

AI-Based Risk Prediction for Major Complications After Breast Surgery in 737,730 Patients

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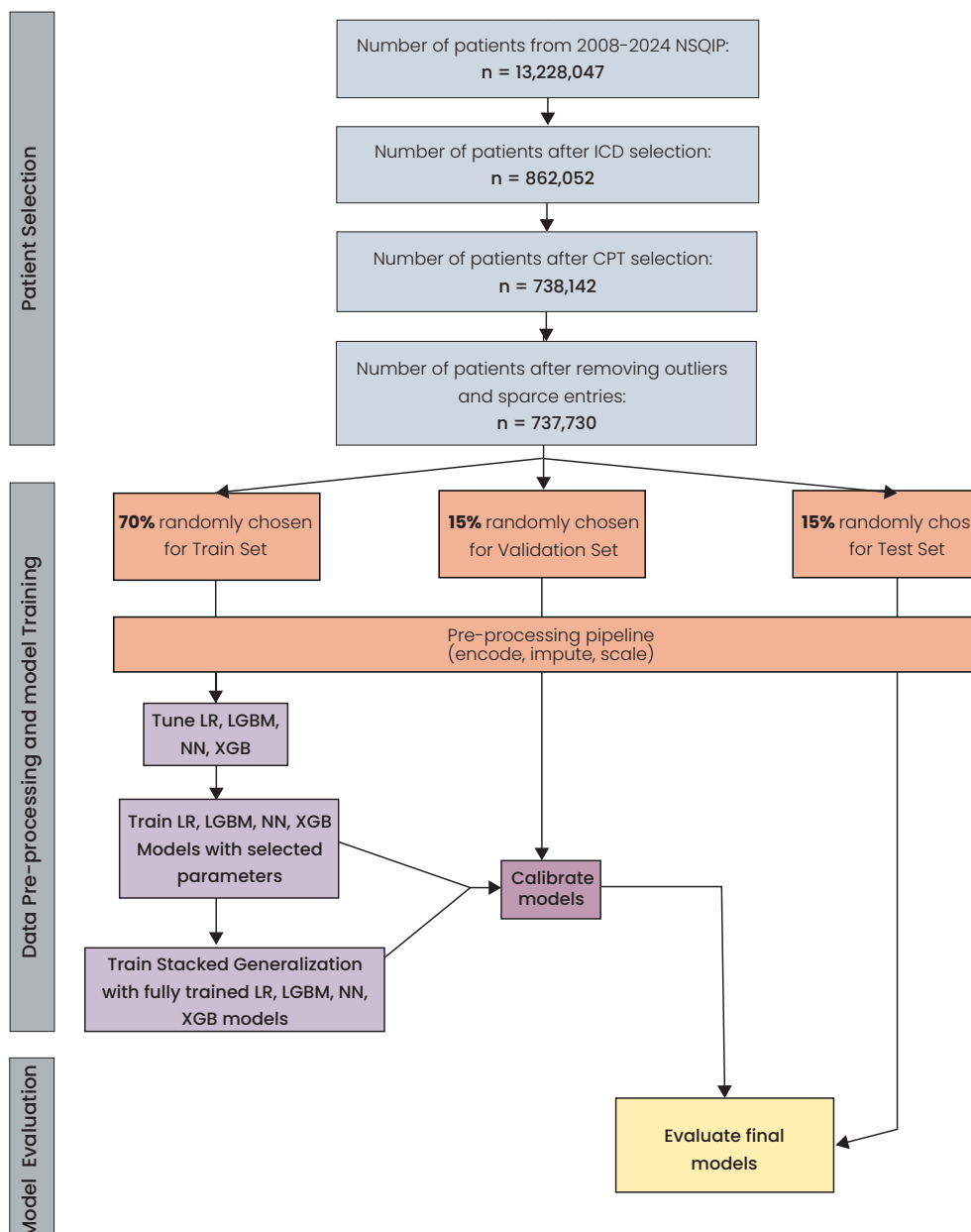
BACKGROUND

- Breast surgery has heterogeneous complication risk
- Current tools poorly calibrated & non-procedure-specific
- ML enables nonlinear, patient-specific prediction

STUDY OBJECTIVE

To develop and validate interpretable, outcome-specific machine learning models that accurately predict major 30-day postoperative complications following oncologic and reconstructive breast surgery, and to translate these models into a clinically accessible decision-support tool (PRO-BREAST) to improve preoperative risk stratification, patient counseling, and surgical planning.

