



# HEARTwise ML

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**HEARTwise**  
REFINED TRIAGE FOR SMART EVALUATION

Hospital and Home Early Warning  
AI-Refined Triage with Wearables and Instruments for Smart Evaluation

# Introduction - HEARTwise

- Belgian Project approved within FOD innovation initiatives
- Duration: July 2024 - December 2025
- Collaboration between 4 Belgian hospitals:
  - Jan Yperman Hospital: coordinating hospital
  - University Hospital Antwerp
  - AZ West Veurne
  - Sint-Andries Tielt



# Project scope:

## Improving the Early Warning Score (EWS) process

- **EWS:** A standardized method used in healthcare to assess a patient's clinical condition

Physiological Parameters	3	2	1	0	1	2	3
Respiration Rate (BPM)	≤8		9-11	12-20		21-24	≥25
Oxygen Saturation (%)							
Any Supplemental Oxygen							
Temperature (°C)							
Systolic Blood Pressure (mmHg)							≥20
Heart Rate (BPM)	≤40		41-50	51-90	91-110	111-130	≥131
Level of Consciousness				A			V, P or U

NEWS Scores	Clinical Risk
0 Aggregate 1 - 4	Low
RED Score* (Individual parameter scoring 3) Aggregate 5 - 6	Medium
Aggregate 7 or more	High

# Projectscope: Improving the Early Warning Score (EWS) process

- How?

## Automatic

EWS in the hospital:  
Increase frequency  
Automatic/semi-continuous  
Measurement via WEARABLES



## Telemonitoring

EWS care pathway in the home setting:  
Patient goes home with **wearables** and  
is monitored at home for **10 days**  
Follow-up via **patient platform/application**  
and **dashboard**

