Enhancing Clinical Care by Developing and Deploying AI within a Health Care System

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Heart Failure

Article | Published: 25 March 2020

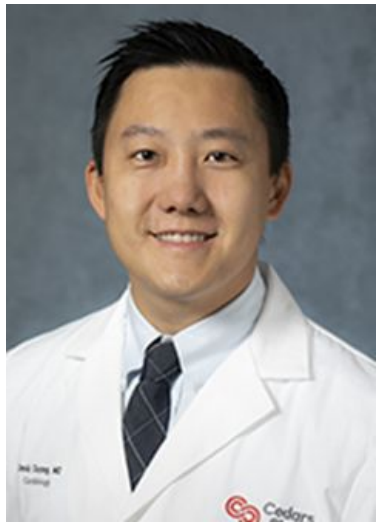
Video-based AI for beat-to-beat assessment of cardiac function

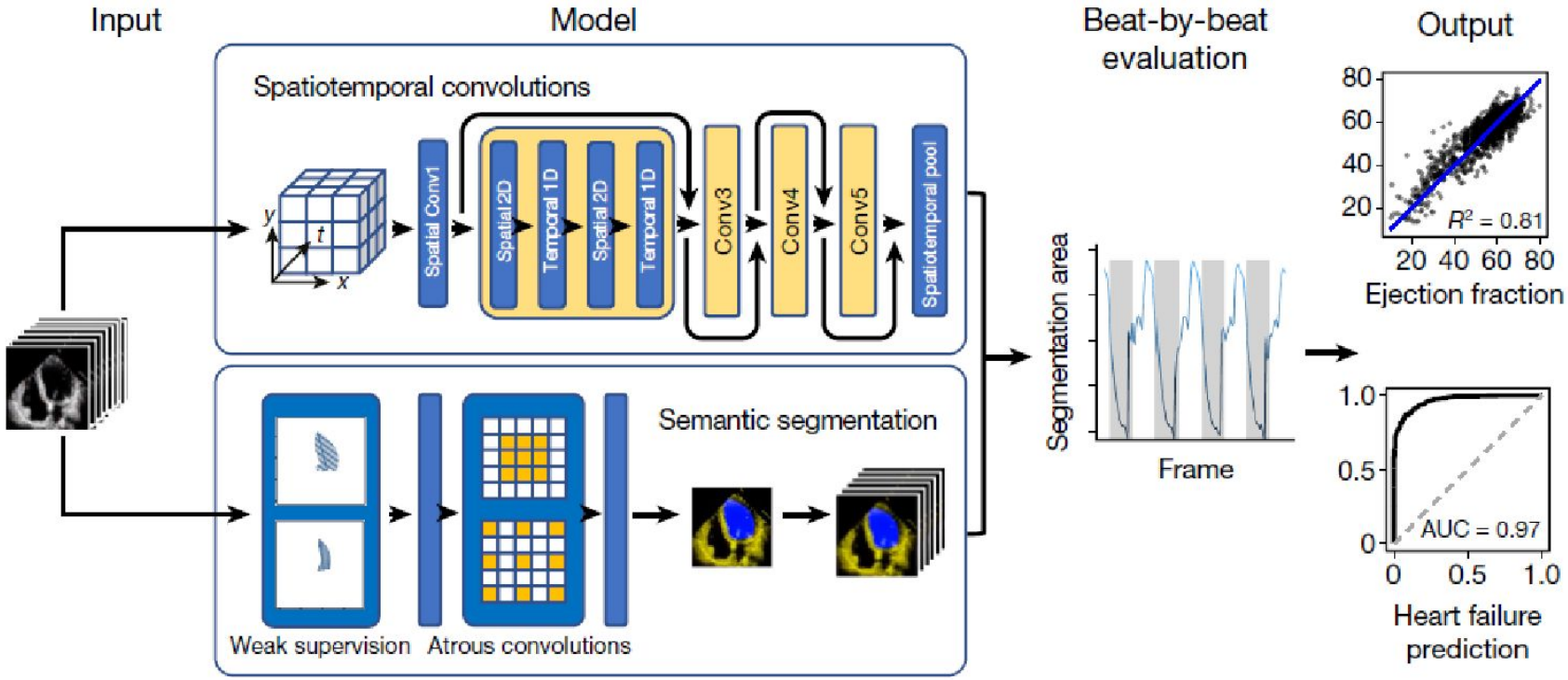
David Ouyang, Bryan He, Amirata Ghorbani, Neal Yuan, Joseph Ebinger, Curtis P. Langlotz, Paul A. Heidenreich, Robert A. Harrington, David H. Liang, Euan A. Ashley & James Y. Zou

