Sleeve or Bypass? An Interpretable Method to Safely Select Bariatric Procedures

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Problem Statement

Previous work from bariatric surgery researchers have attempted to quantify the risks of the surgery, but improvements can be made to enable doctors and patients to be more aware of surgical risks. Using 5 years of MBSAQIP data we estimate the 30-day death, 30-day reoperation, 30-day readmission, 30-day venous thrombosis (VTE), and length of hospital stay using high-performing, interpretable machine learning models.

What is Bariatric Surgery?

Bariatric surgery is a procedure that modifies the digestive system to assist in weight loss. There are two popular options currently used: sleeve gastrectomy and gastric bypass.

Sleeve Gastrectomy   Gastric Bypass
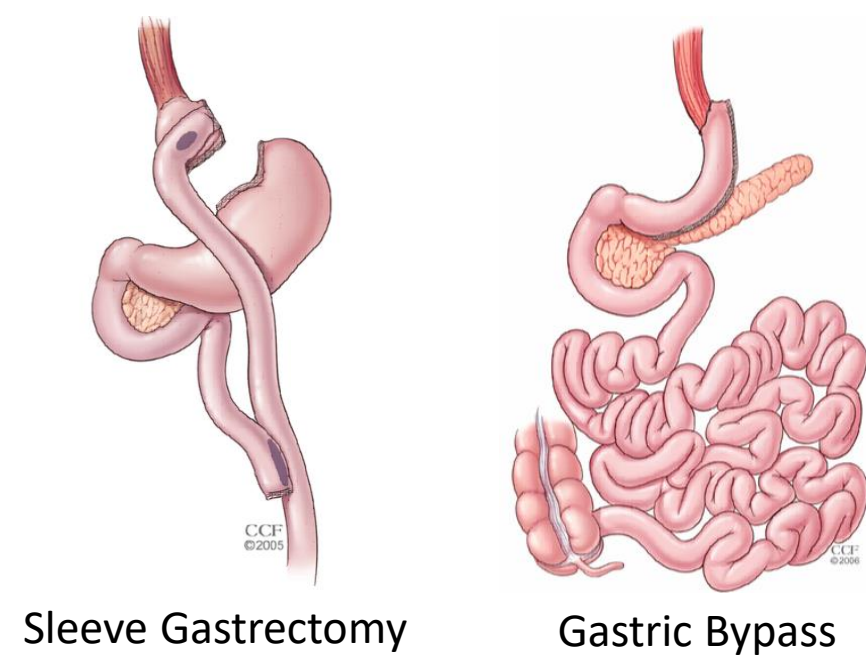
Analytics Approach

Modeling Consideration	Baseline Model	MIT Model
5-year Dataset from MBSAQIP	✓	✓
Logistic Regression	✓	✓
Separate Sleeve and Bypass Models		✓
Feature Selection		✓
Regularization		✓
Concurrent Procedures as a Risk Factor		✓
Venous Thrombosis and Length of Stay Models		✓

