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Costas T. Lambrew Research Retreat 2024

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### Machine Learning Approaches for Neurological Risk Stratification Within 6 Hours Of Cardiac Arrest

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## Background

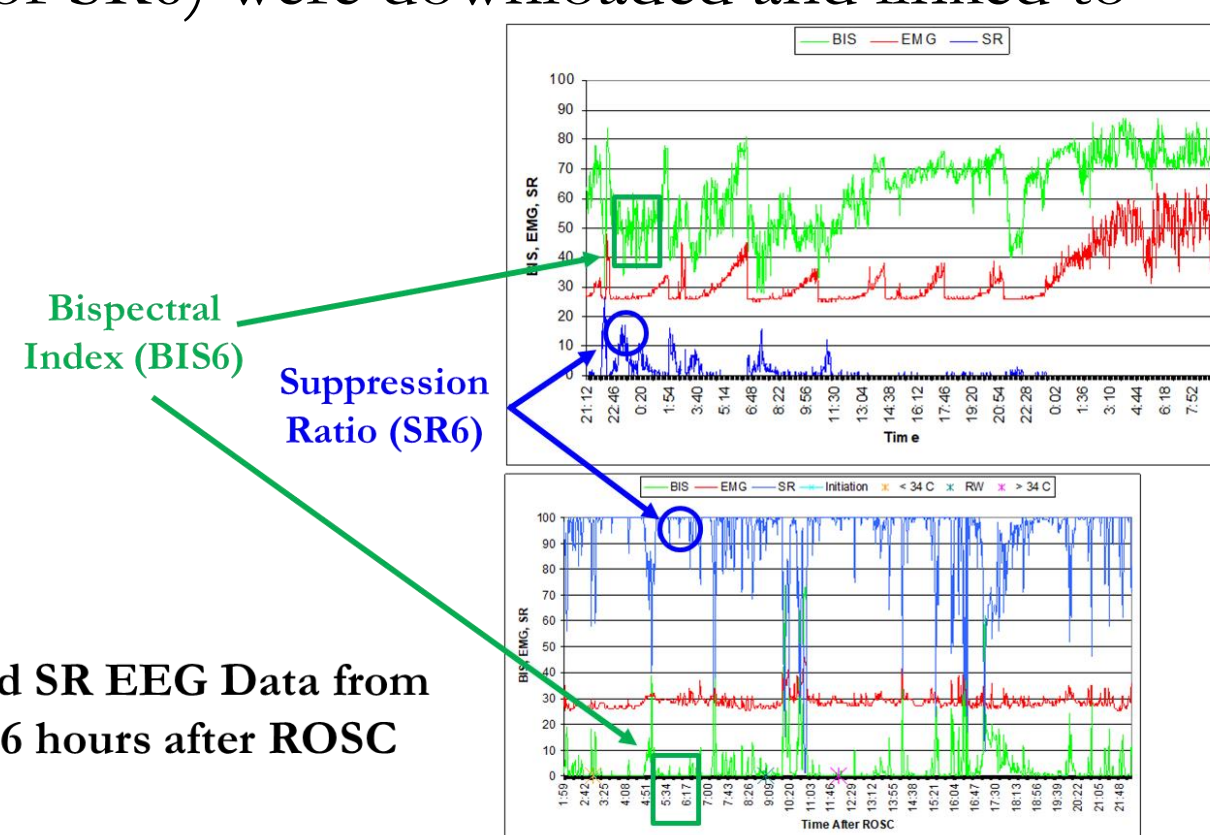
- Prognostication of neurological outcome should be delayed at least 72 hours after cardiac arrest. Early stratification of risk severity provides important information enabling improved medical decision making, research enrollment, and precision medicine approaches.
- We propose that electroencephalography (EEG)-derived indices are valid biomarkers of severity of neurological injury very early after cardiac arrest.
- This study was designed to assess the relative impact of early clinical data and processed EEG indices in the first 6 hours after **recovery of spontaneous circulation (ROSC)** after cardiac arrest.

