



Using Machine Learning Algorithms and Wearable Technology for the Early Detection of Postoperative Complications After Cardiothoracic Surgery



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INTRODUCTION & OBJECTIVE

Accurate and easy-to-implement methods to detect complications before symptom onset after cardiothoracic surgery are needed.

The objective of this pilot study was to evaluate whether a machine learning algorithm—previously developed for the early detection of Covid-19—could be extended to the early detection of postoperative complications after cardiothoracic surgery.

METHODS

Design: Prospective observational cohort study conducted from July 2021 to February 2023

Inclusion Criteria: Patients aged 18 years or older scheduled to undergo cardiothoracic surgery for heart and lung disease.

Exclusion Criteria: Individuals with mental capacity and/or cognitive impairment, specific comorbidities, and/or not owning a smart phone or having an email address.

Wearable Data: Patients were provided with a Fitbit Charge 4 or 5 device, and wore the device for at least 1 week prior to surgery and 90-days postoperatively.

Clinical Data: Patient demographics and pre-, peri-, and post-operative data were collected from electronic medical records. A modified version of the EuroQol5D18 (EQ-5D) daily survey was administered

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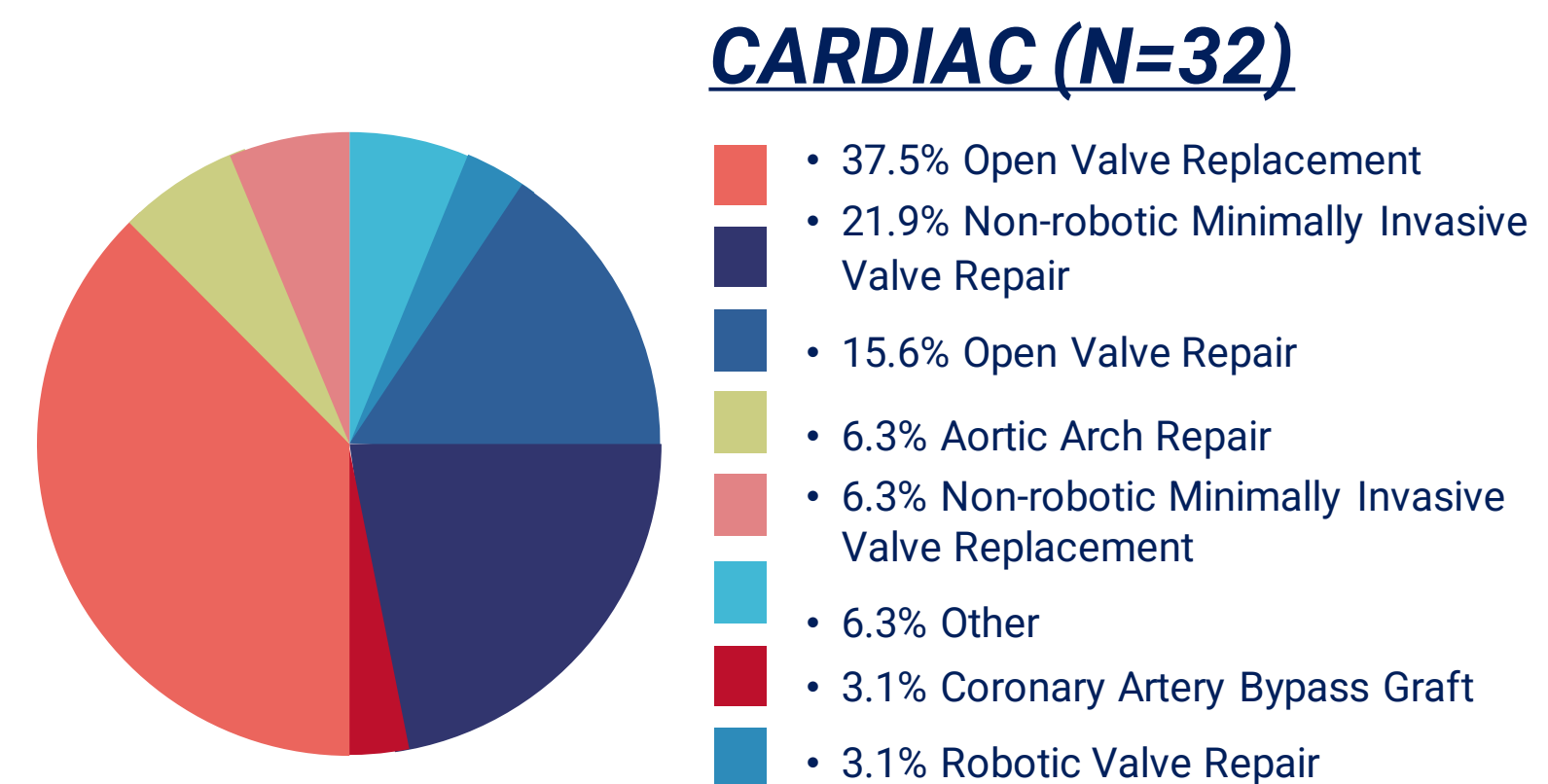
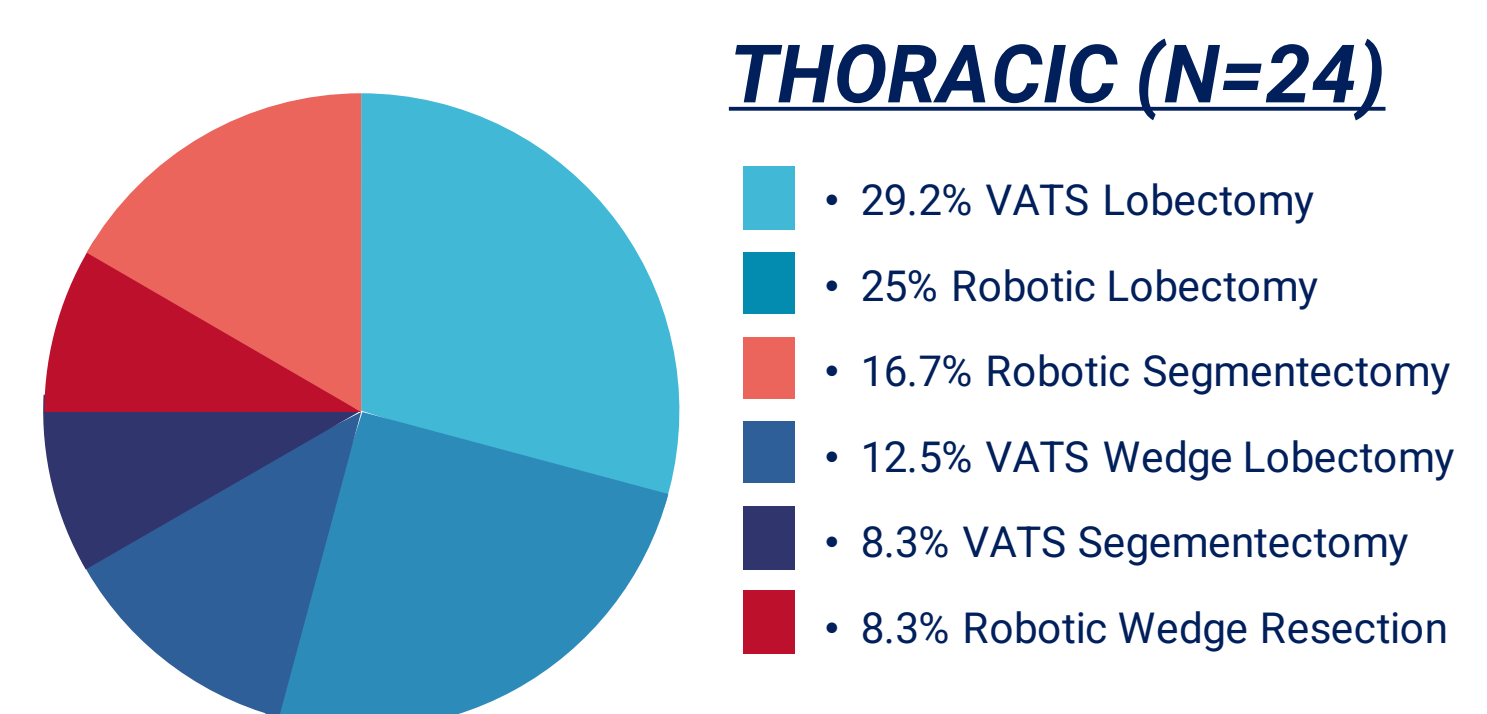
METHODS CONTINUED: NIGHTSIGNAL ALGORITHM