## Visual

Better visualization of EWS data  
via dashboard



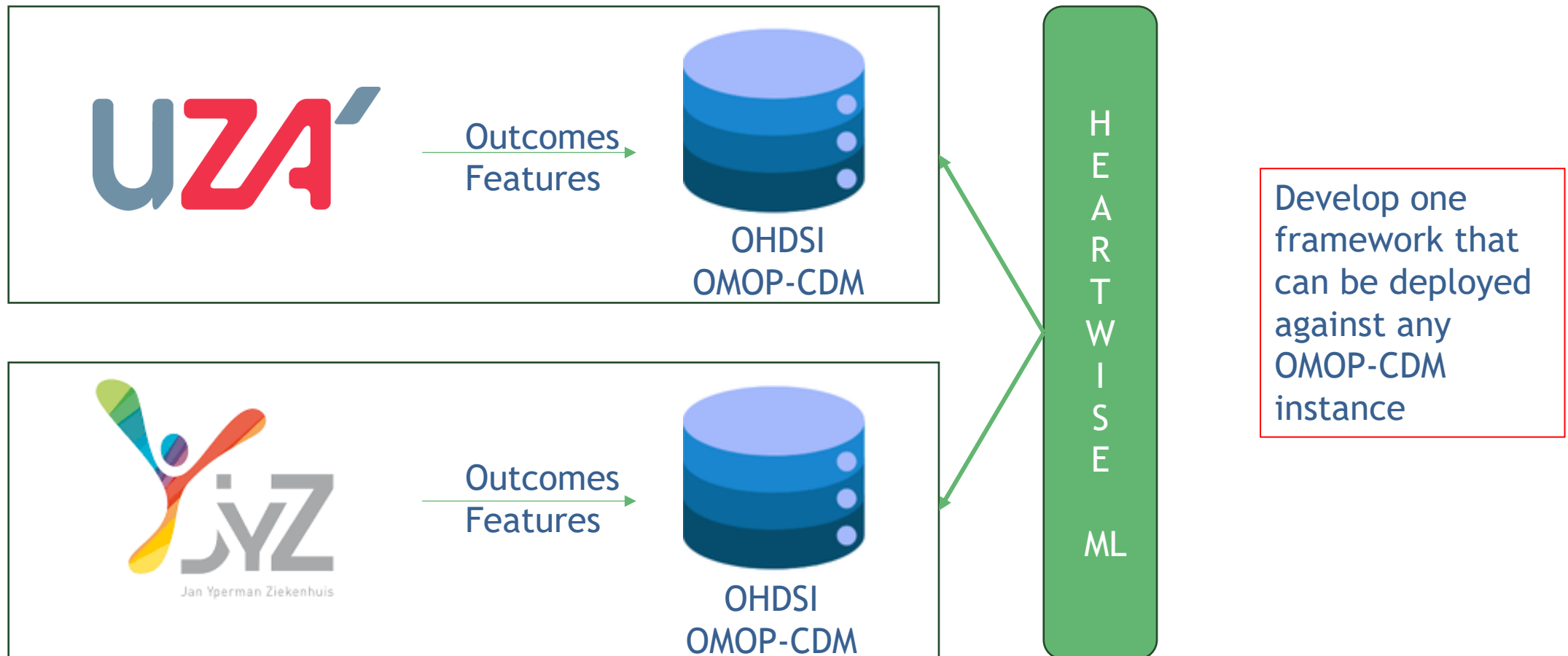
## Smarter

Developing an ML model to  
predict patient condition  
deterioration

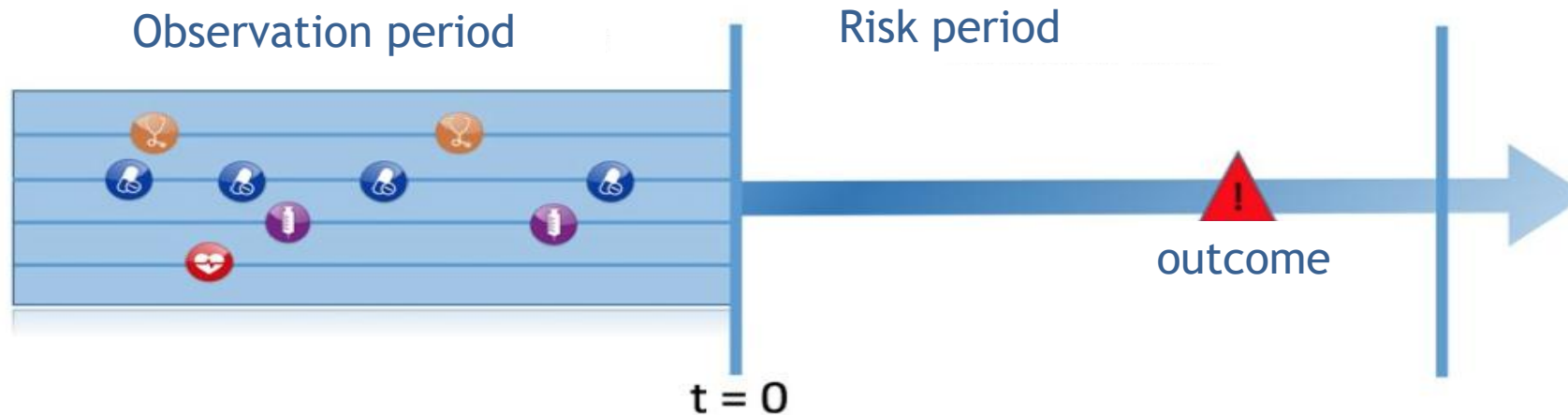


# HEARTwise ML

- Leverage OMOP to develop ML framework that can be used to train models at both hospitals



