

9. November 2023 - Update Kardiologie Hirslanden Klinik Linde

# Möglichkeiten und Grenzen der Künstlichen Intelligenz in der Medizin. Braucht es uns Mediziner in Zukunft noch?

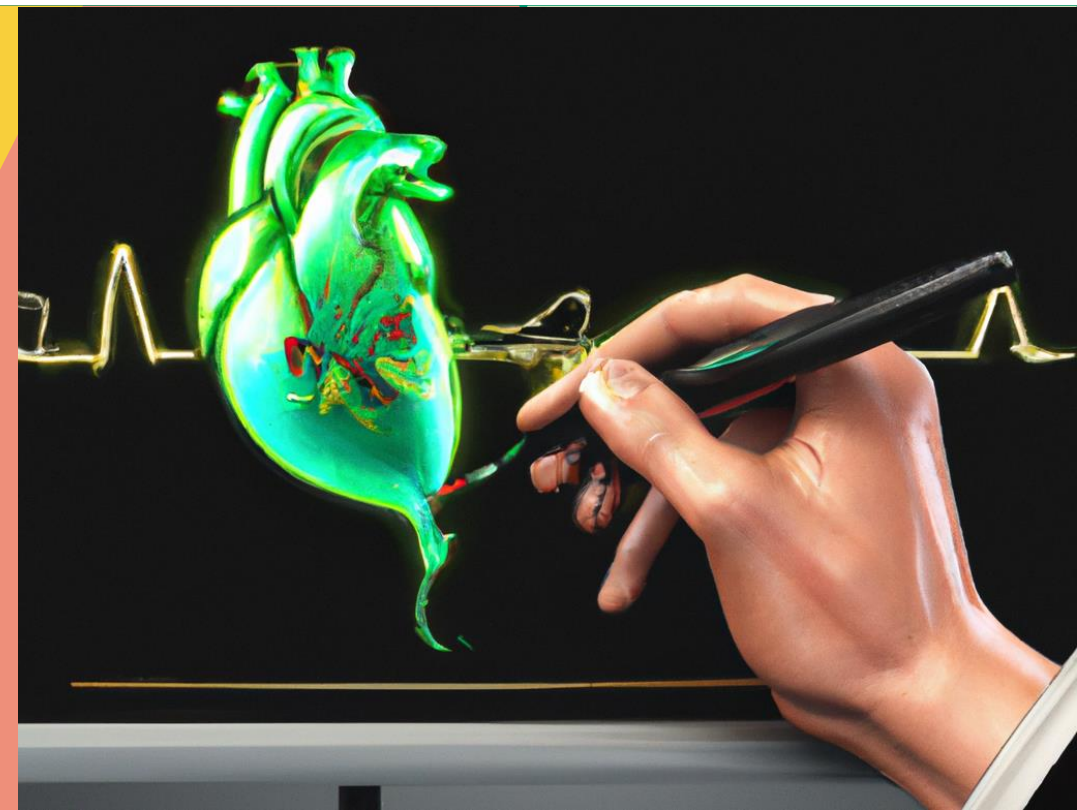
Prof. Dr. med. Christoph Gräni

Leiter Kardiale Bildgebung

Universitätsklinik für Kardiologie

Inselspital Bern

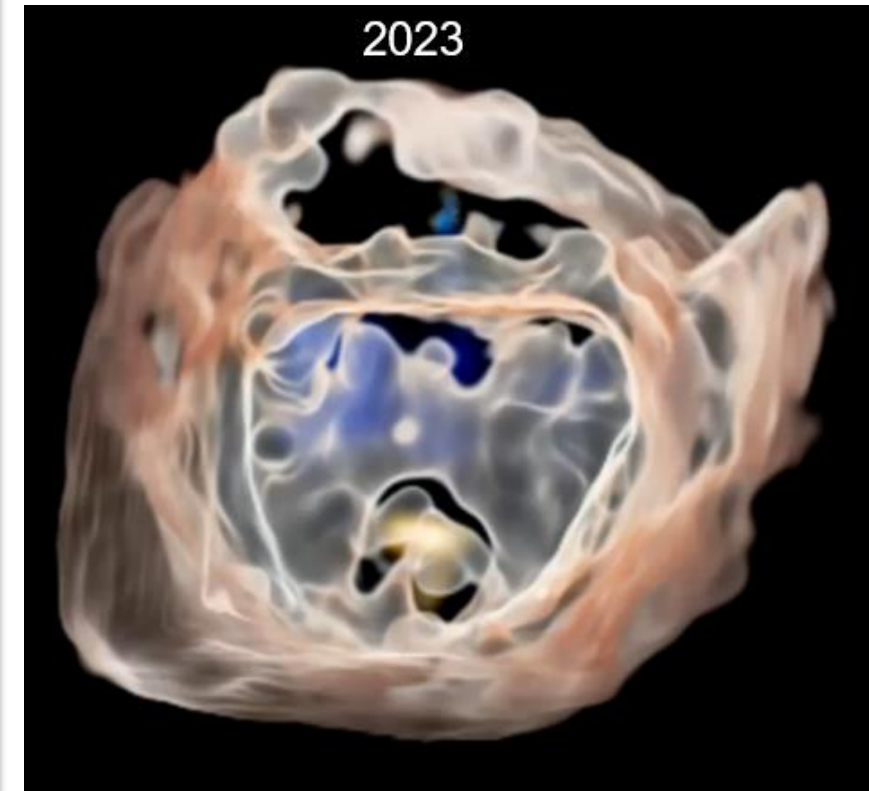
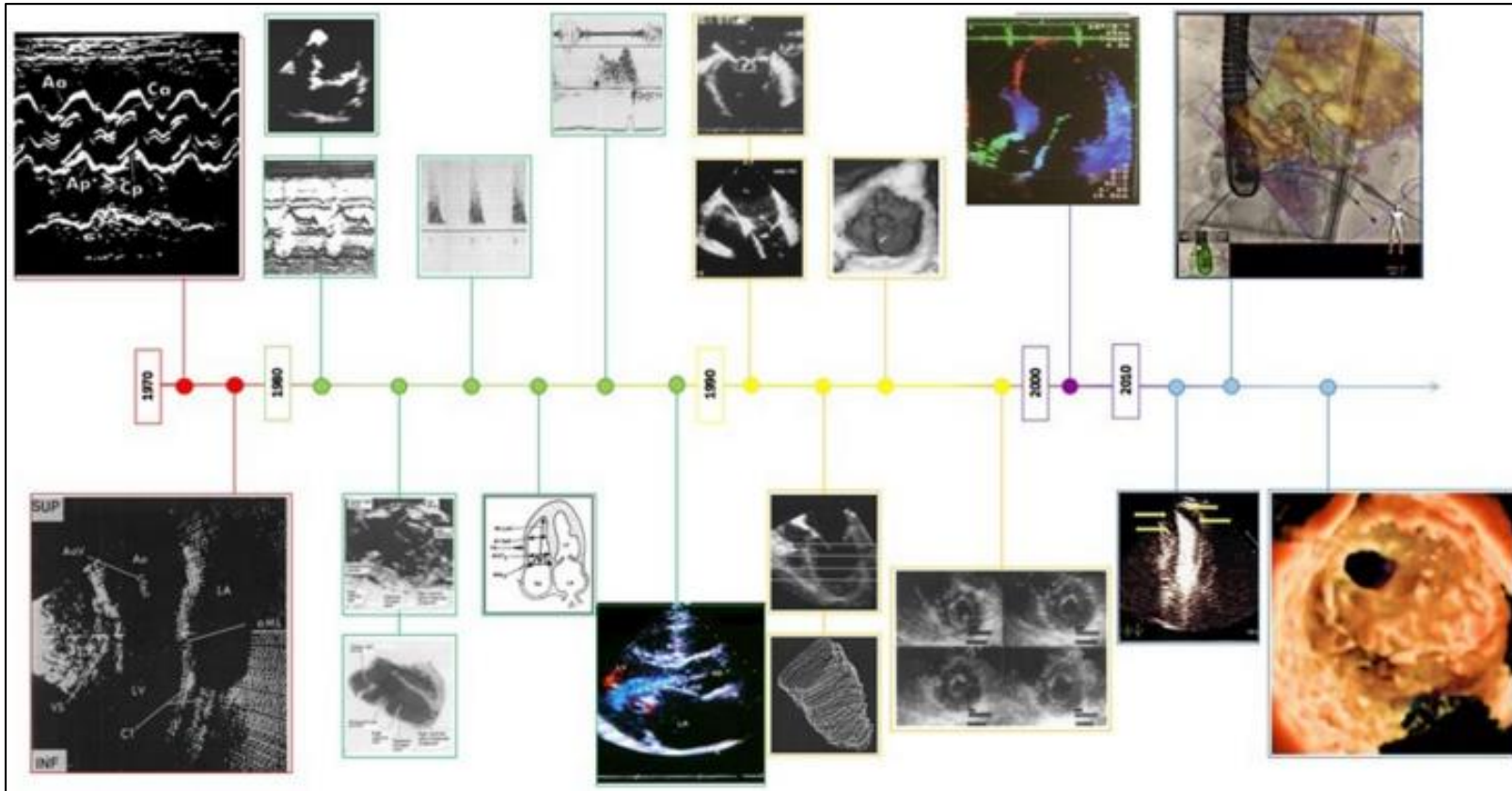
Twitter: [@chrisgraeni](https://twitter.com/chrisgraeni)



