

Prediction of complications and risk factor analysis in breast cancer reconstruction surgery

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Motivation

Predicting postoperative complications following breast reconstruction using clinical factors is essential for improving patient care. Yet, most studies focus on **individual or limited complication outcomes**. Our work trains and validates models for **five major post-reconstruction complications**, cross-references key features, and identifies Significant risk factors.

1 Study Population

This retrospective population-based cohort study utilized data from Clalit Health Services (**CHS**), the largest integrated healthcare provider and payer system in Israel.

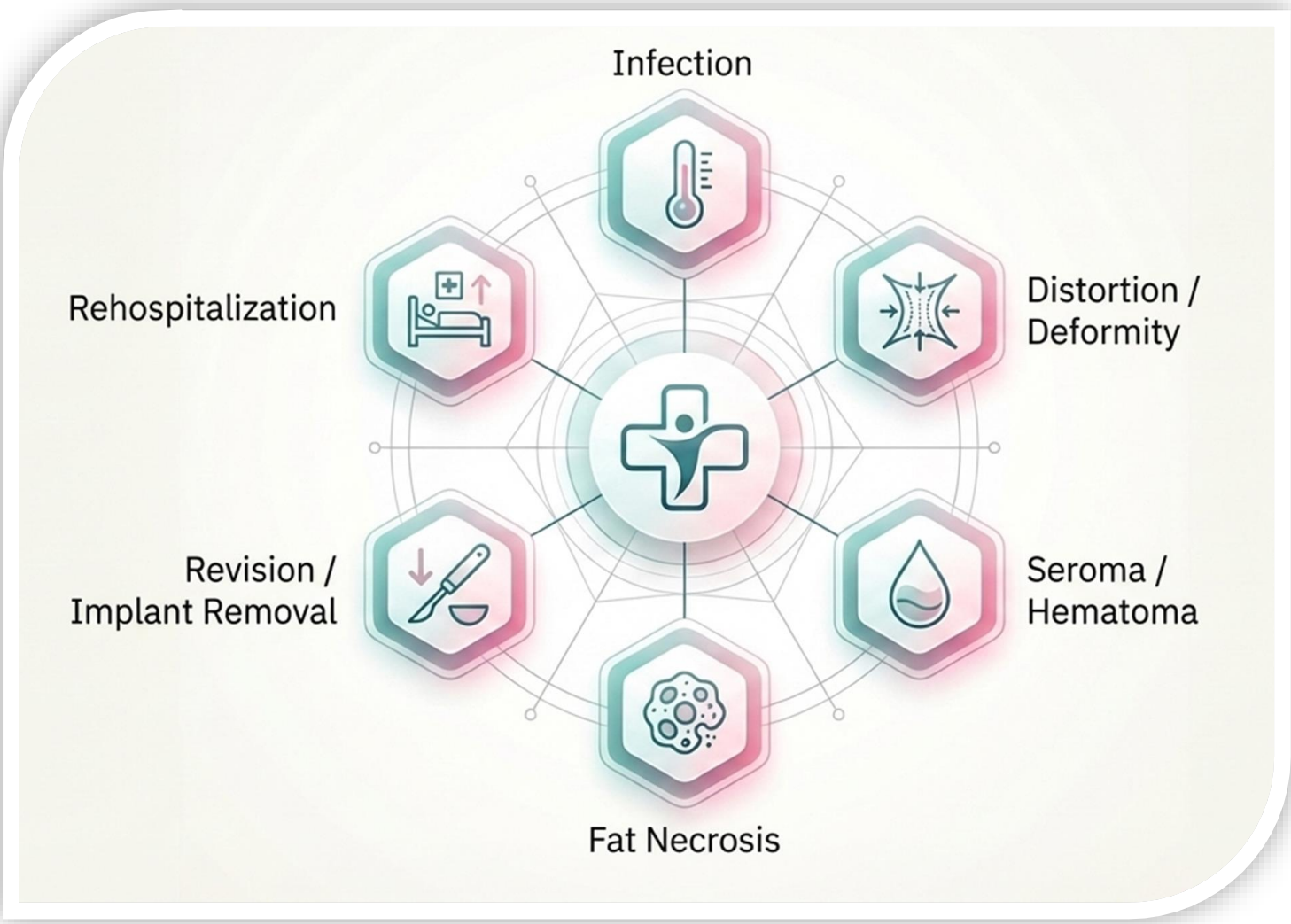
Inclusion Criteria: Female patients aged 18 years or older, insured by CHS, who underwent partial or complete mastectomy with subsequent breast reconstruction for breast cancer- related indications between 2001 and 2023.

Sample size of final cohort $n=5,620$.

2 Modeling Methods

Complications analysis:

- Prediction of **any complication** within the year following reconstruction (binary outcome)
- Prediction of five major complications: **Infection, Deformity, Seroma/Hematoma, Fat Necrosis, and Implant Revision/Removal**
- Prediction of patient **readmission**
- Survival analysis with any complication as the event.