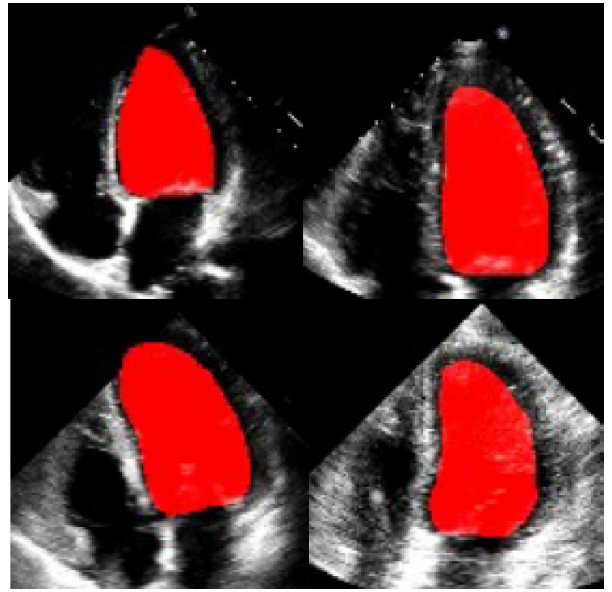
Nature **580**, 252–256 (2020) | Cite this article

16k Accesses | **58** Citations | **167** Altmetric | Metrics

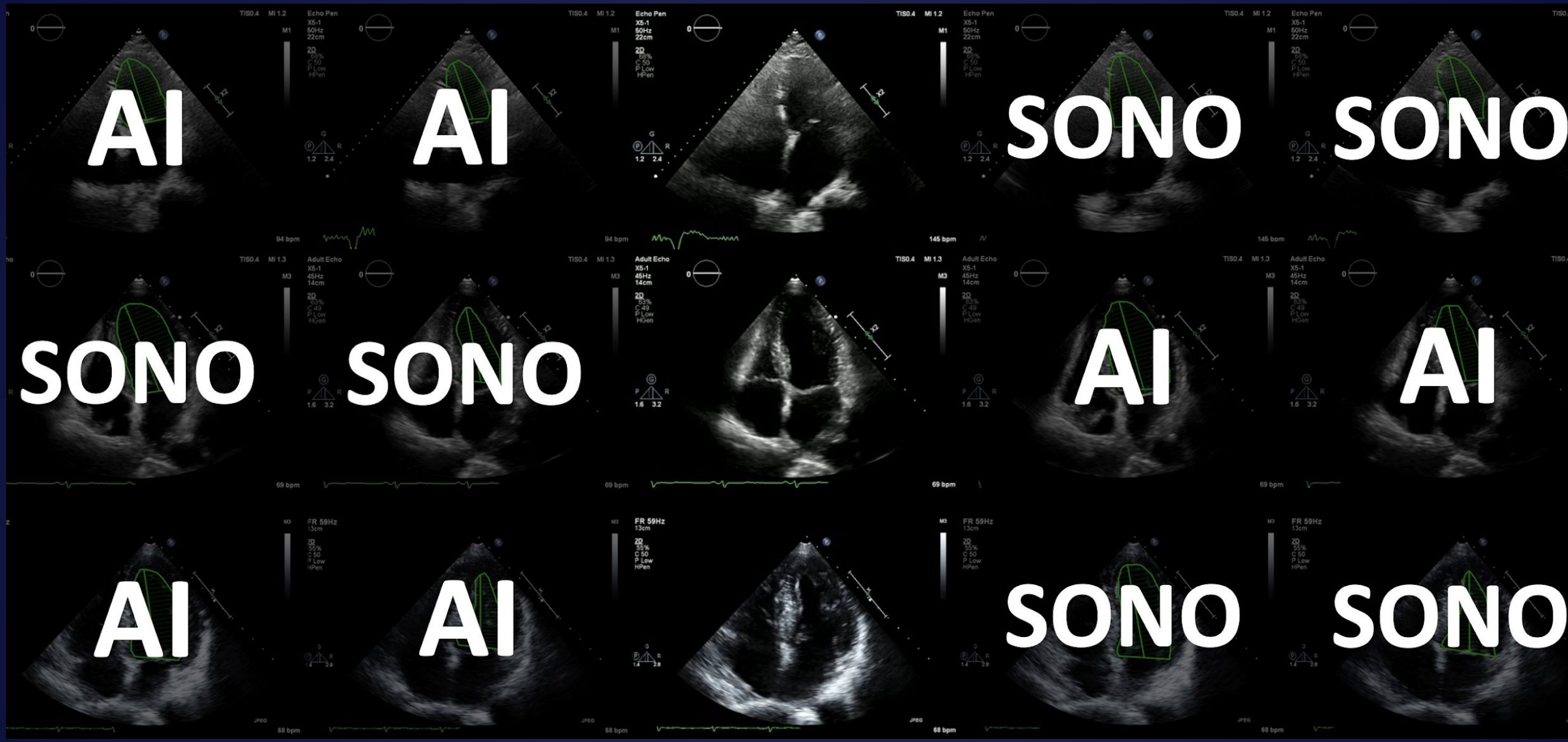
D. Ouyang





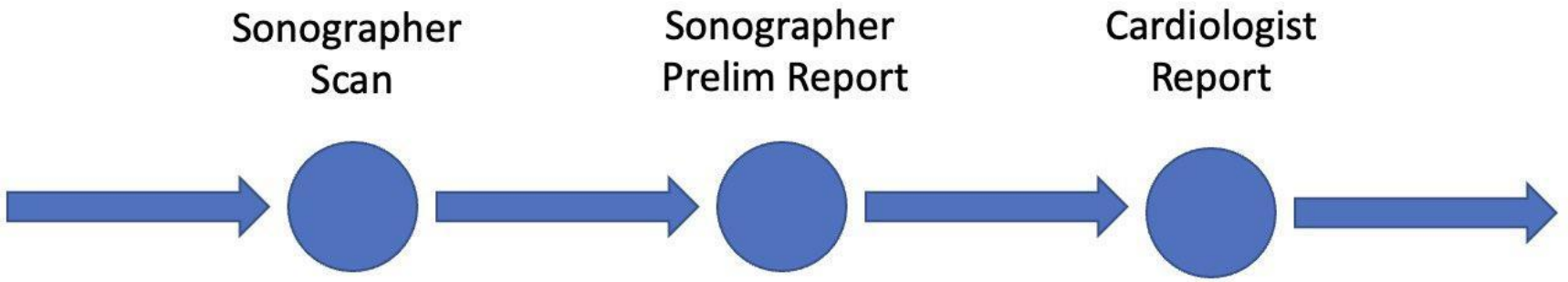


