STAY AMAZING

NewYork-Presbyterian

WITH WORLD-CLASS DOCTORS FROM

COLUMBIA

Weill Cornell Medicine

Building Safe, Scalable and Useful AI Products for a Health System

Ashley Beecy, MD, FACC | May 12, 2025

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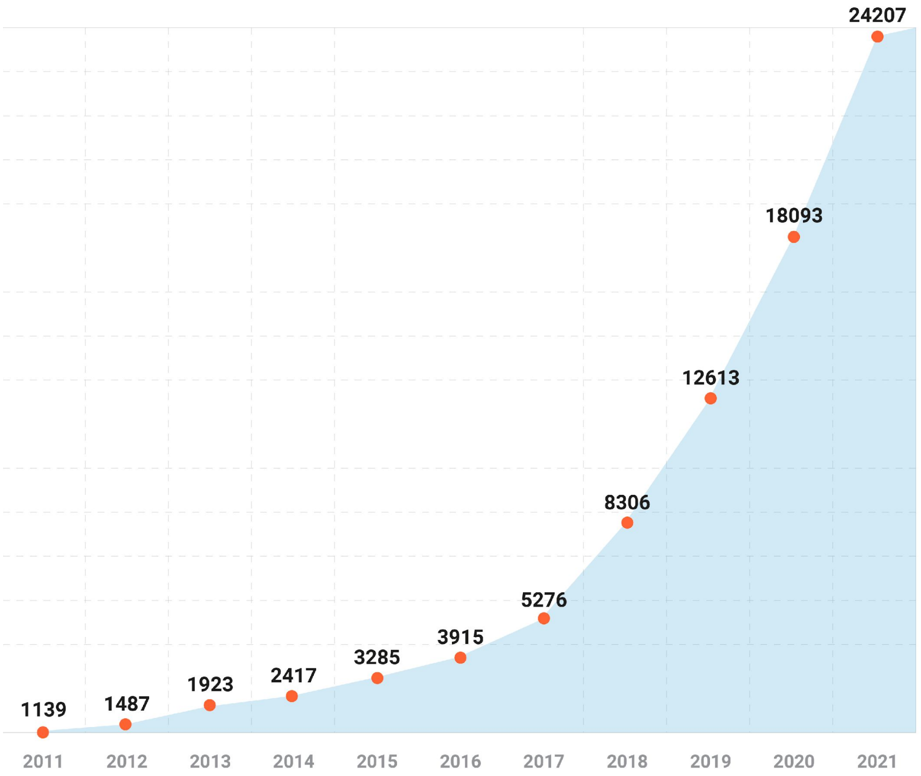
DATE	WEIGHT	BLOOD PRESSURE	PULSE	WEIGHT
8/1	181.0	110/64	82 78	−.8
8/2	181.6	97/57	72	+.6
8/3	182.6	104/57	77	+1.0
8/4	184.4	100/62	93	+1.
8/5	184.2	106/62	86	
8/6	184.8	104/67	86	
8/7	186.7	93/58	83	
8/8	187.4	101/66	72	
	186.3	90/60	79	
	9	100/66	78	
		100/58		
		98/60		
		122/70		

NUMBER OF PUBLICATIONS ON THE APPLICATION OF MACHINE LEARNING IN HEALTHCARE IN 2011–2021



https://pubmed.ncbi.nlm.nih.gov/?term=machine+learning&filter=years.2011-2021&timeline=expanded

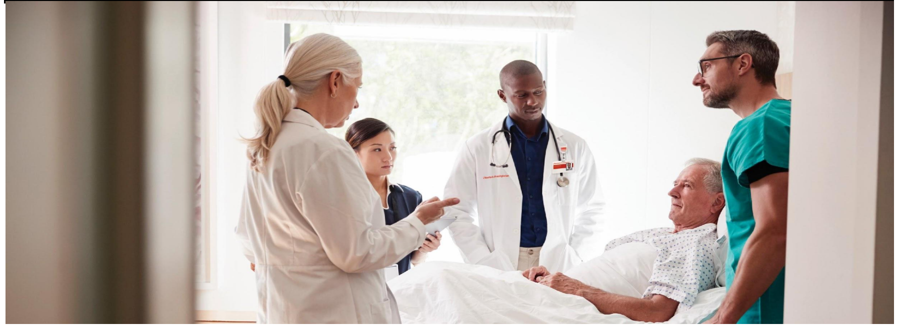
There is exponential growth in the number of machine learning projects representing the multitude of use cases in healthcare.

What Makes Healthcare Different?

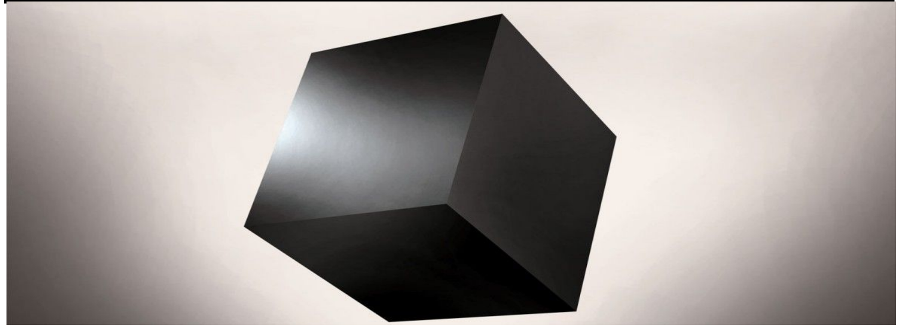
Identifying the Problem

AI Deployment

Solution Performance



Regulation and Trust



Identifying the Problem | What is relevant?

- Understand **org-wide priorities** and challenges
- Assess **current workflow** and solution
- Spot issues and propose **practical, fast solutions**
- Plan **model integration** and affected roles
- Compare AI with **simpler or cheaper alternatives**
- Confirm **data and labels are available**
- Outline key **components for success**

Heart Failure Has Widespread Societal Impacts

>8,000,000	# of adults with heart failure in the U.S. by 2030
1:5	Lifetime risk of developing HF for both men & women >40
$69,700,000,000	$ spent by U.S. health care annually on heart failure

Mozaffarian D, Benjamin EJ, Go AS, et al. Heart Disease and Stroke Statistics-2016 Update: A Report From the American Heart Association. Circulation. 2016;133(4):e38-360.

- Goal: Transform cardiovascular health and heart disease prediction and prevention

- Approach: Apply AI and machine learning to multi-modal data to screen for heart failure, predict progression, and inform care decisions

NewYork-Presbyterian, Cornell Tech and the Cornell Ann S. Bowers College of Computing and Information Science Collaborate to Transform How Health Care is Delivered

Organizations will advance cardiovascular medicine with the use of advanced analytics and artificial intelligence, moving towards prediction and prevention of heart disease.