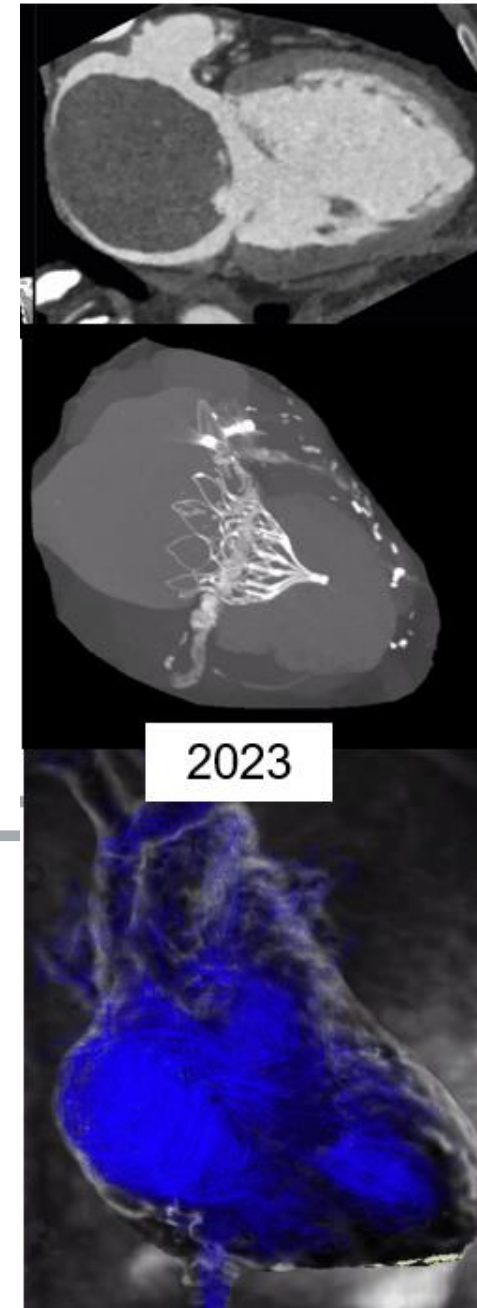
# Agenda

- Multimodality imaging
- How can AI be applied in cardiac imaging
- Practical AI cases
- Outlook, unmet needs, ChatGPT

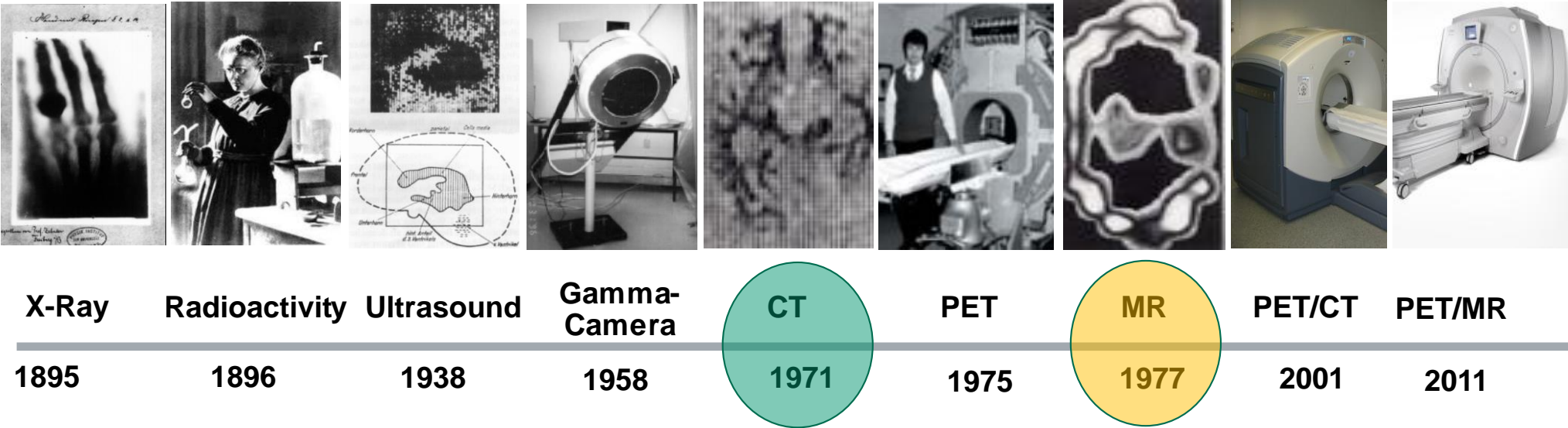
# Evolution of Echocardiography



# Evolution of CT/CMR/Nuclear



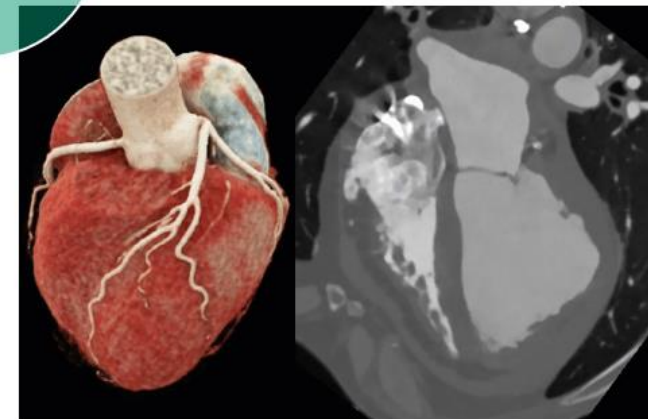
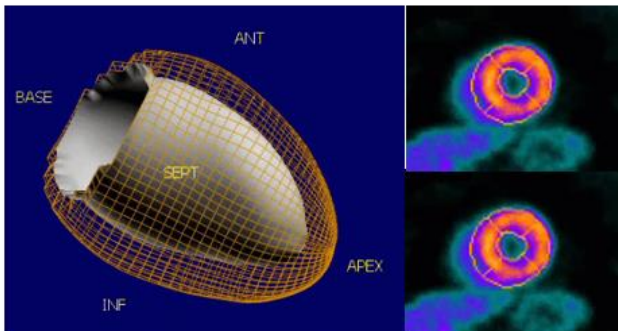
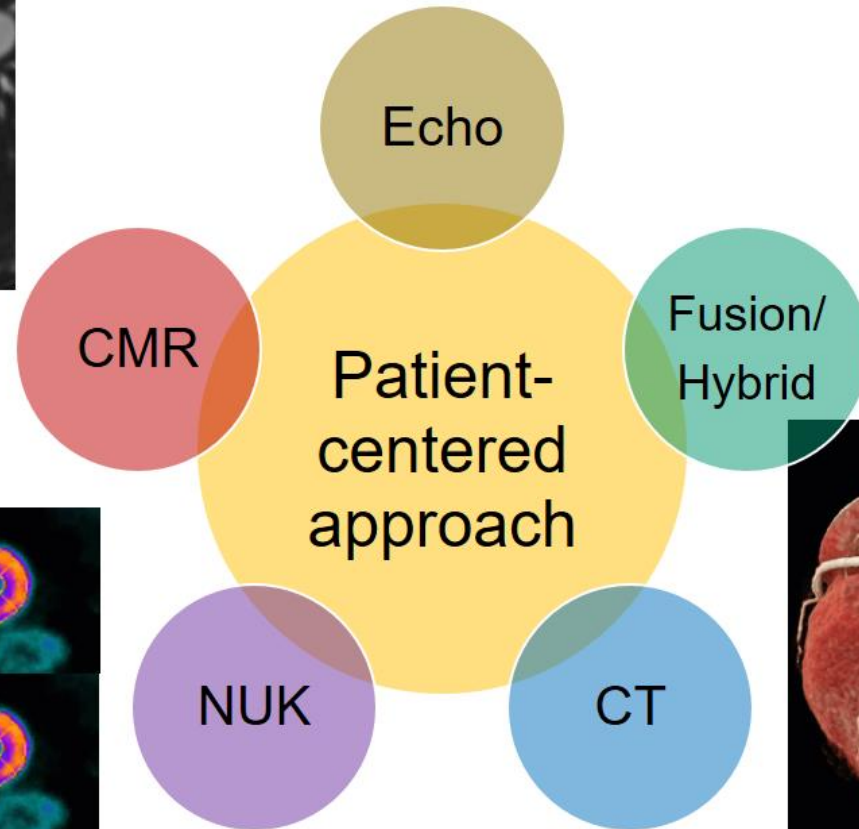
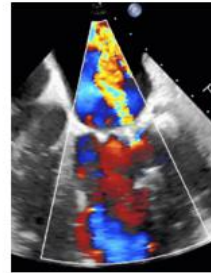
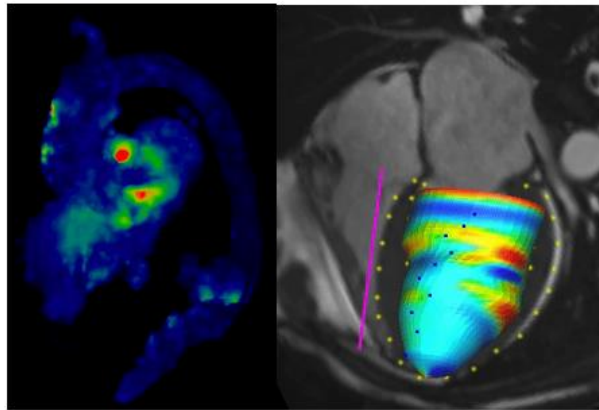
2023





