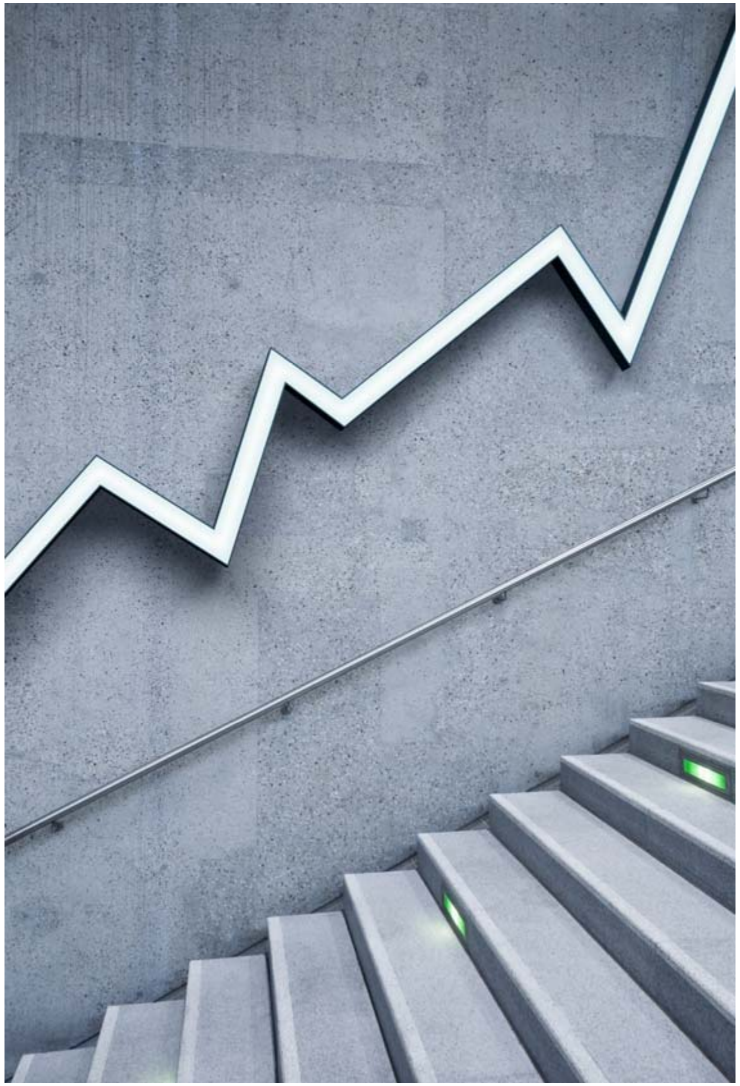

The Use of AI for Atrial Fibrillation Detection

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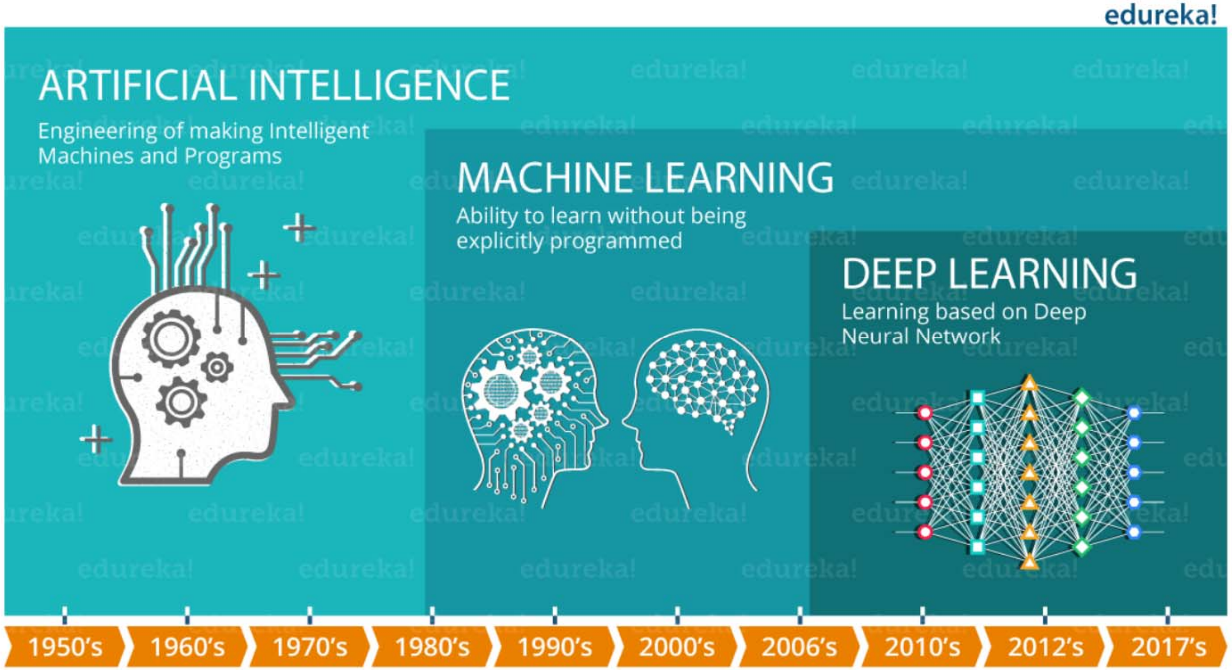
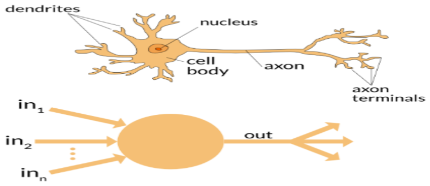
INHA UNIVERSITY COLLEGE OF MEDICINE

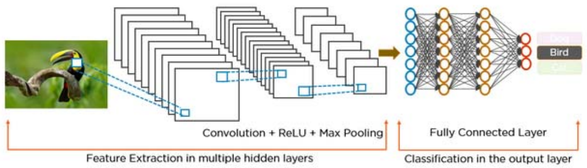
AI (Artificial Intelligence)
Deep learning (Deep neural learning) ; Data driven approach to AI

Main Paradigm of Artificial Intelligence

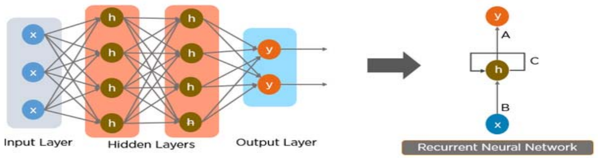




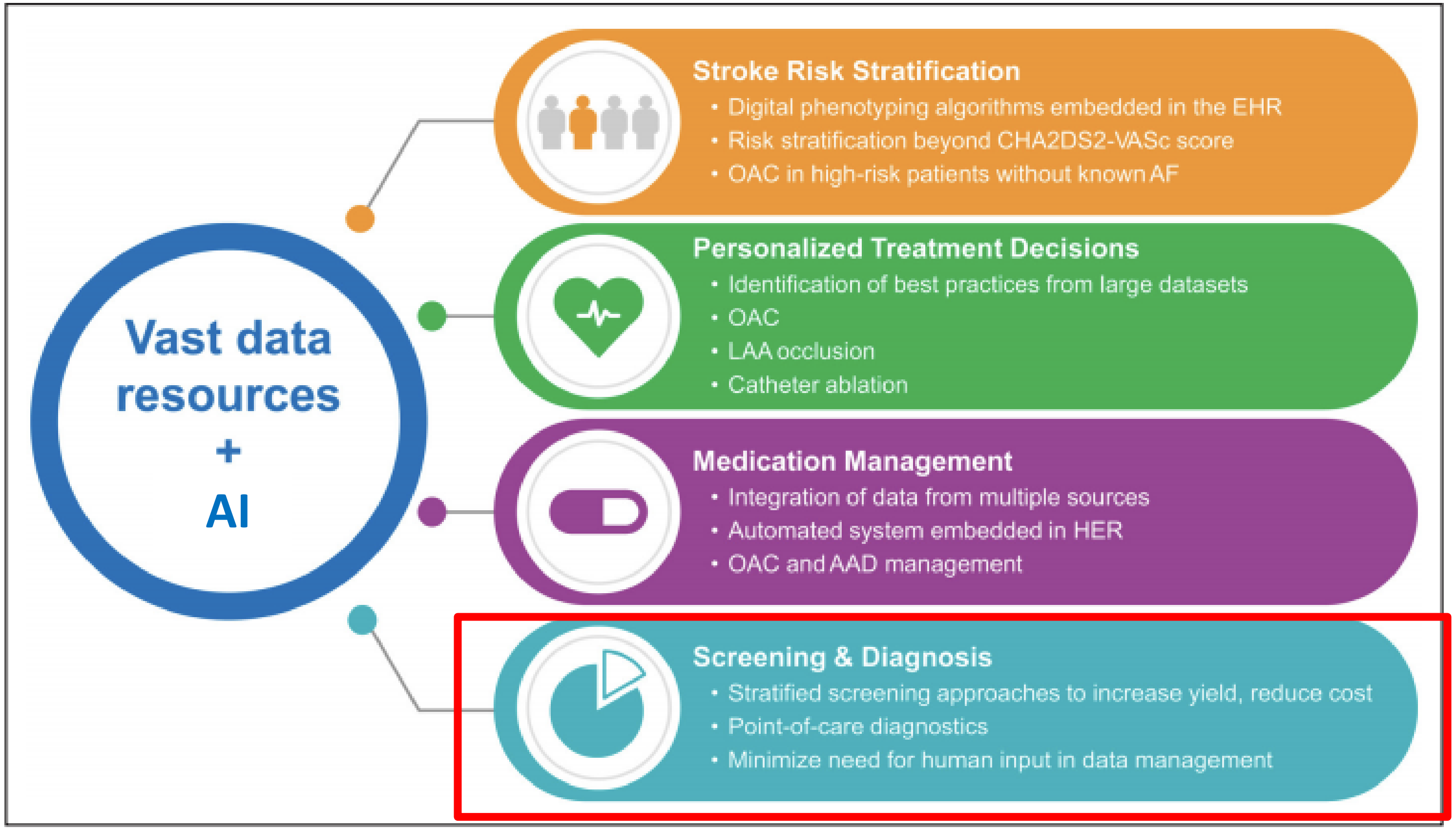
Convolutional Neural Network



Recurrent Neural Network



Applications of AI in the clinical care of AF



Circulation Research. 2020;127:155–169.