Ouyang D, et al. *Nature* (2020).

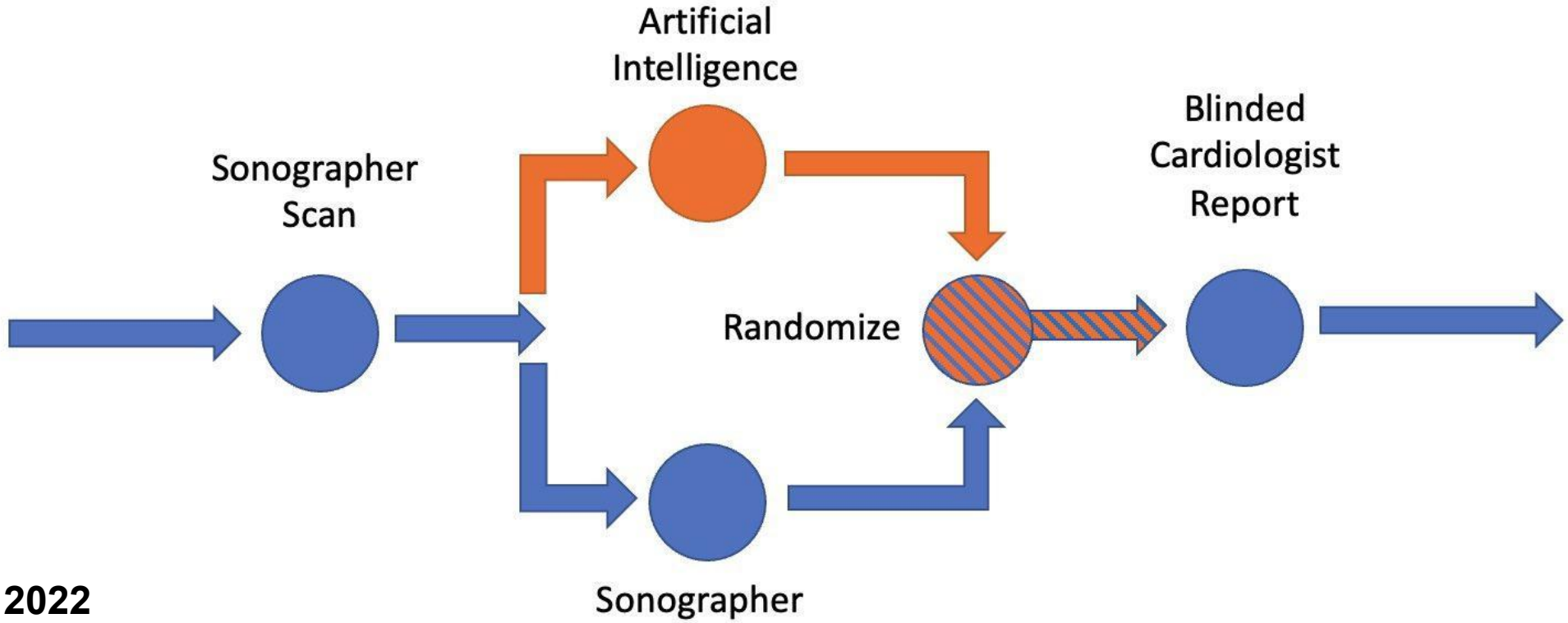


Ouyang D, et al. ESC 2022

Standard Workflow



Randomized Clinical Trial Set-up



Ouyang D, et al. ESC 2022

Trial Results (Ouyang D et al. ESC 2022; n=3495)