Jul 14, 2022

New York, NY

Identifying the Problem | Cardio AI Collaboration

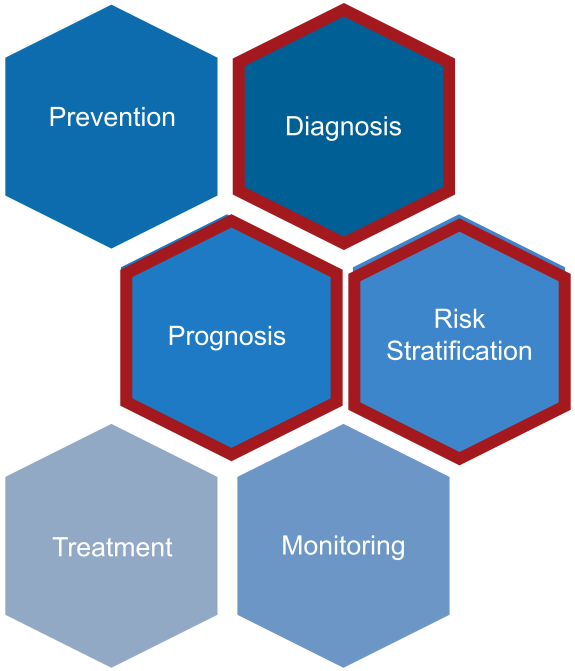
Faculty

Trainees

Staff

How do you get started?

Areas of Focus

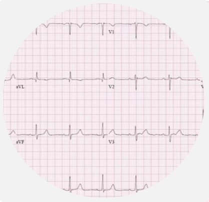


Topics of Interest

- Heart Failure Reduced Ejection Fraction
- LVAD
- Transplant
- Cardio-Oncology
- Heart Failure Preserved Ejection Fraction
- Cardiac Amyloidosis
- Hypertrophic Cardiomyopathy
- Valvular Disease
- Myocarditis
- Cardiac Sarcoidosis
- Pulmonary Hypertension
- Cardiogenic Shock

Identifying the Problem | Cardio AI Collaboration

Prognosticate using multimodal data sources



Identify disease processes with low cost readily available data

Understand severity of illness and management

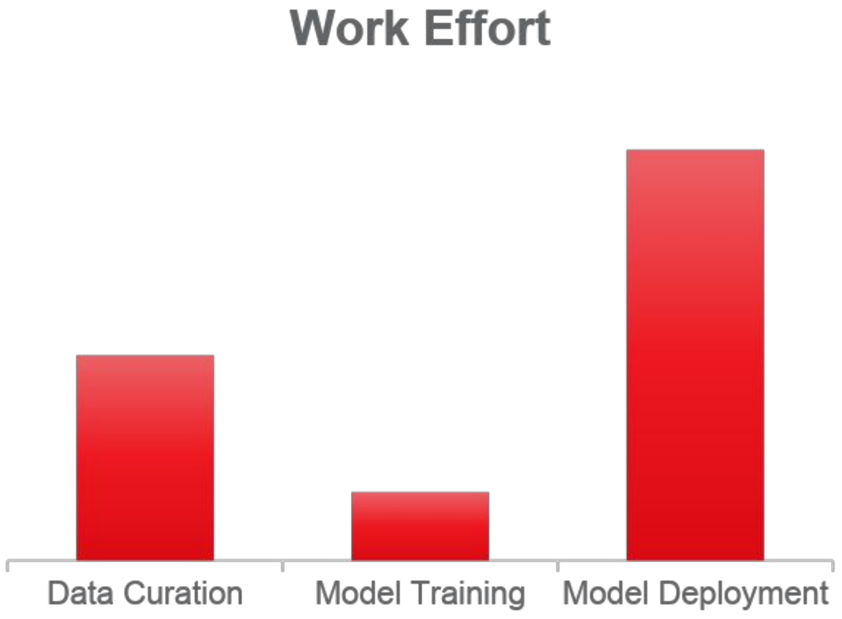
Screen for transition to advanced heart failure

Model disparities in healthcare

Screen for cardiac pathology on existing scans

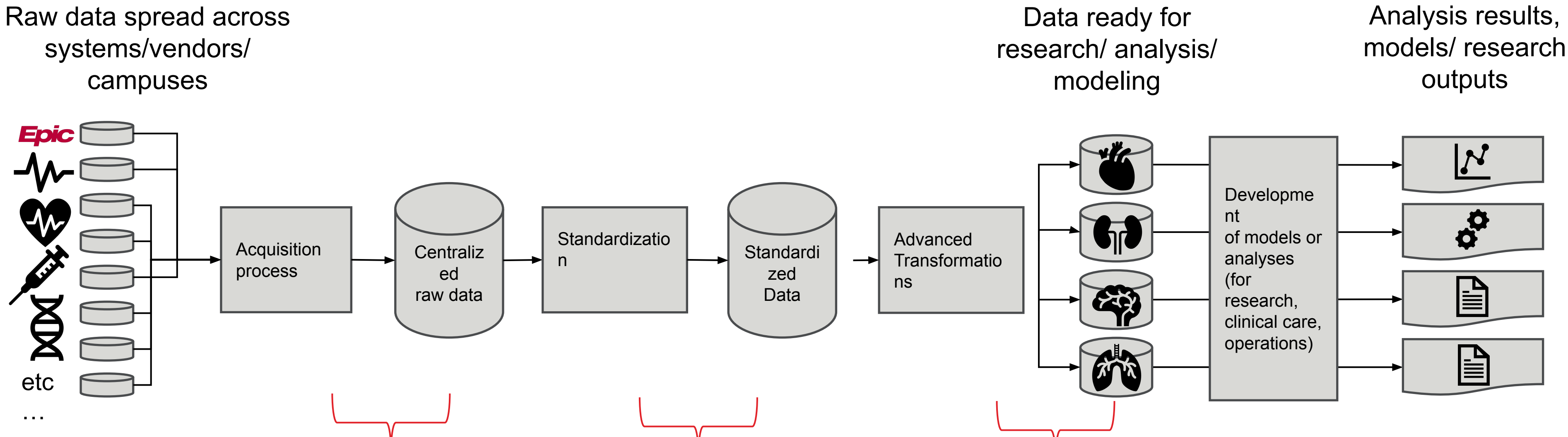
AI Development | Life Cycle

- Data Curation
  - Data Extraction
  - Anonymization
  - Curation
  - Annotation
- Model Training
  - Model Training
  - Model Validation
  - Model Evaluation
- Model Deployment
  - Integration
  - Monitoring
  - Continuous Retraining



AI Development | Cardiovascular Data Infrastructure

AI Development | Cardiovascular Data Infrastructure



- **Hardware upgrade**
- **Imaging data pipeline**
- **System integrations**
- **Data archiving**

- **National registries**
- **EHR Registries**
- **Echo data tables**
- **IDCO**

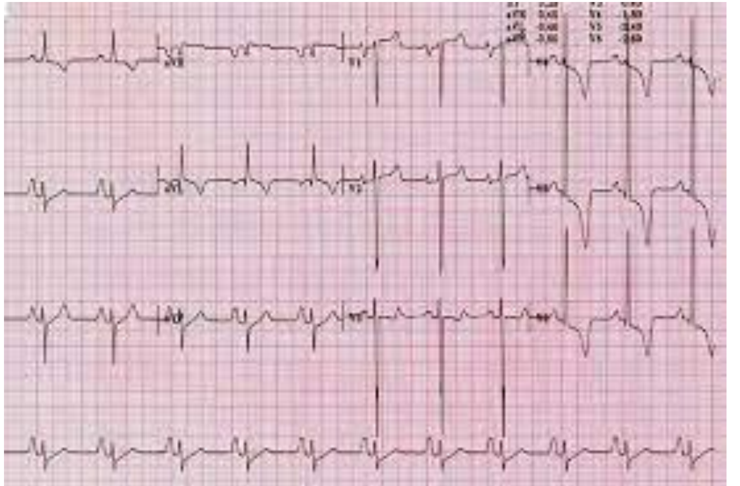
- **EP research repository**
- **ACHD research repository**
- **HF research repository**