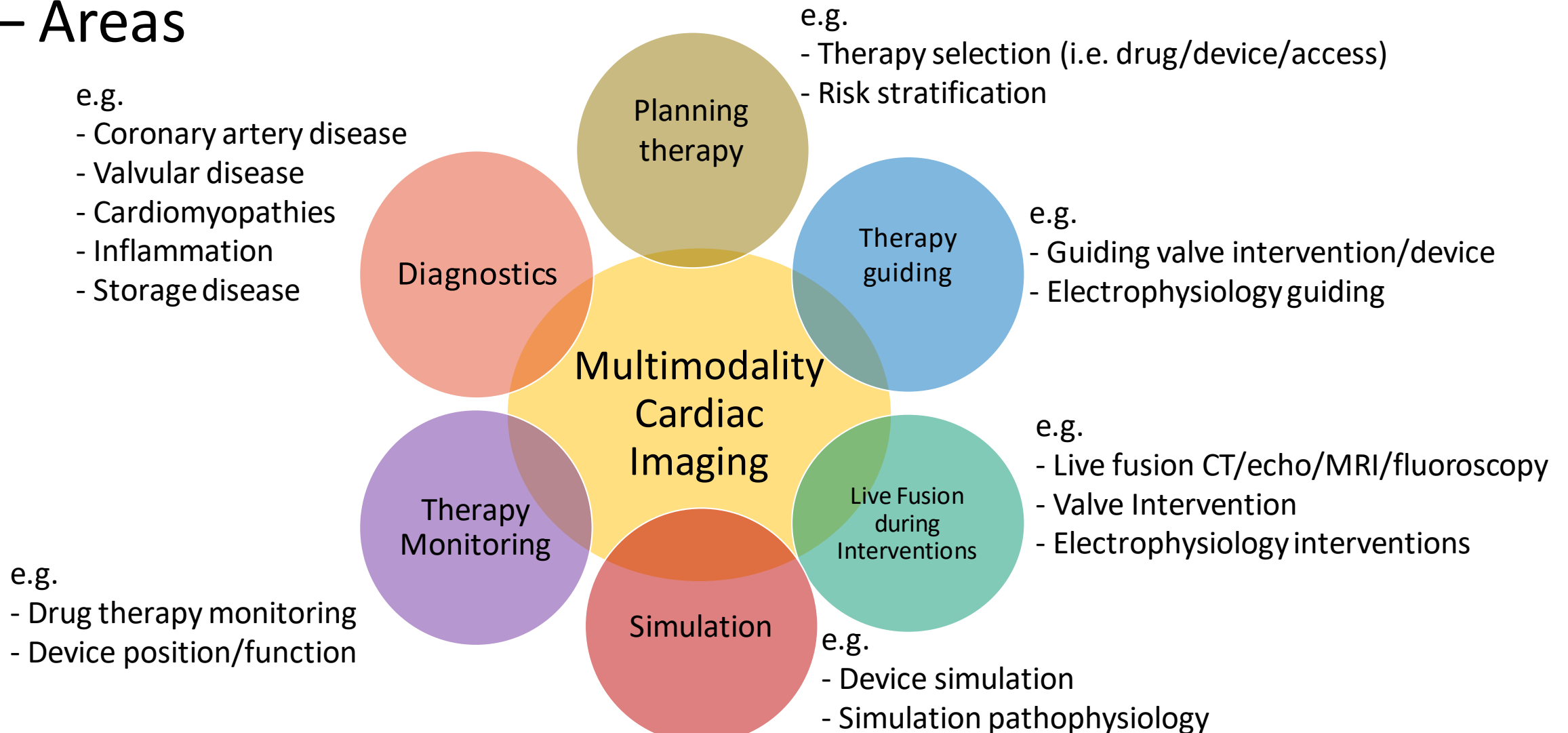
# Multimodality cardiac imaging

– Patient centered



# Multimodality cardiac imaging

## – Areas



**Structural Heart Imaging Market Size 2022-2028- Rising Prevalence Of Structural Heart Disease Expected To Fuel Market Growth**

Published: Apr 27, 2022

Increasing prevalence of structural heart disease is driving the growth of advanced structural heart imaging technologies. The global structural heart imaging market is projected to reach 1.8 billion in 2028 at a CAGR of 10.2%, according to a new report. Increasing prevalence of structural heart diseases, rising awareness,

Review

**Let there be light! The meteoric rise of cardiac imaging** FREE

Anna Reid <sup>1</sup>,  Marc Richard Dweck <sup>2</sup>

Correspondence to Professor Marc Richard Dweck, University of Edinburgh, Centre for Cardiovascular Sciences, Edinburgh EH16 4SB, UK; [marc.dweck@ed.ac.uk](mailto:marc.dweck@ed.ac.uk)

**Trends in Cardiac Imaging: The Future Is Ever More Visible**

Home / Intravision XR / Trends in Cardiac Imaging: The...

Feature | Cardiac Imaging | October 06, 2021

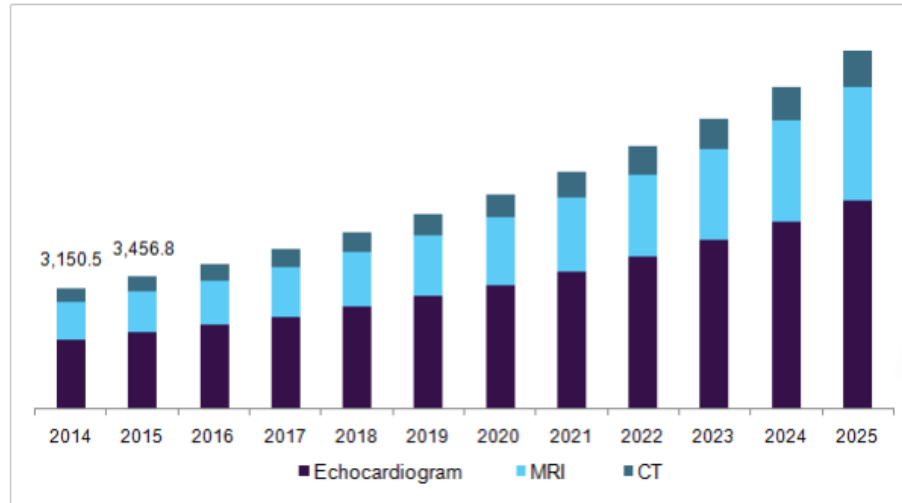
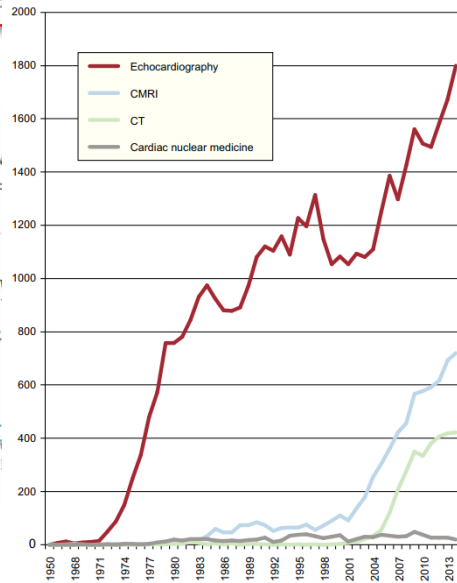
**Trends in Cardiac Imaging Over Past Decade Shows Rapid Rise in CT**

CCTA increased by 355% over past decade, partly fueled by DRA payment changes

**Cardiovascular Imaging Equipment Market is Increasing at a CAGR of 6.13% during the Study Period from 2021 to 2026, States DelveInsight**

The Cardiovascular Imaging Equipment Market is growing due to the rising burden of cardiology disease, the introduction of technologically advanced systems, and the increasing cost of healthcare.

U.S. structural heart imaging market by imaging modality, 2014 - 2025 (USD Million)