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 OCTOBER 1, 2020 VOL. 383 NO. 14

Early Rhythm-Control Therapy in Patients with Atrial Fibrillation

P. Kirchhof, A.J. Camm, A. Goette, A. Brandes, L. Eckardt, A. Elvan, T. Fetsch, I.C. van Gelder, D. Haase, L.M. Haegeli, F. Hamann, H. Heidbüchel, G. Hindricks, J. Kautzner, K.-H. Kuck, L. Mont, G.A. Ng, J. Rekosz, N. Schoen, U. Schotten, A. Suling, J. Taggeselle, S. Themistoclakis, E. Vettorazzi, P. Vardas, K. Wegscheider, S. Willems, H.J.G.M. Crijns, and G. Breithardt, for the EAST-AFNET 4 Trial Investigators*

2789 patients randomized by 135 sites in 11 countries

east

early treatment of
atrial fibrillation for
stroke prevention trial

Patients at risk for cardiovascular events (≒CHA2DS2VASc score ≥ 2) and with recent onset atrial fibrillation, early AF ≤1 year duration of fisrt documented by ECG

east
early treatment of atrial fibrillation for stroke prevention trial

2789 patients randomized by 135 sites in 11 countries

Randomization

Early Rhythm Control

Anticoagulation, rate control and either antiarrhythmic drug therapy or AF ablation
In case of recurrent AF: Re-ablation of adaptation of antiarrhythmic drugs

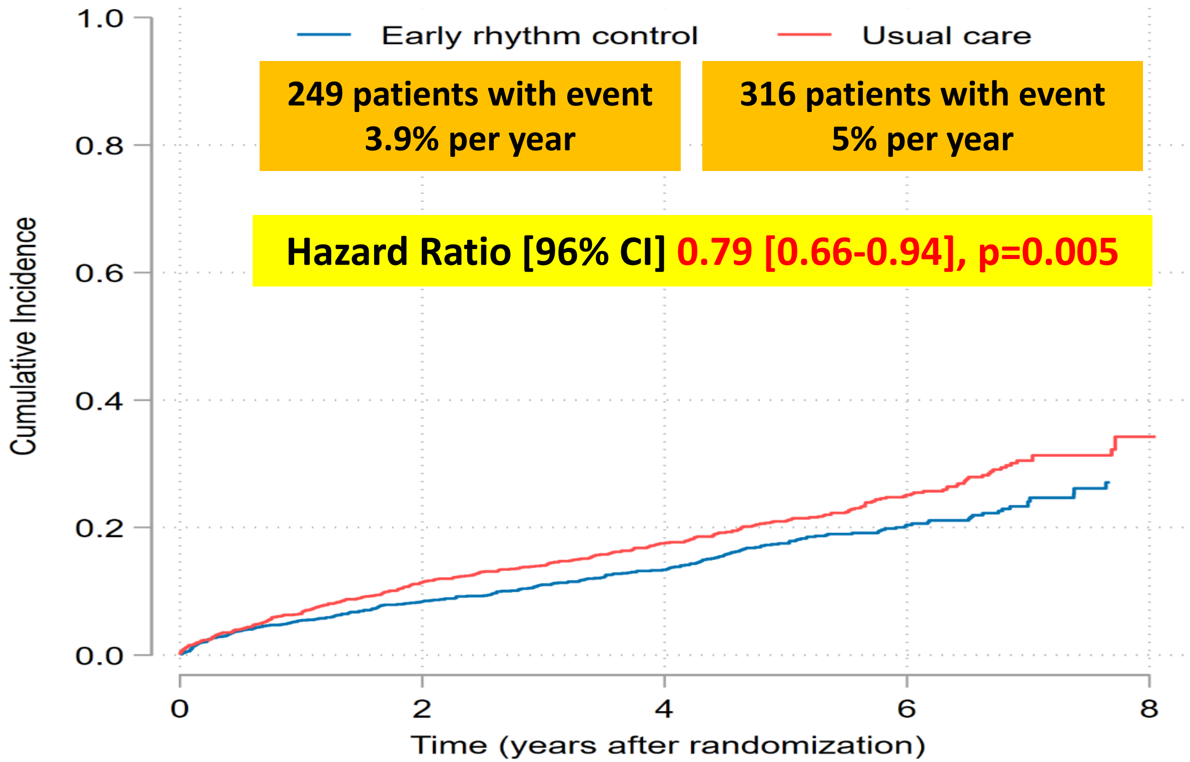
Usual Care

Anticoagulation, rate control, supplemented by rhythm control only in symptomatic patients on optimal rate control therapy

Primary outcome

¦Death from cardiovascular causes, stroke, or hospitalization with worsening of heart failure or acute coronary syndrome

Median of 5.1 years of follow-up per patient

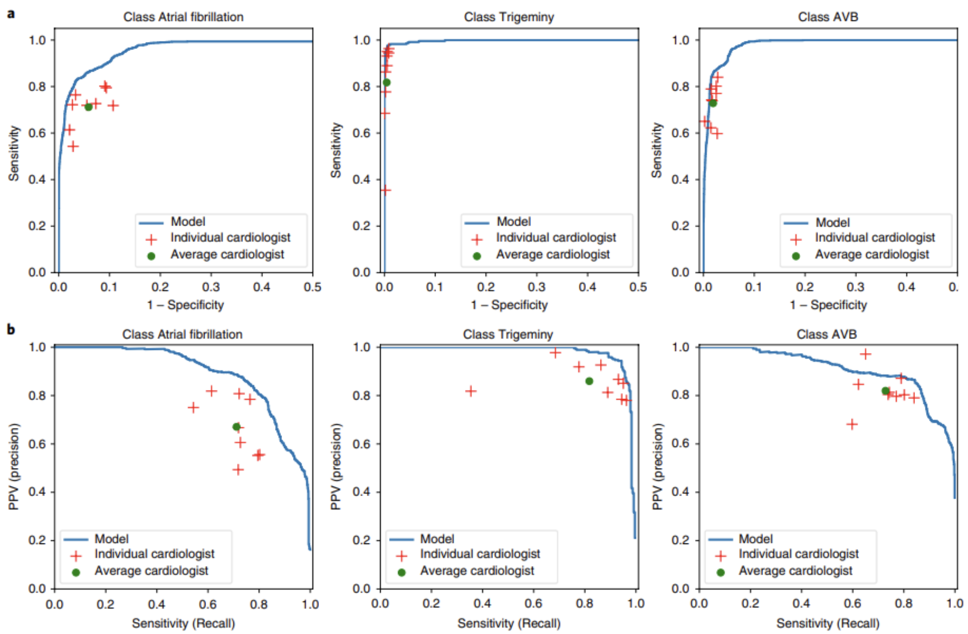


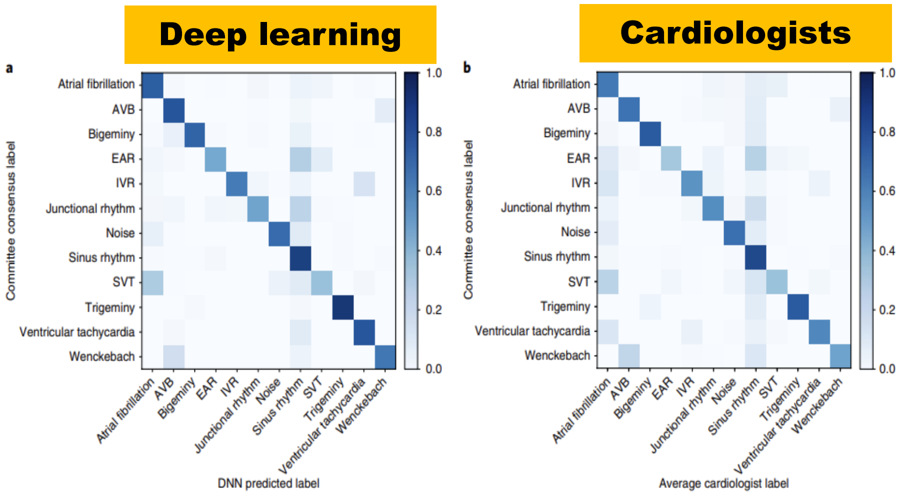
Patients at risk					
Early rhythm control	1395	1193	913	404	26
Usual care	1394	1169	888	405	34

N Engl J Med 2020;383:1305-16.