## Methods/Approach

- Data from the first 6 hours after ROSC in the International Cardiac Arrest Registry (INTCAR) from Maine Medical Center including demographics, cardiac arrest data, admission vital signs and laboratory results were extracted.
- Processed EEG indices at 6 hours after ROSC (bispectral index or BIS6 and suppression ratio or SR6) were downloaded and linked to INTCAR data.



Figure 1: BIS and SR EEG Data from BIS monitors at 6 hours after ROSC

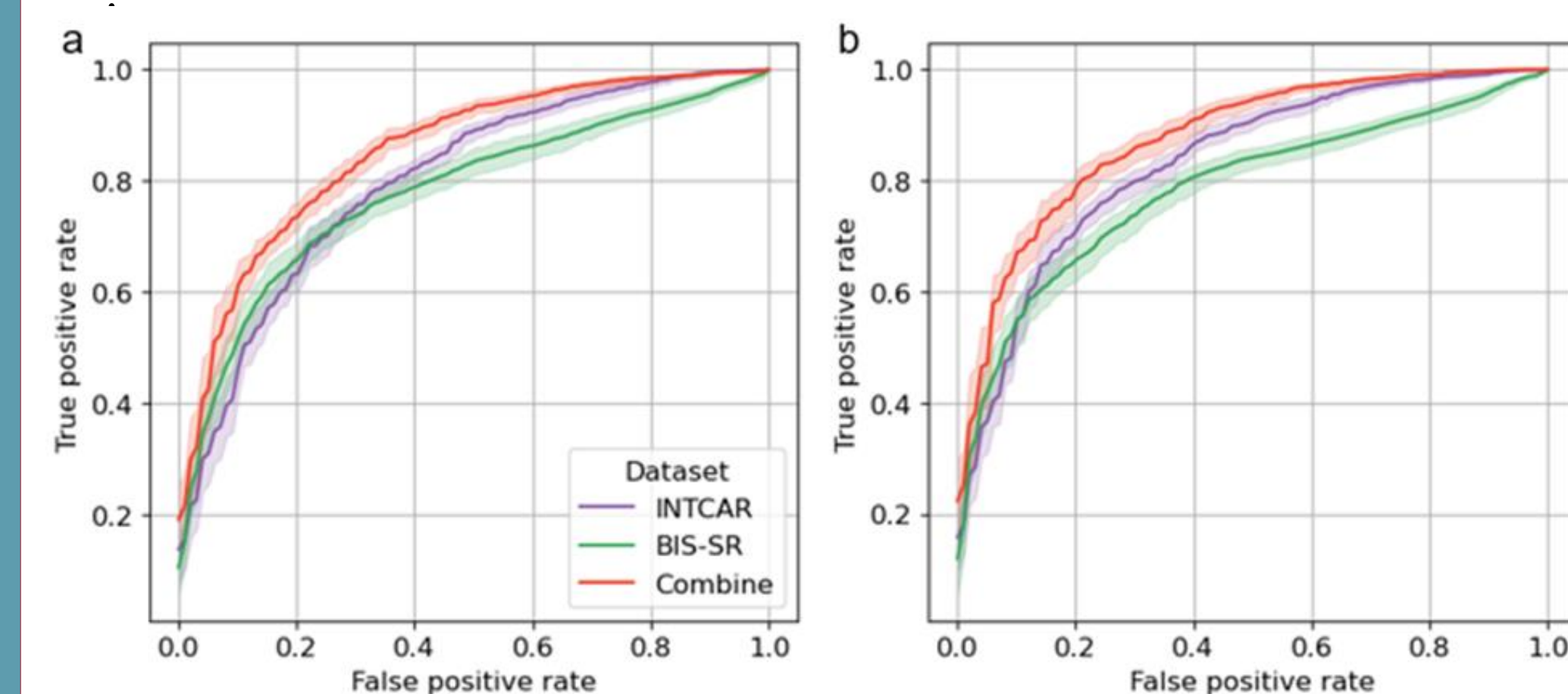


- Cerebral Performance Category (CPC) scores at 6-month follow-up (primary outcome) and hospital discharge were dichotomized into good (CPC = 1-2) and poor (CPC = 3-5) outcomes.
- Three models were trained: INTCAR data, EEG data, and combined INTCAR and EEG BIS6-SR6.
