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METHODS NOTE · Peer-reviewed · Published · Live dashboard figures

CardioOracle: Predicting Cardiovascular Trial Outcomes Using Bayesian Historical Borrowing and Design Feature Analysis

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Abstract

Can we predict the probability of a cardiovascular clinical trial meeting a primary endpoint from historical trial characteristics and design features? Our tool was trained on 784 labelled Phase 2/3 and Phase 3 cardiovascular trials from the ClinicalTrials.gov AACT database, with outcomes assigned via automated p-value extraction, confidence-interval heuristics, and manual landmark curation. CardioOracle combines Bayesian historical borrowing from similar completed trials, conditional power analysis using endpoint-specific formulas, and L2-regularised logistic meta-regression on 18 design features in a weighted ensemble.

The model achieved an AUC of 0.787 (95% CI 0.75 to 0.82; Brier score 0.169) in-sample and 0.745 (Brier 0.196) on 133 temporally held-out post-2020 trials. Leave-one-out analysis confirmed directional accuracy for major outcomes trials such as DELIVER, FINEARTS-HF, and EMPACT-MI. Historical trial data contain quantitatively exploitable signals concerning cardiovascular trial success that can meaningfully inform future prospective design decisions, but predictions are currently limited by observational training data and cannot replace prospective trial monitoring or adaptive interim analyses.

References

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3. Borenstein M, Hedges LV, Higgins JPT, Rothstein HR. Introduction to Meta-Analysis. 2nd ed. Chichester: Wiley; 2021.

Interactive dashboard figures

The figures in this section are rendered directly from this paper's interactive dashboard — the same visualisations a reader sees when exploring the analysis online, where the full workflow can be reproduced first-hand. **Interactive dashboard:** https://mahmood726-cyber.github.io/cardiooracle/

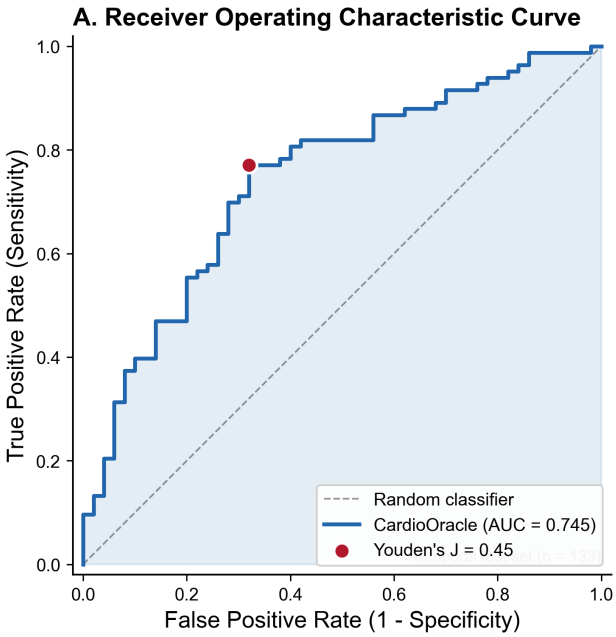

Figure 1. **Roc curve** Rendered directly from the article's live interactive dashboard.

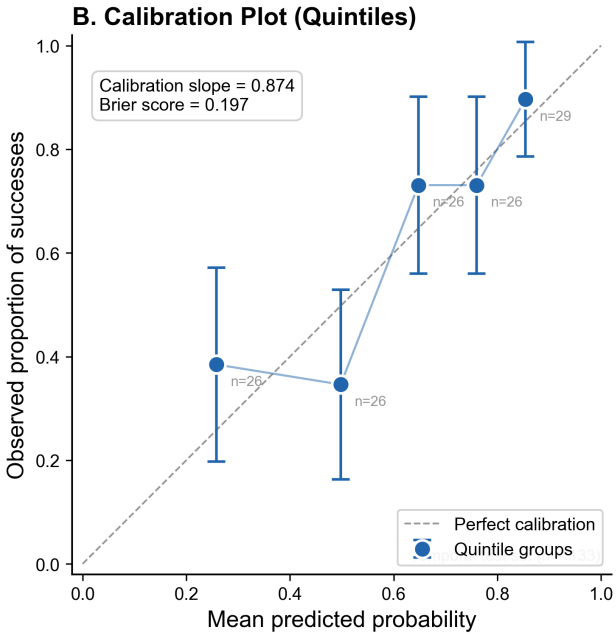

Figure 2. **Calibration** Rendered directly from the article's live interactive dashboard.

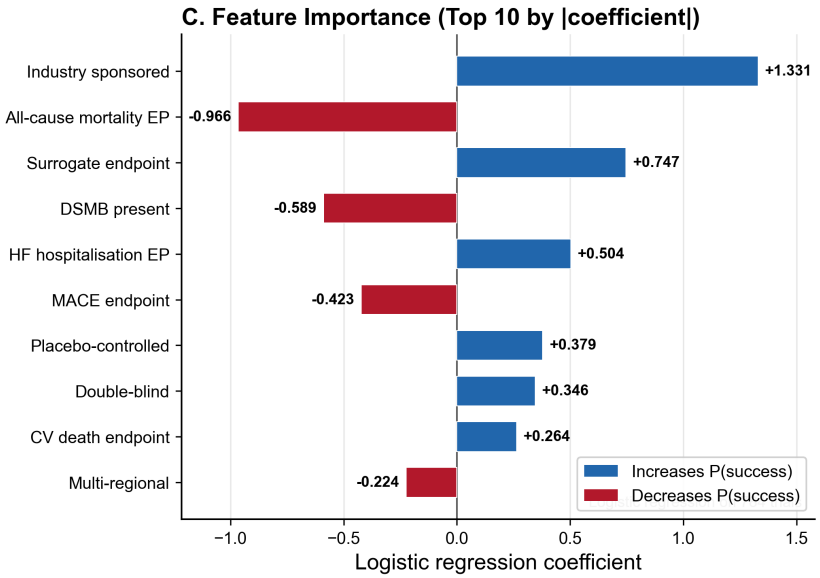

Figure 3. **Feature importance** Rendered directly from the article's live interactive dashboard.

