An EHR-Based Machine Learning Model Predicts Myocardial Infarction Better than an ECG-based Machine Learning Model and the Pooled Cohort Equations

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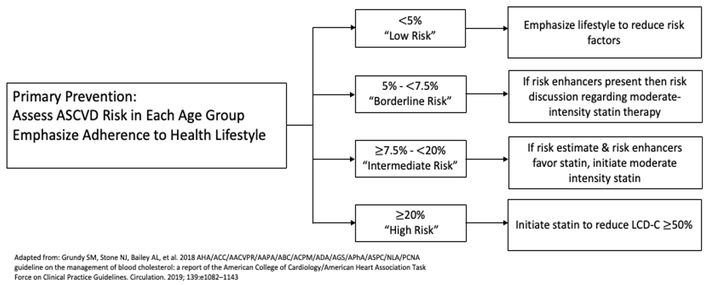
INTRODUCTION

- Patients at high risk for myocardial infarction (MI) benefit from treatments designed for primary prevention, especially cholesterol lowering therapy.
- The pooled cohort equations (PCE) are the most commonly used risk predictor for future atherosclerotic cardiovascular disease (ASCVD), but show only modest performance.



Adapted from: Grundy SM, Stone NJ, Bailey AL, et al. 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA guideline on the management of blood cholesterol: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2019; 139:e1082–1143

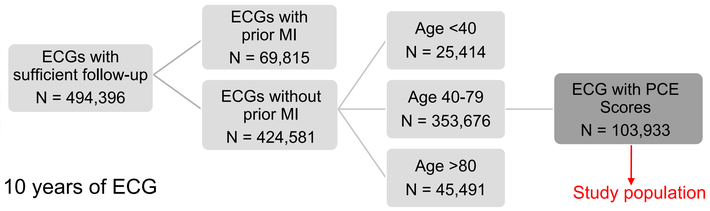
Hypothesis:

Electronic health record (EHR)-based, and ECG-based machine learning models are better at predicting MI as compared to PCE.

METHODS

Study Population

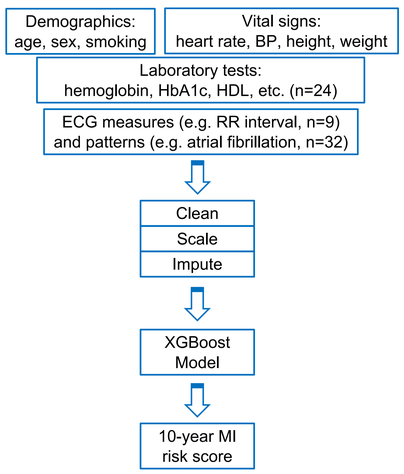
All Geisinger patients ages 40-79 who had 1) at least 1 clinically acquired ECG 2) no history of MI and 3) had PCE scores calculated at the time of ECG



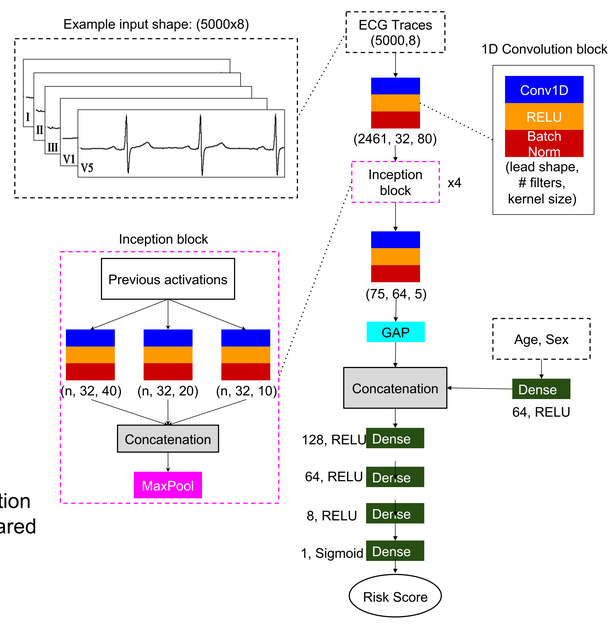
Primary Endpoint: MI event within 10 years of ECG

EHR Data and Machine Learning Models

1. **XGBoost** model with structured EHR data as input features



2. **Deep neural network (DNN)** that used ECG voltage data (10 second, 8 independent leads), age, and sex as inputs



- Models were evaluated by 5-fold cross-validation
- Performances of different models were compared using area under the receiver operating characteristic curve (AUROC)

SUMMARY

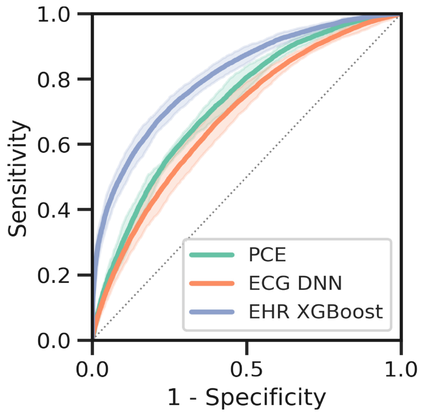
- An EHR-based XGBoost model, but not an ECG-based DNN, is superior to the PCE in predicting future MI.
- Patients identified as high risk by the EHR-based model, but low risk by the PCE, have a high rate of future MI.
- Statin use in that group is low, suggesting ample opportunity for intervention.

RESULTS

A total of **103,933** ECGs from **34,932** patients had sufficient follow-up (occurrence of MI or 10 years follow-up in EHR), **21%** of ECGs were followed by an MI event within 10 years.

Age, yr	**62 (10)**	**Heart Failure**	**5%**
Sex, male	51%	Hypertension	68%
BMI, kg/m2	32 (9)	Diabetes	33%
Smoking	61%	Atrial Fibrillation	17%

The EHR-based XGBoost model had the best performance



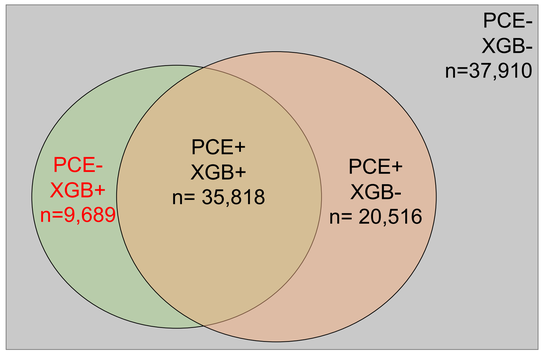
%	PCE	**EHR XGB**	ECG DNN
AUROC	72	**81**	68
Sensitivity	76	**76**	76
Specificity	59	**66**	54
PPV	20	**24**	19
NPV	95	**95**	94

Note: operating points for XGB and DNN models were selected by matching PCE sensitivity

9% (n=9,689) of the total encounters were predicted to be 'high risk' by the EHR-based model and not by the pooled cohort equations.

➢ 10-year MI event rate in this group was 26%

➢ Only 40% of patients in this group were on a statin



	PCE+ XGB+	PCE+ XGB-	PCE- XGB+	PCE- XGB-
n	35,818	20,516	9,689	37,910
MI events	14454	2495	2486	2127
Event rate	40%	12%	26%	6%
% on statin	50%	42%	40%	32%

20% (n=20,516) of encounters were predicted to be 'high risk' by the PCE and not by the EHR-based model. The event rate in that subgroup was 12%.

Limitations

- Retrospective data only
- PCE scores not available on all patients

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