- 6 machine learning algorithms were applied: Catboost, random forest, Xgboost, Adaboost, support vector machine and logistic regression.
- Area-Under-the-Curve (AUC) calculated using ROC curves.
- Variable importance measures** were analyzed using the mean decrease in impurity in random forest analyses.
- Parsimonious model used the top n features to build the model and test AUC to find the threshold for n.

## Results

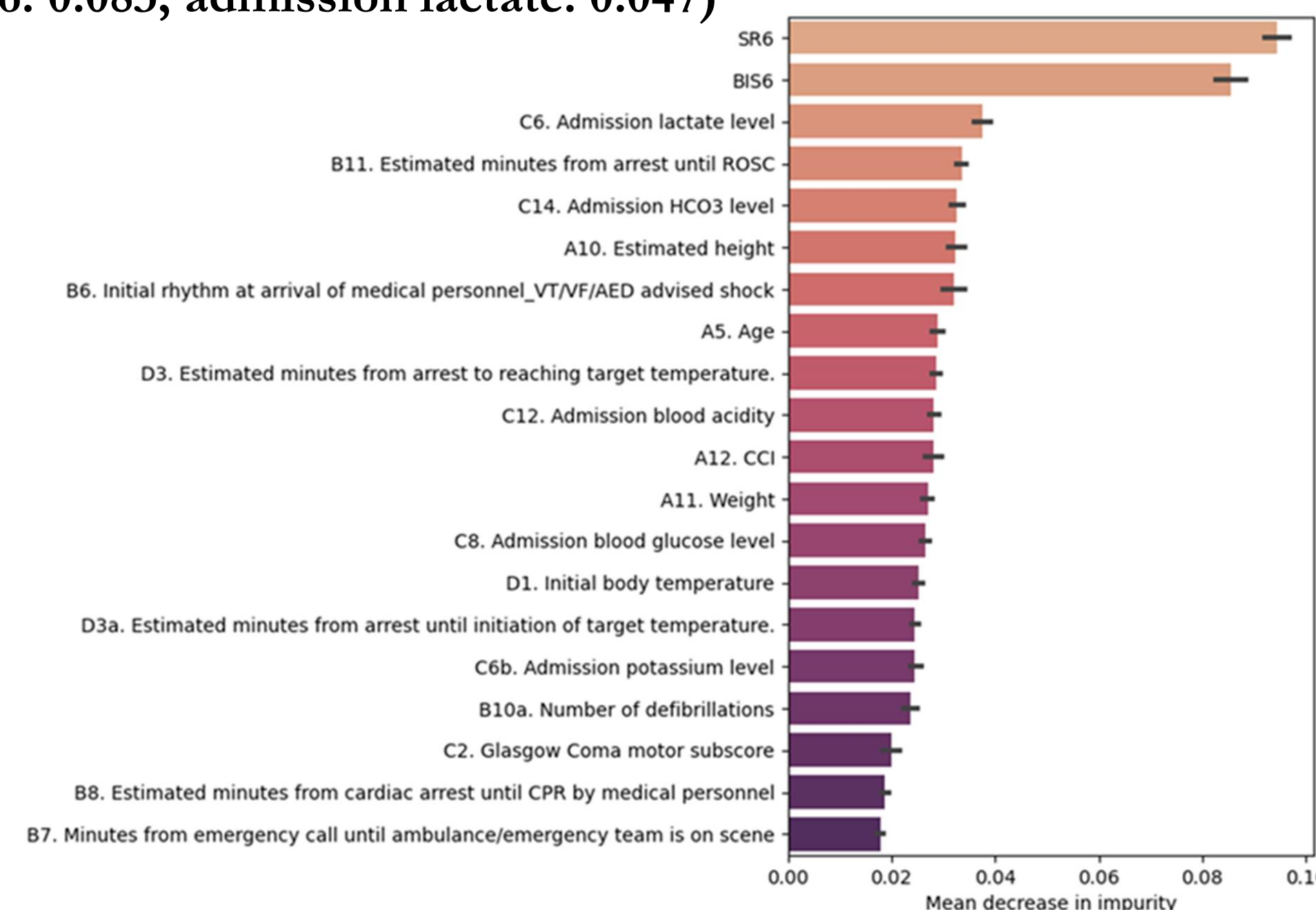
- Among 913 included patients, median age was 59 years (95%CI 23-85), 623 (68%) were male, initial rhythm was shockable in 405 (44%) patients, and average time to ROSC was 23 (95%CI 3-73) minutes.
- Survival to hospital discharge occurred in 41% (364/893), and poor outcome occurred in 72.7% at 6-month follow-up (607/835).