Cross- referencing: SHAP values identified high-ranking features, which were compared across all predictive models and the Cox proportional hazards model to identify consistent risk factors.

3 Results

Infection and **Fat necrosis** models achieved the highest balanced accuracy (**Fat necrosis:** 0.67, 95% CI ;infection: 0.61, 95% CI), while **Seroma/Hematoma** reached 0.63 (95% CI). The other models' performance metrics can be viewed in the added table

BMI, Charlson Comorbidity Index, cholesterol (total and HDL), radiation, and smoking history were significantly associated with outcomes in Cox survival analysis and consistently ranked among the most important SHAP predictors across models.

The concordance between SHAP-based feature importance and **Cox model** significance is shown in the following figure.

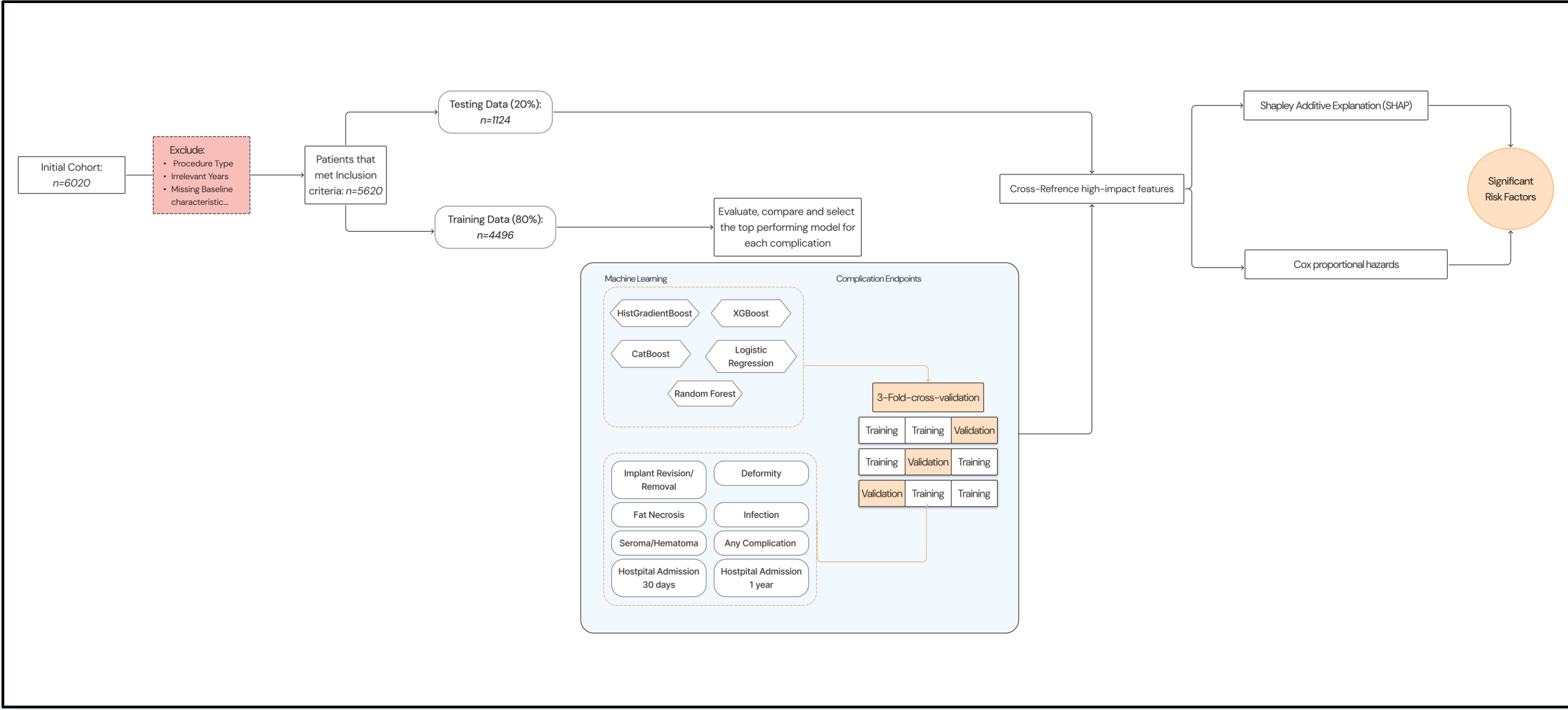