JACC: Cardio  
Volume 9, Issue 10, Oc

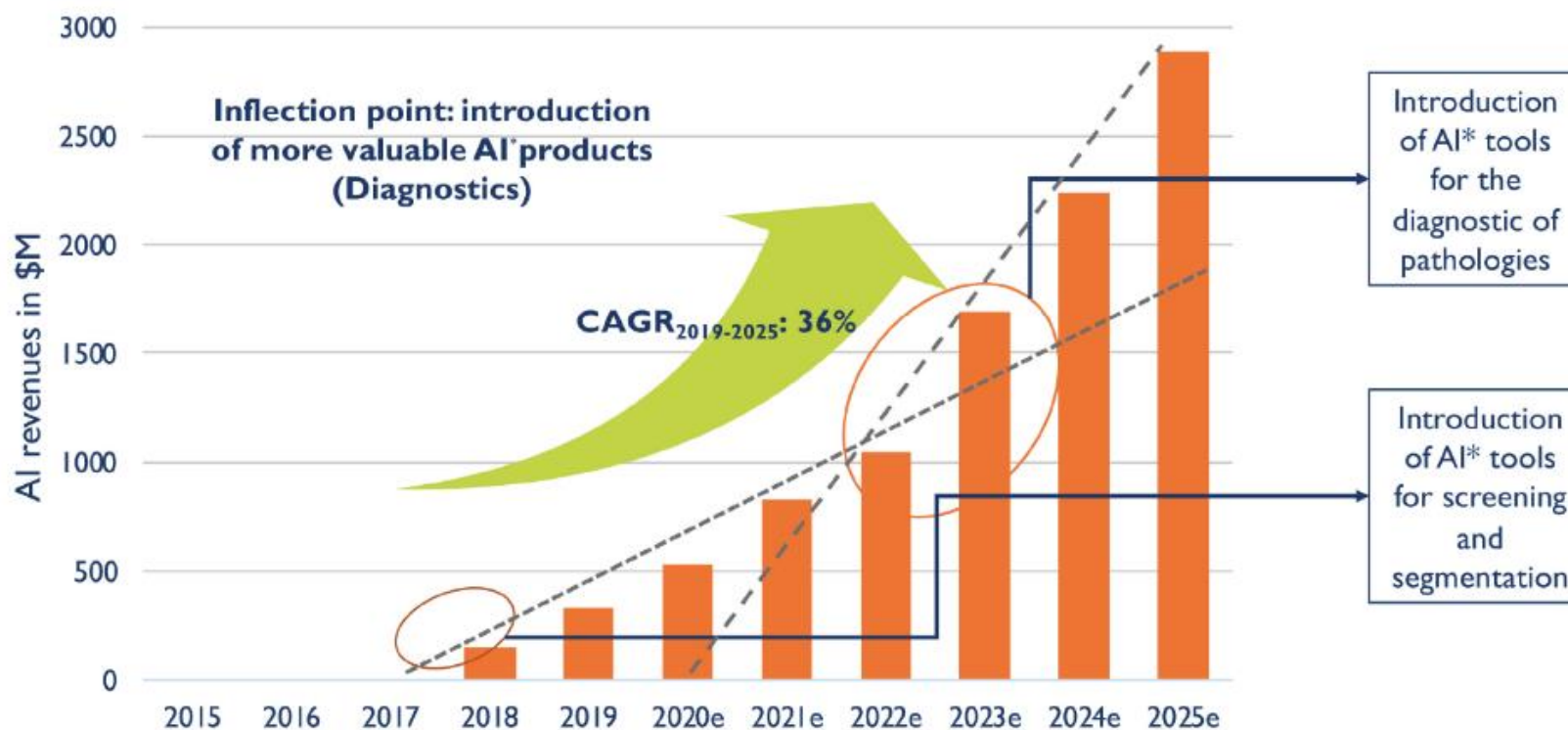
**The Future of Cardiac Imaging Tank Convened by the Cardiology**

Pamela S. Douglas MD (Chair) <sup>1,2,3,4</sup>, Manuel D. Chinnaiyan MD <sup>2</sup>, Meryl S. Cohen MD <sup>5</sup>, Justin I. Prem Soman MD, PhD <sup>1</sup>, Neil J. Weissman MD <sup>1</sup>  
ACC Cardiovascular Imaging Council

Press Release  
**Cardiac Imaging Market Is Likely to Experience a Strong Growth During 2022-2028 with Top Countries Data | New Report Spread Across 87 Pages**  
Published: May 9, 2022 at 3:09 a.m. ET

# Artificial Intelligence revenues for medical imaging: 2015-2025 market forecasts

(Source: Artificial Intelligence for Medical Imaging 2020 report, Yole Développement)



\*AI: Artificial Intelligence



# Why «now» AI in cardiac imaging?

## 12 Behind Today's Computer Vision Emergence



Computational  
power increase

+

Improved  
algorithms

+

Big data availability  
(open source)

+

Big tech  
investment



**Bhavik N. Patel, MD, MBA**

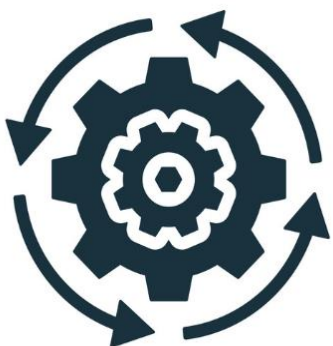
Director of AI, MCA  
Medical Director of AI/ML, Center for Digital Health  
Chair, MCA Radiology AI  
Associate Professor  
Department of Radiology  
Mayo Clinic Arizona  
School of Computing & Augmented Intelligence

Here is the breakdown for the number of FDA-cleared algorithms across specialties as of the FDA's last update in January 2023.

- Radiology 396
- Cardiology 58
- Hematology 14
- Neurology 10
- Clinical chemistry 7
- Ophthalmic 7
- Gastroenterology and urology 5
- General and plastic surgery 5
- Pathology 4
- Microbiology 4
- Anesthesiology 4
- General Hospital 3
- Orthopedic 1
- Dental 1

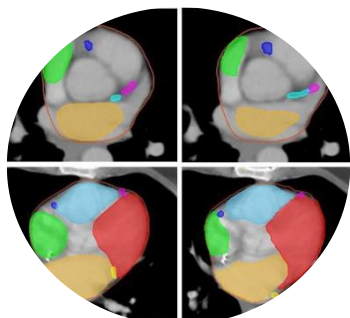
# How can AI be applied in cardiac imaging?

## Workflow



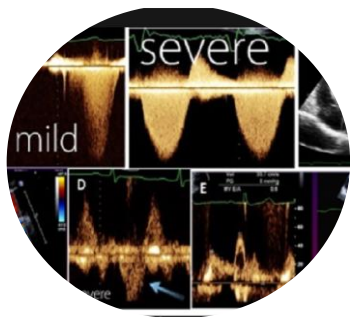
Optimization  
Select machine  
Adapt protocol  
Improve utilization  
Resource allocation

## Segmentation



Segmentation  
Disease detection

## Interpretation



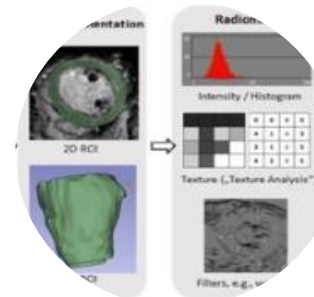
Fast reporting  
(real time)  
Decrease inter-  
and intra-rater  
variability

## Classification



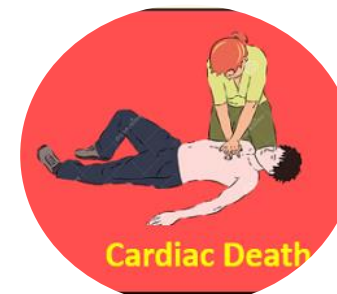
New  
classification  
opposed to  
traditional  
classification

## Radiomics



Feature  
extraction  
(intensity  
histogram)

## Risk stratification



Improve risk  
stratification by  
implementing  
non-traditional  
parameters

## Democratize



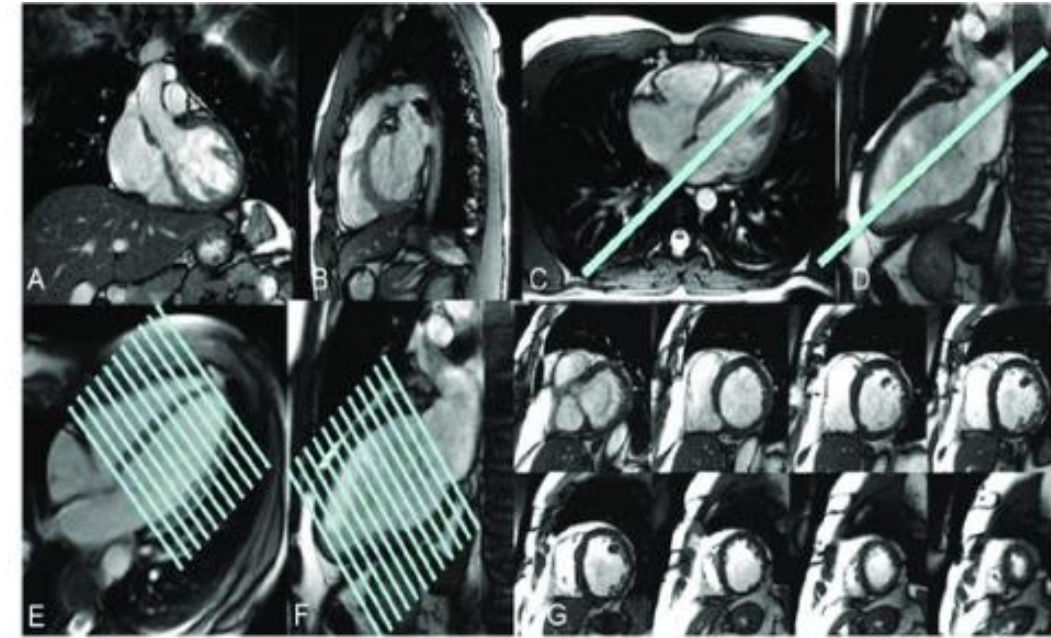
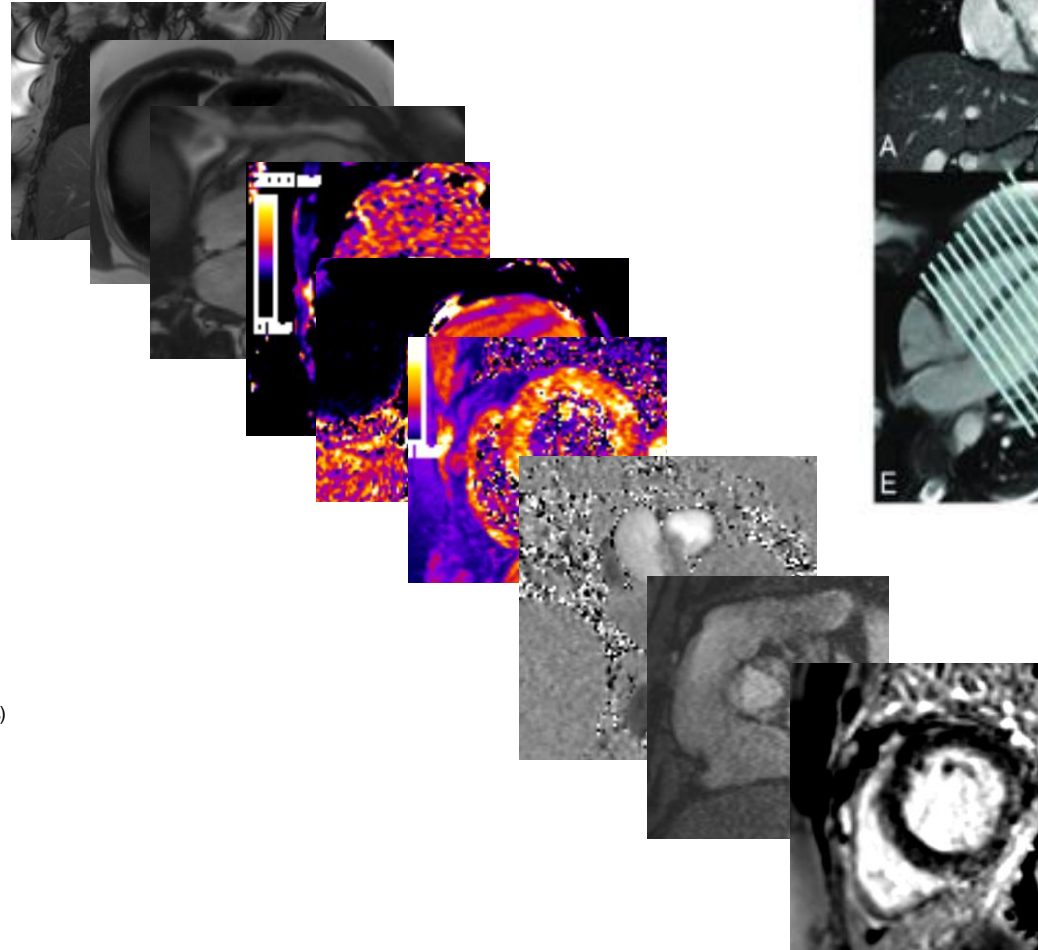
Democratize  
Open access  
Education  
Allow low-income  
countries access  
to high tech  
expertise