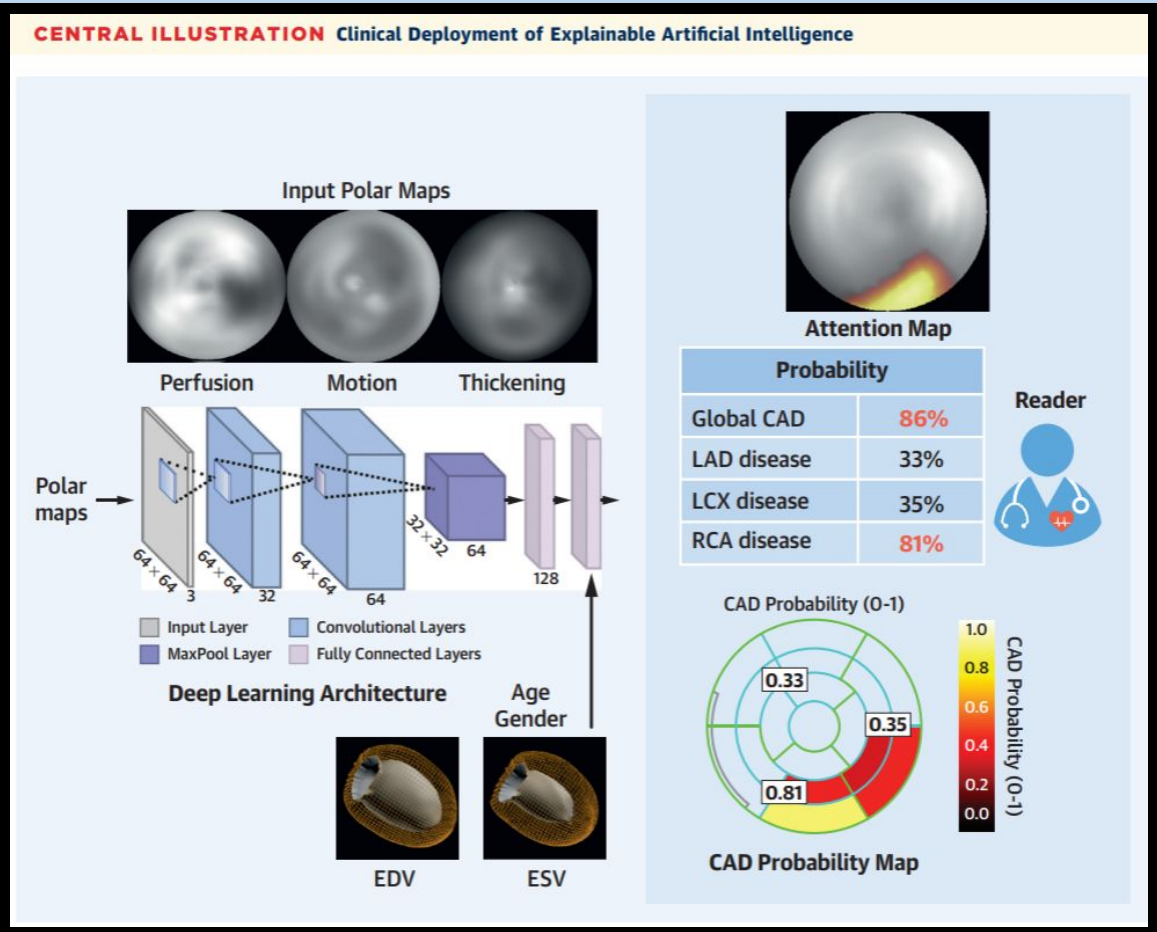
Outcome	AI (n = 1740)	Sonographer (n = 1755)	Mean Difference (95% CI)	P value
Primary Efficacy Outcome: Initial vs. Final Assessment				
Substantial Change	292 (16.8%)	478 (27.2%)	-10.5% (-13.2% to -7.7%)	< 0.001*
Mean Absolute Difference	2.79±5.53	3.77±5.22	-0.97 (-1.31 to -0.61)	< 0.001

