



# AI-Driven Risk Prediction Engine for Chronic Care Patients

Presented by

Arulprasaad J

Nithish Kumar CS

Anirudh S.K

V.G Prakul

# The Challenge in Chronic Care

## The Problem

Chronic conditions like diabetes, obesity, and heart failure drive a significant portion of healthcare burden:

- Approximately **50% of hospital admissions**.
- Up to **80% of total healthcare costs**.

Clinicians currently rely on historical vitals, labs, and adherence data, but lack a forward-looking, explainable view of patient risk.

## Our Solution & Clinical Value

Our goal is to predict 90-day patient deterioration, enabling earlier, more targeted interventions. This proactive approach delivers substantial clinical value:

- Fewer acute care events and hospitalizations.
- Optimized care management and proactive outreach.
- Significant improvement in overall patient outcomes and quality of life.



# Predicting Deterioration: Our Approach

Our engine identifies patients at risk of deterioration, providing actionable insights for care teams.

## Predicted Outcome

Probability of clinical deterioration within 90 days (binary: 1=deterioration, 0=stable).

## Key Inputs

Utilizes data from the last 30–180 days: demographics, vitals, labs, medication adherence, lifestyle logs, and healthcare utilization.

## Scoring Cadence

Patient risk scores are re-calculated nightly or weekly to reflect dynamic health changes.

## Actionable Insights

Patients are grouped into risk buckets (Low, Moderate, High, Very High) with specific "next best actions" tailored to their risk profile.

# Comprehensive Data Integration

Our engine leverages a diverse array of data sources, ensuring a holistic view of each patient's health status.



## EHR Data

Comprehensive clinical history, diagnoses, procedures, and physician notes.



## RPM Devices

Continuous vital signs, activity levels, and biometric data from wearables and home devices.



## Pharmacy Data

Medication fill histories, adherence rates, and prescription details.



## Patient-Reported

Quality of life, symptom burden, and lifestyle information directly from patients.

A consistent **90-day prediction horizon** is used, with patient data aggregated from a **30–180 day look-back window**.

# Dashboard

Ensuring data privacy, security, and ethical use is paramount to our solution.

## Secured Usage

All users are authenticated and allowed secure access to the private data

The screenshot shows the CarePredict AI dashboard. At the top right, there is a user profile for "NITHISHKUMAR CS" with a picture, and options for "Analytics (Admin Only)", "Admin Mode" (which is off), and a sign-out link. Below the header, the main title is "AI-Powered Patient Dashboard" with a subtitle "Real-time ML risk assessment and predictive analytics for chronic care management". On the right side of the dashboard, there is a green button labeled "+ Upload Patient" and a sidebar with links for "Manage account" and "Sign out". A note at the bottom right says "Secured by Clerk Development mode".

## Admin Mode

Admin mode allows to view the detailed view of model not visible to general user  
It shows all the recent scans made during the timestamp

The screenshot shows the CarePredict AI dashboard with "Admin Mode" turned on. The top navigation includes "Dashboard", "ML Analytics" (which is on), and other admin-specific buttons like "Upload Patient Data", "Run ML Analysis", and "Export Data". The main content area has two main sections: "Scan History" (listing recent scans from Supabase) and "ML Model Analytics (Admin View)" (showing real-time model performance metrics). The "Scan History" table has columns for Scan ID, User ID, Name, and Created At. The "ML Model Analytics" section displays three cards: "Total Scans" (1247 This month), "Model Accuracy" (94.2% Current performance), and "Avg Confidence" (92.8% Prediction confidence).

## A Dedicated Database

A database is implemented to track record of all the scans that are done so far

# Strategic Feature Engineering

We extract powerful features from raw data to build a highly predictive model.

## Vitals & Trends

- Mean BP, Heart Rate Variability (HRV)
- SpO<sub>2</sub> trends
- Weight deltas over time

## Laboratory Markers

- HbA1c and its trend
- Lipid panel, Renal function (eGFR, creatinine)
- Inflammatory (CRP) & Cardiac (BNP) markers

## Medication Adherence

- Adherence rates
- Refill gaps
- Regimen complexity & recent changes

## Lifestyle & Social

- Activity & sleep quantity/quality
- Stress/depression indices
- Social support indicators