# Improving workflow in cardiac MRI

~ 60min entire cardiac magnetic resonance

## Protocol

```
trufi_loc_multi_iPAT
trufi_loc_multi_iPAT
trufi_singeshot_tra_iPAT
trufi_singeshot_cor_iPAT
trufi_singeshot_parasag_Aorta
loc_pseudo_2ch
loc_pseudo_4ch
loc_pseudo_SA*
cine_tf2d16_retro_iPAT_SA_VF
cine_tf2d13_retro_iPAT_4ch
tse_11_db_t1_iPAT_SA_basal_midvent_apkal*
tse_11_db_t1_iPAT_4CH*
tirm_20_db_t2_SA_basal_midvent_apkal*
tirm_20_db_t2_4CH*
T2Map_TrueFISP_SA_midvent
T2Map_TrueFISP_4CH
T1Map_LongT1_SA_midvent
T1Map_LongT1_4CH
T2StarMap_8echo_heart_SA_midvent*
Test Perfusion ohne KM (3x SA + 1x 4ch)
Rapsican/Adenosin Stressperfusion
Aminophyllin
cine_tf2d13_retro_iPAT_RVOT
flow_150_tp_Aorta
flow_150_tp_PA
cine_tf2d13_retro_iPAT_3ch
cine_tf2d13_retro_iPAT_2ch
cine_tf2d13_retro_iPAT_AK
TI-Scout SA_midvent (8min nach 2. Hälfte der KM-Dosis)
DE_overview_tfi_psr_SA
DE_overview_tfi_psr_4CH
PSIR_1_slice_MOCO_4ch
PSIR_1_slice_MOCO_3ch
PSIR_1_slice_MOCO_2ch
PSIR_MOCO_SA_Stack (TI+10ms)
T1Map_ShortT1_SA_midvent
```



~1000 Images per scan



# Improving workflow in cardiac MRI



HEARTVISTA IS THE ONLY AI-GUIDED MRI PLATFORM.

With just One Click, the HeartVista Cardiac Package uses AI to prescribe standard cardiac imaging views to acquire images up to 6x faster.

LESS TIME PER MRI SCAN

FEWER BREATH HOLDS

ARRHYTHMIA ROBUST

6x

Faster  
AI controls the scanner and leverages machine learning for fast, accurate scans <sup>1,2,6-7</sup>

15→0

Breath Holds  
Reduces discomfort and increases access for patients with health constraints <sup>3,6-7</sup>

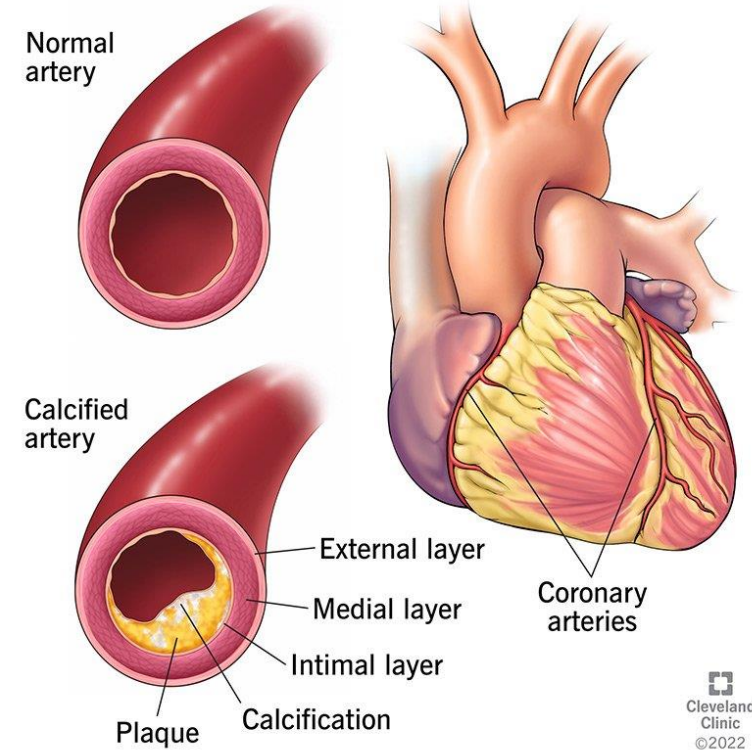
12%

Increased Image Consistency  
Reduces imaging artifacts from arrhythmia by using real-time imaging <sup>1,4-5,8</sup>

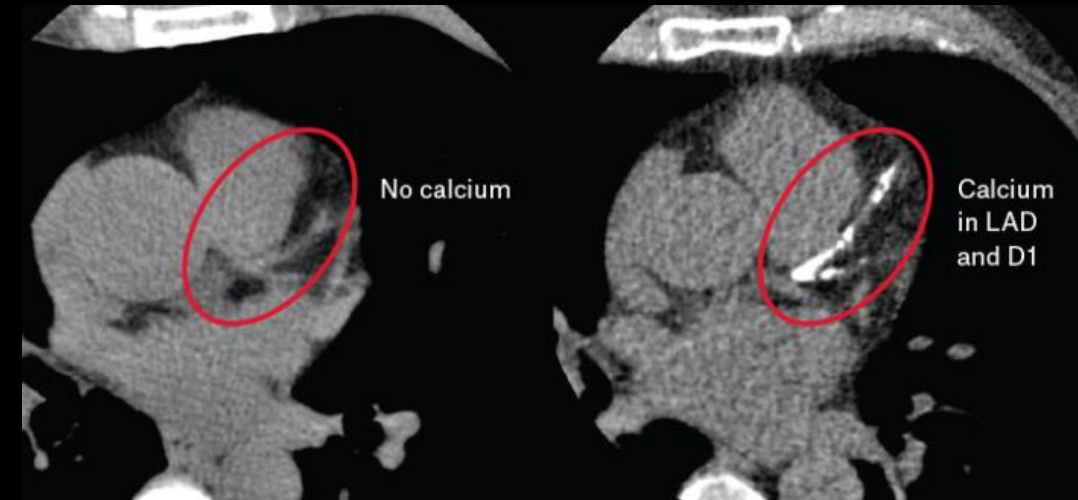
# Calcium score:

- Robust marker for presence of coronary calcifications
- Association with cardiovascular outcomes
- Decision-making tool for statin therapy
- Possibility to quantify from native CT scan
- Compare against reference (accord. age/gender)
- Vast imaging information

