A Reciprocal Approach to Understanding ICU Stays in Alcohol-associated Liver Disease: Bridging Disease-specific Modeling and Clinical Knowledge

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Background

Decompensated alcohol-associated liver disease (ALD) often requires critical care

Prior machine learning (ML) studies predicting ICU length of stay overlook sociodemographic and ALD-specific factors

There is a gap in understanding the full scope of ICU stays for patients with ALD

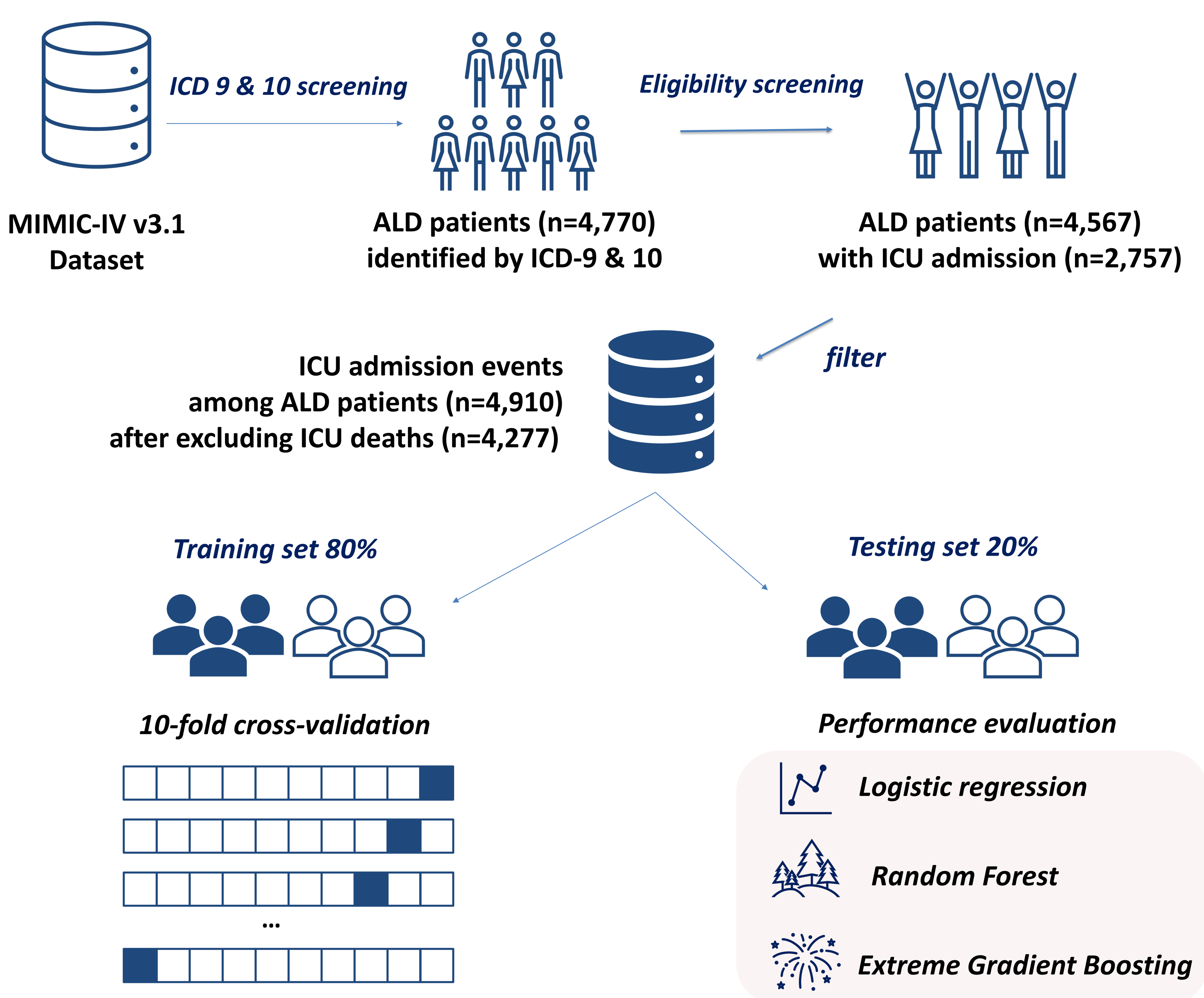
Objectives

To identify the optimal ML model for predicting extended ICU stays among patients with ALD

To emphasize disease-specific features for model optimization

To examine the bidirectional relationship between model interpretation and clinical knowledge

Methods



Outcome : Extended ICU stay (≥4 days)

Features : Information available upon ICU admission

Software : R version 4.5.1

Preprocessing
- Identify and preprocess outliers
- Address data entry errors
- Drop or impute missing data

Balance accuracy and clinical utility
- Transform features into ALD-specific predictors (e.g., AST/ALT ratio, MELD-Na score)

Relate findings to clinical knowledge
- Feature importance scores to explain model's reasoning

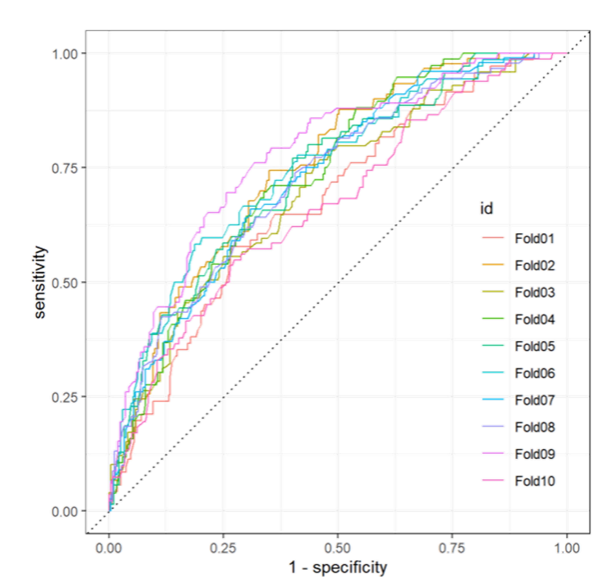
Prevent overfitting
- 10-fold cross-validation on the training set
- Performance evaluation on the testing set