Algorithm Design: Uses a deterministic finite state machine (FSM) based on overnight resting heart rate to detect abnormal increases in resting heartrate.

Alerts

- **Green Alert (Normal)** - a patient's average RHR on a certain night within 3 bpm compared to cumulative baseline RHR
- **Yellow Alert** - a patient's average RHR on a certain night between 3-4 bpm compared to cumulative baseline RHR
- **Red Alert** - a patient's average RHR on a certain night greater than 4 bpm compared to cumulative baseline RHR

OPERATIVE CHARACTERISTICS



RESULTS

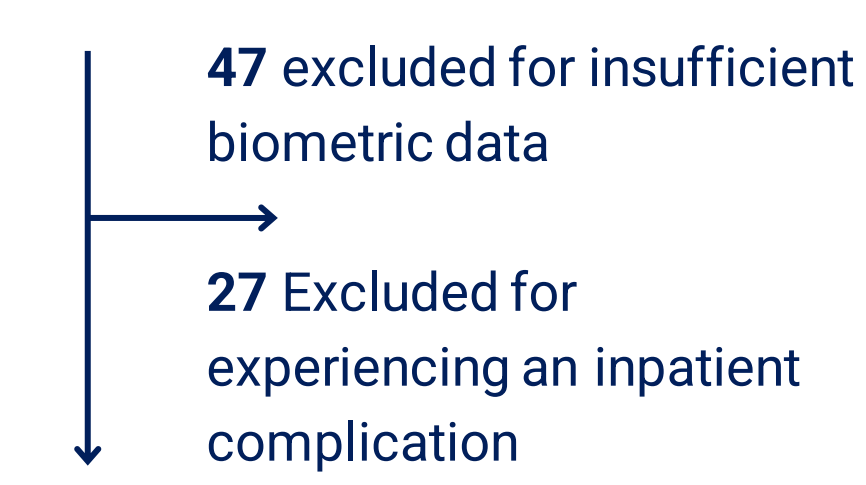
311 Eligible Cardiac & Thoracic Surgery Patients