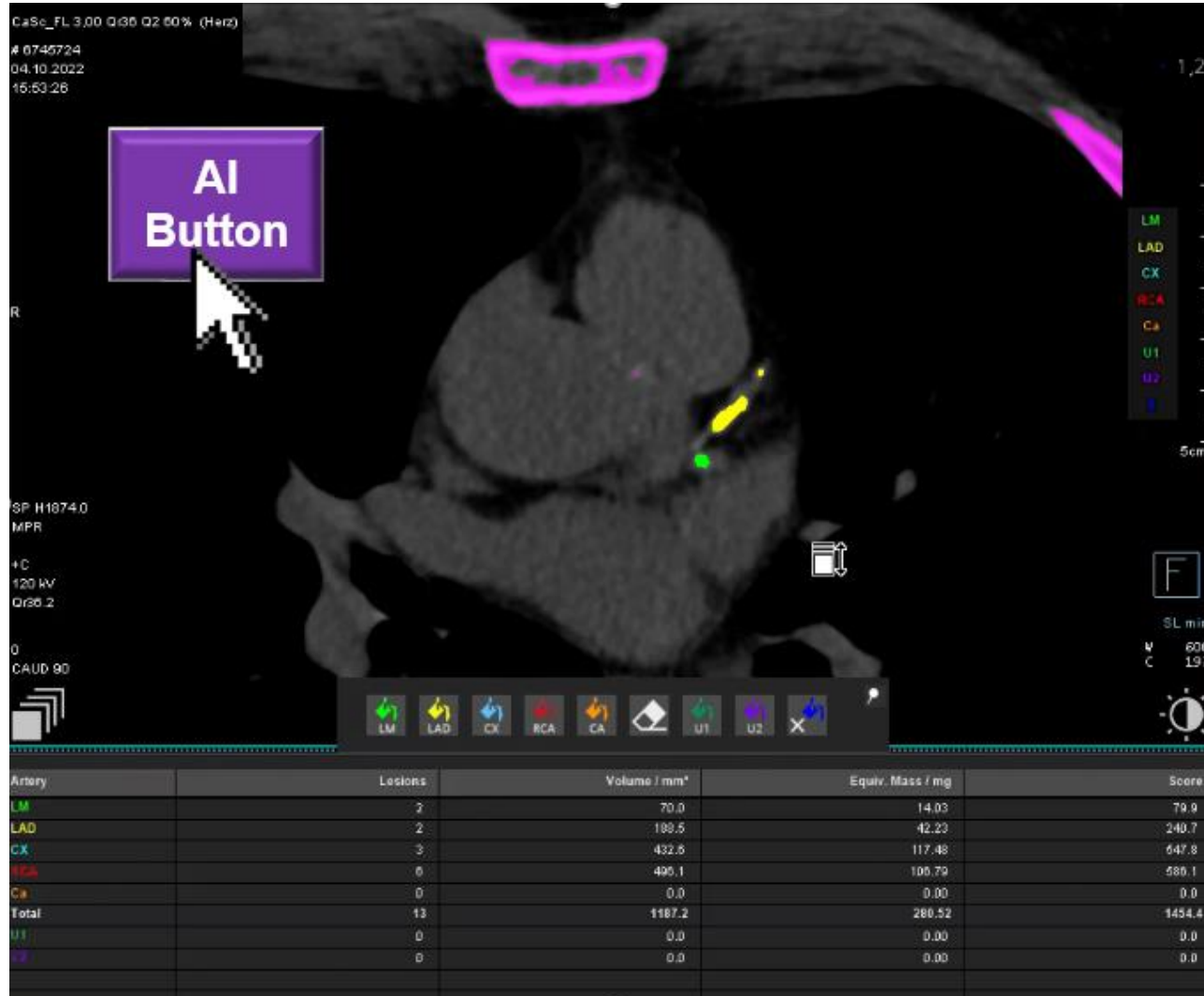
## Coronary artery calcification



Cleveland  
Clinic  
©2022

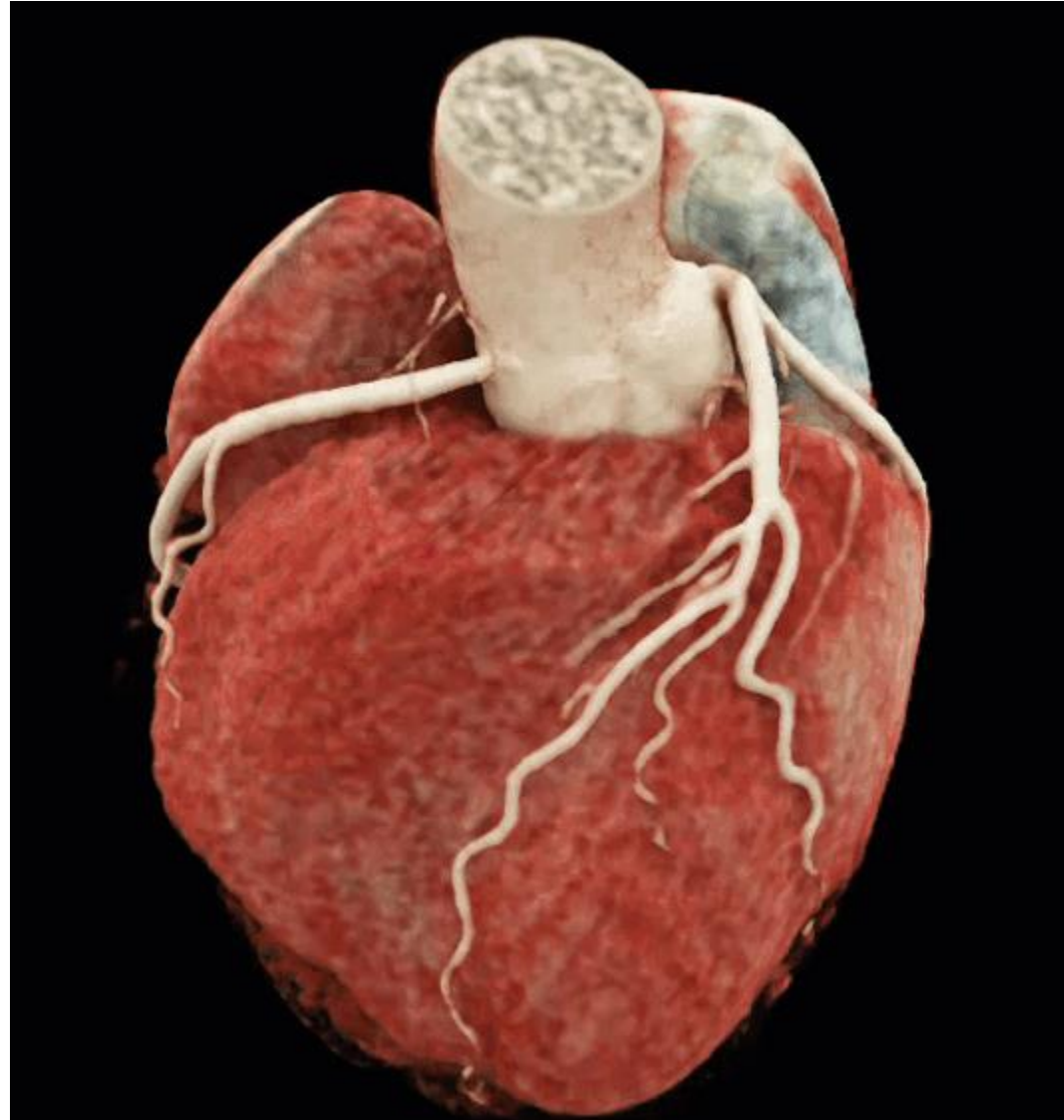


# Calciumscore: using AI

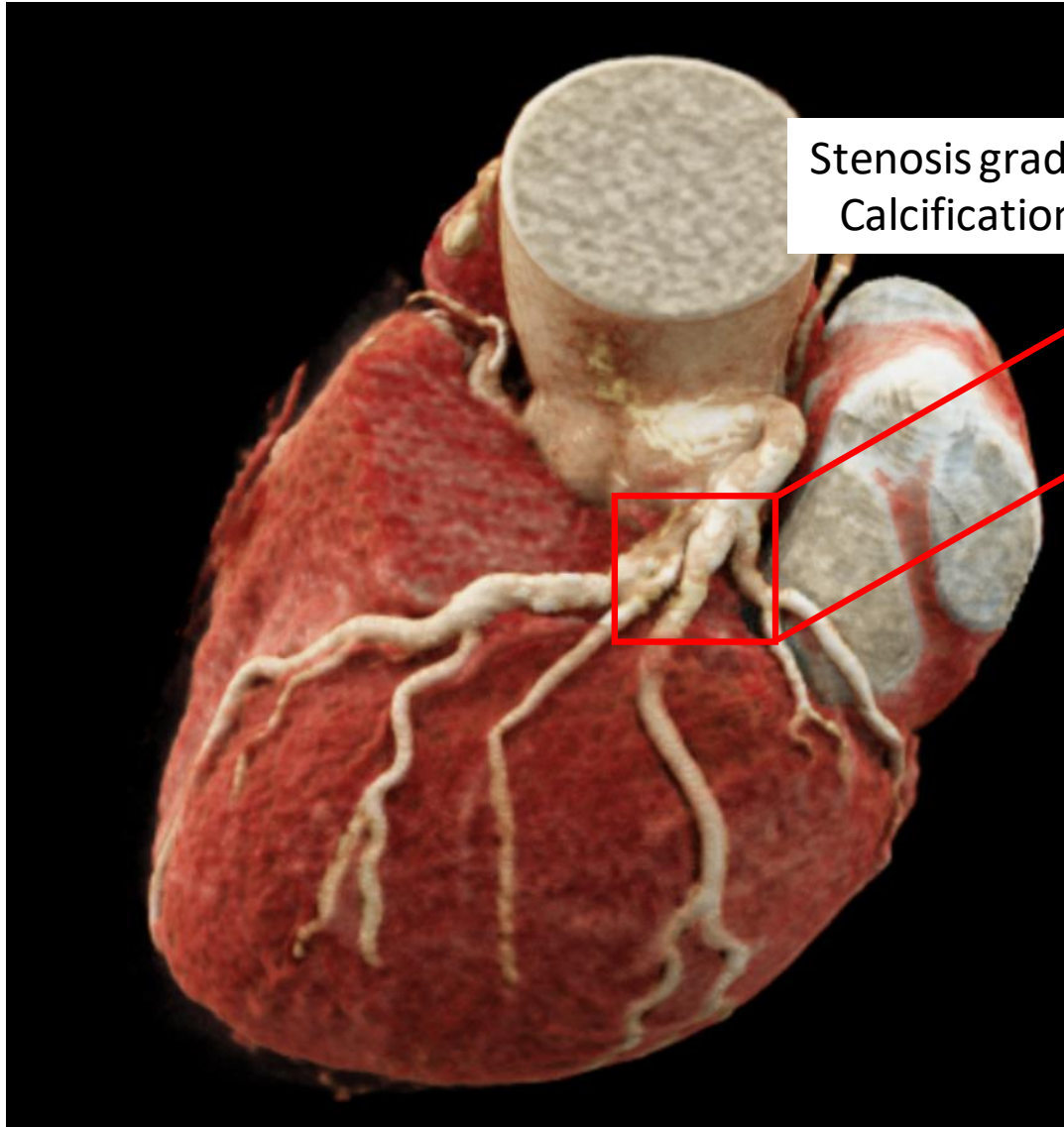


# Cardiac CT

- First-line imaging modality in symptomatic patients for coronary artery disease assessment
- Assessment takes 15-20minutes
- Motion artifact, poor opacification, beam hardening, calcification