AI vs. Cardiologist in arrhythmia

12 rhythm classes using 91,232 single-lead ECGs from 53,549 patients who used a single-lead ambulatory ECG monitoring device

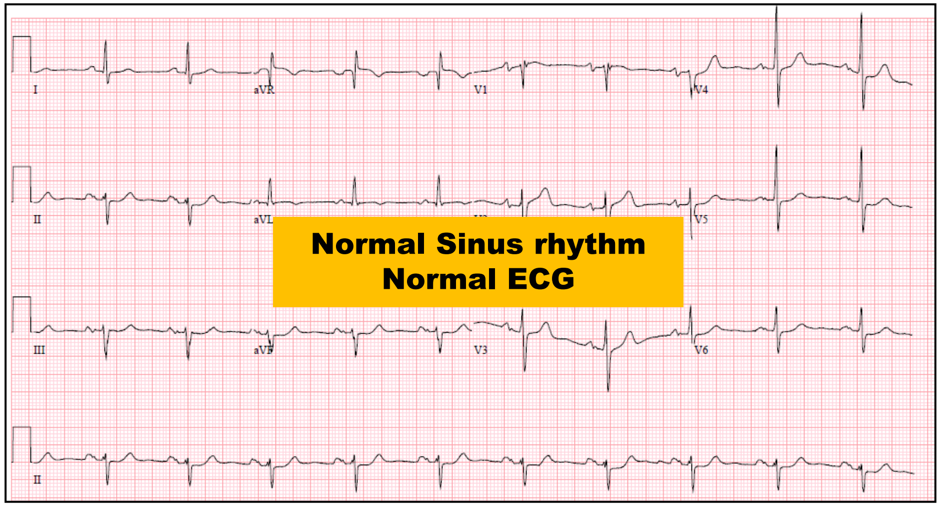




- Deep learning approach can classify a broad range of distinct arrhythmias from single-lead ECGs with **high diagnostic performance similar to that of cardiologists.**

Nature Medicine | VOL 25 | JANUARY 2019 | 65–69

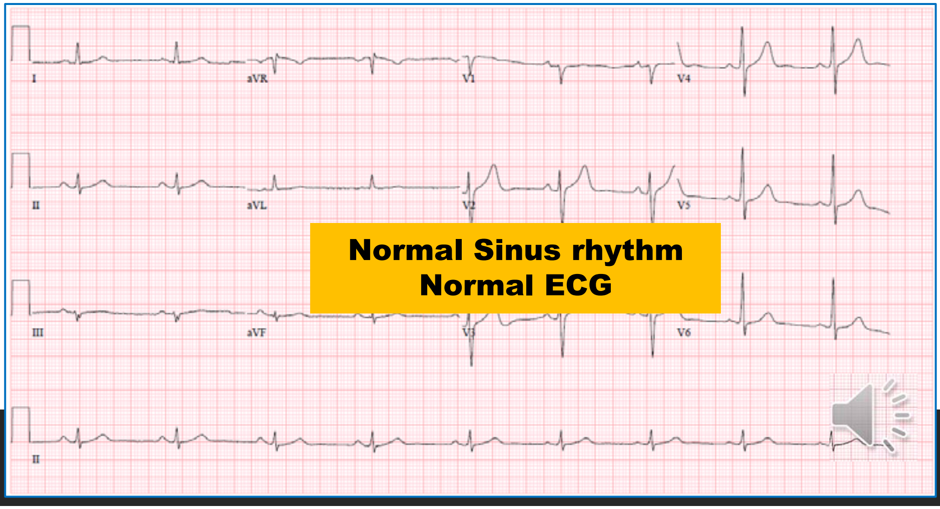
Which one is Real Normal ?



62/M PAF
PAF normal / AF duration of 5yrs

VS.

59/M Healthy
Real Normal



Background & Aim of Our Study

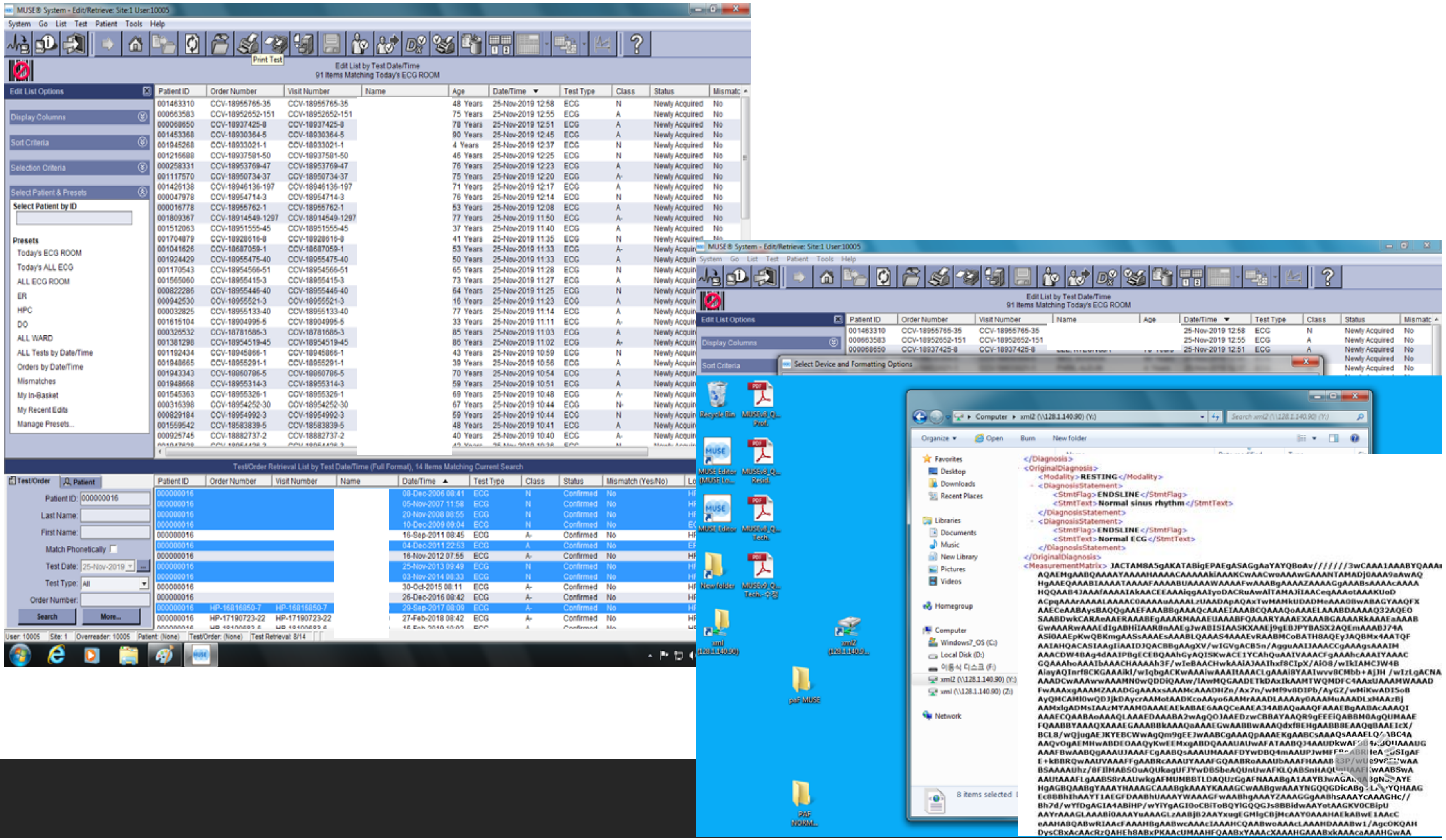
- ✓**Atrial fibrillation is the most common arrhythmia with fatal complications (stroke, heart failure, etc.), and diagnosis (electrocardiogram) is important.**

- ✓**The yield of paroxysmal atrial fibrillation is very low, and exhaustive tests are repeated. The normal sinus rhythmic electrocardiogram (PAF NSR) of atrial fibrillation patients differs slightly from the real normal rhythm (Real NSR), but it is impossible to discriminate with the eyeball of an existing ECG machine or a doctor (even a cardiologist).**