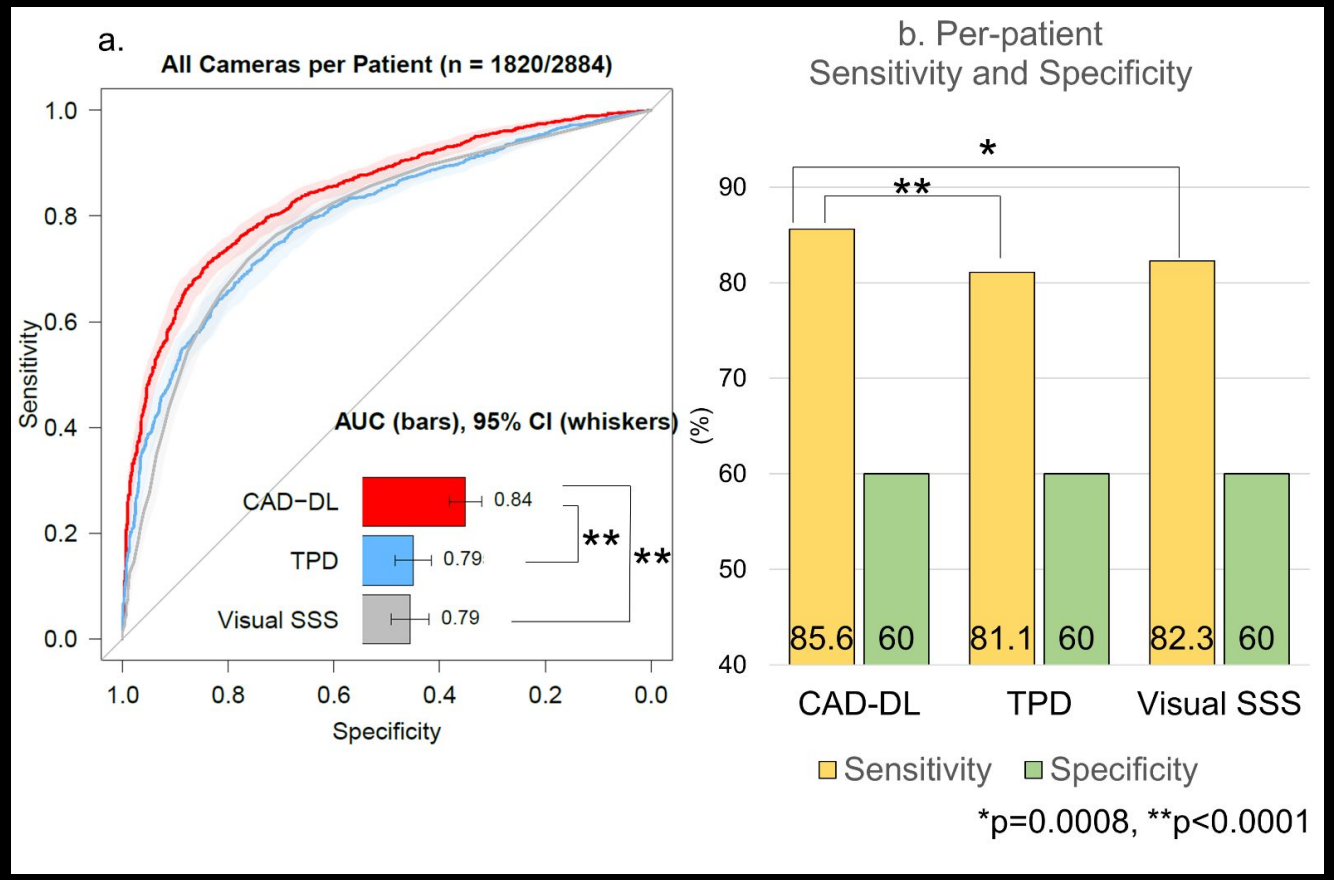
Conclusion

- For adult patients undergoing echocardiographic quantification of cardiac function, initial assessment of LVEF by AI was noninferior and superior to initial sonographer assessment.
- After blinded review of initial LVEF assessment, cardiologists were less likely to substantially change their final report with initial AI assessment than sonographer assessment.
- AI guided assessment took less time for cardiologists to overread and was more consistent with historical cardiologist assessment (test-retest precision).

Coronary Artery Disease

Doctor vs machine: predicting CAD from MPI





n=3578 patients, SPECT MPI + cor angio 6m
Comparison to visual scoring, multiple camera types

Explainable AI results <12s

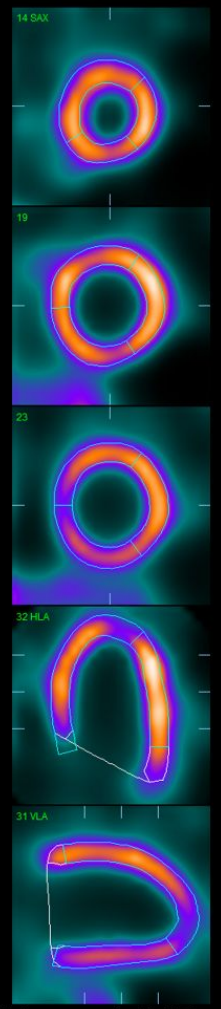
*CAD-DL Coronary Artery Disease deep learning