191 Patients Enrolled



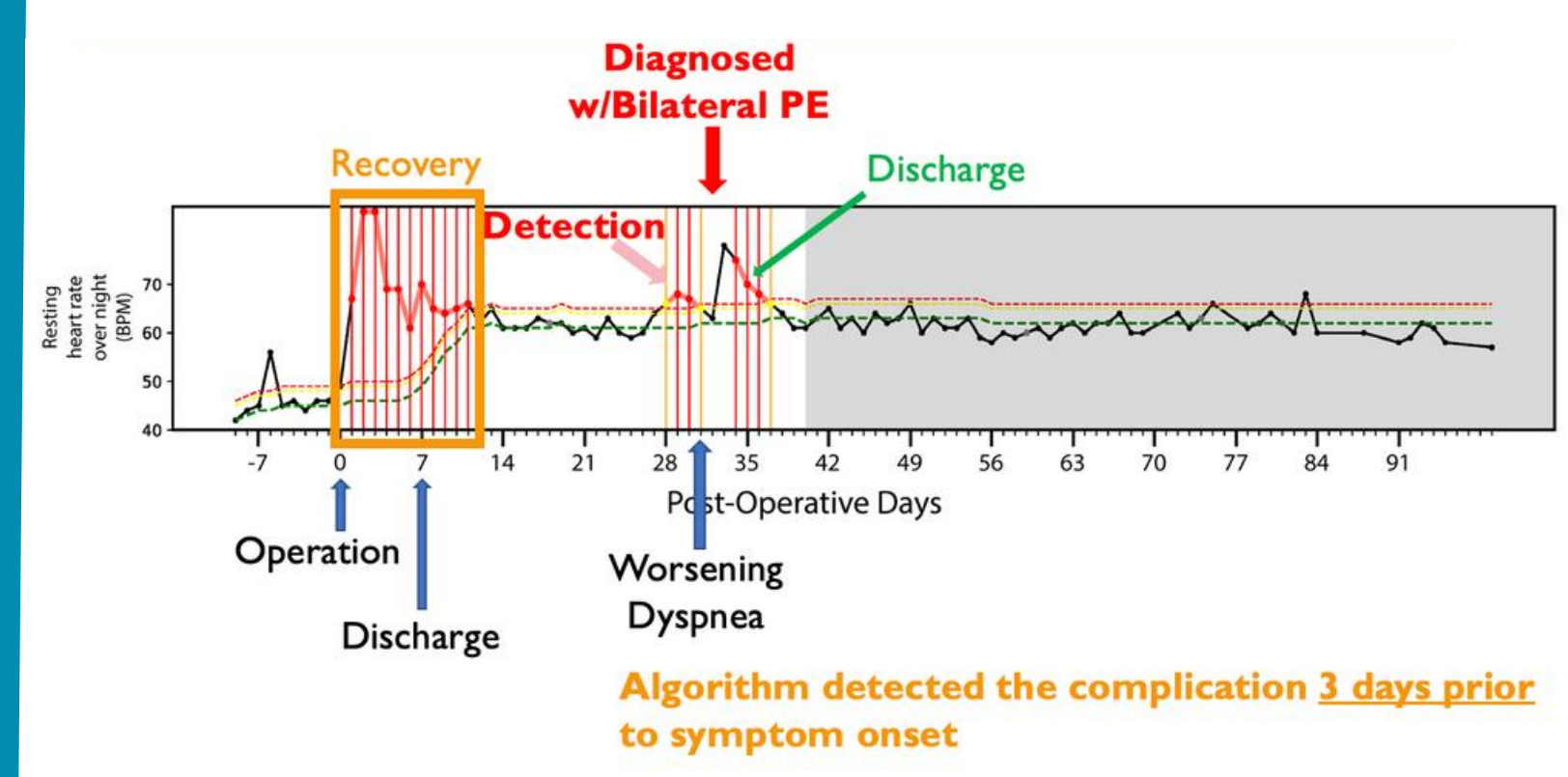
130 Patients Completed 90-Day Post-op Course



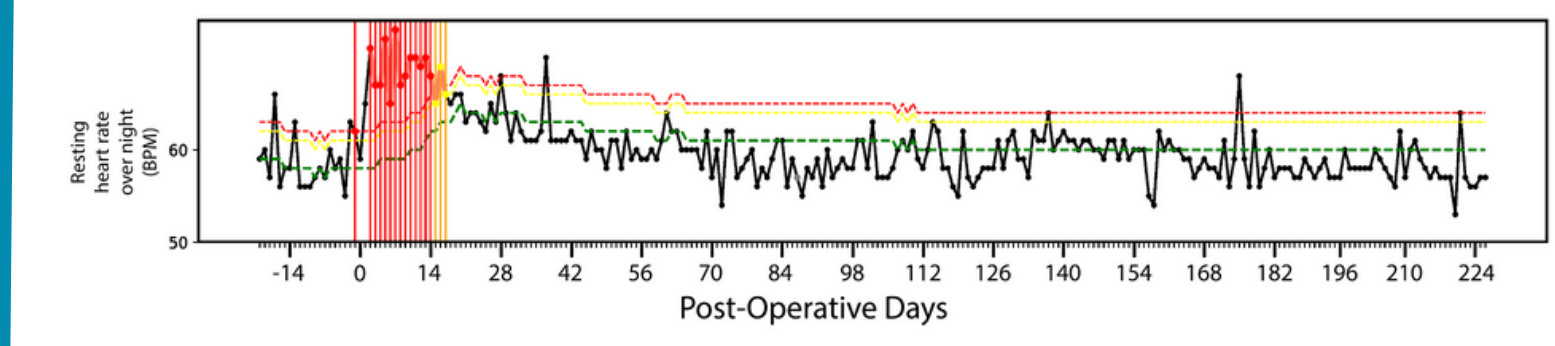
36 Patients with No Post-operative Event