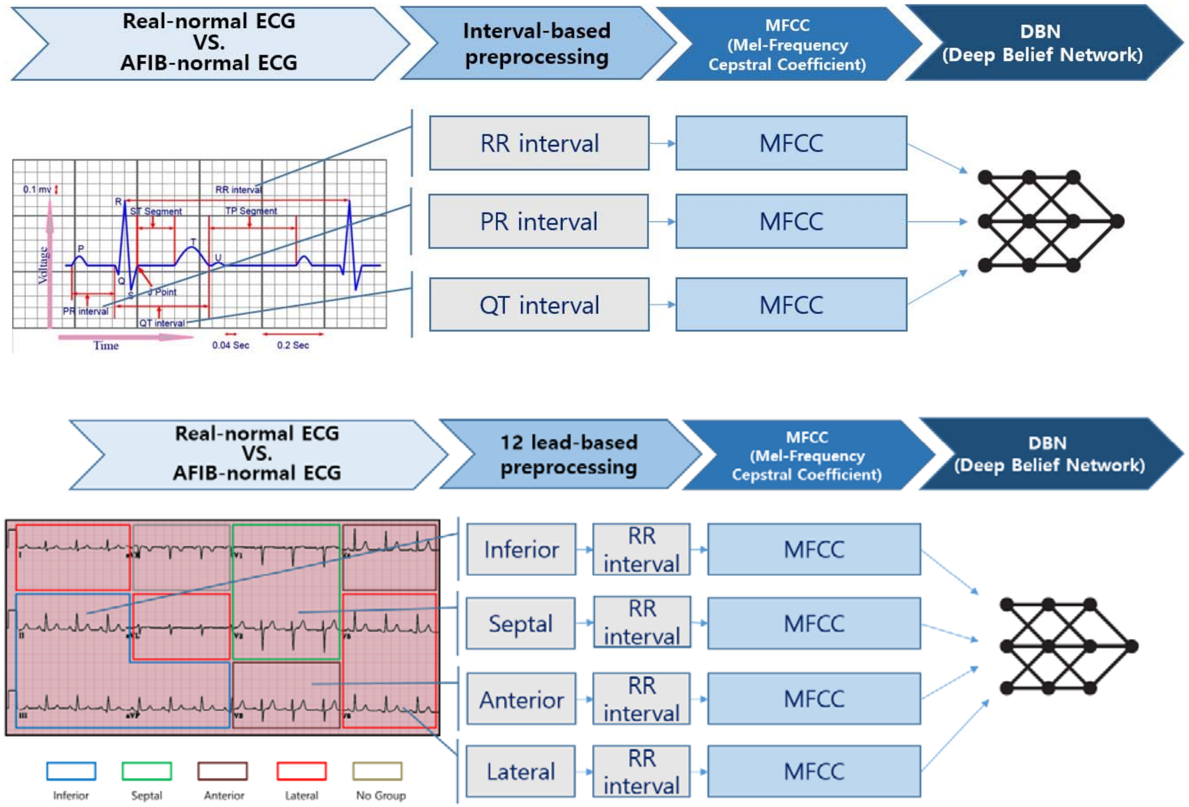
- ✓**We aim to predict the probability of atrial fibrillation during SR by deep learning artificial intelligence (AI) using the most accessible, essential, and inexpensive 12-lead ECG.**

- ✓**Existing and emerging technologies have been used to successfully identify AF in a variety of clinical and community settings, and these technologies promise to revolutionize AF detection, screening, and personalized medication method modification.**

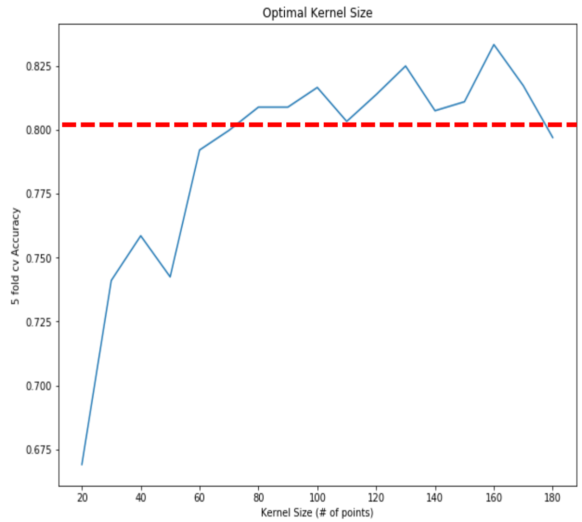
EKG System & Data extraction



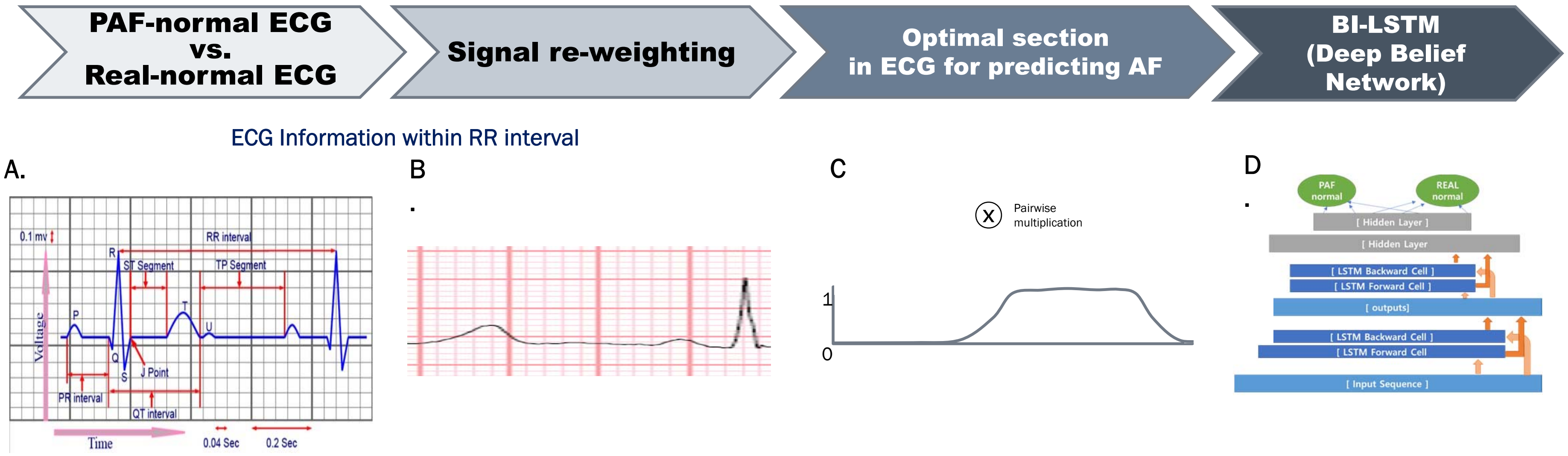
The experiment for the optimal sample size to predict AF