Fig: Workflow and process diagrams for the study

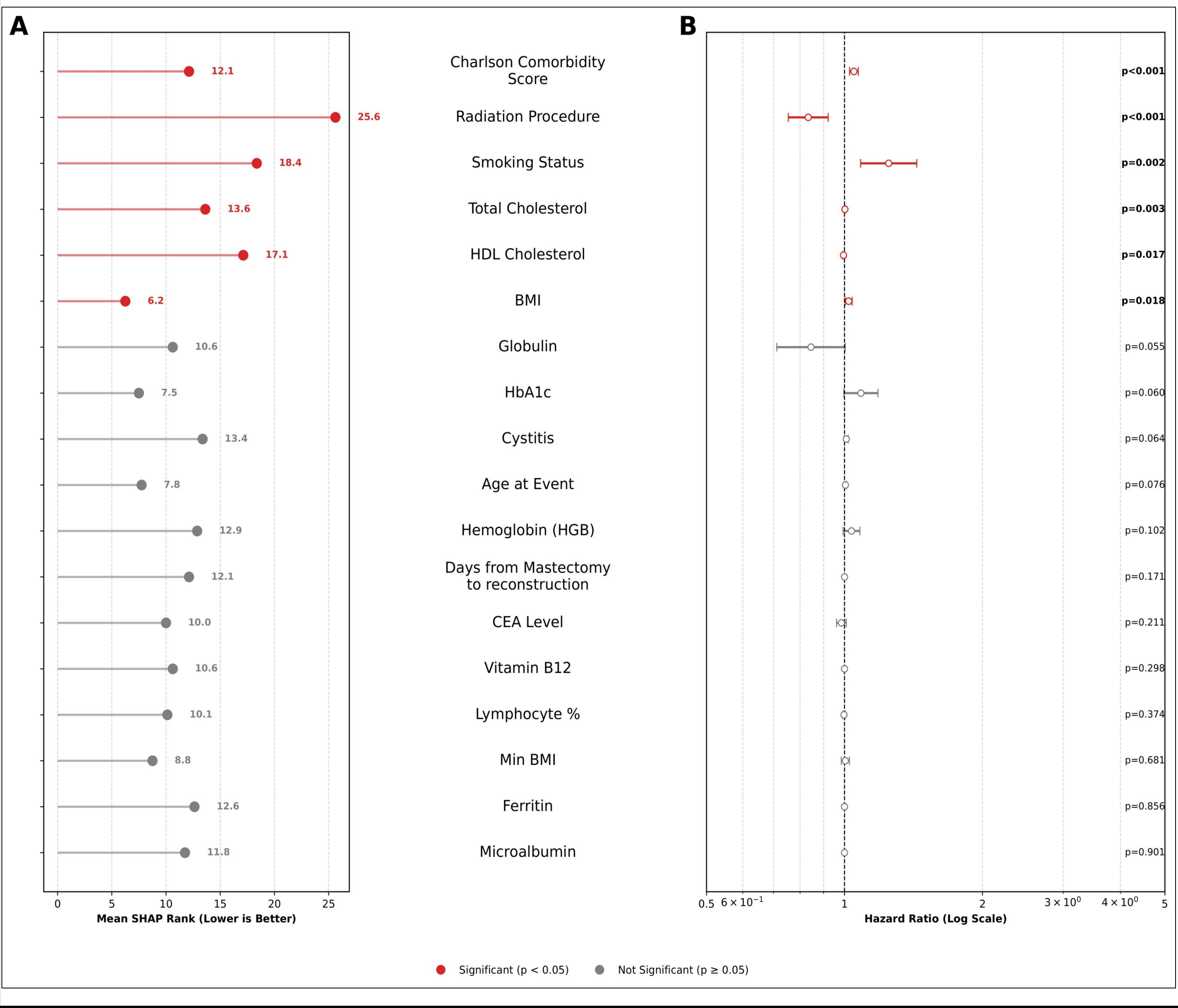


Table: Feature Predictive importance versus clinical risk

4 Conclusion

Key risk factors (BMI, Charlson Comorbidity Index, and cholesterol) demonstrated consistent influence across predictive and survival models. This concordance supports their use in risk stratification and informed patient counseling following breast reconstruction.

Outcome	Prevalence	Balanced Accuracy (Mean ± 95% CI)	ROC-AUC (Mean ± 95% CI)
Deformity	2.7%	0.59 ± 0.07	0.56 ± 0.11
Implant Revision/Removal	8.5%	0.58 ± 0.05	0.56 ± 0.07
Fat Necrosis	0.9%	0.67 ± 0.11	0.61 ± 0.16
Infection	9.2%	0.62 ± 0.04	0.62 ± 0.06
Seroma/Hematoma	1.5%	0.63 ± 0.08	0.59 ± 0.13
Any Complication	32.1%	0.55 ± 0.02	0.54 ± 0.04
Admitted within 30 days	7.7%	0.57 ± 0.04	0.54 ± 0.06
Admitted any time	36.2%	0.58 ± 0.03	0.58 ± 0.03

Table: Model performance metrics