METHODS



RESULTS

Figure 1. Risk stratification across outcome-specific models Patients were stratified into four risk categories (very low, low, moderate, high) based on model-predicted probabilities. Observed complication rates increased monotonically across risk strata, demonstrating effective clinical risk stratification and strong agreement between predicted and observed outcomes.

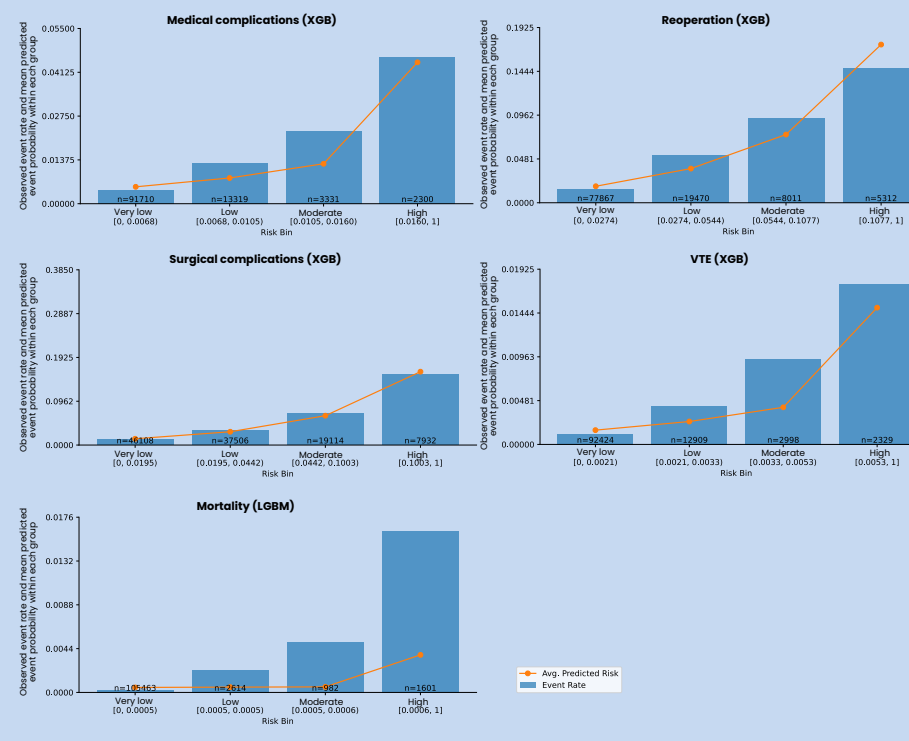


Figure 2. Feature importance using SHAP analysis Relative SHAP values identify key contributors to model predictions across outcomes. Patient frailty and comorbidity burden primarily drive medical complications and mortality, while procedural complexity is most strongly associated with surgical complications.