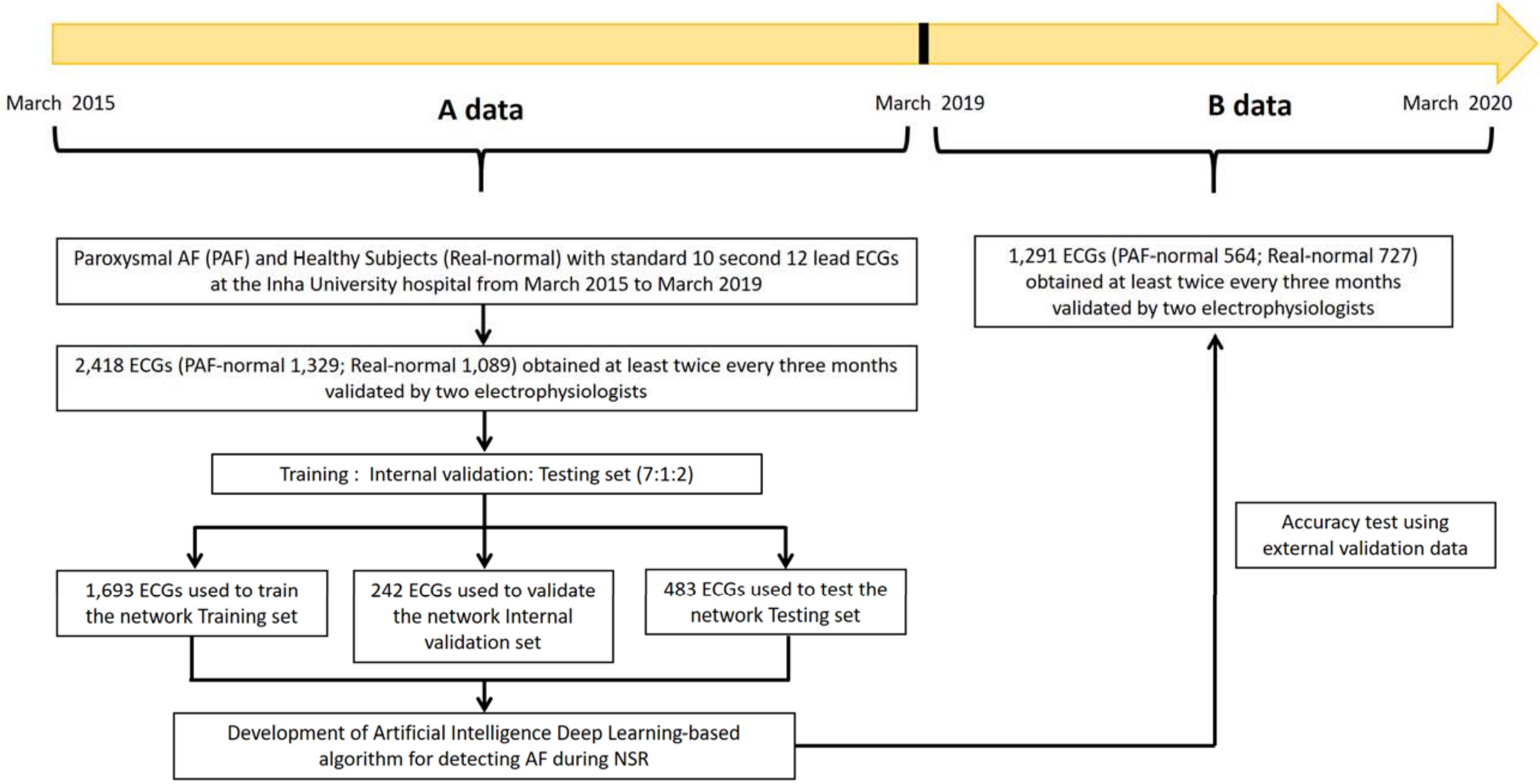
Optimal size for high accuracy



Optimal section detection for AF prediction during NSR



Creation of the study data sets

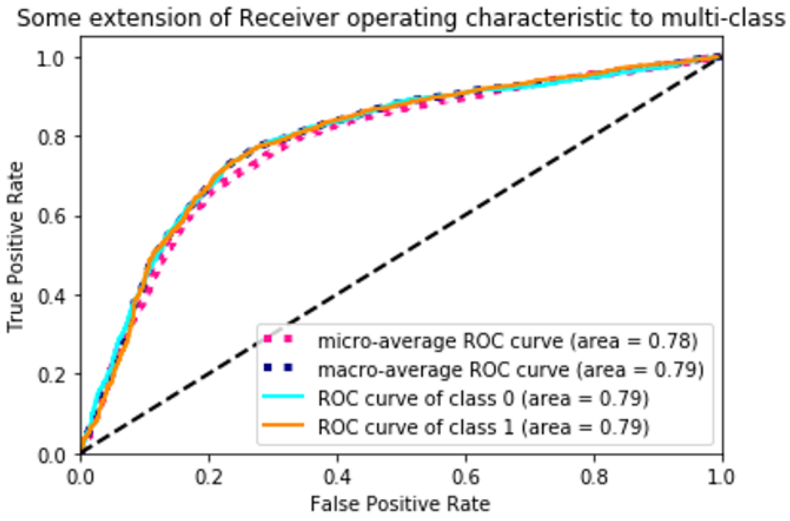


Developed AI deep learning algorithm Performance to predict AF

acc: 0.728

	precision	recall (sensitivity)	f1-score	support
Real normal	0.78	0.64	0.70	2096
PAF normal	0.69	0.82	0.75	2074
accuracy			0.73	4170
macro avg	0.74	0.73	0.73	4671
weighted avg	0.74	0.73	0.73	4671

		Normalized Confusion Matrix	
True Label	**Real Norm**	0.64	0.35
	PAF Norm	0.18	0.82
		Real Norm	**PAF Norm**
		Predicted Label	



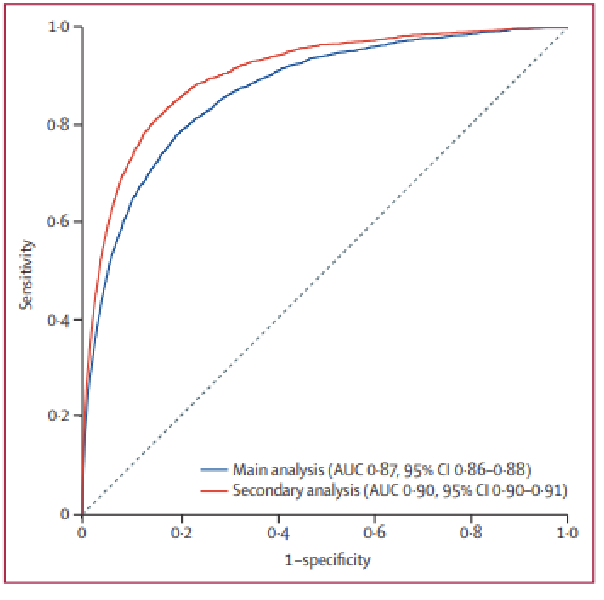
An artificial intelligence-enabled ECG algorithm for the identification of patients with atrial fibrillation during sinus rhythm: a retrospective analysis of outcome prediction

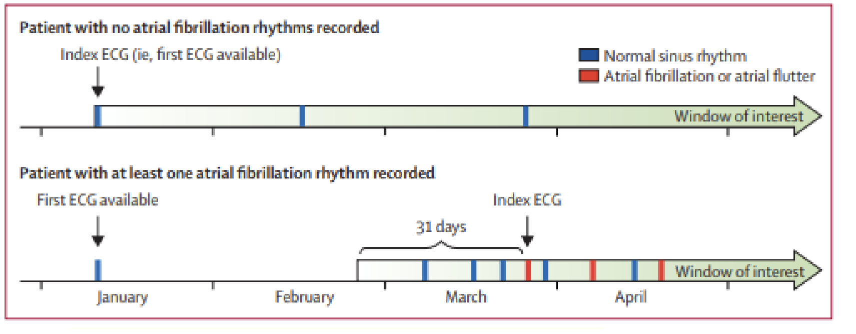
Zachi I Attia, Peter A Noseworthy*, Francisco Lopez-Jimenez, Samuel J Asirvatham, Abhishek J Deshmukh, Bernard J Gersh, Rickey E Carter, Xiaoxi Yao, Alejandro A Rabinstein, Brad J Erickson, Suraj Kapa, Paul A Friedman*

	AUC	Sensitivity	Specificity	F1 score	Accuracy
Main analysis	0·87 (0·86–0·88)	79·0% (77·5–80·4)	79·5% (79·0–79·9)	39·2% (38·1–40·3)	79·4% (79·0–79·9)
Secondary analysis	0·90 (0·90–0·91)	82·3% (80·9–83·6)	83·4% (83·0–83·8)	45·4% (44·2–46·5)	83·3% (83·0–83·7)

Data in parentheses are 95% CIs. In the main analysis, only the score of the first normal sinus rhythm ECG in the window of interest was used. In the secondary analysis, the highest score for all ECGs done in the first month of the window of interest was used. AUC=area under the curve. ECG=electrocardiograph.

Table: Model performance



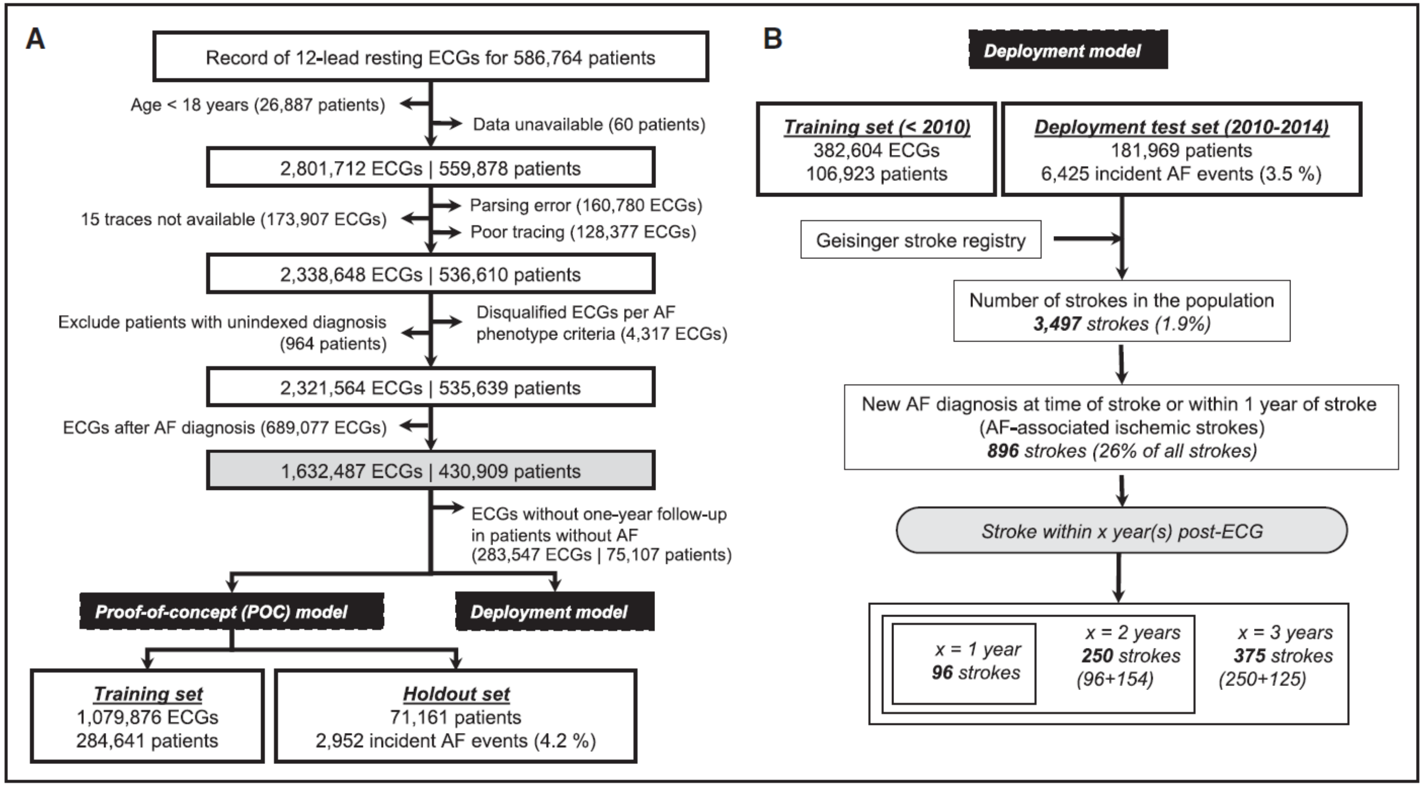


Lancet. 2019 Sep 7;394(10201):861-867.