# The challenge of predictive models

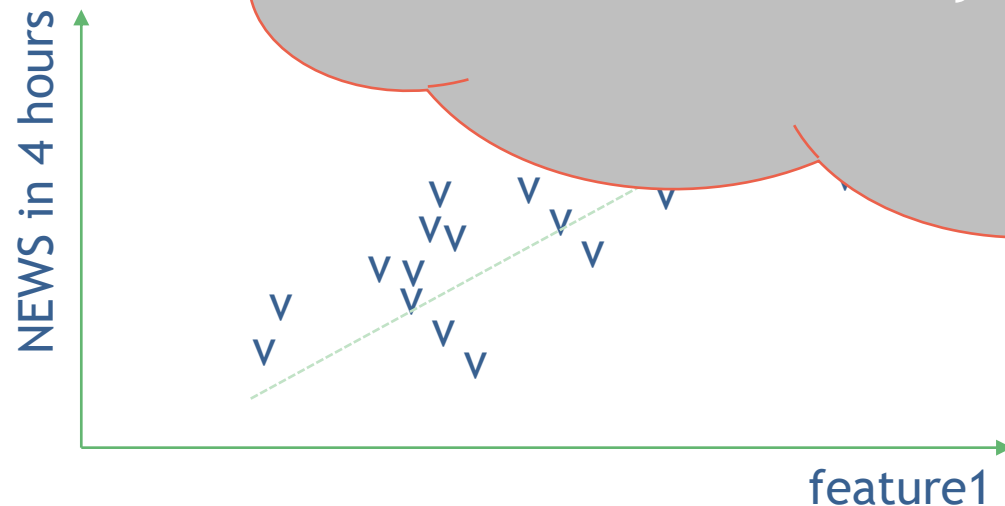


- Can we, using available clinical observations, predict an outcome at  $t=0$  (index date) within a defined risk period?
- Target cohort: Patients with at least one visit and more than one NEWS score, aged over 18 years. Pediatric and pregnant patients are excluded. NEWS data collected after April 1, 2021.
- Outcome cohort: Patients experiencing deterioration (various definitions possible).
- Risk period: For example, the next 4, 8, or 12 hours.
- Models: Regression and classification based on age, gender, NEWS, comorbidities, etc.

# Regression

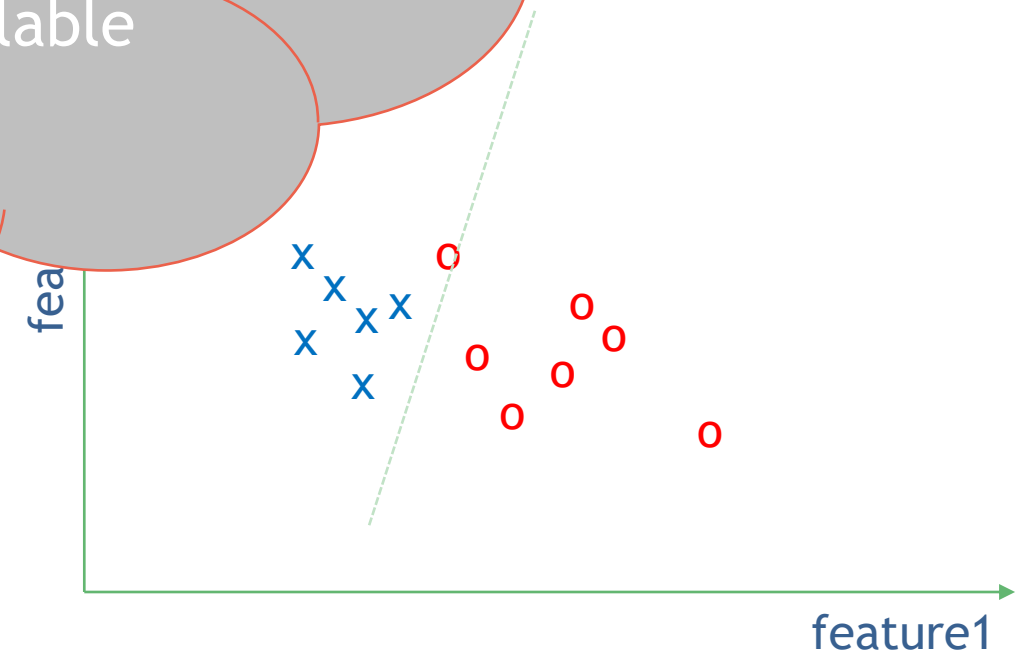
- **Goal:** Predicting a continuous value over time.
- **Example:** Accurately predicting NEWS score 12 hours based on previous NEWS score and oxygen saturation.

We want to implement different models, features, outcomes, and feature-engineering steps in a flexible, reusable, and scalable way...



# Classification

- **Goal:** Predict whether a patient will fall into a risk category within 4, 8, or 12 hours.
- **Example:** Predict whether a patient will have a NEWS score of 4, 8, or 12 hours.