AI Development | Cardiovascular Data Infrastructure

Electrocardiogram (ECGs)

- ECG machine upgrades to transmit all ECGs centrally
- Prospective “printing” to .xml files
- Conversion of >10 million ECGs to .xml files

TABLE NAME	DESCRIPTION
stg_muse_site0001_diagnosis	staging table for ecg diagnosis text
stg_muse_site0013_diagnosis	staging table for ecg diagnosis text
stg_muse_site0001_patientdemographics	staging table for ecg patient demographics
stg_muse_site0013_patientdemographics	staging table for ecg patient demographics
stg_muse_site0001_ecgmeasurements	staging table for ecg measurements
stg_muse_site0013_ecgmeasurements	staging table for ecg measurements
stg_muse_site0001_testdemographics	staging table for ecg study information
stg_muse_site0013_testdemographics	staging table for ecg study information
ecg_key_link	reference table to crosswalk source ecg ids to model keys
ecg_study	table which contains ecg study information
ecg_diagnosis_text	table which contains ecg diagnosis text informaiton
ecg_measurements	table which contains ecg measurement information



AI Development | Cardiovascular Data Infrastructure

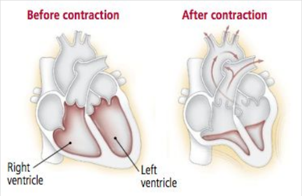
Epic_MedicationID	GenericName	Epic_GenericID	PHARM_CLASS	PHARM_SUBCLASS	HF_Class
71705	Ezetimibe-Simvastatin	3999400230	Antihyperlipidemic	Antihyperlipidemics - Combinations	Antihyperlipidemics - Combinations
142237	Icosapent Ethyl	3950003510	Antihyperlipidemic	Antihyperlipidemics - Misc.	Antihyperlipidemics - Misc.
51610	NULL	3699100220	Antihypertensive	Antihypertensive Combinations	Antihypertensives - Misc.
111566	amLODIPine Besylate-Valsa	3699300210	Antihypertensive	Antihypertensive Combinations	Calcium Channel Blockers
10637	Acetazolamide Cap ER 12H	3710001000	Diuretics	Carbonic Anhydrase Inhibitors	Carbonic Anhydrase Inhibitors
5231	Digoxin Tab 125 MCG (0.12	3120001000	Cardiotonics	Cardiac Glycosides	Cardiac Glycosides
47559	Cardioplegic Soln	4020001000	Cardiovascular Age	Cardioplegic Solutions	Cardioplegic Solutions
114764	Aliskiren-Hydrochlorothiazi	3699600215	Antihypertensive	Antihypertensive Combinations	Direct Renin Inhibitors
50775	Buchu-Cornsilk-Ch Grass-H	3799200410	Diuretics	Diuretic Combinations	Diuretics - Miscellaneous
31494	Fenofibrate Micronized Ca	3920002510	Antihyperlipidemic	Fibric Acid Derivatives	Fibric Acid Derivatives
24739	Carvedilol Tab 3.125 MG	3330000700	Beta blockers	Alpha-Beta Blockers	HF Beta Blocker
44726	Spironolactone-HCTZ	3799000220	Diuretics	Diuretic Combinations	HF Potassium Sparing Diuretics
7691	Pravastatin Sodium Tab 20	3940006510	Antihyperlipidemic	HMG CoA Reductase Inhibitors	HMG CoA Reductase Inhibitors
96483	Isosorb Dinitrate-hydrALAZ	4099500240	Cardiovascular Age	Cardiovascular Agents Misc. - Combination	Hydralazine
115479	Tadalafil Tab 2.5 MG	4030408000	Cardiovascular Age	Impotence Agents	Impotence Agents
145568	Milrinone Lactate in Dextro	3135005011	Cardiotonics	Inotropes	Inotropes
39265	Ezetimibe Tab 10 MG	3930003000	Antihyperlipidemic	Intestinal Cholesterol Absorption Inhibitors	Intestinal Cholesterol Absorption Inhibitors
162255	Furosemide in Sodium Chlo	3720003010	Diuretics	Loop Diuretics	Loop Diuretics
129051	Nitroglycerin Cap ER 6.5 M	3210003000	Antianginal agents	Nitrates	Nitrates

AI Development | Model Build

Echo - VO2

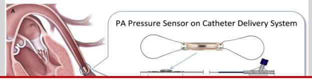
Echo → VO$_2$

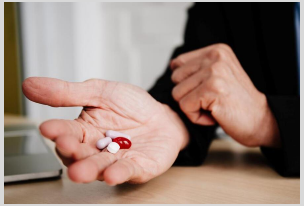
CT - EF



CT → LVEF

Remote Management



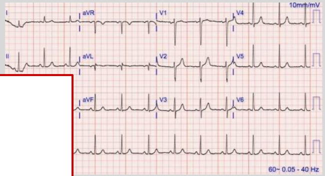


Device → Treatment

Remission - HF

Echo → LV Recovery

ECG - Dynamics



ECG → Hemodynamics

Opportunistic screening is the practice of detecting diseases or health risks during routine clinical care, even when the patient isn't being evaluated specifically for that condition.