20 Patients with Evaluable Post-operative Event

TRUE POSITIVE EXAMPLE



RESULTS CONTINUED:

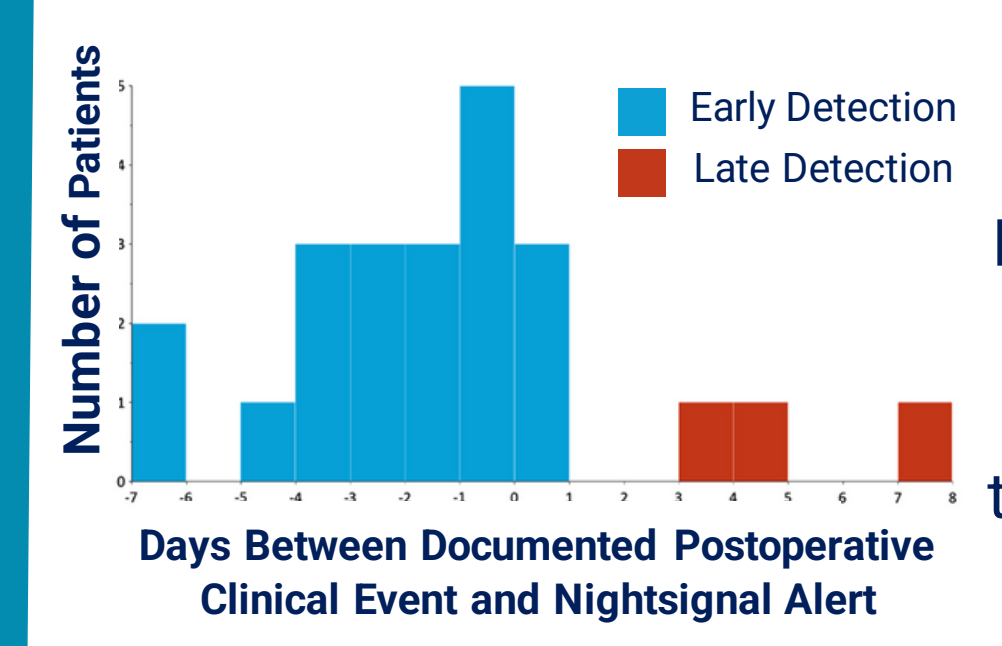


True Negative: An example of a true negative detection for a patient with no postoperative clinical events or red alerts.

Predicted Label	
True Negative: 164	False Positive: 63
False Negative: 4	True Positive: 23

Specificity: 0.72 Sensitivity: 0.85
NPV: 0.98 PPV: 0.27

The NightSignal algorithm detected **23 out of 27** postoperative events.



In true positives, the algorithm detected postoperative events a median of **2 (IQR: 0.5 to 3.5) days prior** to the onset of symptoms

CONCLUSIONS

Machine learning analysis of high-resolution RHR data passively collected by wearable devices **could detect postoperative events with a sensitivity of 85%**, most of which were major postoperative complications.

Most of these complications were identified **several days prior to the onset of symptoms** related to that complication

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