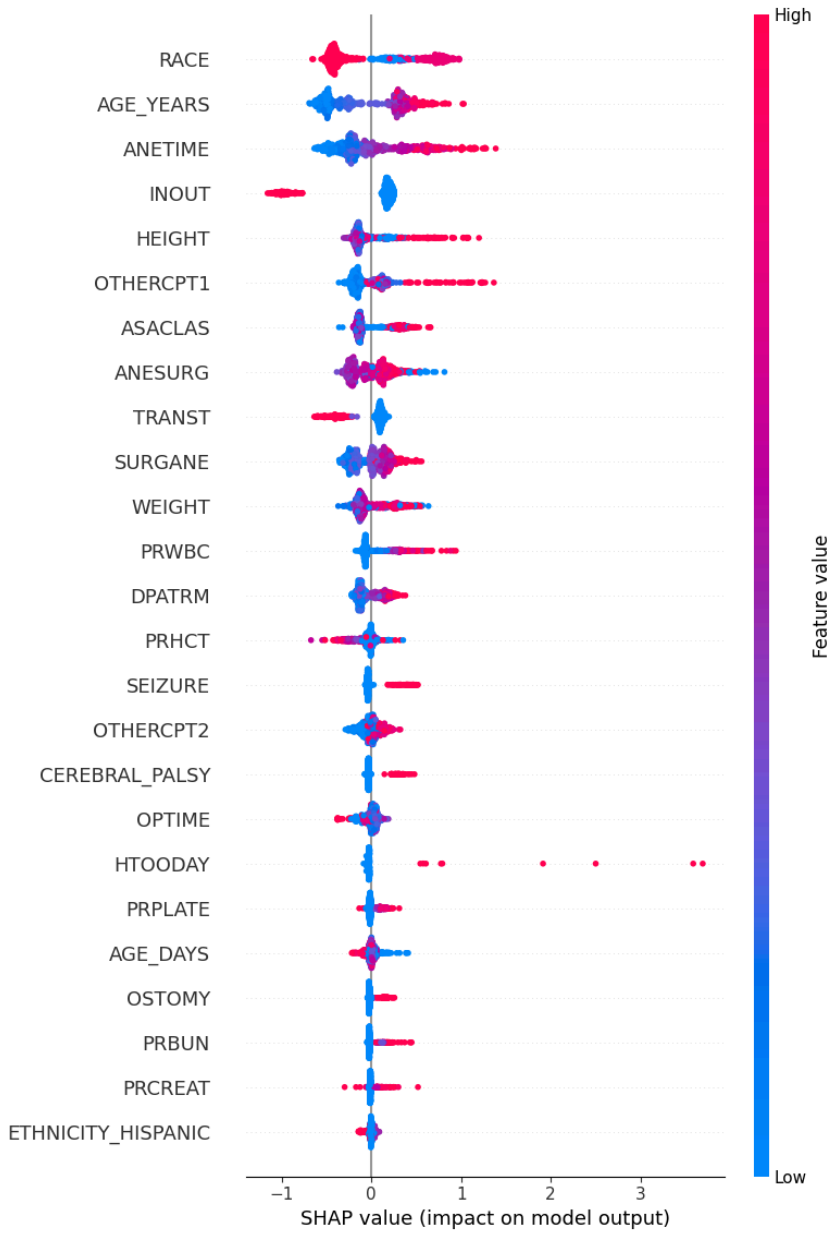
Background: Developmental Dysplasia of the Hip (DDH) is one of the most common pediatric musculoskeletal conditions, characterized by abnormal development of the hip joint that can range from mild instability to complete dislocation. When conservative management fails, open hip reduction is often required, particularly in older or more complex cases. Prolonged hospital stays following this procedure place a significant burden on patients, families, and healthcare systems.

Methods: Using NSQIP data (2016–2022), a retrospective cohort study identified 3,288 pediatric patients (mean age 1.98 years) who underwent open hip reduction for DDH (ICD-10-CM Q65.0–Q65.9). A CatBoost model incorporating demographics, comorbidities, and surgical details was developed to predict extended length of stay (eLOS), defined as greater than the 75th percentile of 3 days. SHAP values quantified each variable's contribution, and the model achieved strong performance with an AUC of 0.88.

Results: In SHAP analysis, race had the greatest impact on the model with a value of .46, corresponding to a 0.46-day increase in predicted length of stay for Asian and Black patients compared to White patients. Other important predictors included increased age (0.40 days), anesthesia time (0.33 days), inpatient versus outpatient status (0.33 days), and patient height (0.19 days). Concurrent procedures, type of anesthesia, and anesthesia duration also contributed, each shifting eLOS by approximately 0.17 days

Conclusion: This study demonstrates that machine learning, specifically the CatBoost model with SHAP predictions, can effectively predict extended Length of Stay following open hip reductions for DDH in pediatric patients and achieve strong discriminative performance. As race is the most influential predictor for this model, it warrants further investigation into potential disparities in care and socioeconomic factors. Age, anesthesia time, and inpatient status were also significant contributors, suggesting opportunities to optimize perioperative planning and develop effective clinical pathways.

Figure 1: SHAP Heatmap of Variable Impact on eLOS


RACE
AGE_YEARS
ANETIME
INOUT
HEIGHT
OTHERCPT1
ASACLAS
ANESURG
TRANST
SURGANE
WEIGHT
PRWBC
DPATRM
PRHCT
SEIZURE
OTHERCPT2
CEREBRAL_PALSY
OPTIME
HTOODAY
PRPLATE
AGE_DAYS
OSTOMY
PRBUN
PRCREAT
ETHNICITY_HISPANIC
−1
0
1
2
3
SHAP value (impact on model output)
High
Feature value
Low