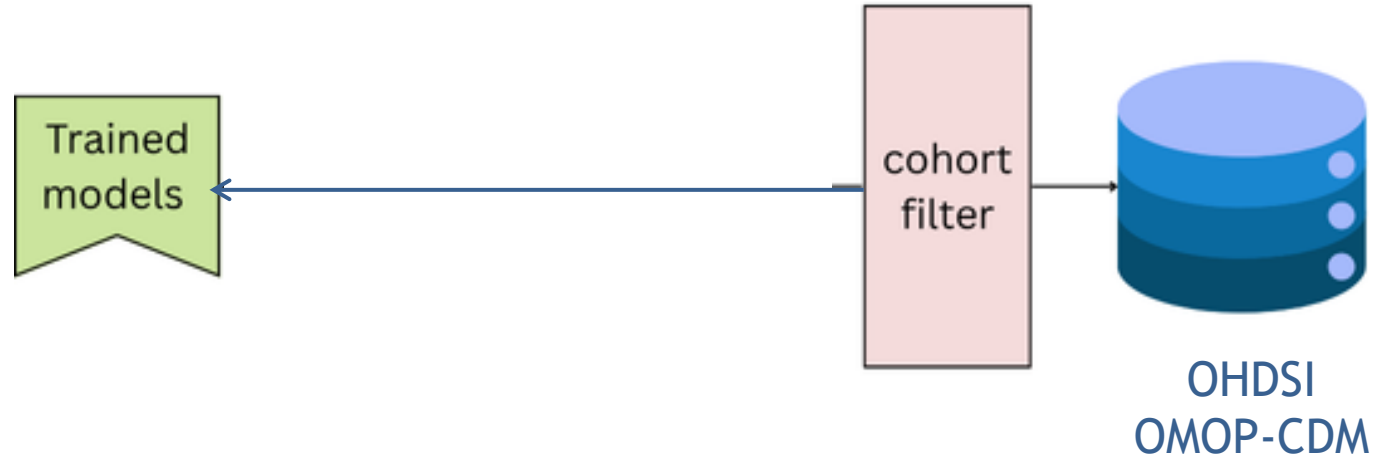
# HEARTwise ML framework

- Leverage OMOP to develop ML framework that can be used to train models at both hospitals