Figure 2: AUC to Predict Outcome a) at discharge b) 6 month followup



- a) For **CPC at discharge**, AUC:
- 0.80 for INTCAR data (purple)
  - 0.77 for BIS6 - SR6 (green)
  - 0.85 for combined INTCAR and EEG (red)
- b) **CPC at 6-month follow-up**, AUC:
- 0.83 for INTCAR (purple)
  - 0.79 for BIS6 - SR6 (green)
  - 0.88 for combined INTCAR and EEG (red)

Figure 3: SR and BIS achieved the greatest mean decrease in impurity for Variable Importance Measurement (SR6: 0.103, BIS6: 0.083, admission lactate: 0.047)



## Results

Figure 4: Processed EEG recordings with **Bispectral Index (BIS)** and **Suppression Ratio (SR)** from three different patients:

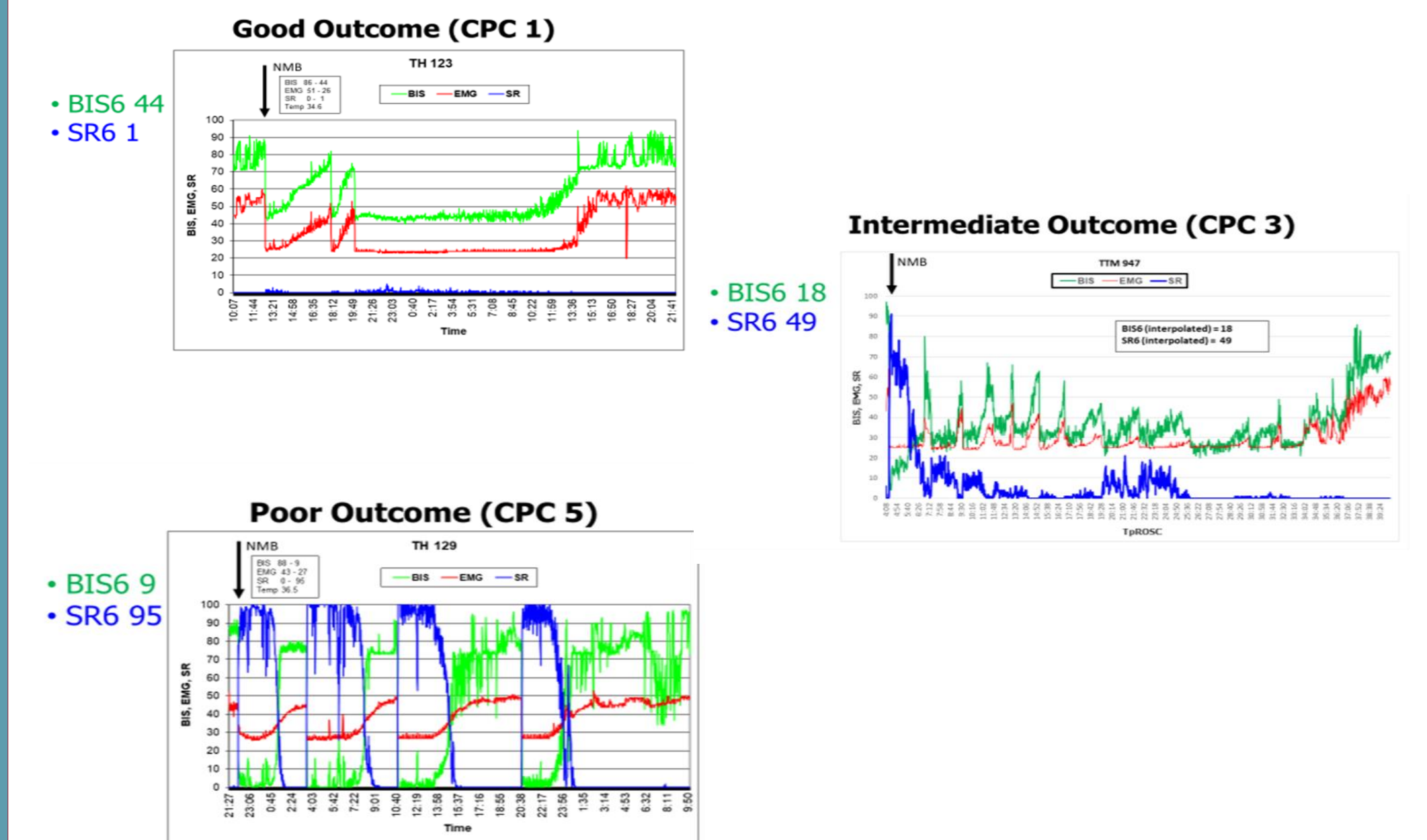
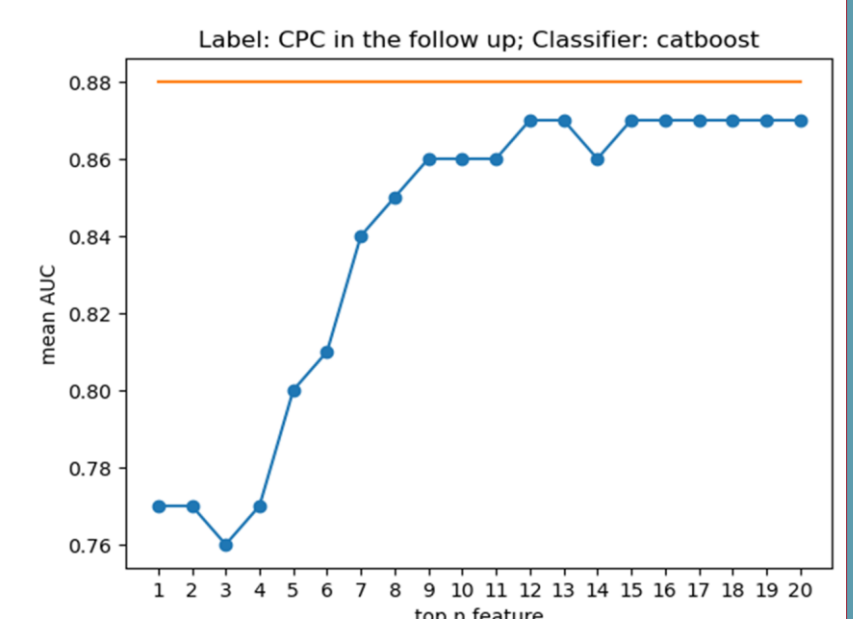


Figure 5: Parsimonious model includes 12 variables, AUC 0.87



- The addition of early processed EEG variables BIS and SR significantly contributes to identification of neurological risk in the first 6 hours after ROSC.
- Combined with early clinical data, this novel addition provides reliable risk stratification and may allow a personalized medicine approach to TTM after cardiac arrest

## Funding and Contact

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