Our approach follows previous work by using MBSAQIP data and considering logistic regression. Our contribution comes from creating separate models for each surgery type to allow for variation in coefficients. We assessed the performance of state-of-the-art architectures but opted to use logistic regression when considering interpretability and performance. Lastly, we add feature selection, regularization, concurrent procedures, and venous thrombosis and length of stay models.
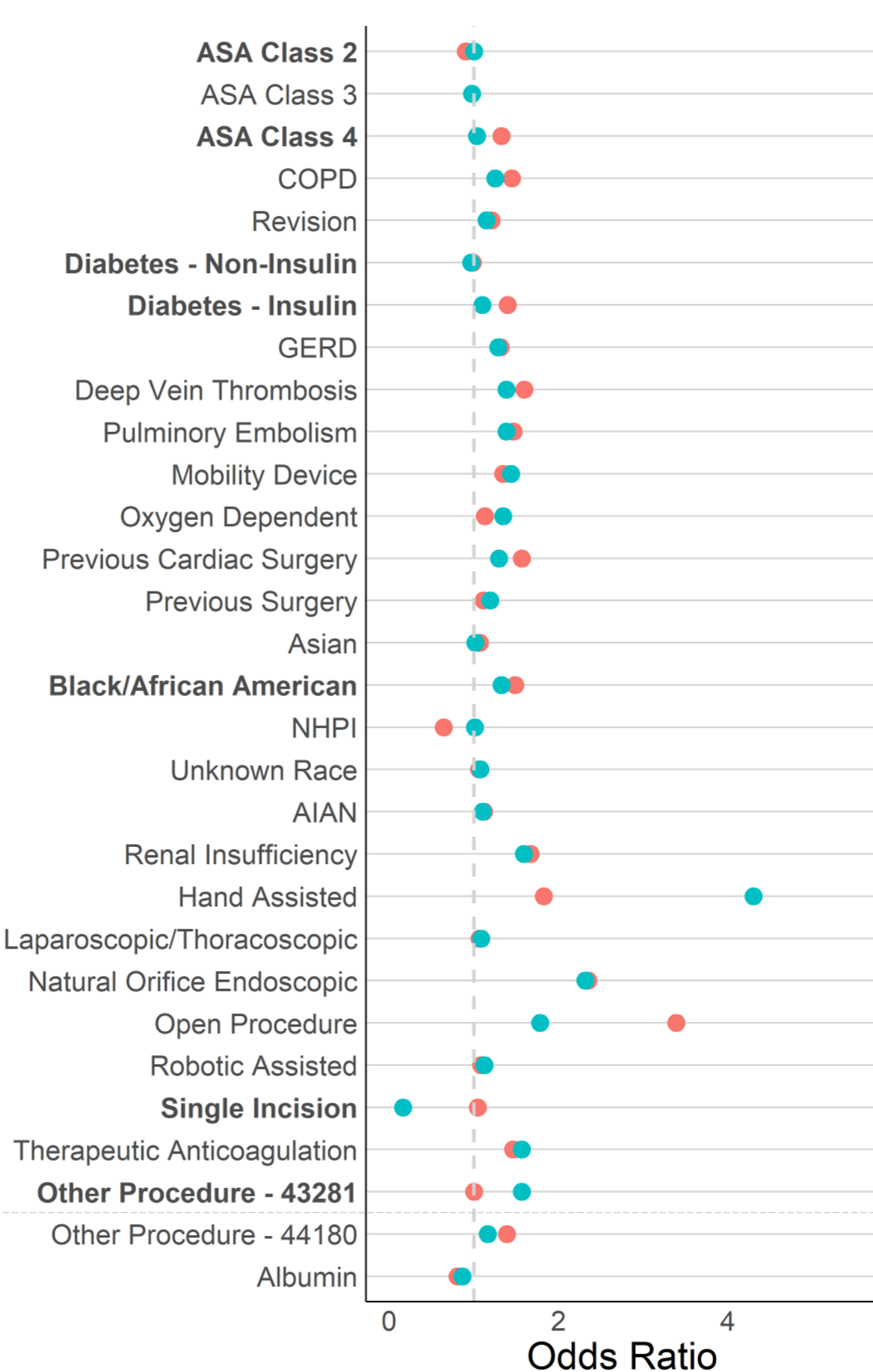
Interpretable and Independent Coefficients

