Using machine learning algorithms to predict extended length of stay from revision hip arthroplasty procedures

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INTRODUCTION:

While increased wear rates and improvements to implant longevity have revolutionized the success of index total hip arthroplasties, numerous etiologies, including aseptic loosening, mediate post-operative complications indicating revision total hip arthroplasty (rTHA) procedures. In addition to technical complexity and operative heterogeneity, the prevalence of rTHA is expected to increase by more than 70% by 2030. Therefore, characterizing and predicting surgical outcomes following rTHA is of paramount importance in attenuating adverse events, improving patient satisfaction, and mitigating overall cost. This study employs supervised machine learning (ML) algorithms to predict outcomes following rTHA performed for aseptic loosening.

METHODS:

A cohort of patients that underwent elective rTHA surgeries from the ACS-NSQIP database were filtered by CPT code, then sub-filtered by ICD for aseptic loosening. Seven ML algorithms were trained and modeled using patient demographics, co-morbidities, surgical variables, and lab values to predict extended length of stay (LOS) following rTHA. Permutation feature importance (PFI) was also employed on the best performing model to identify and provide weighted variables most predictive of extended LOS.

RESULTS:

1772 patients were included after all selection criteria. The average AUC was 0.740; six models demonstrated good predictive ability with AUC values above 0.7. The best performing model was the gradient boosted classifier (GBC), with PFI identifying age, preoperative hematocrit level, and preoperative creatinine level as the most predictive values for extended LOS.

DISCUSSION AND CONCLUSION:

The results of this study implicate a myriad of readily available variables in extended LOS following rTHA for aseptic loosening. In addition to addressing correctable risk factors, the results of this study could be employed in other domains, including augmenting pre-operative risk stratification and facilitating conversations regarding surgical expectations and planning. Finally, the results corroborate the findings of previous studies that establish ML's utility to augment orthopedic surgery research, and serve as an example for one its multifaceted applications as an invaluable tool in its application to additional domains of orthopedic surgery and healthcare in general.

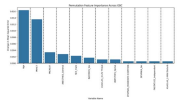

Figure 2: Permutation Feature Importance for GBC

Comorbidities	
Smoking	250
Diabetes	209
Congestive Heart Failure	13
COPD	74
Dialysis	11
Hypertension requiring medication	995
Moderate Exertion	86
At Rest	5
History of Oral Steroid Use	107
Bleeding Disorder	57
Renal Failure	2
Laboratory Values	
Sodium	139.37 ± 2.80
HCT	40.84 ± 4.39
Creatinine	0.98 ± 0.68
WBC	6.93 ± 2.27
BUN	17.82 ±7.93
Platelet Count	243.67 ± 70.54

Table 2: Summary of patient characteristics included in data analysis.

Demographics	n = 1772
Age (year)	65.76 ± 11.83
BMI	29.91 ± 6.50
Gender	(n =)
Male	959
Female	813
Race	
American Indian or Alaskan Native	18
Asian	24
Black or African American	171
Native Hawaiian or Pacific Islander	7
White	1552
Ethnicity Hispanic	47
Functional Status	
Independent	1731
Partially Dependent	37
Totally Dependent	4

Table 1: Demographic summary of patients included in the data analysis.

ASA Classification	
1	41
2	845
3	831
4	55
5	0

Table 3: Summary of ASA physical status classification types for participants.

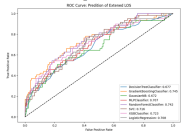

Figure 1: ROC curves for various ML algorithms to predict extended length of stay

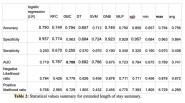

Table 4: Statistical values summary for extended length of stay summary.