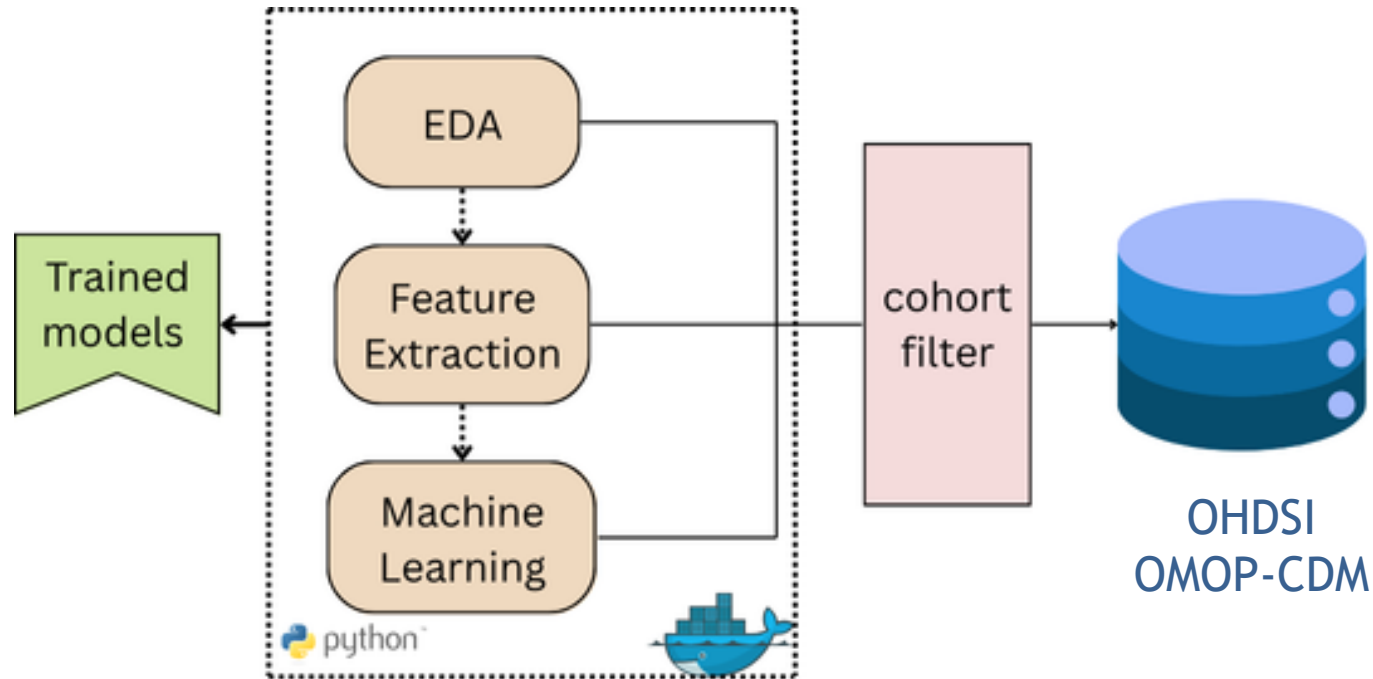




# HEARTwise ML framework



# HEARTwise ML framework



**Modular framework with three main components: Exploratory data analysis, Feature extraction, Machine learning (training)**

- Each component can be executed independently
- Containerized and version control applied
- Data analysts can add new features and models

## Development of HEARTwise Machine Learning framework to predict patient deterioration using existing OMOP CDM NEWS variables

HEARTwise poster at the OHDSI Europe 2025 symposium

### Three-phase approach to design and develop the HW ML models

**Background:** The data track of the Belgian FOD innovation project HEARTwise is a collaboration between Jan Yperman Ziekenhuis (JYZ), Universitair Ziekenhuis Antwerpen (UZA), and edenceHealth. It focuses on the development of a scalable and flexible ML pipeline to predict the deterioration of a patient's health status. The models will be trained using historical data in existing OMOP-CDM databases, primarily using NEWS variables. NEWS is an early warning system used to assess a patient's health status, facilitating early detection and response to clinical deterioration in adult patients.

**Methods:** The three-phase approach to the ML framework (Figure 1) is designed with a focus on allowing for fast technical iterations and extensibility for future enhancements (e.g., additional features, models, and deployment).



Figure 1: The workflow of the framework (left) and the three-phased approach of the project (right).

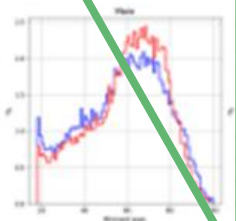
**Results:** The same patient selection criteria are applied to the JYZ and UZA datasets to compare overall distribution during Exploratory Data Analysis (EDA). Due to differences in patient populations and the hospitals' nature (regional vs. university), the patient characteristics are expected to differ. An example comparison is shown in Figure 2.

Insights from EDA have helped to assess data quality of NEWS variables and to inform the initial cohort selection:

1. Patients with at least one visit with more than one NEWS above 18 years of age
2. Exclusion of pediatric and pregnant patients
3. NEWS data collected after April 1, 2021

**Conclusion:** As a summary, initial ML model is prepared for testing, and the development of the framework is in progress. The framework has a modular design, which decouples feature extraction and engineering from ML model training, enhancing adaptability and enabling support for diverse data models beyond OMOP CDM.

Figure 2: The age at first NEWS measurement (one visit with more than one NEWS) categorized by gender (Male and Female). The age at the first NEWS measurement normalized count of NEWS occurrence would be excluded as the calculation.



### Exploring the data and technical proof-of-concept (Phase : 1)

- EDA
- Prototype ML pipeline with Linear regression model (age, gender, NEWS)

### Enrichment of models and features (Phase : 2)

- Robust pipeline for new feature inclusion
- Advanced machine learning models
- Assessments based on common metrics

### Applicability in a real-world context (Phase : 3)

- Refinement of models
- Incorporating explainability techniques
- Investigating next step to develop scalable and production ready models