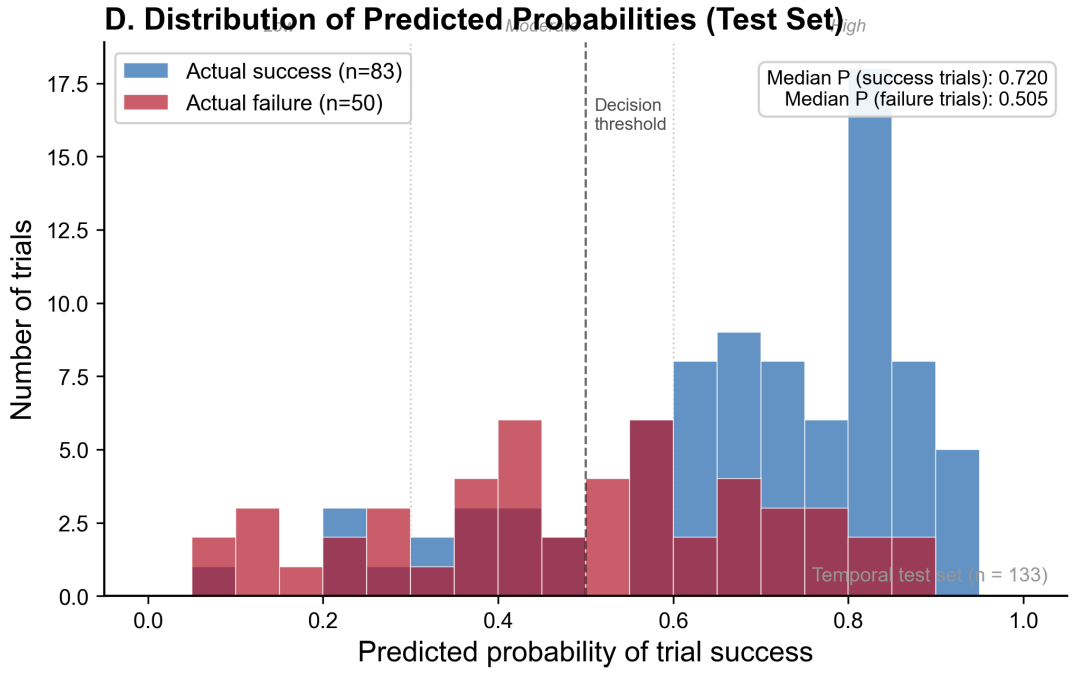

Figure 4. **Prediction distribution** Rendered directly from the article's live interactive dashboard.

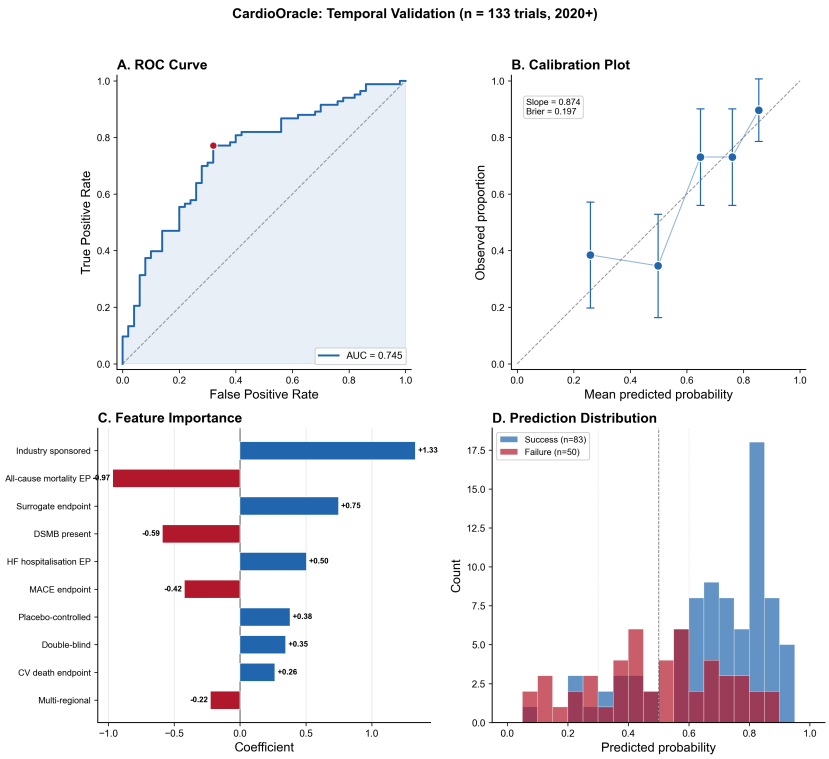

Figure 5. Composite all Rendered directly from the article's live interactive dashboard.

HOW TO CITE

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