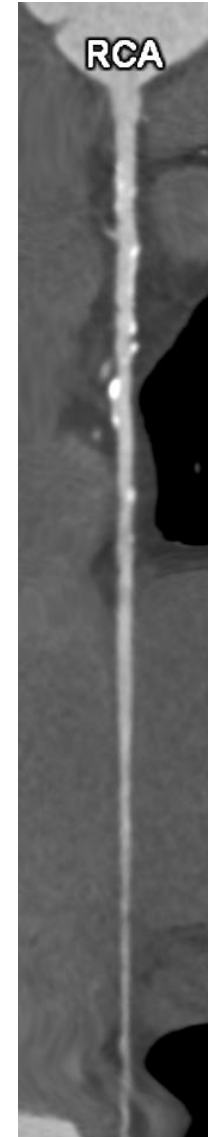




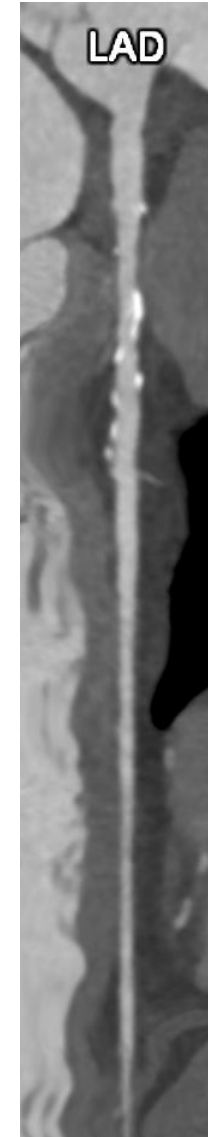
Stenosis grading  
Calcifications



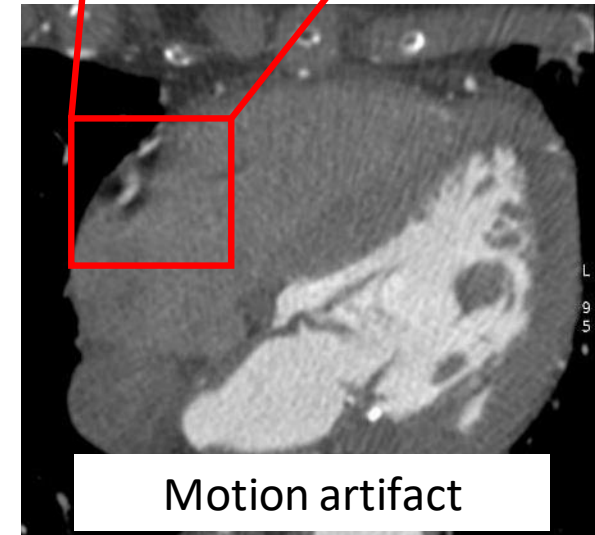
RIM



RCA



LAD



Motion artifact

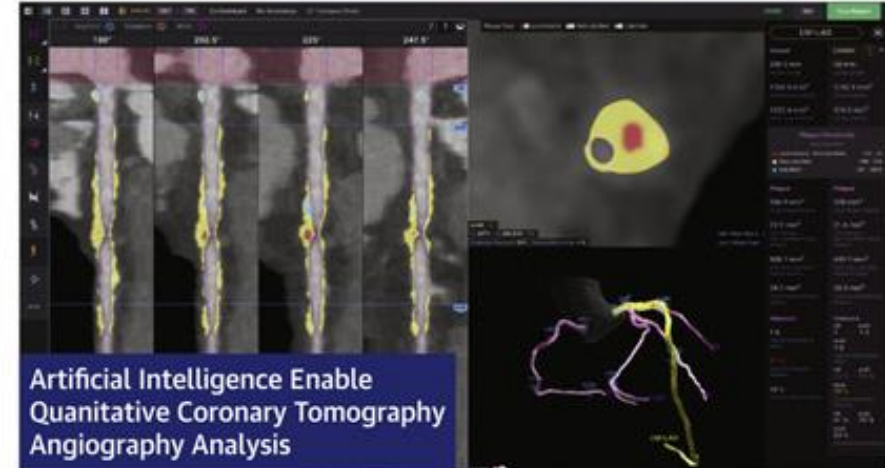
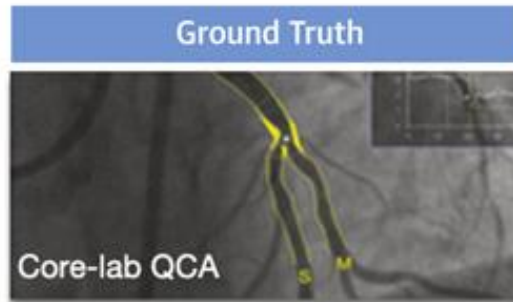
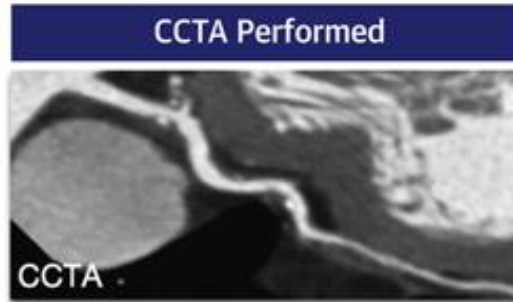
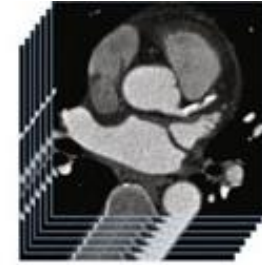
# Cardiac CT

- AI approach: series of CNN models for image quality assessment, coronary segmentation and labeling, lumen wall evaluation and vessel contour determination



CREDESCENCE Trial  
Data  
21 Centers  
303 Patients

All CCTA  
data and  
series

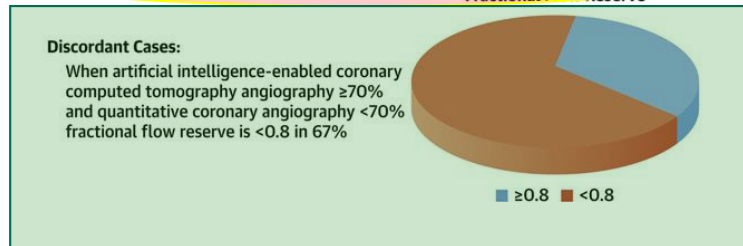


Artificial Intelligence Enabled Quantitative CT Artificial Intelligence-Enabled Coronary Computed Tomography Angiography Analyses Enables Rapid and Accurate Identification and Exclusion of High-Grade Stenosis With Close Agreement to Blinded, Core-Lab Interpreted Quantitative Coronary Angiography

Artificial Intelligence-Enabled Coronary Computed Tomography Angiography vs Quantitative Coronary Angiography for Detection of Stenosis, Per Patient

Artificial Intelligence-Enabled Coronary Computed Tomography Angiography vs Quantitative Coronary Angiography	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy	Area Under the Receiver-Operating Characteristic Curve
≥50% Stenosis	94%	68%	81%	90%	84%	0.88
≥70% Stenosis	94%	82%	69%	97%	86%	0.92

Fractional Flow Reserve







# Automated Echocardiographic Quantification of Left Ventricular Ejection Fraction Without Volume Measurements Using a Machine Learning Algorithm Mimicking a Human Expert

