

A Dual-Phase AI and Machine Learning Approach to Predict Operative Mortality in Aortic Surgery

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THE CLINICAL GAP

- EuroSCORE II and STS risk calculators offer **limited granularity** for aortic surgery
- Neither tool identifies **patient subpopulations** within this heterogeneous cohort
- Clinicians rely on **coarse population-level estimates** rather than individualized risk profiles
- Result: suboptimal perioperative planning and variable outcomes

"What we need: a tool that tells you not just the average risk, but **which patient this is.**"

METHODS

- Cohort:** 829 patients, LIMR, Jan 2014–Jun 2025. Variables: age, sex, surgical priority, procedure type, indication, CPB time, cross-clamp time, prior intervention, OR extubation.
- Phase 1 (Unsupervised):** PCA for dimensionality reduction → K-medoids clustering to identify phenotypes.
- Phase 2 (Supervised):** Logistic Regression, Random Forest, XGBoost. 80:20 split, stratified 5-fold cross-validation. Benchmarked vs. EuroSCORE II.

829

Patients

Hidden Structure Discovered

3 biologically distinct phenotypes. Mortality in Cluster C was **7×** that of Cluster A (14.6% vs 2.1%, $p < 0.001$) — invisible to conventional scoring.

5%

Operative Mortality

Superior Predictive Performance

XGBoost AUC 0.95 substantially outperformed EuroSCORE II. Top drivers: surgical priority, cross-clamp time, age — clinically meaningful and deployable.

AUC 0.95

XGBoost (cross-val: 0.83)

Immediate Clinical Translation

Phenotype-aware prediction enables pre-operative ICU positioning, perfusionist briefing, and earlier shared decision-making before the first incision.

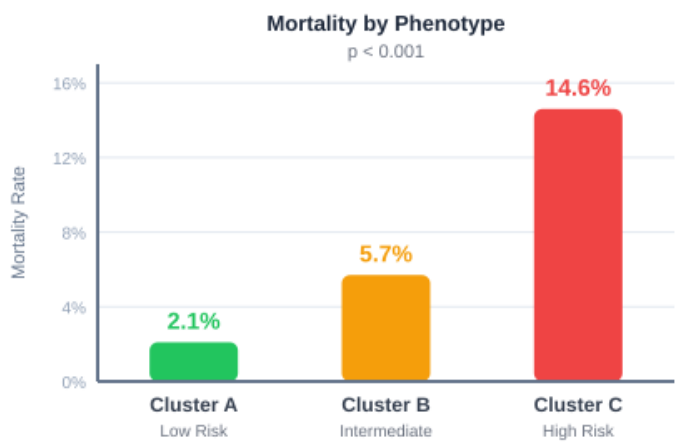
AUC 0.73

EuroSCORE II

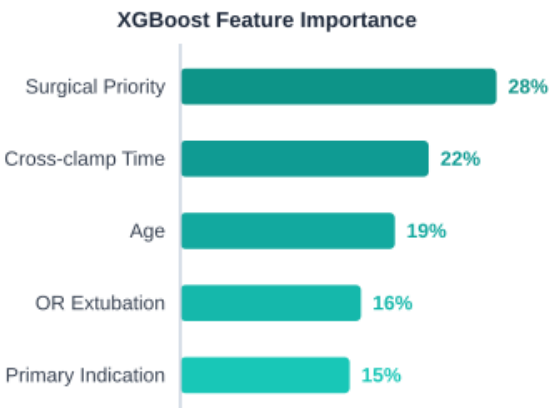
Take-Home Message

Aortic surgery patients are *not* one population. We can now identify the high-risk Cluster C patient **before the chest is open**, and act on it.

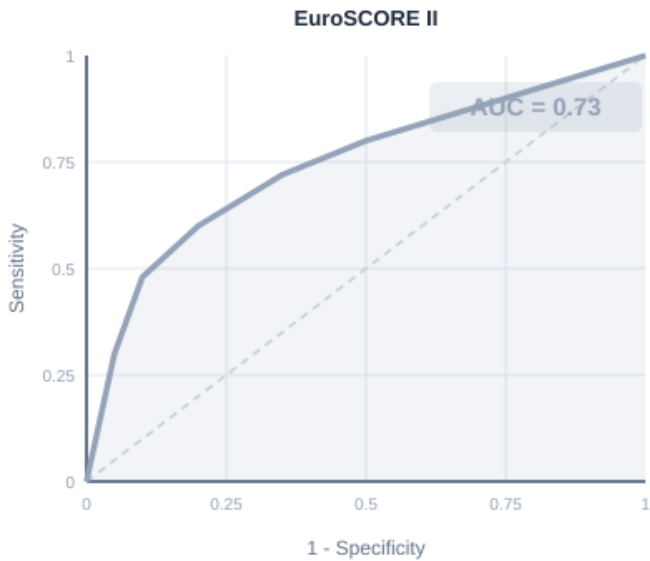
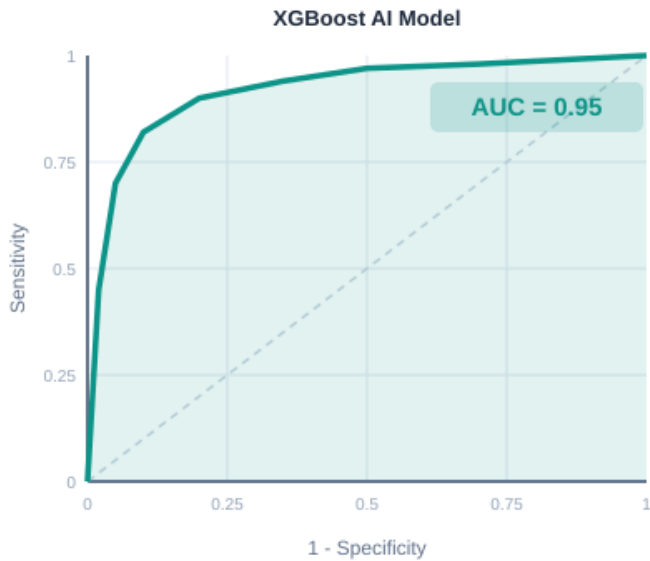
PHASE 1: PHENOTYPING



FEATURE IMPORTANCE



PHASE 2: XGBOOST VS EUROSORE II



XGBoost: AUC 0.95 | Accuracy 92% | Precision 64% | Recall 70% | F1 67% | EuroSCORE II: AUC 0.73