Results

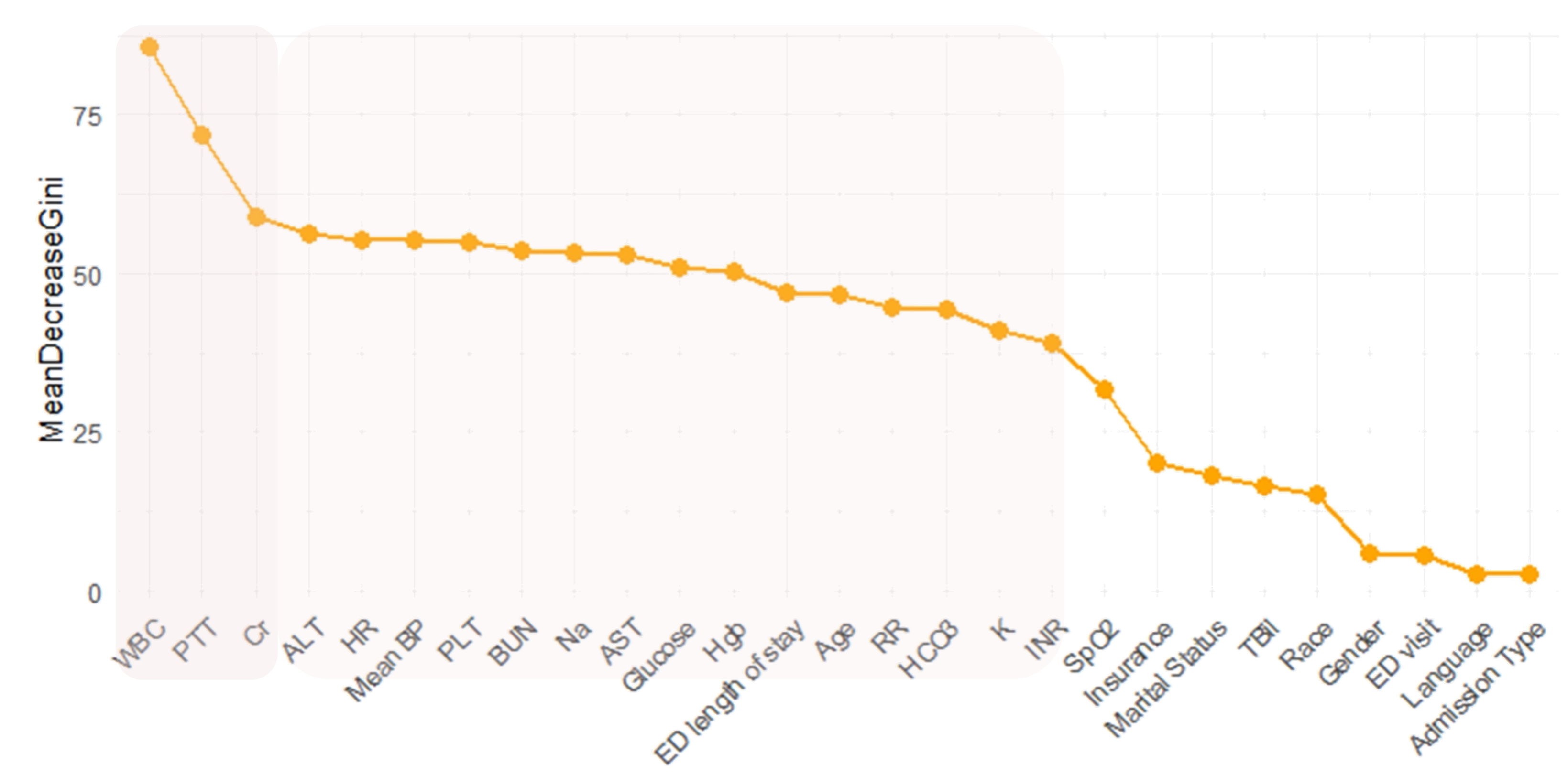
Mean ICU length of stay = 3.4 ± 5.6 days

Extended ICU stays (≥4days) = 24.9%

Successful classification of extended ICU stays by integrating ALD-specific features into ML algorithm
- Random Forest demonstrated best performance
- Focusing on top 10 significant features compromised performance
- Incorporating AST/ALT ratio and MELD-Na slightly improved performance



Model	Feature selection	AUC value
Logistic regression	All predictors	0.688
XG Boost	All predictors	0.705
Random Forest	All predictors	0.718
	Top 10 predictors†	0.704
	Optimization‡	0.707



Comparable to previous findings on ICU length of stay
- Mean blood pressure & heart rate are key predictors

Importance of ALD-specific variables
- Liver enzymes (ALT, AST)
- Coagulation dysfunction (Platelet, PTT)
- Infection and electrolyte imbalances associated with ascites (WBC, sodium)
- Indicators of hepatorenal syndrome (Cr, BUN)

Conclusion & Implications

Feature selection enhanced interpretability, but slightly reduced predictive performance
- Likely due to limiting the influence of individual features

Limitations in generalizability
- Male 71.4% White 78.2% English-speaking 94.0%

Considerations for future research
- Include additional subtle features (e.g., clinical notes, temporal aspects, workflow variability, comorbidities)
- Test the model on a demographically diverse sample

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