This new approach yields models that include between 10 and 17 risk factors compared to the baseline models, which all use 25 different risk factors. By having fewer risk factors in the model, doctors have better insight into the true risks. This approach allows for certain risks to be greater for the sleeve than the bypass which previous attainable in previous models where the surgery type is used as an input that affects all patients uniformly. For example, in the 30-day death model, patients who with a myocardial infarction are at lower risk from a bypass. Odds ratios of 1 signify no additional risk. Features below the dotted lines are continuous variables.
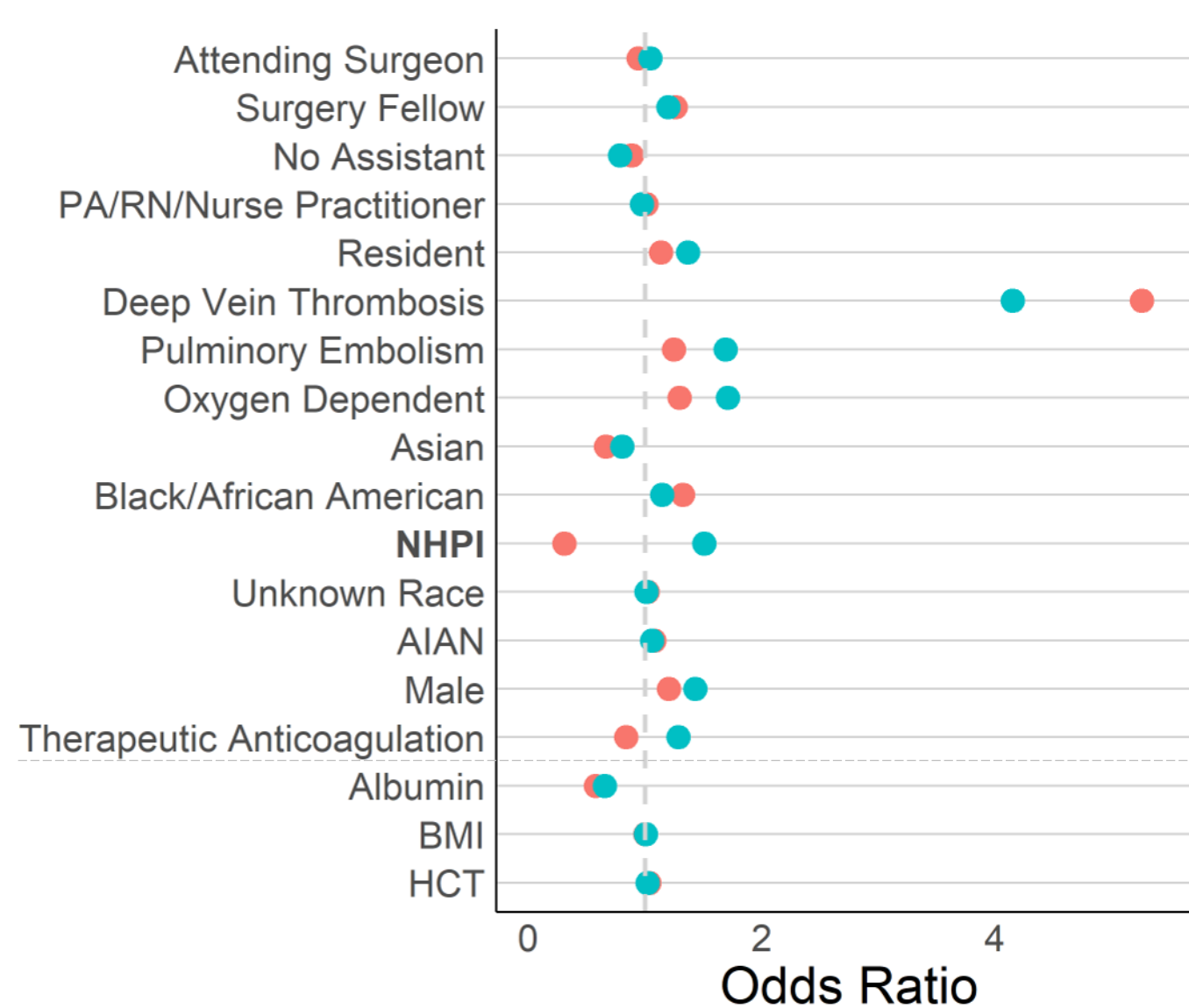
30-Day Death Model Coefficients
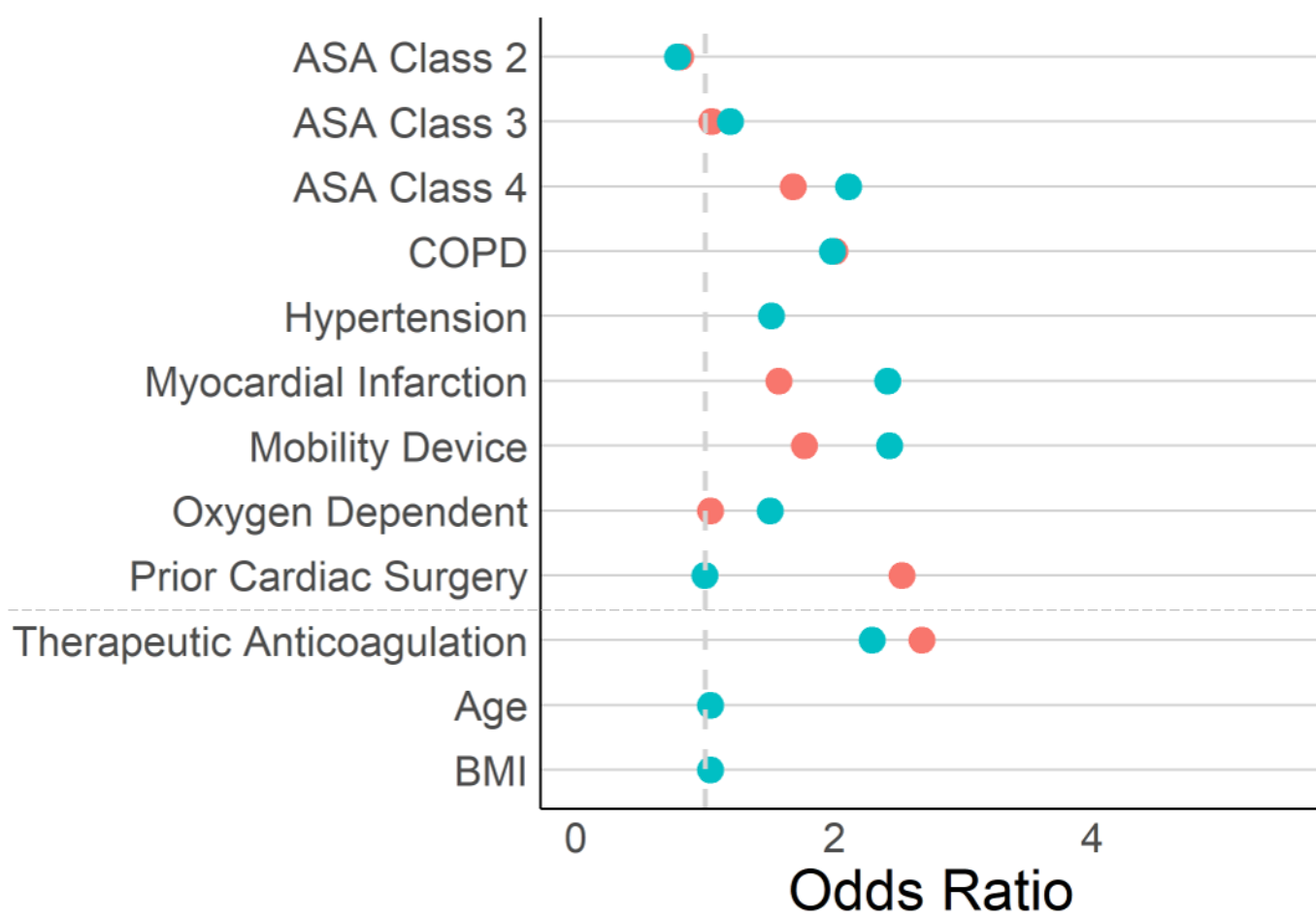
30-Day Readmission Model Coefficients