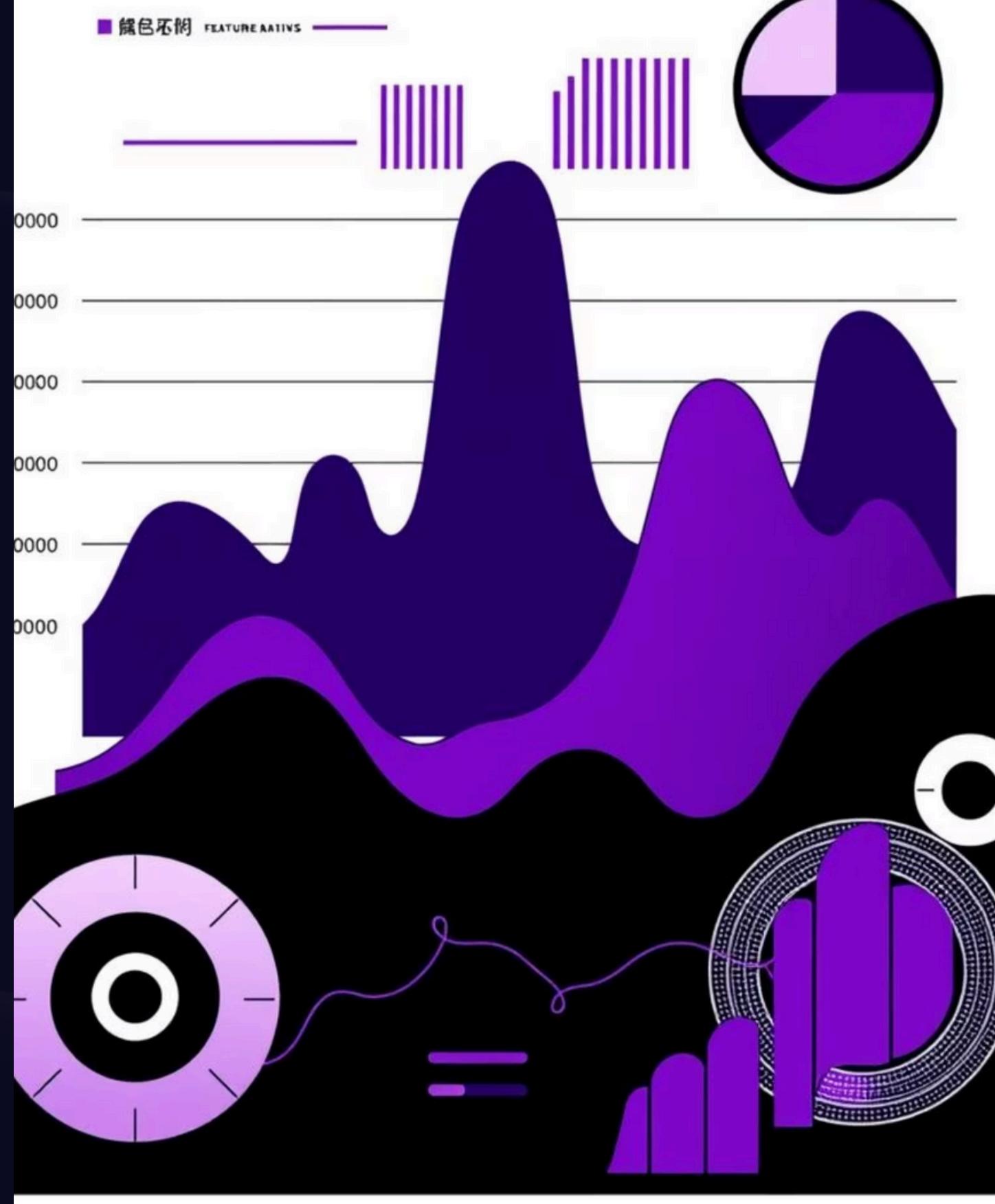
## Healthcare Utilization

- Outpatient visits (OP)
- Emergency Department (ED) / ICU / Hospitalizations
- Missed appointments, Telehealth use

Rigorous feature stability and leakage checks are performed to ensure model robustness and prevent data contamination.

特征工程

• 丽格工程 Engineering



# Your AI-Powered DASHBOARD

## AI-Powered Patient Dashboard

Real-time ML risk assessment and predictive analytics for chronic care management