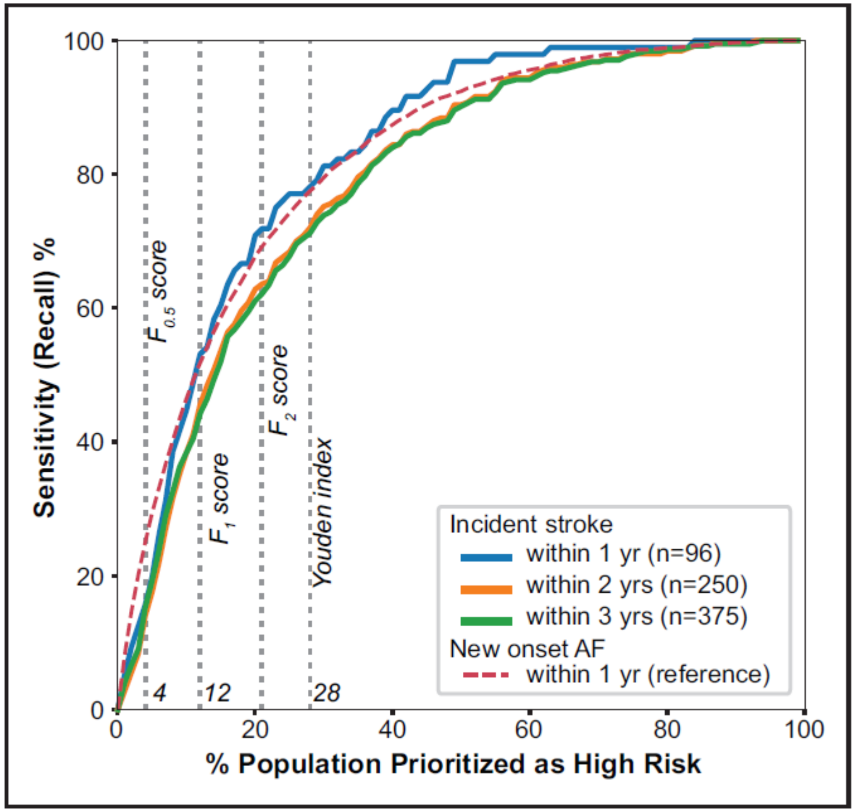
Circulation

ORIGINAL RESEARCH ARTICLE

Deep Neural Networks Can Predict New-Onset Atrial Fibrillation From the 12-Lead ECG and Help Identify Those at Risk of Atrial Fibrillation–Related Stroke

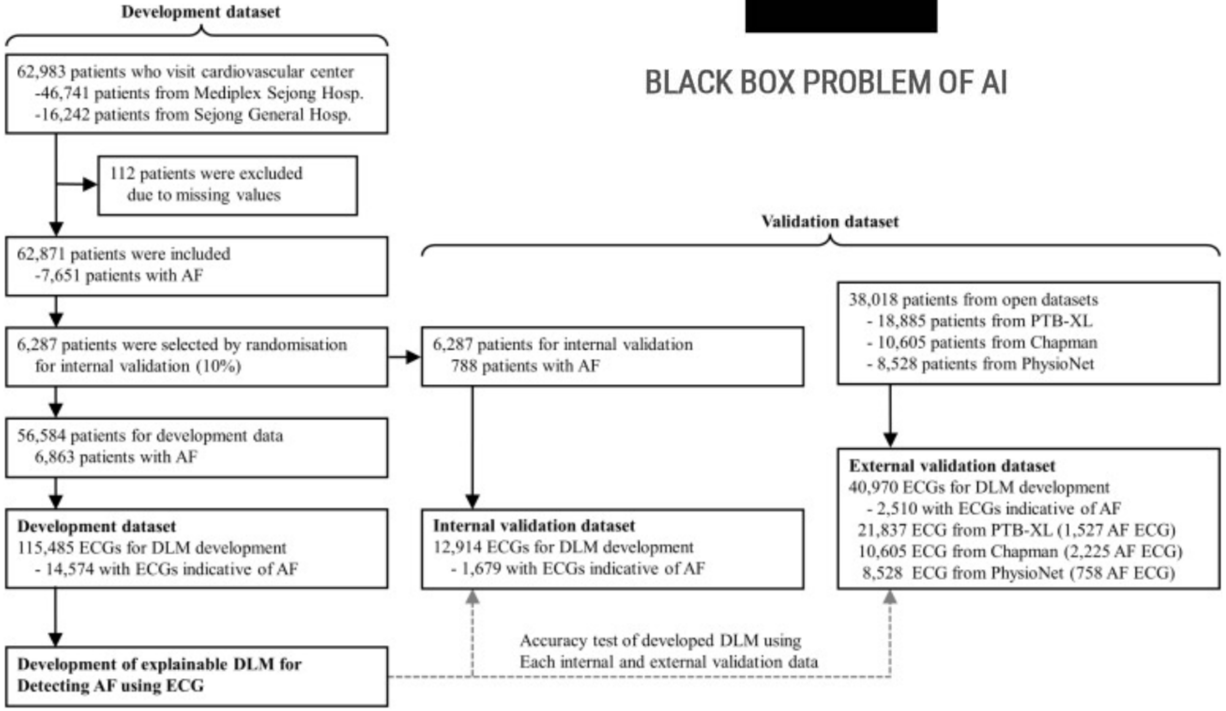


Sensitivity of the model to potentially prevent AF-related strokes



- This data simulating a real-world deployment scenario demonstrate that using this tool identifies a high-risk population that can be targeted for increased screening and may prove useful for helping to prevent AF-related strokes.

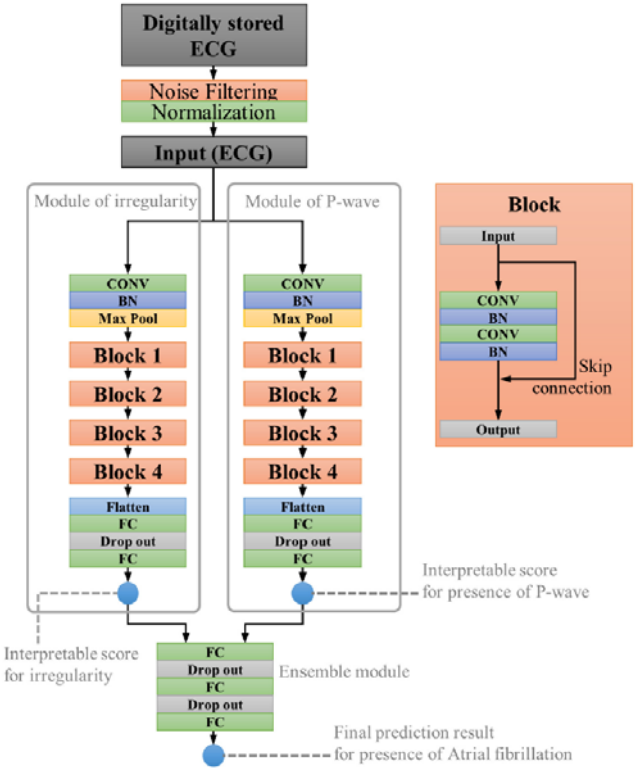
Explainable artificial intelligence (XAI) to detect atrial fibrillation using ECG



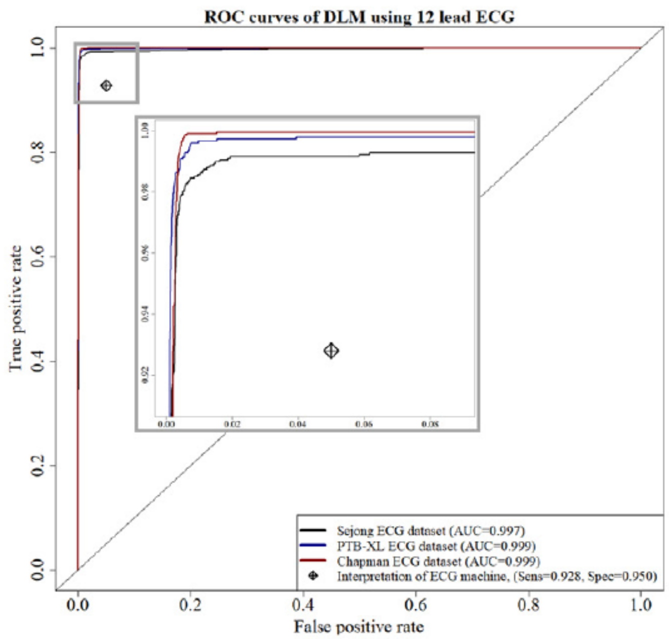
Int J Cardiol . 2021 Apr 1;328:104-110.