30-Day Reoperation Model Coefficients

Length of Stay Model Coefficients

30-Day VTE Model Coefficients

● Bypass   **BOLD:** Statistically significant difference
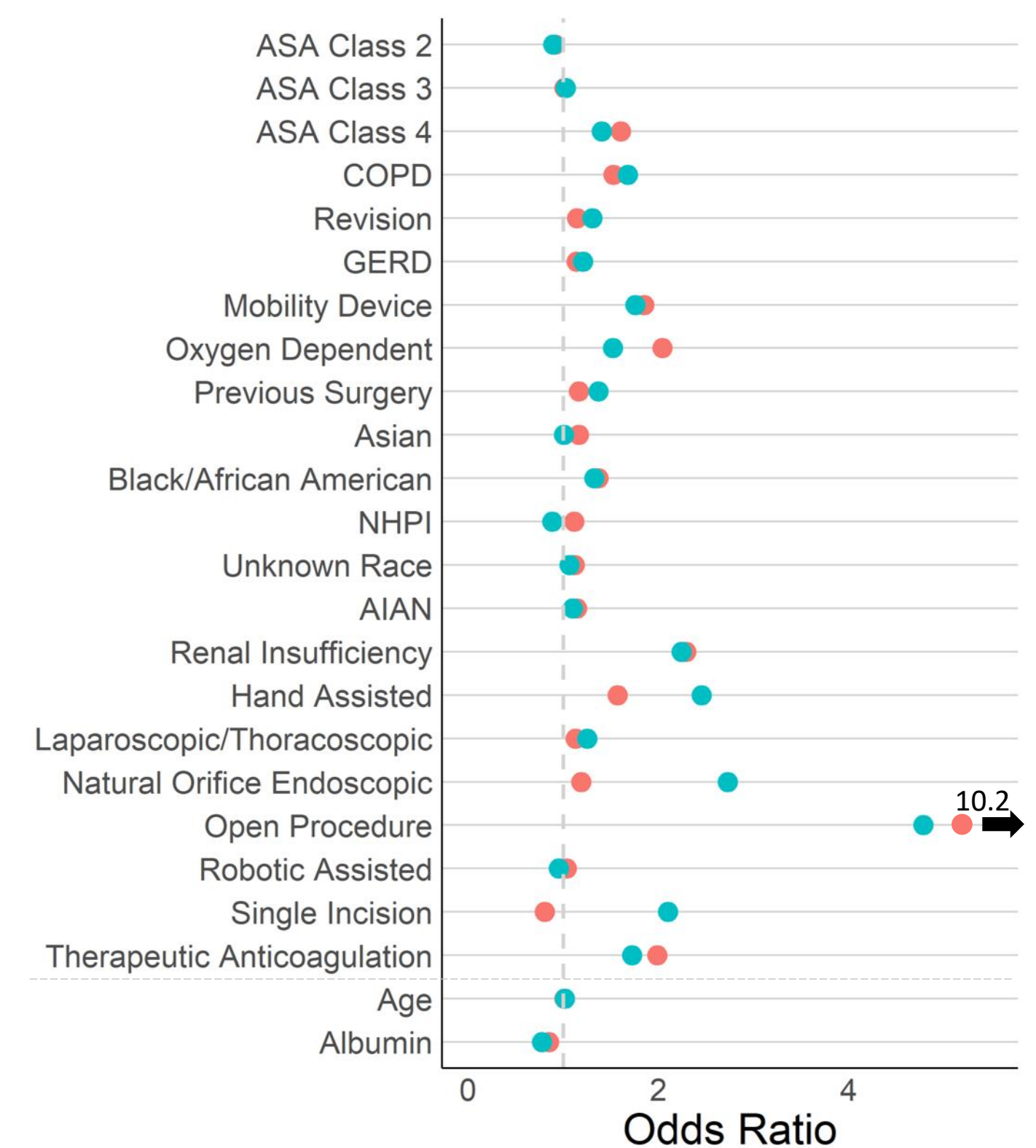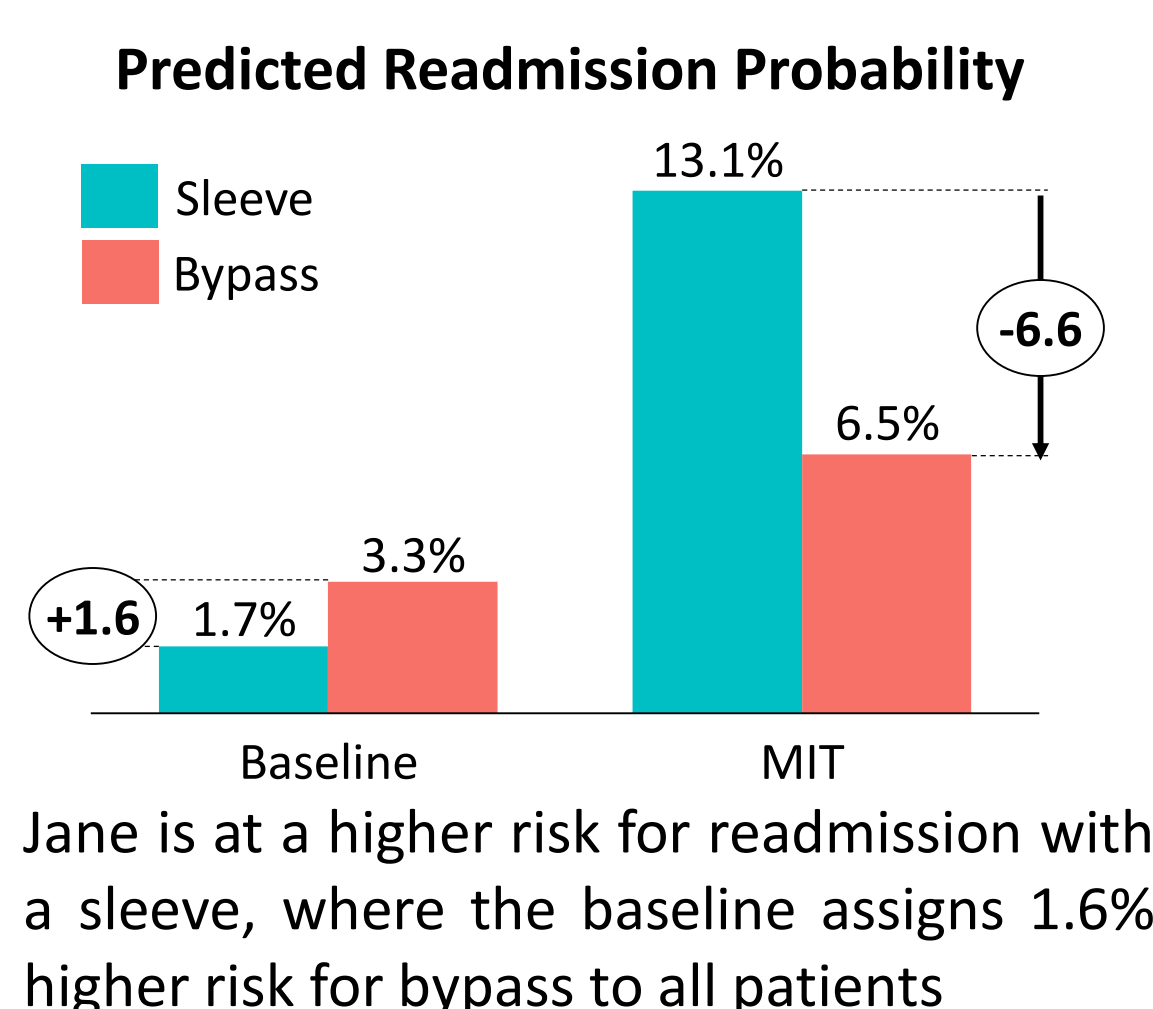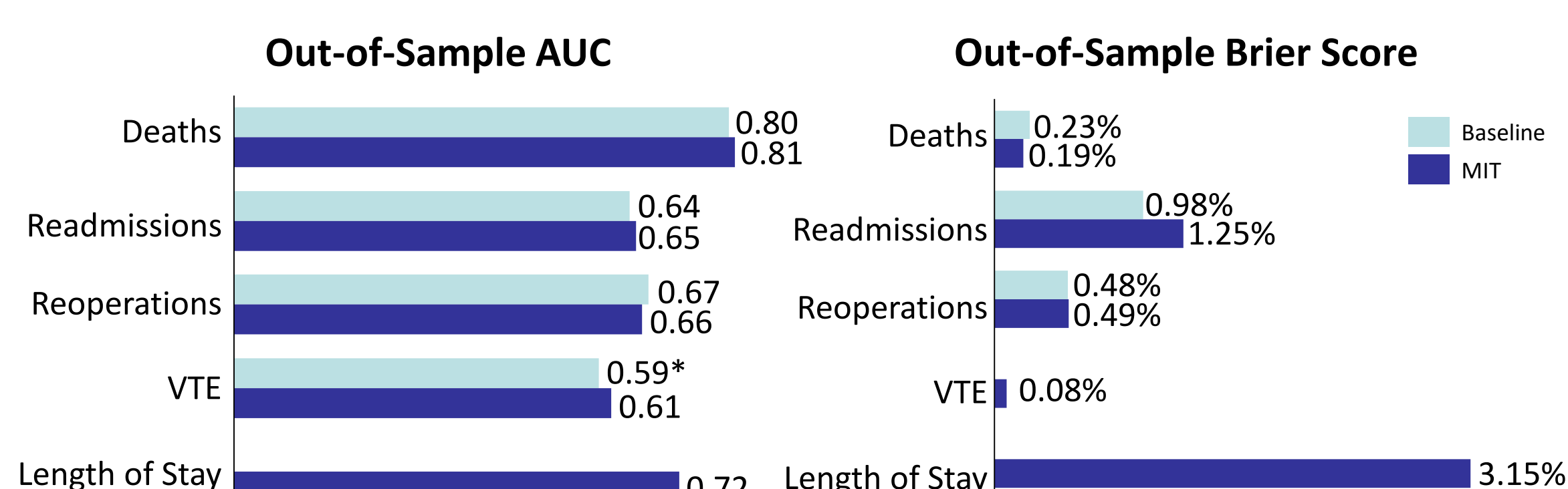● Sleeve   between coefficients at 5% Level