+ Upload Patient Data

Run ML Analysis

Export Data

### ML Analysis Report

Results from CSV batch processing

**30**

Patients Processed

**8**

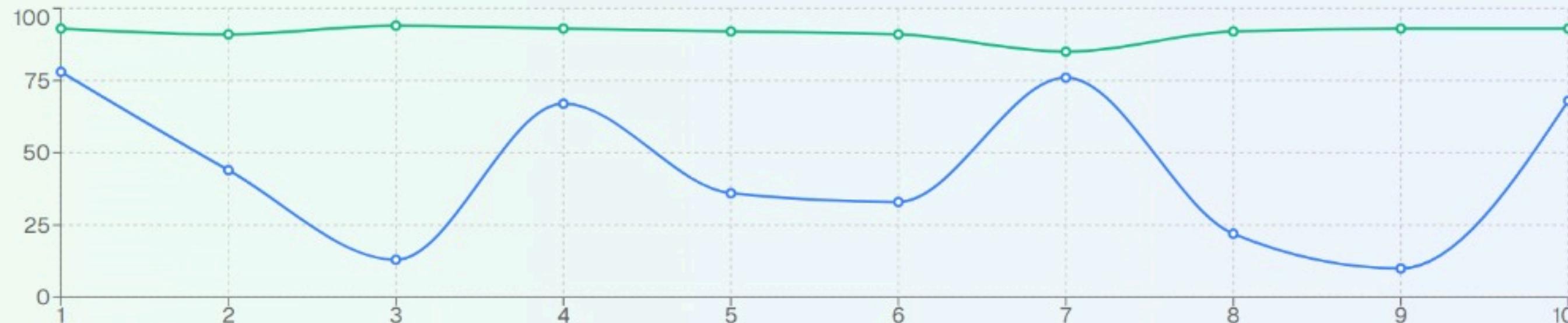
High Risk Identified

**52.3%**

Average Risk Score

**2.4 seconds**

Processing Time



# PERFORMANCE REPORT

## ML Model Performance Report

Sub-model and fusion model performance metrics

### Sub-Model Performance & Key Features

Sub-Model	Type	Classes	Accuracy	Top Contributing Feature
Demographics	Logistic	0-3	0.97	icu_admissions_last180
Vitals	Random Forest	0-1	0.97	cholesterol_ratio
Labs	XGBoost	0-3	0.95	hospital_visits
Medication	LightGBM	0-3	0.98	chronic_condition_2
Lifestyle	Random Forest	0-1	1.00	cholesterol_ratio
Healthcare Usage	Logistic	0-3	0.98	mean_systolic_bp

### Fusion Model (Final Prediction)

**Type:** XGBoost (binary)

**Accuracy:** 0.58

#### Precision/Recall:

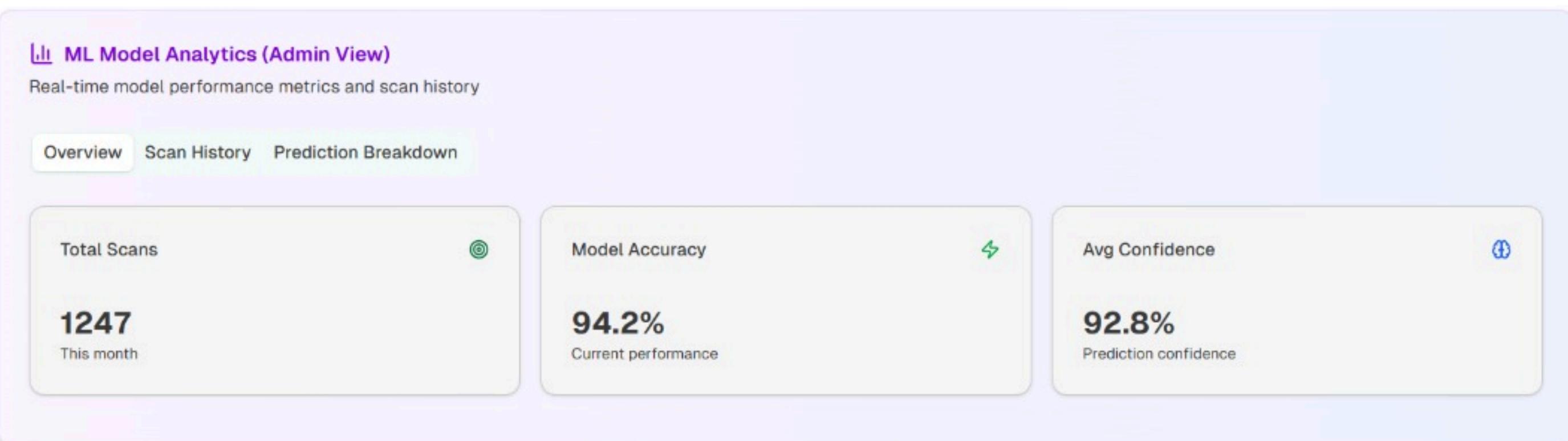
- Class 0 → Precision: 0.47 | Recall: 0.08
- Class 1 → Precision: 0.57 | Recall: 0.95

