



Multivariable Risk Prediction Model for Severe Rebound Pain after Upper Limb Surgery involving Single-Shot Brachial Plexus Block

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INTRODUCTION

Single-shot brachial plexus blocks are widely used for upper extremity surgeries. While they offer excellent analgesia and recovery benefits, up to 50% of patients may experience rebound pain after block resolution.¹ Identifying high-risk patients may guide selective use of continuous nerve catheters and reduce unplanned healthcare visits.² This study aimed to develop and internally validate a multivariable model to predict severe rebound pain after upper extremity surgery involving single-shot brachial plexus blockade.

METHODS

A retrospective cohort study was conducted at St. Paul’s Hospital, Vancouver, Canada (2016–2019), with ethics approval (UBC REB #H20-01349). Adults undergoing upper extremity surgery with single-shot brachial plexus blocks were included. Patients with uncontrolled pain in PACU, continuous catheters, or incomplete follow-up were excluded. Severe rebound pain was defined as a transition from NRS ≤3 in PACU to NRS ≥7 within 48 hours.

A priori predictors were age, sex, surgery type, planned admission, local anesthetic type, dexamethasone use, and intraoperative anesthesia type. Model performance was evaluated using area under the receiver operating characteristic curve (AUROC), Nagelkerke’s R², scaled Brier score, and calibration slope.*

RESULTS

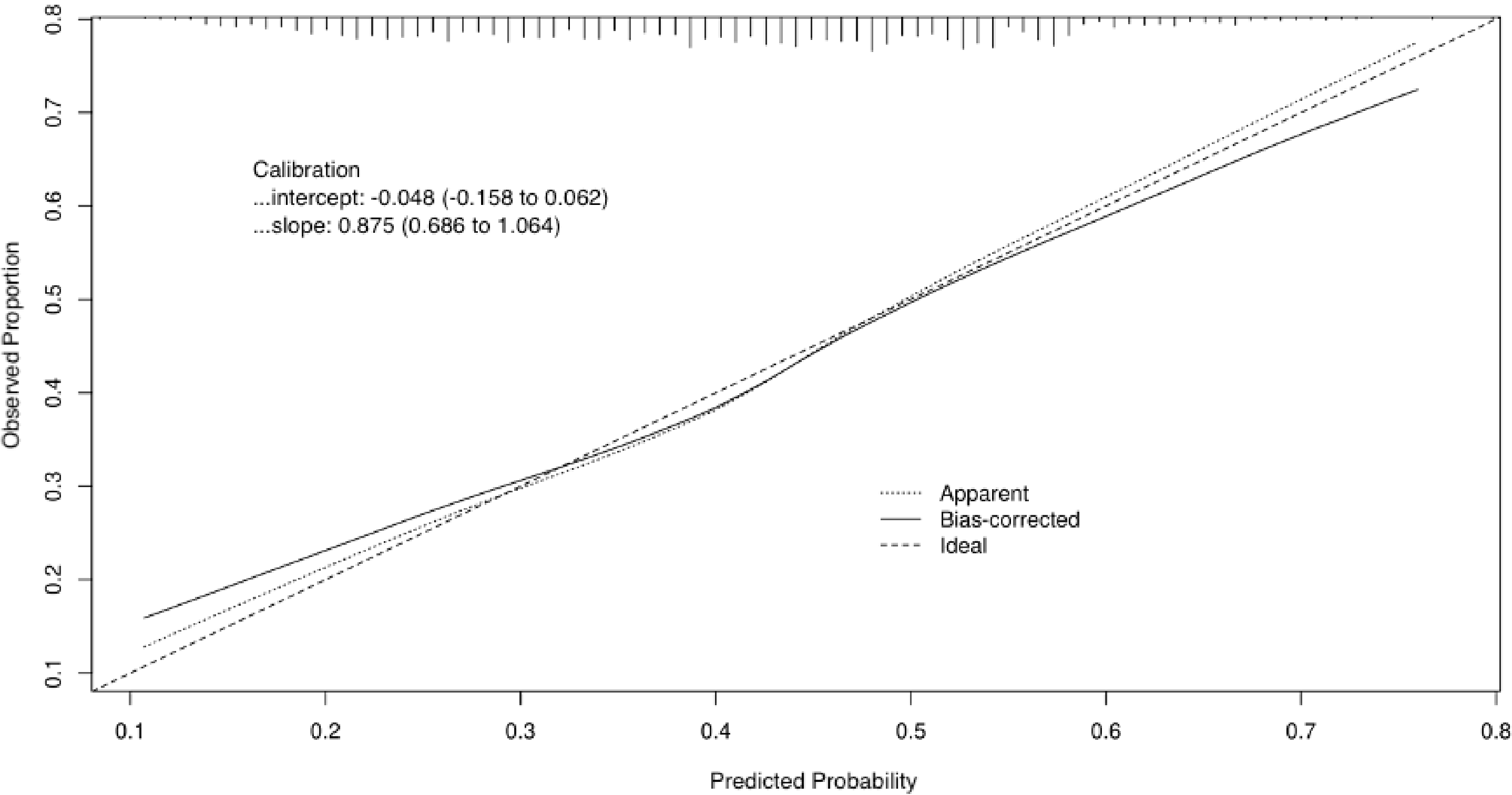
Out of the 1,530 patients (mean age 48 ±17 years) in the cohort, 574 of 1,441 (39.8%) experienced severe rebound pain. Those affected were more likely to be younger, female, and to have undergone longer tourniquets time, open bony or trauma-related procedures without dexamethasone.^{1,2} Internal validation revealed poor model performance, with AUROC of 0.651 (95% CI 0.622–0.679), Nagelkerke’s R² of 0.084, and Scaled Brier Score 0.062. Calibration slope of 0.875 (95% CI 0.686–1.064).

*AUROC: Measure of discrimination, or the model’s ability to accurately discriminate those with or without the outcome
Brier score: Quantifies the squared differences between actual and predicted risks
Nagelkerke’s R²: Quantifies the degree of outcome variation that is explained by variables included in the model
Calibration: Indicates the extent of agreement between observed outcomes and predicted risks

Table 1. Discrimination measures of the primary model for severe rebound pain risk prognostication.

Performance Measures	Original	Optimism	Corrected	95% CI
AUROC	0.667	0.016	0.651	0.622, 0.679
Nagelkerke’s R ²	0.110	0.026	0.084	NA
Scaled Brier Score	0.081	0.020	0.062	NA

Figure 1. Calibration Plot. Calibration of the model shows that actual risks may be less extreme than those predicted by the model at the extremes of ranges.



DISCUSSION

- 40% of patients experienced severe rebound pain despite well-controlled PACU analgesia, 7.8% of whom required unplanned healthcare visit due to pain
- Predictors aligned with previous lower extremity findings (younger, female, tourniquet duration, no dexamethasone use, open bony trauma)²
- Model performance was weak-to-moderate (AUROC 0.65; R² 0.084)
- Routine perioperative data are insufficient for reliable prediction
- Future models should incorporate psychological and patient-centered factors (anxiety, catastrophizing, previous pain experience, chronic pain, opioid use)³
- Tourniquet duration was predictive but limited to postoperative use

CONCLUSION

A multivariable model using routine clinical data showed limited predictive performance for severe rebound pain after upper extremity surgery. Future models should integrate psychosocial and procedural variables like predicted surgical duration for personalized pain management.

REFERENCE

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