Otaki..Slomka. JACC Imaging 2022

P. Slomka

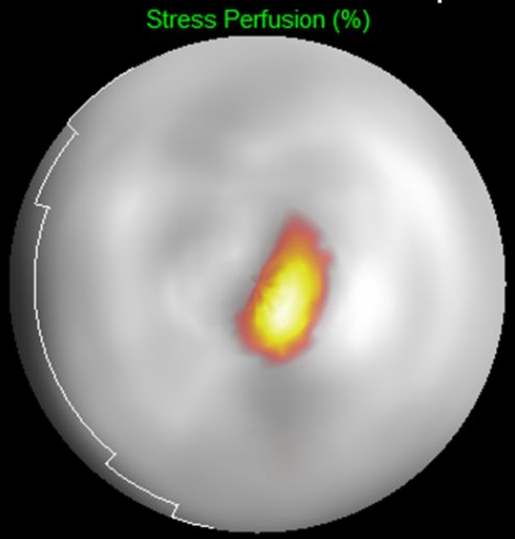
Deep learning from SPECT: case example

a. Perfusion



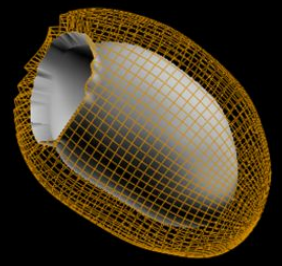
Stress TPD 4%

b. CAD attention map

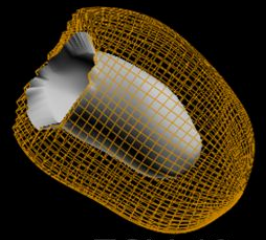


72 years old, Male

d. Gated SPECT

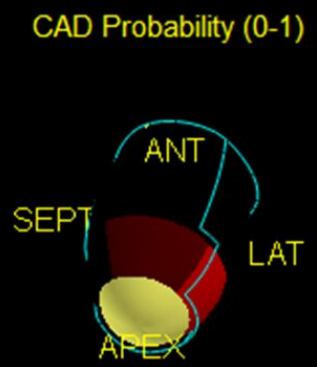


Stress EDV 121ml



Stress ESV 40ml

c. CAD probability map



CAD probability	
Global CAD	0.88
LAD disease	0.86
LCX disease	0.28
RCA disease	0.31

85% stenosis in the proximal left anterior descending artery (LAD) artery on coronary angiography

Processing Time:5 sec

Visual assessment was interpreted as normal.

Otaki, Singh JACC Imaging 2021

Sudden Cardiac Arrest

Sudden cardiac arrest

By the time 911 is called, too late for >90%

9-1-1

- Prediction & Prevention is the Key

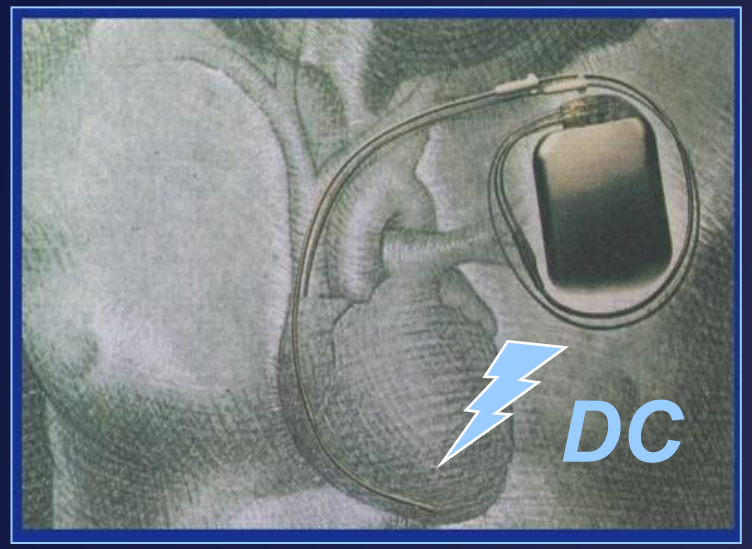
Chain of Survival

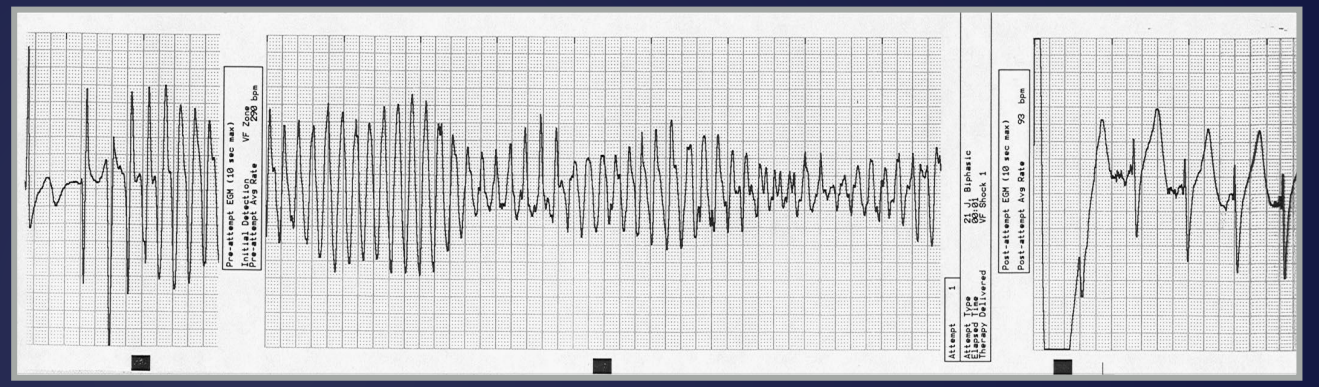
Prediction (Prevention) → Early Access → Early CPR → Early Defibrillation → Early Advanced Care

New Research → New Treatments

Chugh/CSMC

Primary prevention Implantable Cardioverter-Defibrillator (ICD)
Treatment of Shockable Lethal Heart Rhythms





- Main predictor of risk LV ejection fraction (imaging marker) <35%
- Yielding diminishing returns
- Among patients with ICDs, life-giving therapies in 1-3% per year (33-99 ICDs to save 1 life/yr)
- Need novel risk prediction tools