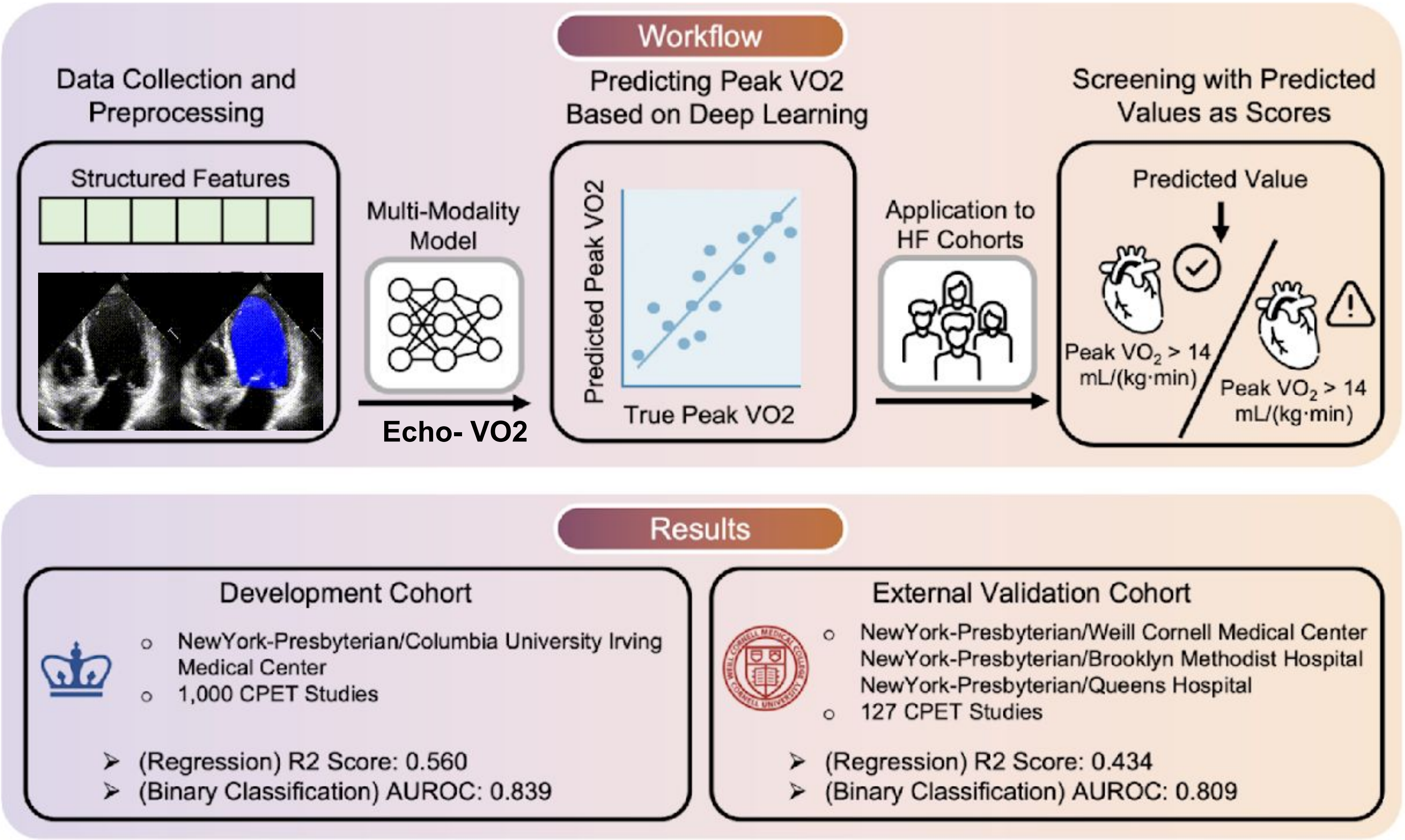
AI Development | Model Build

- 5–25% of heart failure patients progress to advanced stages (~200,000/year).

- 1-year survival without advanced therapies is 25–50%; only ~6,000 receive advanced treatments annually.

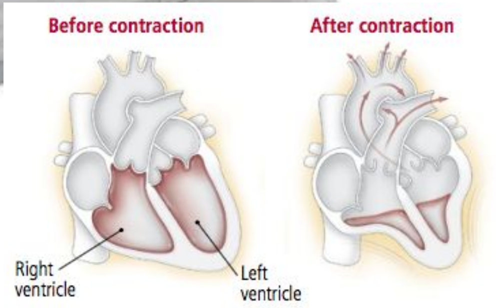
- Echocardiography is commonly available but limited in estimating mortality.

- Cardiopulmonary exercise testing (CPET) is a strong mortality predictor but requires specialized equipment and expertise, limiting accessibility.

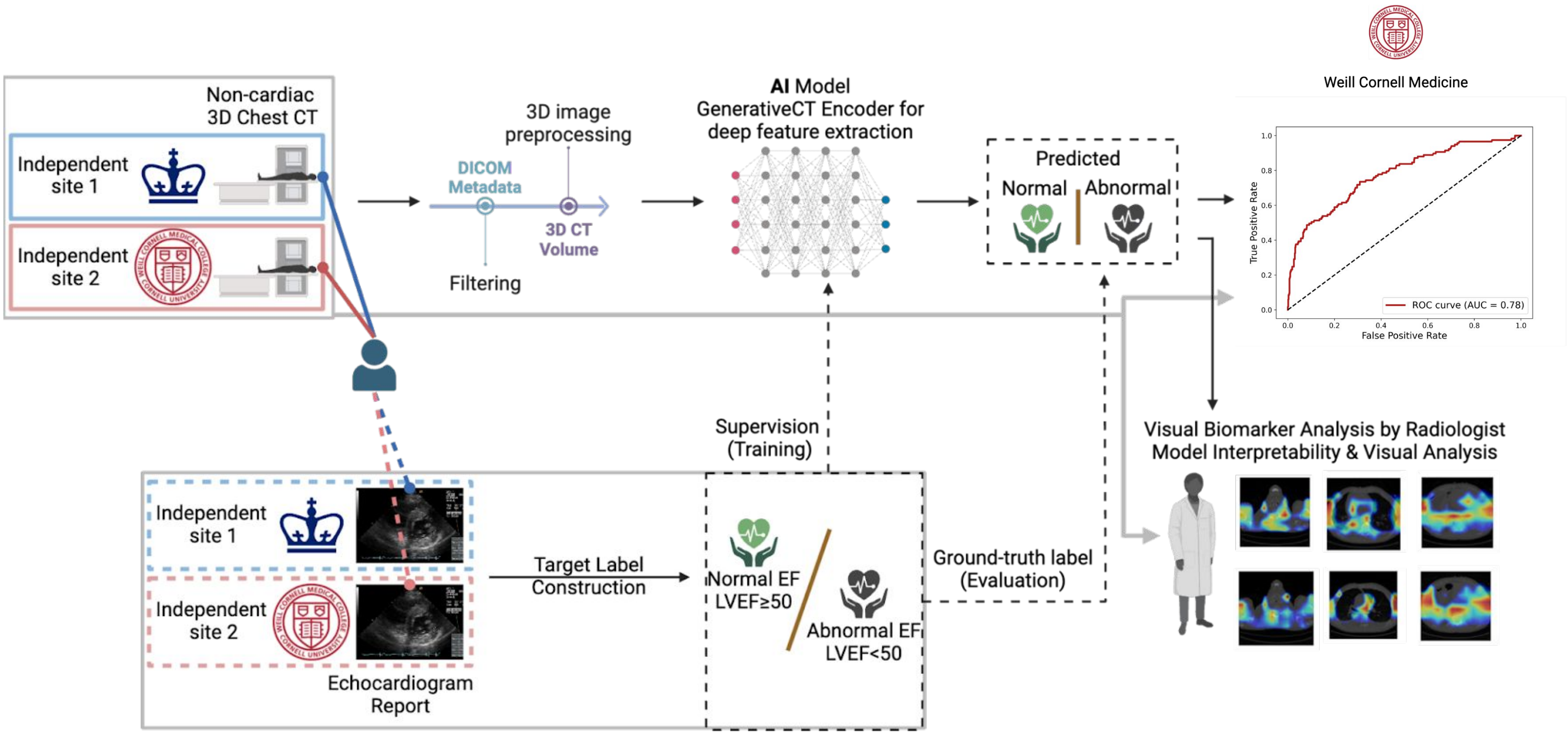

Workflow
Data Collection and Preprocessing
Structured Features
Multi-Modality Model
Echo- VO2
Predicting Peak VO2 Based on Deep Learning
Predicted Peak VO2
True Peak VO2
Application to HF Cohorts
Screening with Predicted Values as Scores
Predicted Value
Peak VO_2 > 14 mL/(kg·min)
Peak VO_2 > 14 mL/(kg·min)
Results
Development Cohort
NewYork-Presbyterian/Columbia University Irving Medical Center
1,000 CPET Studies
(Regression) R2 Score: 0.560
(Binary Classification) AUROC: 0.839
External Validation Cohort
NewYork-Presbyterian/Weill Cornell Medical Center
NewYork-Presbyterian/Brooklyn Methodist Hospital
NewYork-Presbyterian/Queens Hospital
127 CPET Studies
(Regression) R2 Score: 0.434
(Binary Classification) AUROC: 0.809