**Observation:** Strong recall for high-risk patients (Class 1), low performance for low-risk (Class 0)

# MODEL ANALYTICS

 Scan History  
Recent scans retrieved from Supabase

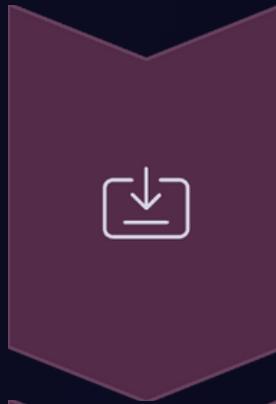
Scan ID	User ID	Name	Created At
a81bc81b-dead-4e5d-abff-90865d1e13b5	p002	Karana	7/9/2025, 5:53:09 pm
a81bc81b-dead-4e5d-abff-90865d1e13b1	user_32MRmHchAYlo14lpkhOITOSbG0b	Nithish	7/9/2025, 5:35:37 pm



N

# Advanced Modeling Approach

Our unique two-stage ensemble model combines precision with modularity and interpretability.



## Stage 1: Domain-Specific Sub-Models

Leveraging diverse algorithms (Logistic Regression, Random Forest, XGBoost, LightGBM), sub-models predict domain-specific risk scores (0-3).



## Stage 2: Fusion Model

A gradient boosting model combines these domain scores to predict the final 90-day deterioration probability.

This architecture provides modular explainability, robustness to domain drift, and easy ablation for feature analysis. Our models are trained on patient-level data splits, typically **70% training, 15% validation, and 15% testing**, stratified by outcome.



# Rigorous Evaluation Metrics

Our model's performance is comprehensively assessed across discrimination, calibration, and operational impact.



## Discrimination

Measured by **AUROC** (Area Under the Receiver Operating Characteristic curve) and **AUPRC** (Area Under the Precision-Recall curve), critical for imbalanced outcomes.



## Calibration

Assessed via **Brier Score** and calibration curves, ensuring predicted probabilities align with actual outcomes.



## Operational Metrics

Analysis of Confusion Matrix at various thresholds, including Sensitivity, Specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV).



## Threshold Optimization

Decision thresholding is optimized using methods like **Youden's J statistic** or cost-sensitive utility functions to maximize clinical utility.

These metrics confirm the model's reliability and its ability to accurately identify at-risk patients.

# Evaluation Metrics Values

## Multi-Modal Patient Risk Prediction Models

### Data Split:

- X: (30,000, 66), y: binary [0, 1]
- Train: 20,999
- Validation: 4,501
- Test: 4,500

## Fusion Model (Final Prediction)

Type: XGBoost (binary)

Accuracy: 0.58

Precision/Recall: 0.58

Class 0 → P: 0.46 | R: 0.09

Class 1 → P: 0.58 | R: 0.93

Observation: Strong recall for high-risk

patients (Class 1), low performance for low-risk (Class 0)

### • Sub-Model Performance & Key Features:

#### • Demographics

- Model: Logistic Regression
- Classes: 0–3
- Accuracy: 98%
- Top Feature: chronic\_condition\_2

#### • Vitals

- Model: Random Forest
- Classes: 0–1
- Accuracy: 98%
- Top Feature: mean\_systolic\_bp

#### • Labs

- Model: XGBoost
- Classes: 0–3
- Accuracy: 96%
- Top Feature: triglycerides

### • Sub-Model Performance & Key Features:

#### • Medication

- Model: LightGBM
- Classes: 0–3
- Accuracy: 99%
- Top Feature: medication\_burden

#### • Lifestyle

- Model: Random Forest
- Classes: 0–1
- Accuracy: 99%
- Top Feature: social\_support\_score

#### • Healthcare Usage

- Model: Logistic Regression
- Classes: 0–3
- Accuracy: 99%
- Top Feature: icu\_admissions\_last180

# Transparent Explainability

Our engine provides both global and patient-specific insights into risk factors, fostering trust and enabling informed clinical decisions.

## Global Explainability

Leveraging SHAP (SHapley Additive exPlanations) values, we identify the top drivers across patient populations, such as:

- HbA1c trend and eGFR values
- Medication refill gaps and ED visits
- Heart Rate Variability (HRV)

Model diagnostics also monitor stability across folds and potential feature drift, ensuring long-term reliability.





# Actionability & Care Pathways

Our predictions directly translate into precise, protocol-driven clinical actions, optimizing patient care and resource allocation.

## High Risk Protocol

Initiate a [virtual visit](#) within 24 hours.  
Adjust diuretics/antihypertensives per protocol, order immediate labs, and consider social support referral if score indicates high need.

## Moderate Risk Protocol

Trigger a [nurse outreach](#) to assess current status. Conduct a medication adherence check and tighten Remote Patient Monitoring (RPM) alerts for closer surveillance.

## Care Gap Closure

Automated triggers for missed appointments, overdue vaccinations, and personalized lifestyle coaching recommendations based on risk drivers.