Chugh/CSMC

UNMET NEED: A Risk Prediction Score Beyond the Ejection Fraction

2002: Population-based Learning Health System for SCA

Integration of
PRE-HOSPITAL & HOSPITAL
Clinical Data, individual level

+

Chugh/CSMC

CCAP Population Cohorts

Oregon (2002- Discovery) & Ventura (2015- Validation)

Clinical Data Repository & Biobank

≈1 million

≈850 K

Cedars-Sinai Heart Institute

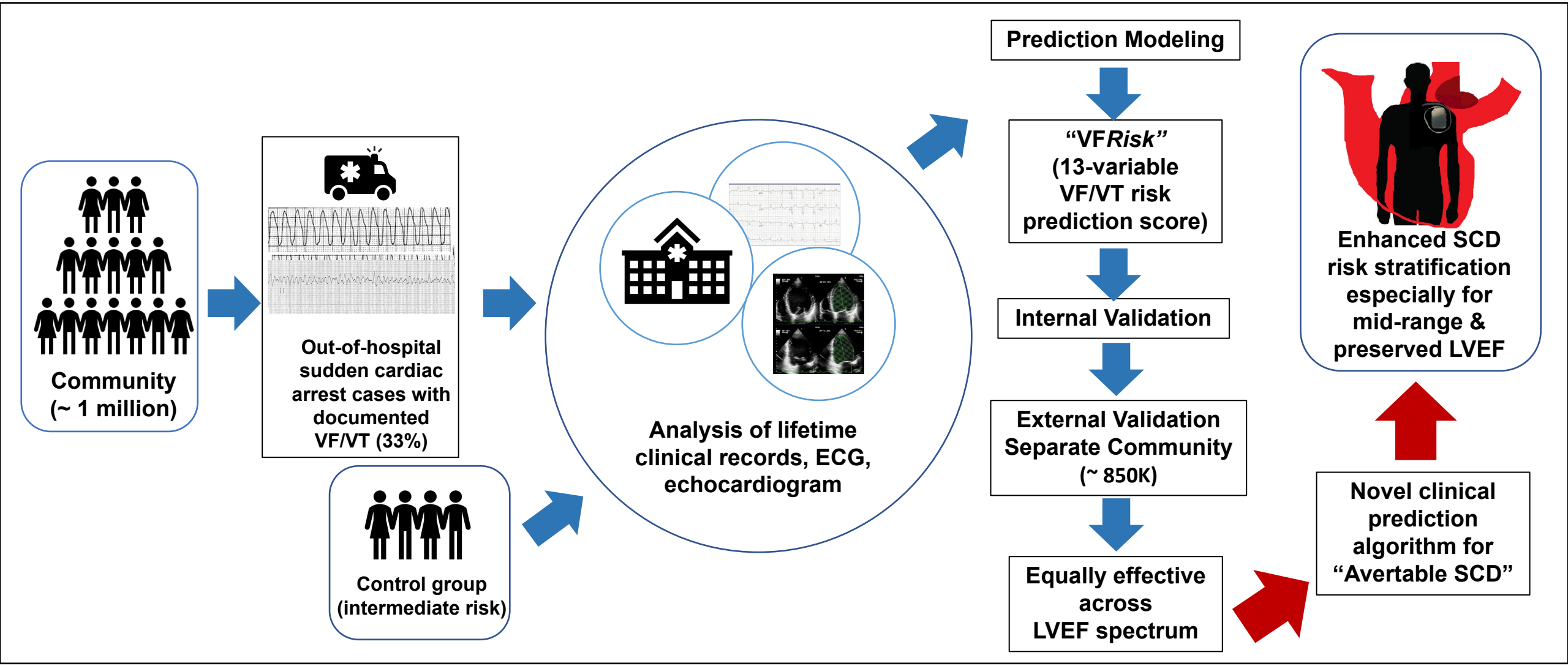
County of Ventura EMS California

AMR American Medical Response

Ventura County Fire Department Fire & Rescue

Chugh/CSMC

Prediction of SCD Manifesting with Shockable Rhythm
VFRisk (VF 93%/Pulseless VT 7%)