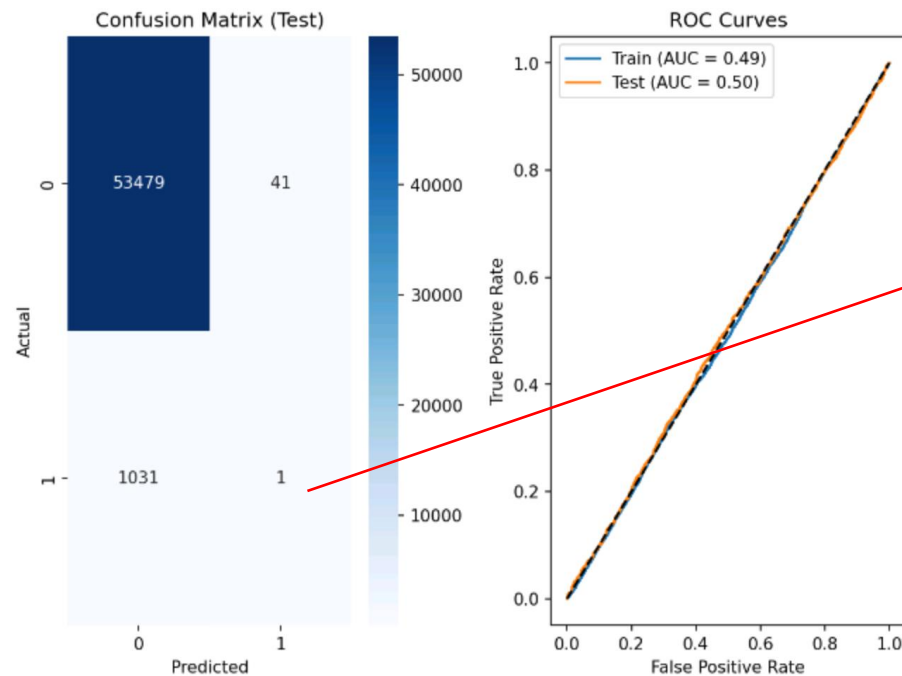


# Example: predicting patient deterioration

## Developing a flexible framework:

- Run multiple models on multiple outcomes and feature sets.
- Compare model performance.
- Execute a QA suite after each training round.

Examples of automated QA output for a random classifier:



In the test set: the random model correctly predicted the >7 NEWS within 4 hours outcome only once.