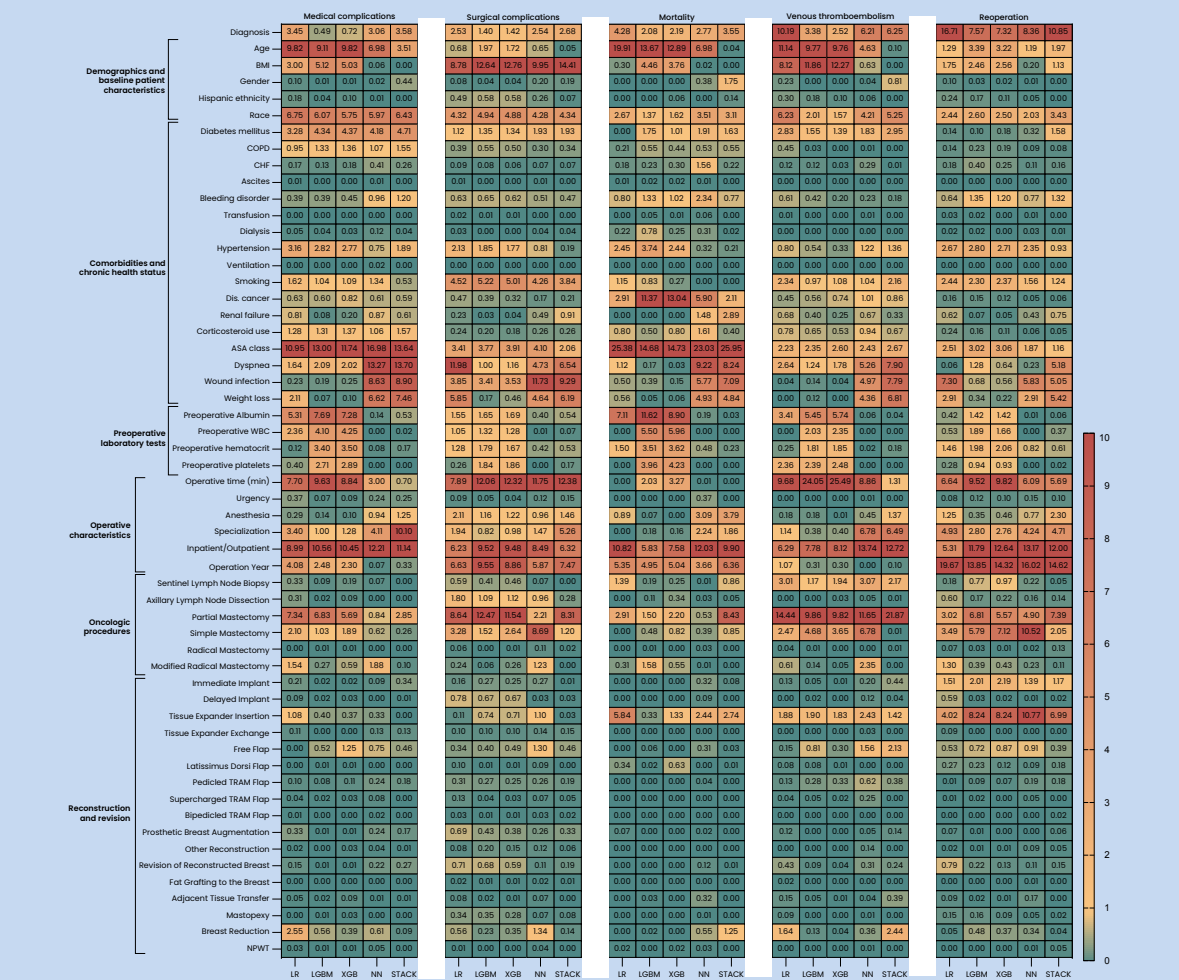
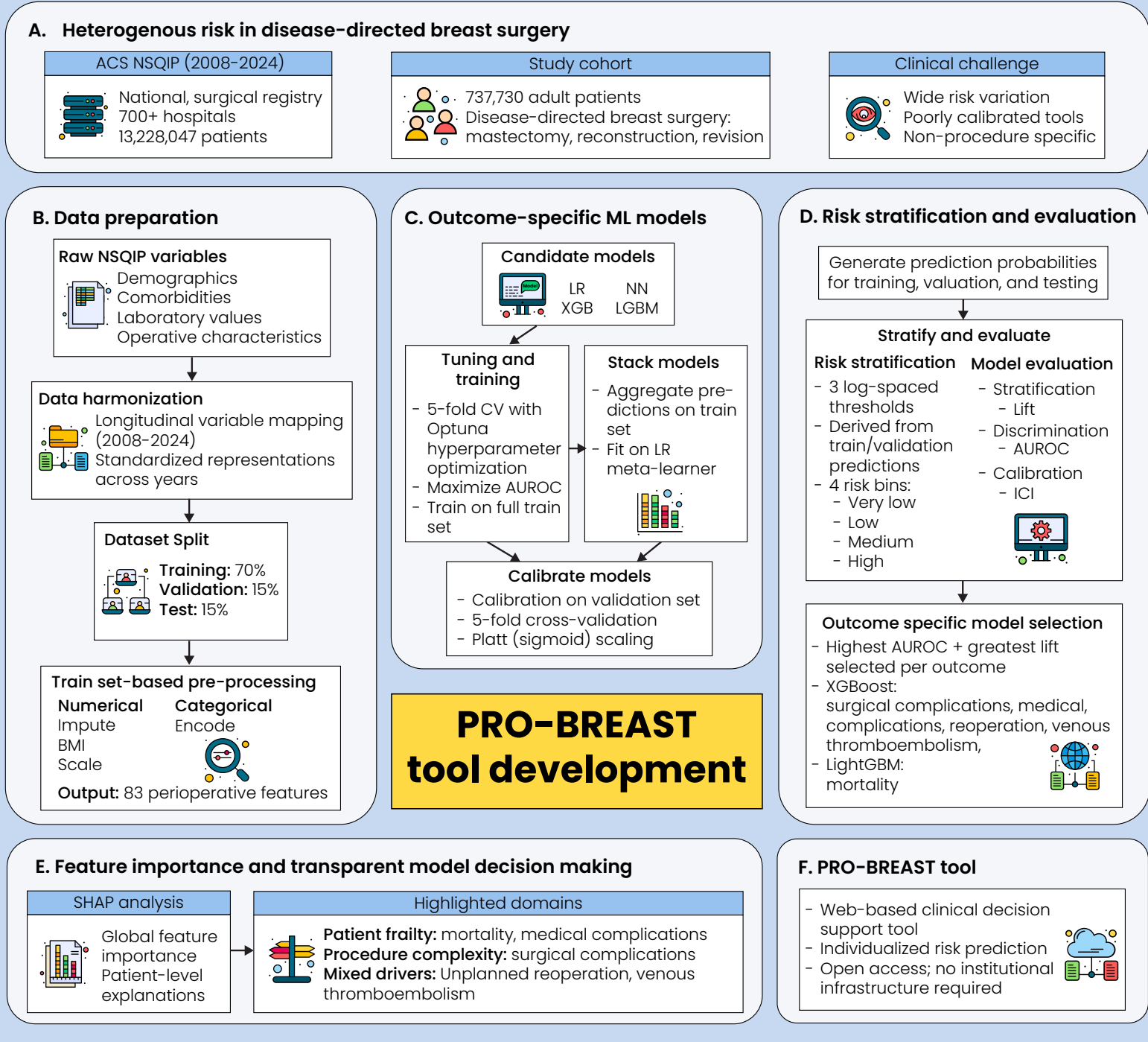


Figure 3. PRO-BREAST model development and clinical deployment Overview of the end-to-end pipeline from national dataset extraction and preprocessing to machine learning model development, validation, and deployment as a web-based clinical decision support tool for individualized risk prediction and shared decision-making.



CONCLUSIONS

- ML models accurately predict 30-day complications after breast surgery.
- Demonstrate strong calibration and risk stratification.
- PRO-BREAST enables individualized, interpretable risk prediction.

LIMITATIONS

- Limited to 30-day outcomes
- Registry data constraints (missing granularity)
- Requires external validation

IMPLICATIONS

- Enables personalized preoperative counseling with patient-specific risk estimates.
- Improves identification of high-risk patients for targeted optimization and surveillance.
- Highlights modifiable risk factors (e.g., smoking, nutritional status, comorbidities).
- Facilitates shared decision-making between surgeons and patients.
- Provides a scalable, web-based tool that can be integrated into clinical workflows.

ACKNOWLEDGEMENTS

- None