Chugh SS, et al. JACC Clinical Electrophysiology 2022

VFRisk: Clinical Risk Prediction Tool for Avertable SCD (VF/pulseless VT

Cardiovascular risks

Diabetes

Prevalent cardiovascular disease

MI

Atrial fibrillation

Stroke

Heart failure

Comorbidities

COPD

Seizure disorder

Syncope

ECG /Echo parameters

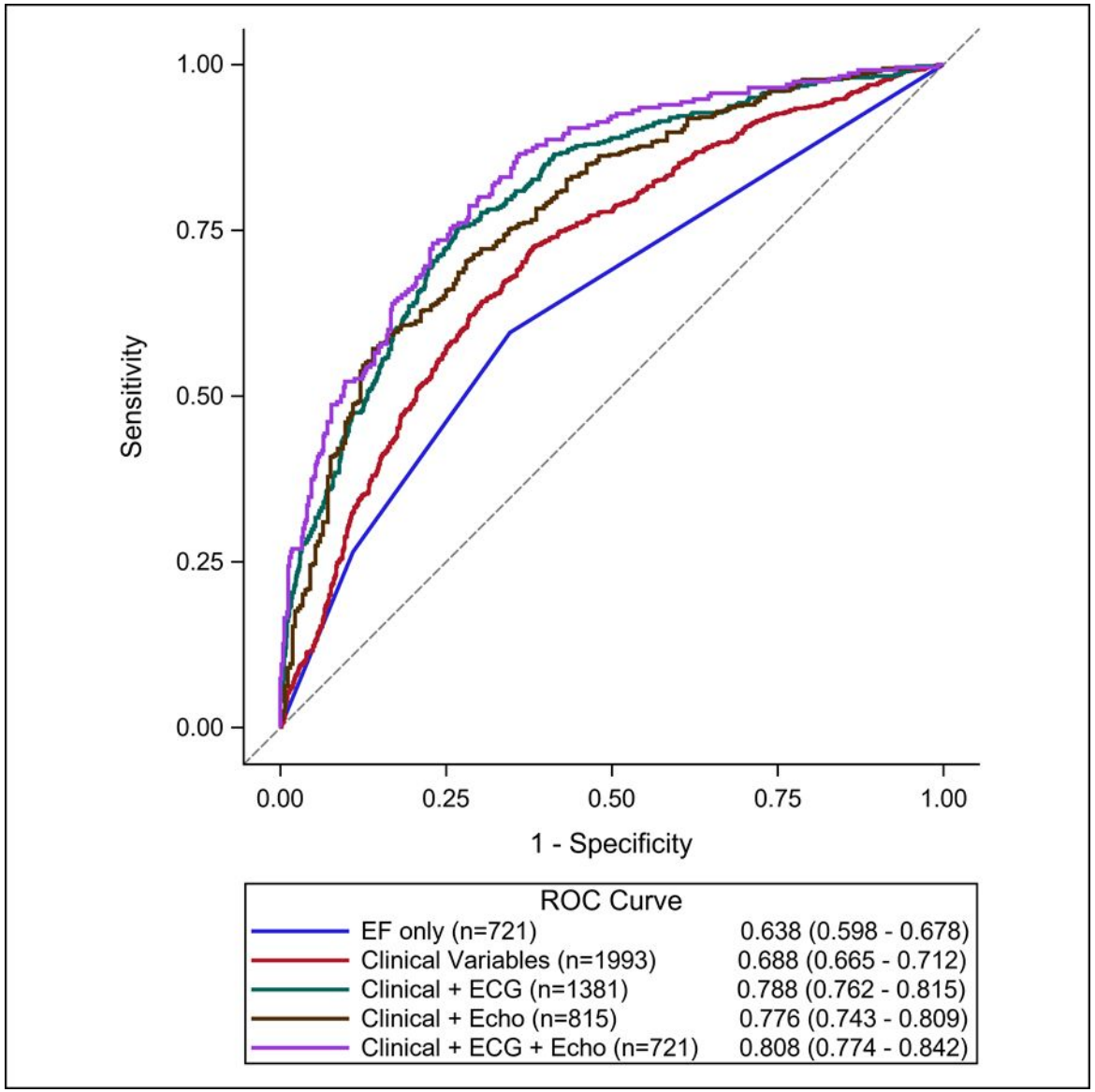
Heart rate >75 bpm

QTc ≥460 ms female, ≥450 ms male

Tpeak-end (lead V5) ≥90ms

Delayed intrinsicoid deflection ≥50 ms

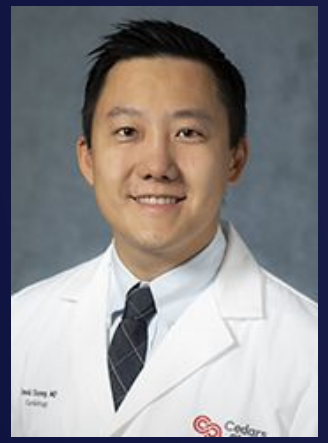
LVH by echocardiogram

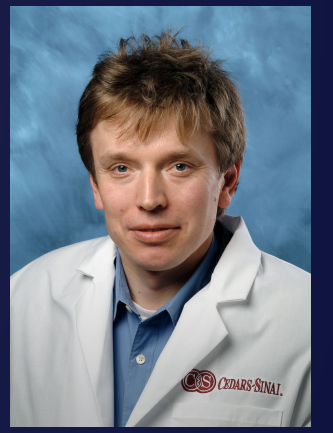


Chugh SS, et al. JACC Clinical Electrophysiology 2022

Refining Prediction of Avertable SCD

LV EF 30% → 35 → 20% → 50 → 50%





Multi-modality Ai: Machine learning/Deep Learning

- Image analysis (ECG, Echo)
- Whole genome sequencing
- Phenotype-omics analysis

O.S.C.A.R. (*O*bservational *S*tudy of *C*ardiac *AR*rest)

- 400,000 patients in the Cedars-Sinai Clinical Data Warehouse
- 10 year f/u (2016- 2025)
- Assessment of VFrisk in an intermediate risk population
- Using NLP, ML/DL (multi-modality Ai)
- Springboard to clinical trials in the field




Chugh/CSMC