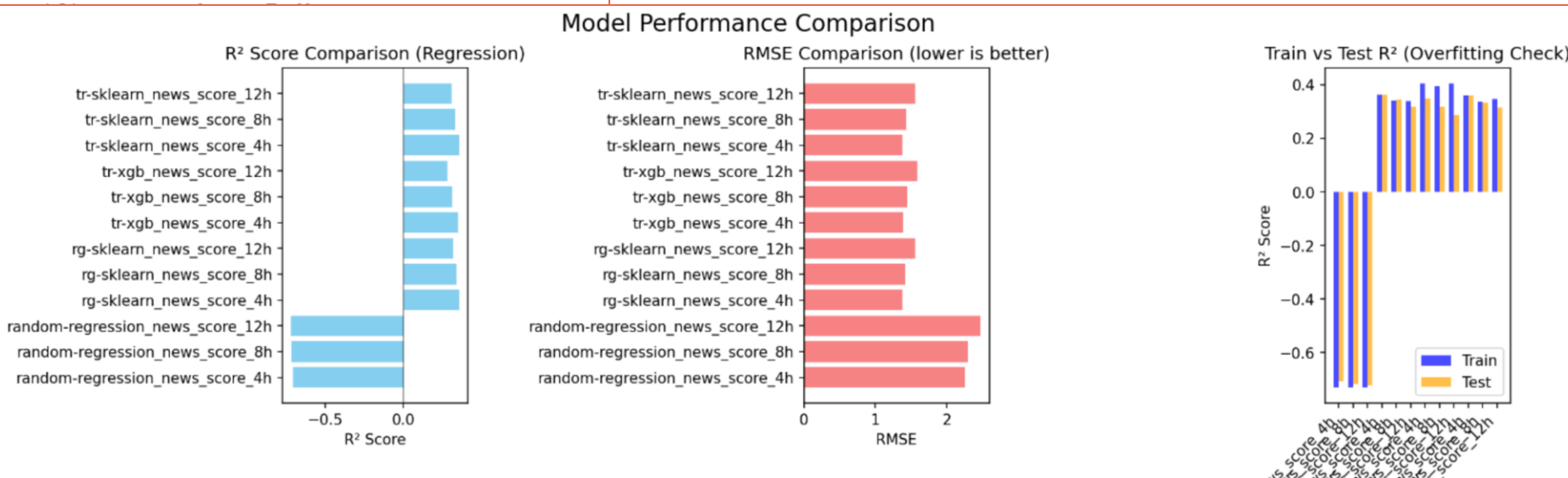




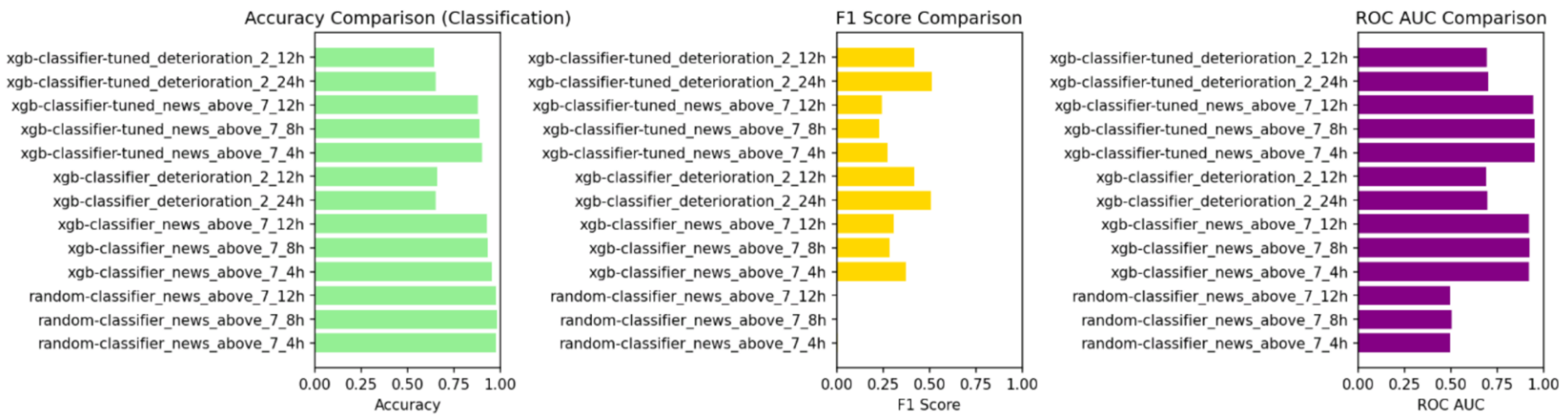
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Outcome: ne  
Model Type:  
Device: cpu  
Features: [  
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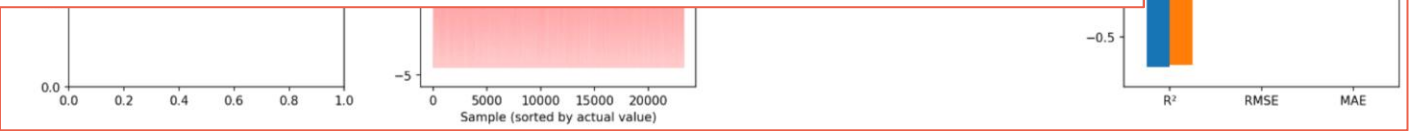
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Test sample  
Performance  
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Test Recall: 0.0007  
Test F1: 0.0014  
Test ROC AUC: 0.4945  
Overfitting: No



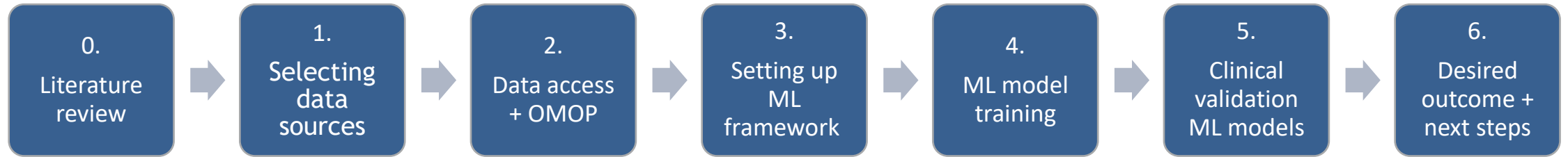
## Comparisons of model performances



## Automated models



## Current status ...



We are here: iterating and model explainability/validation

## ... and next steps

- Validation and explainability: workshop with clinicians
- Investigation and reporting on path to production/useage
- Dissimination and onboarding



# Thank you!

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## HEARTwise

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