AI Development | Model Build

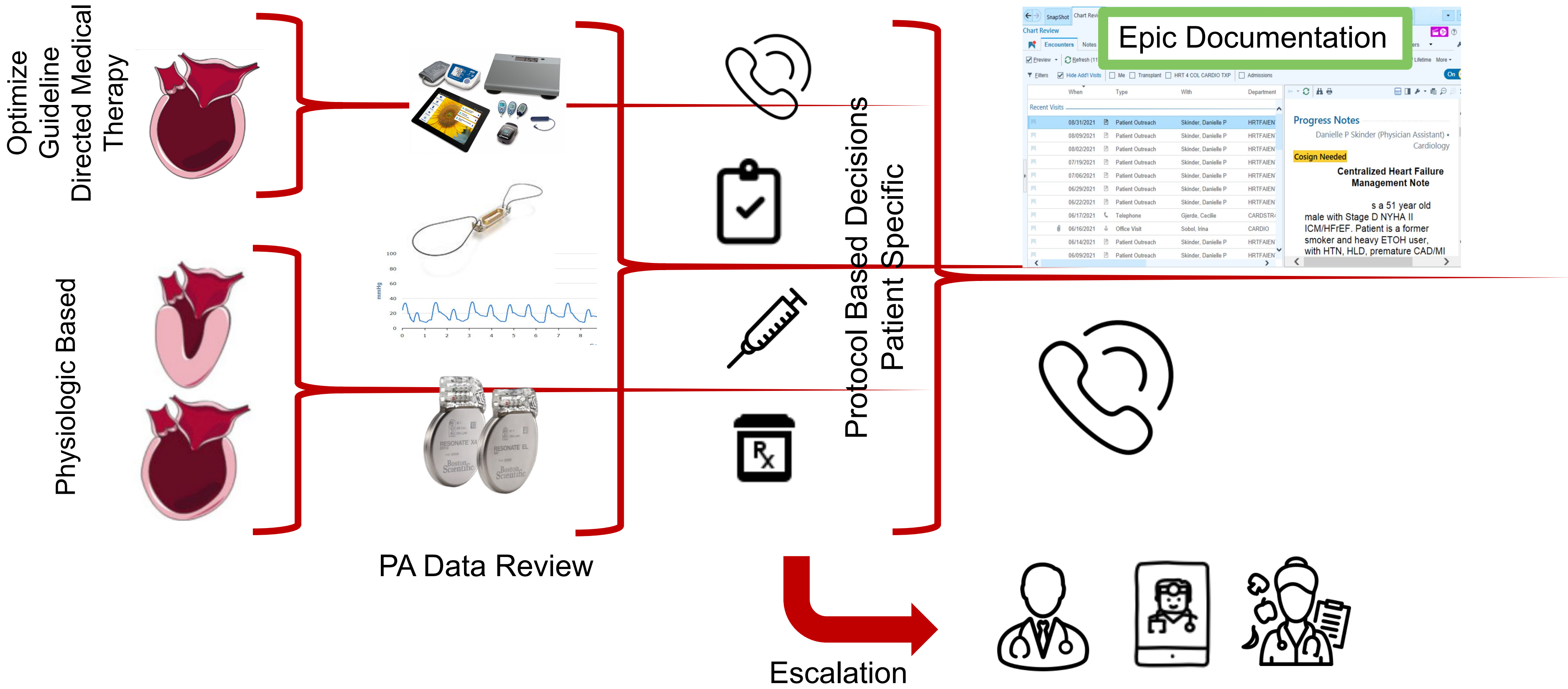
- Over 80 million computed tomography scans(CTs) are performed in the US yearly.
- Many CTs ordered for non-cardiac indications.
- Opportunity to identify patients early that would benefit from optimal heart failure care.



