A machine learning approach to predicting surgical intervention in patients with vertebral osteomyelitis and discitis (VOD)

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Introduction

- Vertebral osteomyelitis and discitis (VOD) is a serious disease with long-term effects on mortality and morbidity
- Patients with VOD typically present with back pain
  - A nonspecific symptom that can delay diagnosis
- Treatment modalities
  - Medical treatment only
  - Surgical intervention

Objective

To develop a machine learning model able to predict the need for surgical intervention in patients with vertebral osteomyelitis and discitis (VOD).

Methods

- Patients with VOD identified via ICD-10 diagnosis codes M46.2,3,4,5
- Primary outcome of interest
  - Surgical intervention
- Covariates of interest
  - Age, sex, race, first-recorded lab values, first-recorded vital signs, first-recorded culture result, and admit diagnosis
- Preprocessing
  - Missing values replaced via mean imputation
  - Dataset balanced by under-sampling
- XGBoost algorithm used to develop an interpretable model capable of predicting surgical intervention

Cohort characteristics

	Nonsurgical (N=772)	Surgical (N=339)
Age, mean (std)	59.1 years (16.1)	59.4 years (13.3)
Sex		
Male, n (%)	511 (66.2%)	211 (62.2%)
Female, n (%)	261 (33.8%)	128 (37.8%)
Race		
Caucasian, n (%)	460 (59.6%)	256 (75.5%)
Black, n (%)	286 (37.0%)	70 (20.6%)
Other, n (%)	24 (3.1%)	10 (2.9%)
Asian, n (%)	2 (0.3%)	3 (0.9%)

Results

- Total of 1111 visits with a VOD diagnosis
  - 772 nonsurgical visits
  - 339 surgical visits
- Model metrics:
  - Accuracy=0.74
  - Sensitivity=0.77
  - Specificity=0.72
  - AUC=0.82

ROC curve
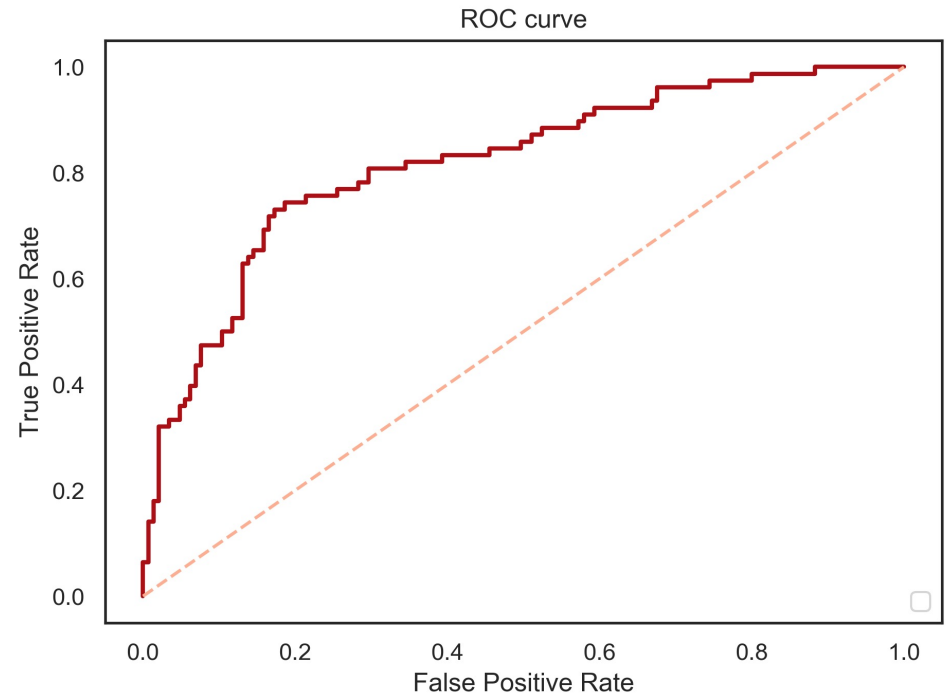
Results

- Top ten model features
  1. Platelet count
  2. HDL
  3. Admit diagnosis of unspecified fever
  4. % neutrophils
  5. % monocytes
  6. Positive *Staphylococcus epidermidis* culture
  7. LDH
  8. Urinary nitrites
  9. Urine pH
  10. O2 flow

Conclusion

- Gradient-boosted decision tree model with readily available clinical data
  - Reliably predicts need for surgical intervention with modest performance
- Early evidence regarding the applicability of modern ML classifiers to spine surgery data
- Next steps to increase prediction power and improve overall performance
  - Further refinement of features
  - Optimization with larger datasets