Impact

Jane, 68
BMI: 40.5

Risk Factors:
Sleep Apnea
Hyperlipidemia
High Blood Pressure
Concurrent Enterolysis

Predicted Readmission Probability

Sleeve
Bypass

Baseline: 1.7% (+1.6) / 3.3%
MIT: 13.1% / 6.5% (-6.6)

Jane is at a higher risk for readmission with a sleeve, where the baseline assigns 1.6% higher risk for bypass to all patients

Performance

Out-of-Sample AUC

	Baseline	MIT
Deaths	0.80	0.81
Readmissions	0.64	0.65
Reoperations	0.67	0.66
VTE	0.59*	0.61
Length of Stay		0.72

Out-of-Sample Brier Score

	Baseline	MIT
Deaths	0.23%	0.19%
Readmissions	0.98%	1.25%
Reoperations	0.48%	0.49%
VTE	0.08%	
Length of Stay		3.15%

In AUC (left) and brier score (right), our models achieve similar performance to the baseline, but our models offer interpretability and greater flexibility to give individualized risk assessment

References: Grieco A, Huffman KM, Cohen ME, Hall BL, Morton JM, Ko CY. The Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program bariatric surgical risk/benefit calculator: 30-day risk. Surg Obes Relat Dis. 2021 Jun;17(6):1117-1124. doi: 10.1016/j.soard.2021.02.005. Epub 2021 Feb 11. PMID: 33773930.