AI Development | CT-EF

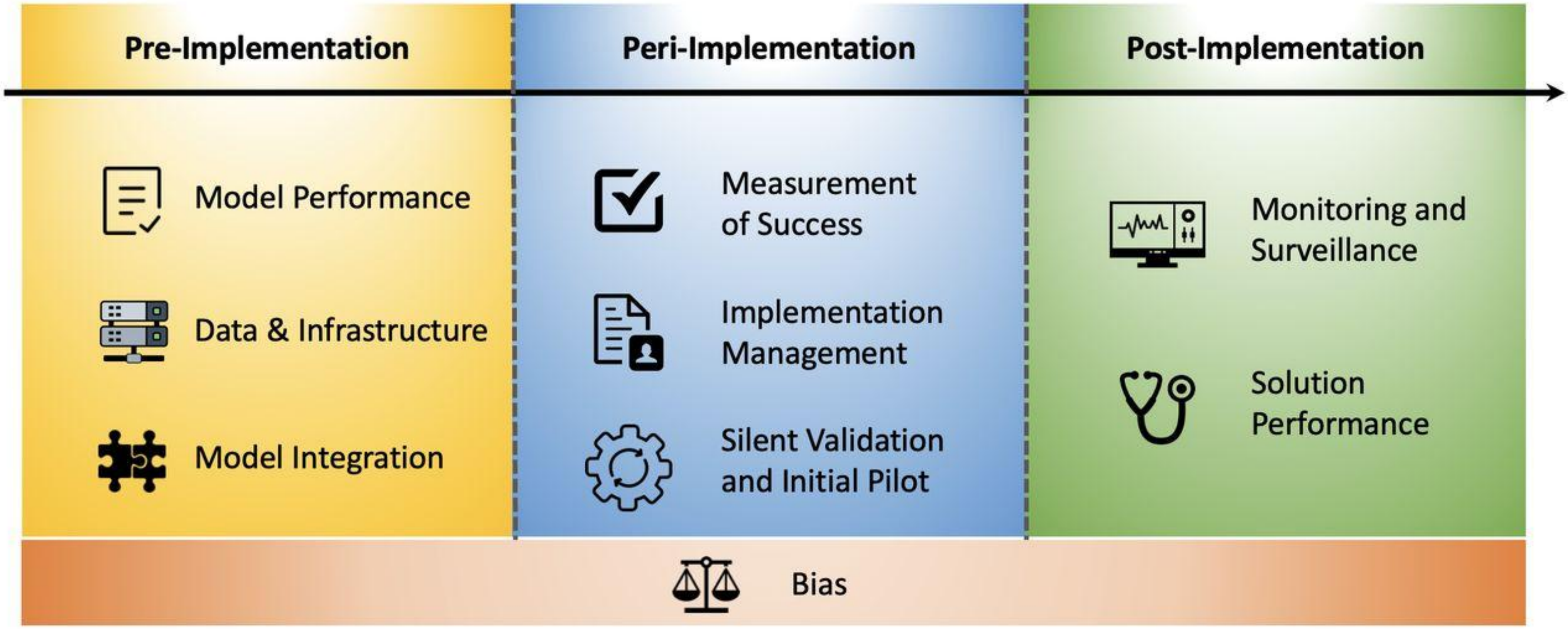


AI Development | Centralized Remote Management Program



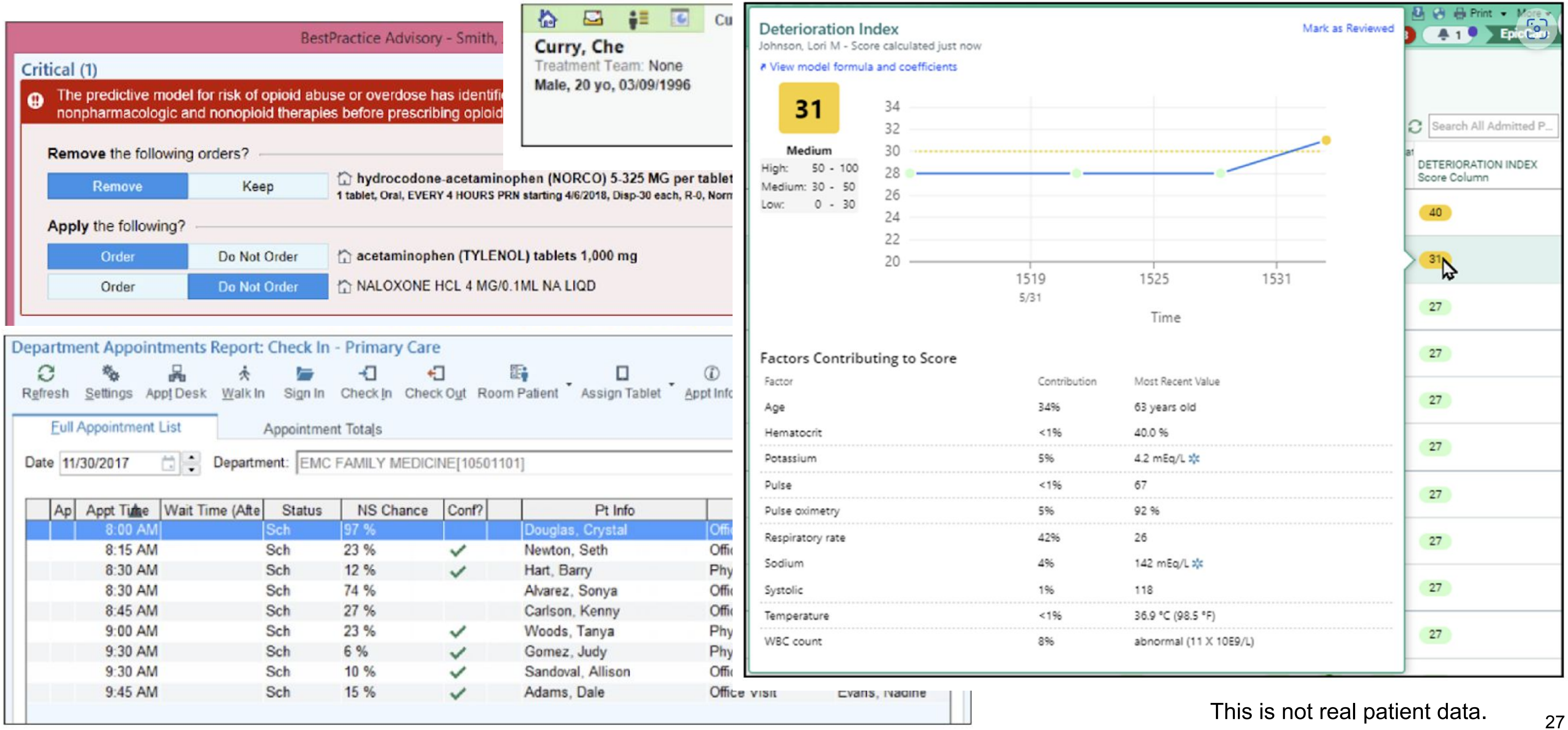
AI is poised to transform medicine if we can empower our providers by *effectively delivering* this assistive technology into the healthcare system.

AI Deployment | Process Flow



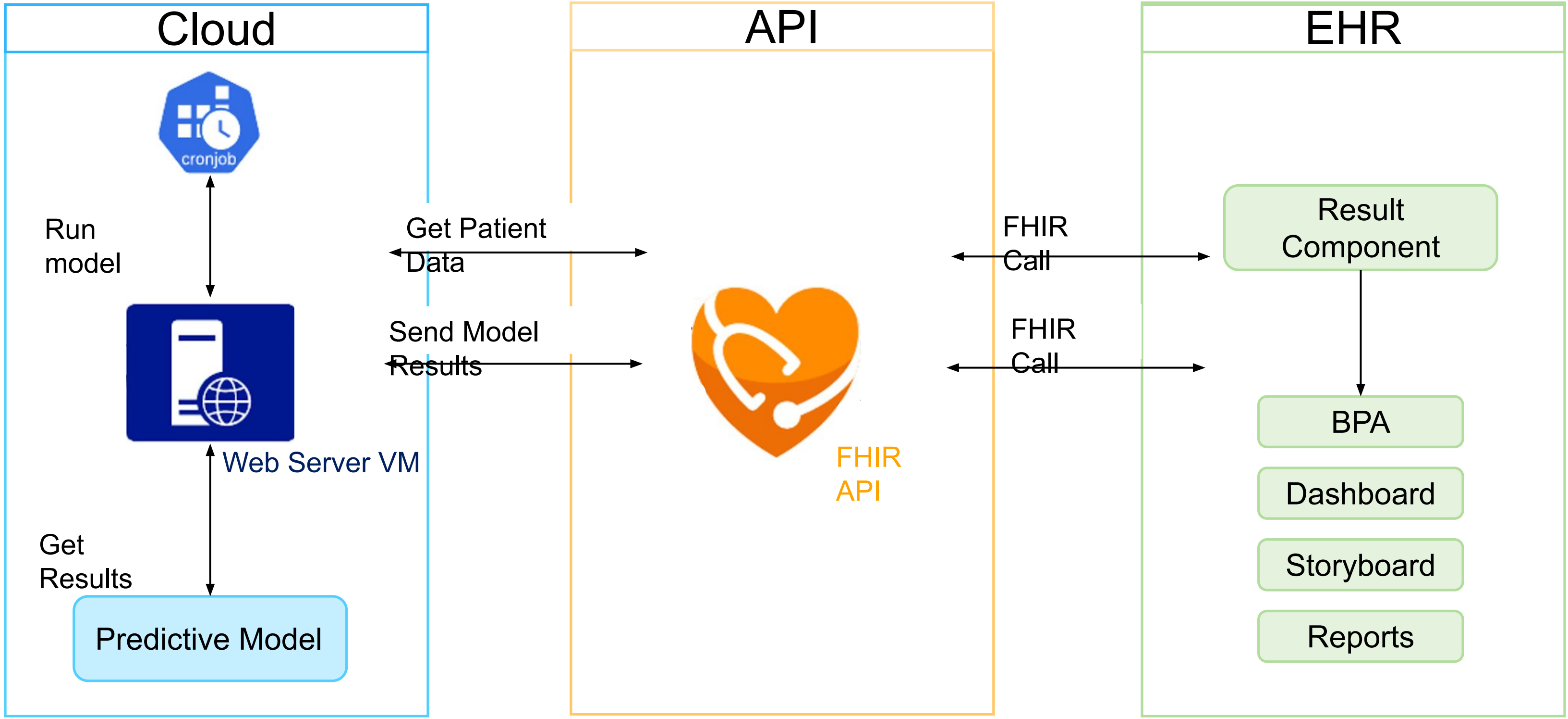
Wang F, Beecy A, Implementing AI models in clinical workflows: a roadmap, *BMJ Evidence-Based Medicine* Published Online First: 24 June 2024. doi: 10.1136/bmjebm-2023-112727