Explainable artificial intelligence (XAI)
; irregularity & P wave presence

Architecture of explainable DLM



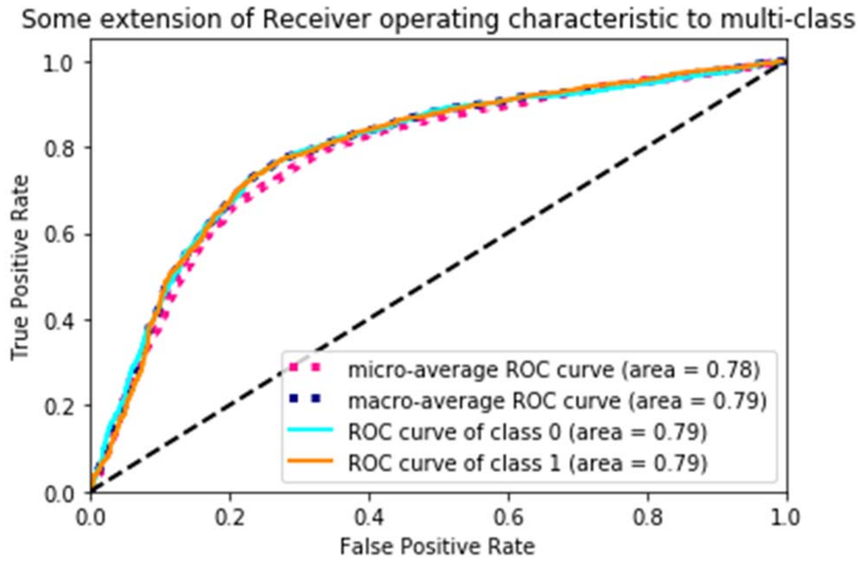
Performances of explainable deep learning model to detect atrial fibrillation



ROC curves for the neural networks on the testing dataset

A. ROC(Receiver Operating Characteristic) curves to multi-class using data A

AUC of ROC : 0.79
Recall : 82%
Specificity : 78%
F1 score : 75%



B. ROC(Receiver Operating Characteristic) curves to multi-class using data B

AUC of ROC : 0.75
Recall : 77%
Specificity : 72%
F1 score : 74%

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(9742, 2) (9742, 2)
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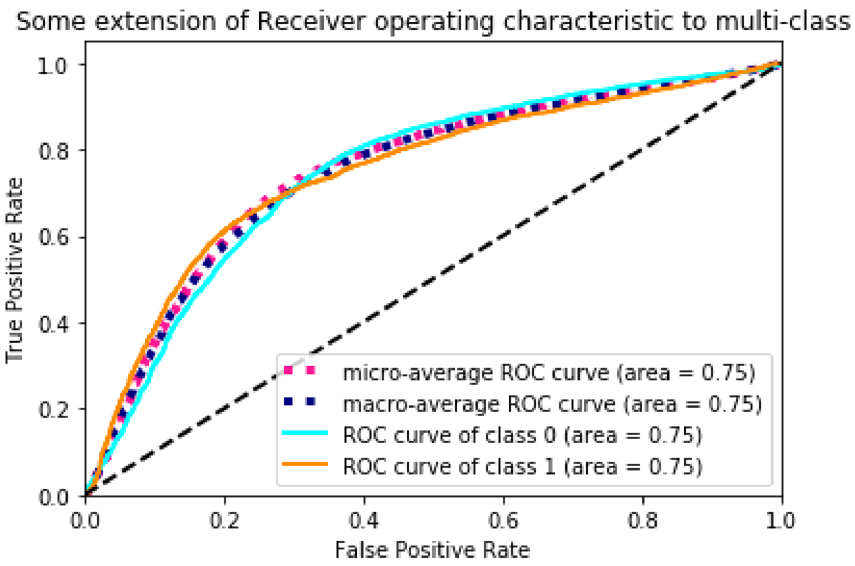
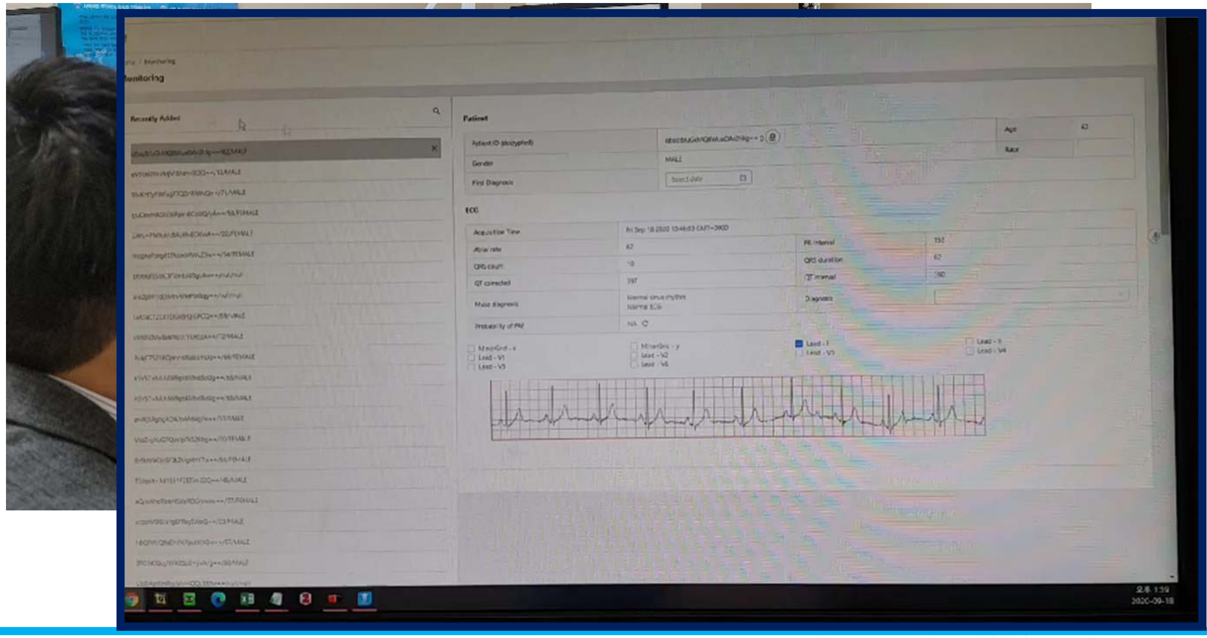
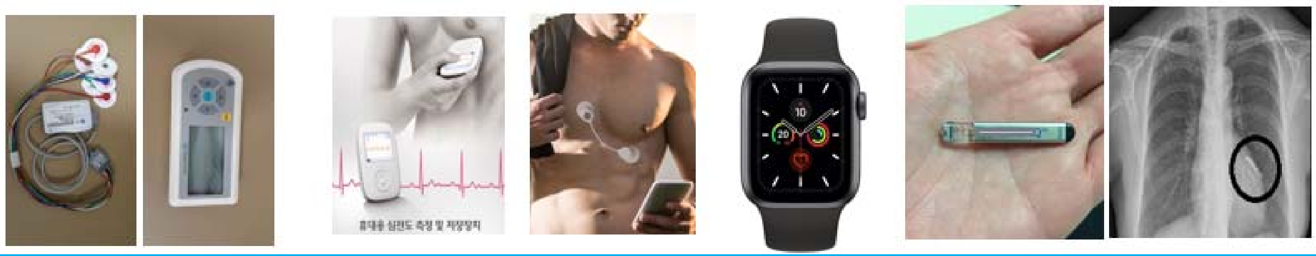