AI Deployment | Sample Model Integration Points

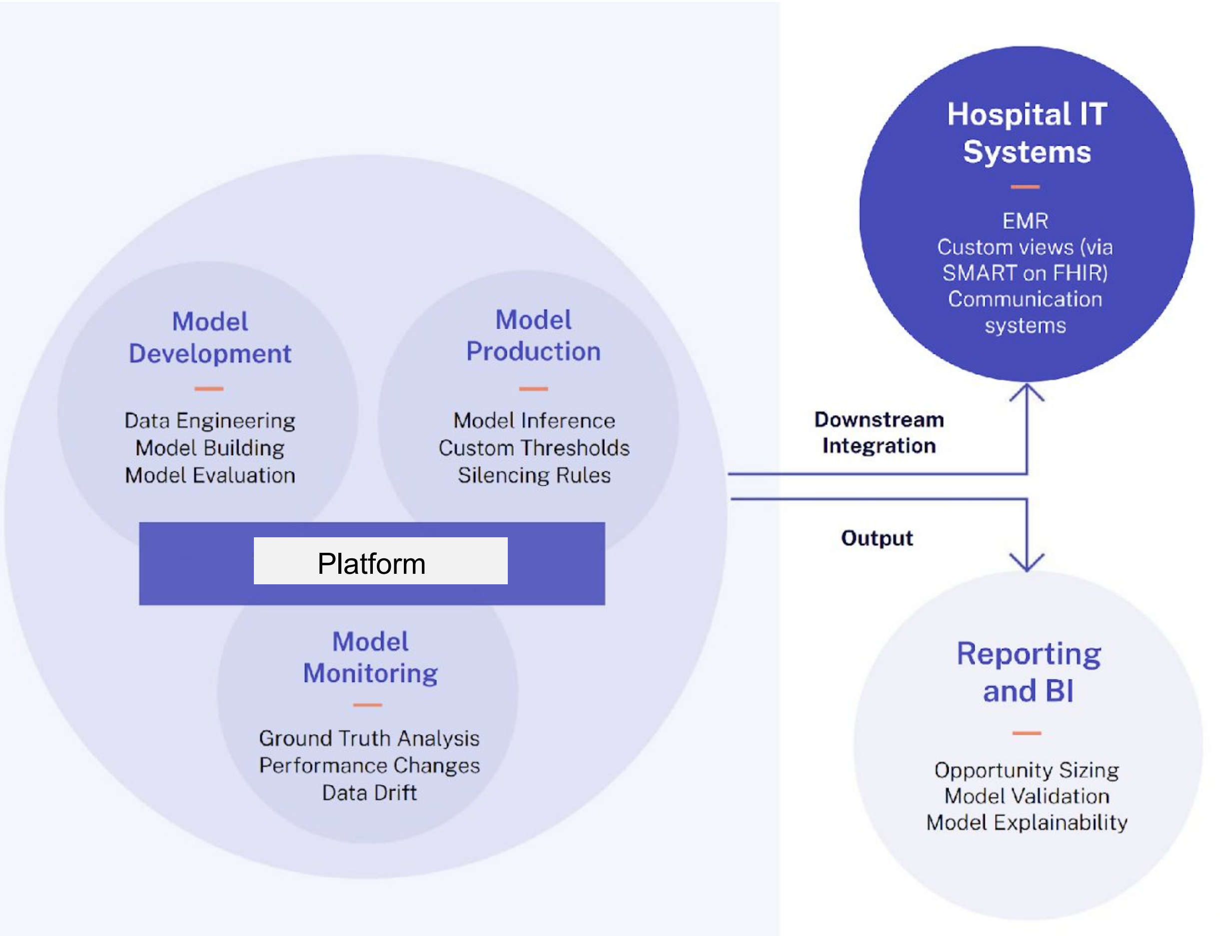


This is not real patient data.

AI Deployment | Sample Model Architecture



Solution Performance | Monitoring and Surveillance



Solution Performance | Monitoring and Surveillance

Model Monitoring

- Inputs/Outputs
- Data Drift
- Performance

Technical Monitoring

- Run times
- Security
- Version control

Solution Monitoring

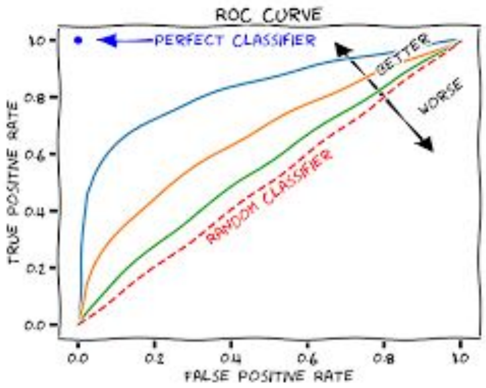
- Outcomes
- Usability
- Feedback

Regulatory and Compliance

- Policy adherence
- Health equity
- Federal regulations

Solution Performance | Model Performance

The solution performance is more than an AUC



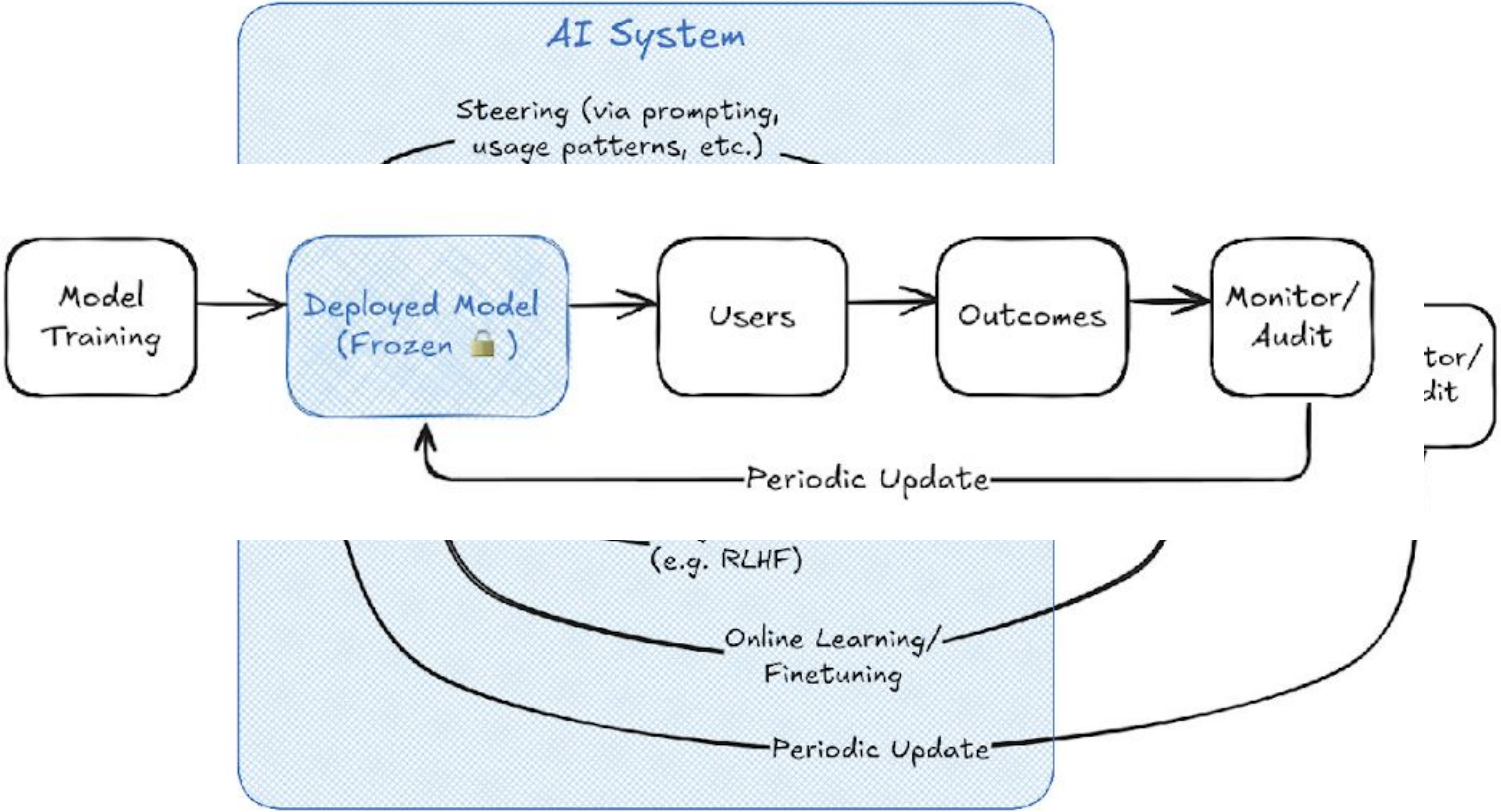
An AI solution requires contextual assessment

Determine the testable metrics at the initiation of integration

Compare the metrics to standard of clinical care before integration

Consider ability to measure the metrics and the resources involved

Solution Performance | Adaptive Systems



Rosenthal, Jacob T., Ashley Beecy, and Mert R. Sabuncu. "Rethinking clinical trials for medical AI with dynamic deployments of adaptive systems." *npj Digital Medicine* 8.1 (2025): 1-6.

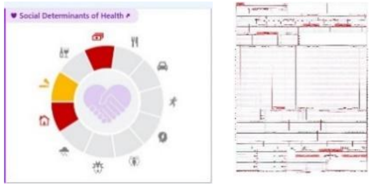
Transparency and Trust | A Heart Failure Learning Health System

An iterative process where the AI model's outputs are continuously collected.

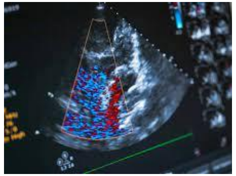
Registry of AI Results

HF Clinical Team Reviews Patient List

Clinical Data Entered into Chart



Recommendations are Made



Follow-up and Monitoring

Solution Performance | Governance

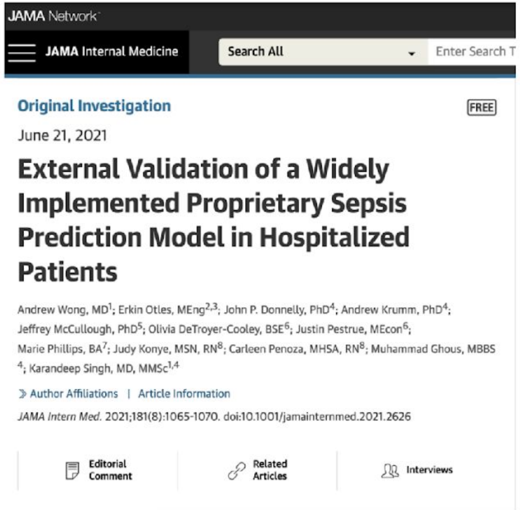
Solution Performance | Governance

Risk to patient privacy

Through secondary use of patient data in AI model training and inference

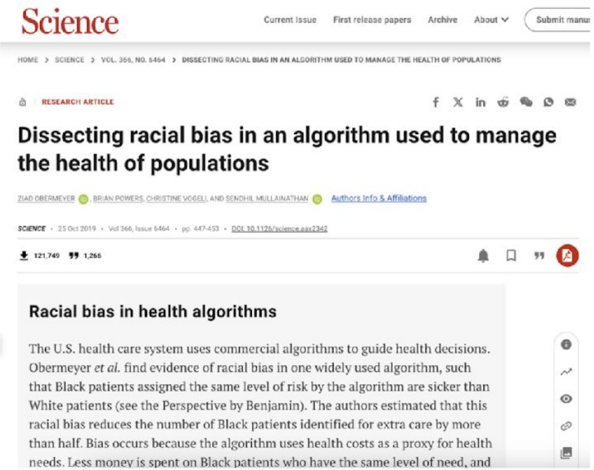
Risk to the quality of patient care

Through substitution of medical judgment by AI technology



Regulatory risk

If our use of AI does not meet regulatory requirements, e.g., for nondiscrimination



Slide courtesy of Beth Percha

Regulation and Trust | National Collaboration

National Organizations

CHAI™
Coalition for Health AI

health ai partnership

AFDO RAPS
HEALTHCARE PRODUCTS COLLABORATIVE

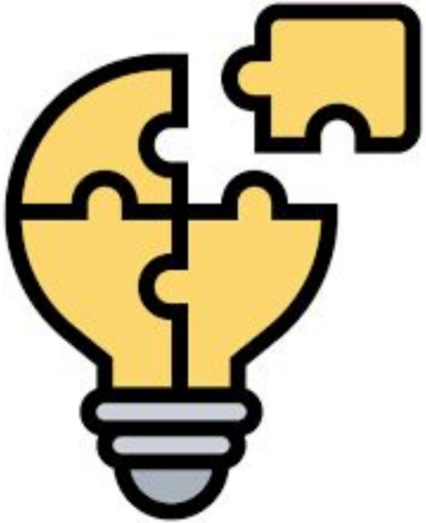
VALID AI

Advocacy

GREATER NEW YORK HOSPITAL ASSOCIATION
GNYHA

ONC

Summary



- Spend time up front understanding the problem, the proposed integration and the resources needed
- Verify the presumed value propositions via testing in real-world integration
- Understand the performance with integration includes more than the technical metrics
- Build consensus and trust with stakeholder involvement, transparency and communication

Questions