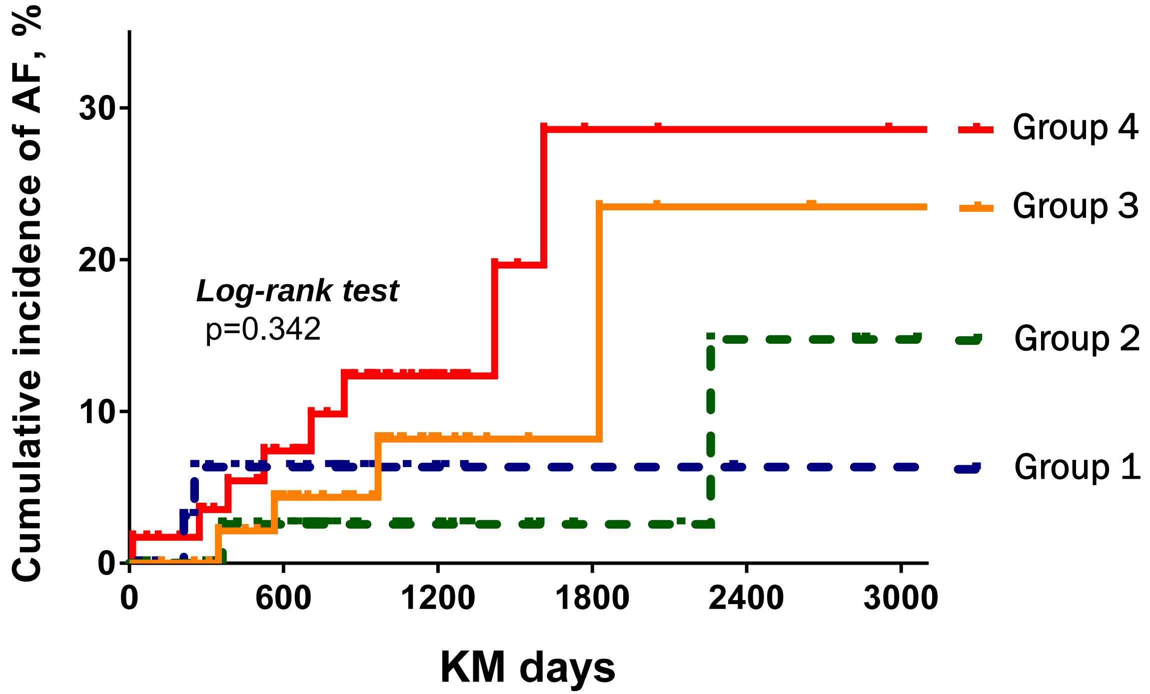
Clinical application



Diagnostic Modalities/ Decision Making / Follow-up



Kaplan–Meier curves for AF incidence according to AI-guided PAF probability in ESUS patients

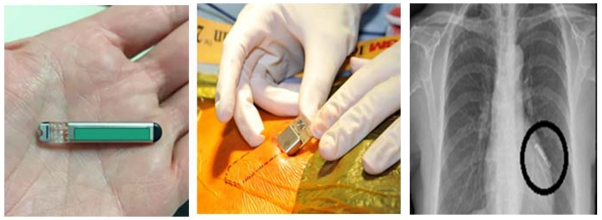


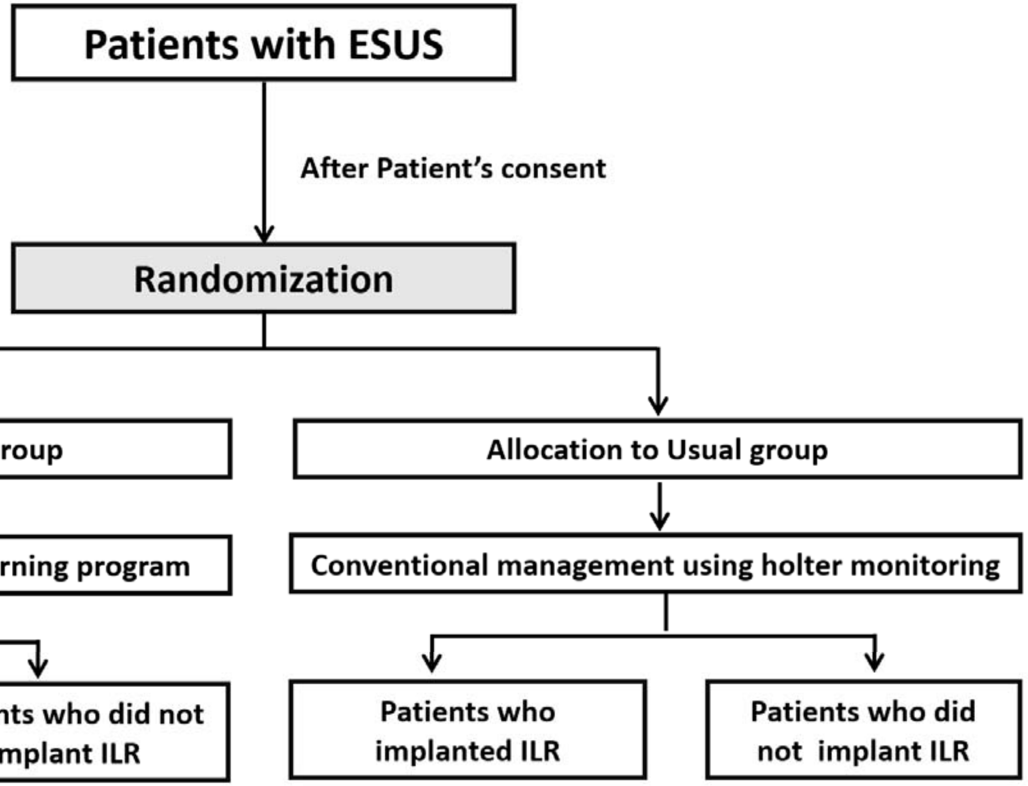
ESUS with NSR ECG

- Group 1: PAF probability 0-25% using deep learning program
- Group 2: PAF probability 25-50% using deep learning program
- Group 3: PAF probability 50-75% using deep learning program
- Group 3: PAF probability 75-100% using deep learning program

Number at Risk (days)	0	600	1200	1800	2400	3000
Group 1 (PAFp 0-25%)	34	24	9	6	6	5
Group 2 (PAFp 25-50%)	43	36	18	10	8	5
Group 3 (PAFp 50-75%)	50	44	14	6	5	2
Group 4 (PAFp 75-100%)	58	46	18	8	7	5

Ongoing Prospective trial

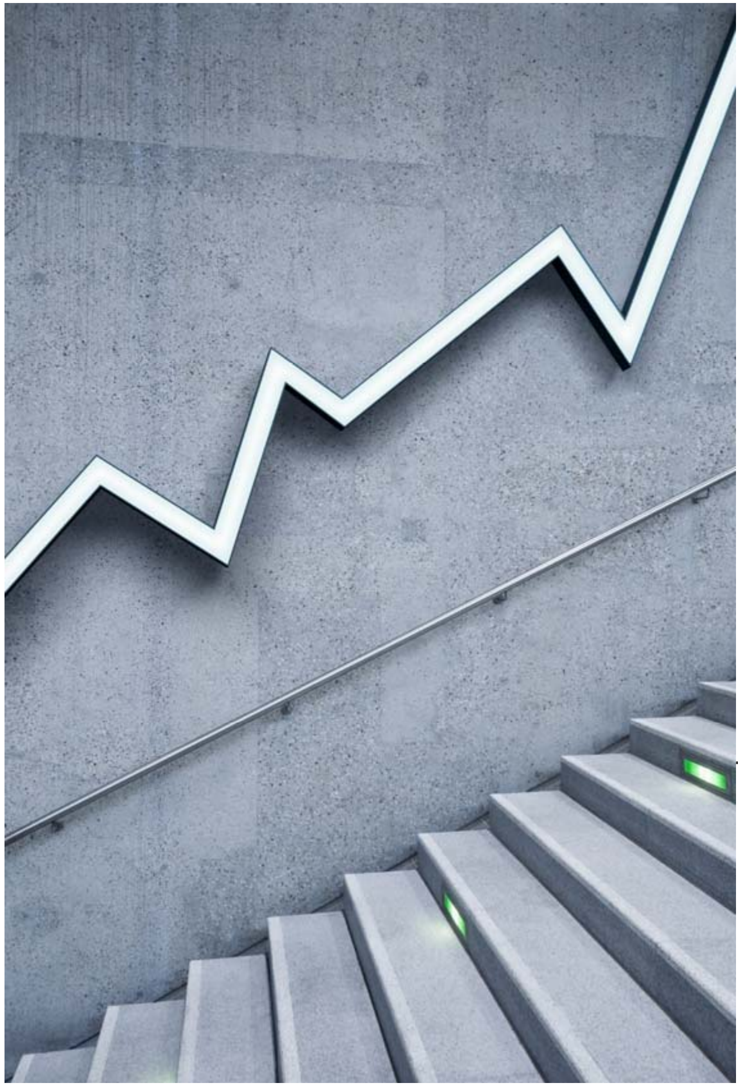




- ✓ **Primary outcome**: 1) ILR implantation
  2) stroke recurrence
  3) AF recurrence
- ✓ **Secondary outcome**: major bleeding , thromboembolic event

Summary

1. **The AI-ECG algorithm's performance holds tremendous promise as a rapid, inexpensive, and noninvasive tool capable of assessing arrhythmia, especially AF risk.**
2. **Our developed AI deep-learning algorithm for the calculation of PAF probability during NSR using 12-lead ECGs was excellent for the identification of PAF (recall of 82%, specificity of 78%, F1 score of 75%, and overall accuracy of 72.8%).**
3. **This has important implications for AF screening and the management of ESUS patients. AI may discriminate 'hidden' AF during NSR and can also be helpful in identifying if AF is the underlying cause of the stroke in patients with ESUS.**
4. **Despite concerning AI performance (sensitivity & specificity) , the more data that we have, the smarter these AI will get.**
5. **Further studies are needed to evaluate their possible use in future prognostic models for precise decision-making in daily practice.**



Thank You
For Your Attention !