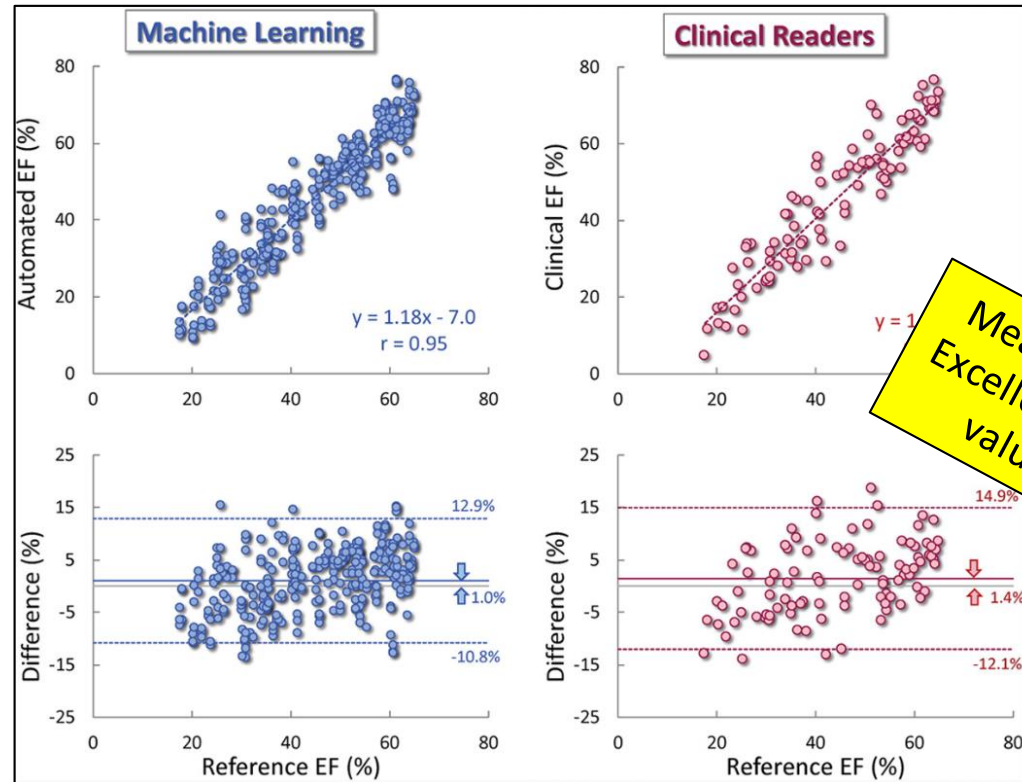
Federico M. Asch, Nicolas Poilvert, Theodore Abraham, Madeline Jankowski, Jayne Cleve, Michael Adams, Nathanael Romano, Ha Hong, Victor Mor-Avi, Randolph P. Martin and Roberto M. Lang ✉

Originally published 16 Sep 2019 | <https://doi.org/10.1161/CIRCIMAGING.119.009303> | Circulation: Cardiovascular Imaging. 2019;12:e009303

**Training set: >50'000 TTEs**

**Testing set: 99  
Echocardiographies**

**Reference: 3 experts**





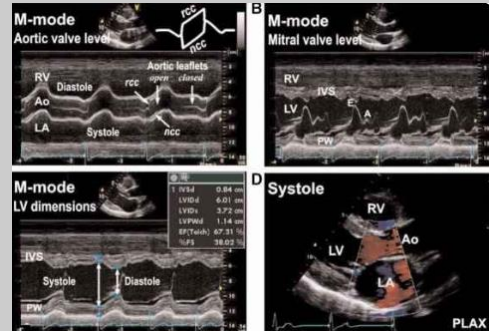
# Classical TTE workflow

Image acquisition and measurements



Navigate loops  
Detect best of all EDV-ESV ...  
Measures +++  
click click click ...

**30-40min** for a complete reported echo



Check measurements  
Normal / Abnormal  
Aggregate multiples measures  
Check Guidelines  
Push it into the report



Gather all informations  
Make sure you don't make any error reporting the values.  
Write a report

Conclusions



# Optimized workflow using Us2.ai

Acquire images



All measures are ready and interpreted in  
**2-3 minutes**

Conclusions



## Full auto measures

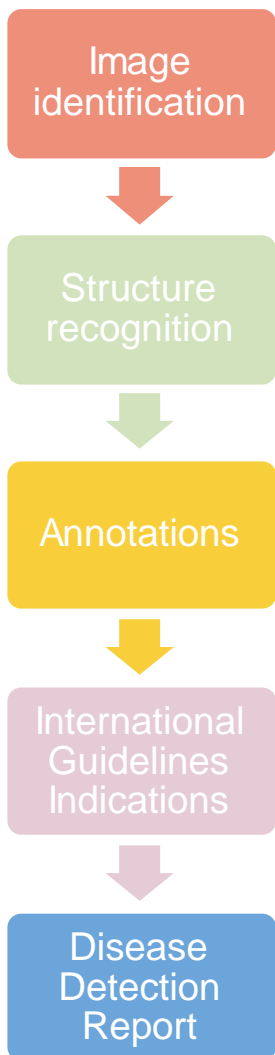
- WITHOUT ECG
- EF
- LA & RV Strain
- RVOT
- ...

**Classification** Normal /  
Abnormal according to latest  
international guidelines



**Automated reporting  
of all measurements**

# Disease detection – Us2.ai powered diagnosis support



## Disease detection

- ✓ Heart failure (HF)  
HF with reduced ejection fraction | HF with preserved ejection fraction  
| HF with mid-range ejection fraction
- ✓ Pulmonary hypertension & right heart failure
- ✓ Hypertrophic cardiomyopathy
- ✓ Cardiac amyloidosis
- ✓ Valvular disease  
Aortic stenosis | Mitral regurgitation  
| Tricuspid regurgitation
- ✓ Ischemic heart disease (regional wall motion abnormalities)

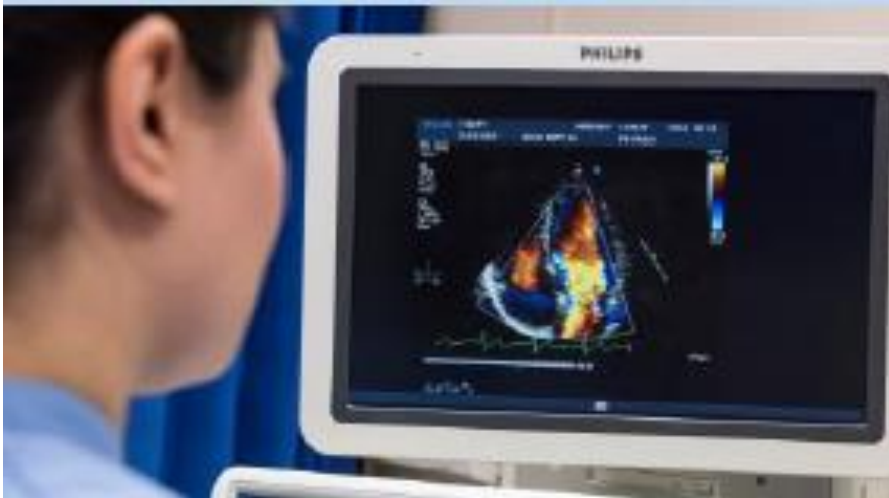
**Us2.ai** software facilitates the possible detection of multiple disease conditions. All clinical conditions are suggested based on international guidelines.

8 Us2.ai :: Ultrasound Anyone Anywhere

US2.AI

# Echocardiography today → tomorrow

## Today



Requires years of specialist  
training to read



## Tomorrow

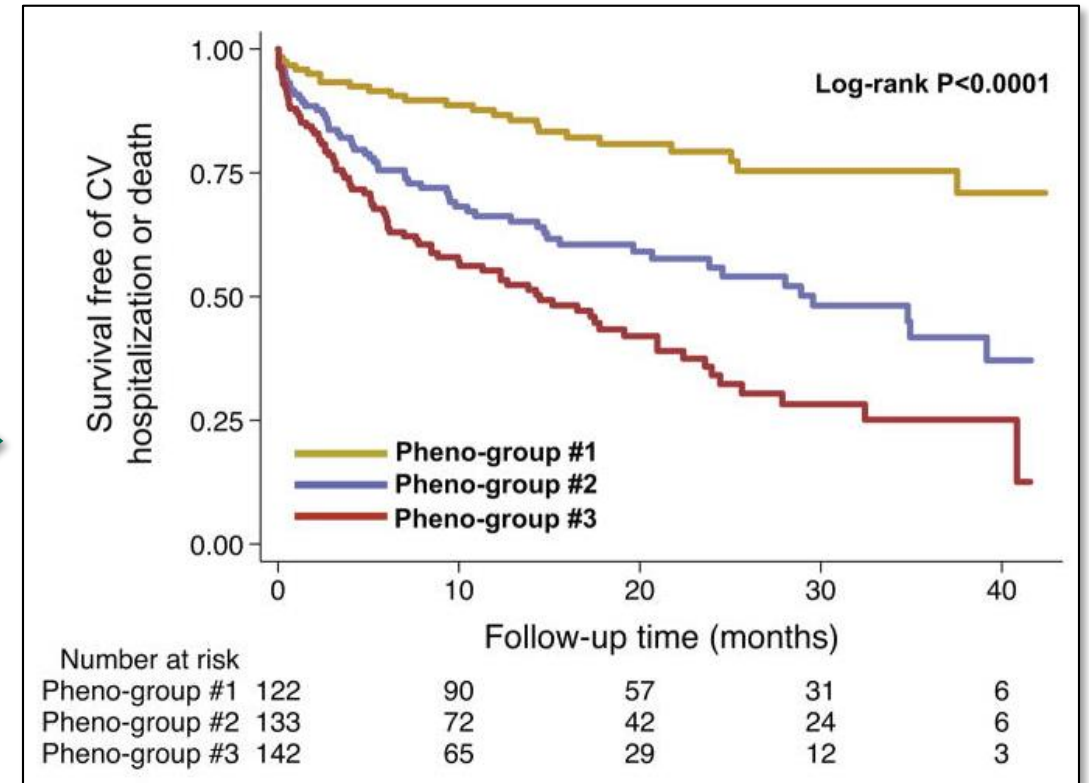
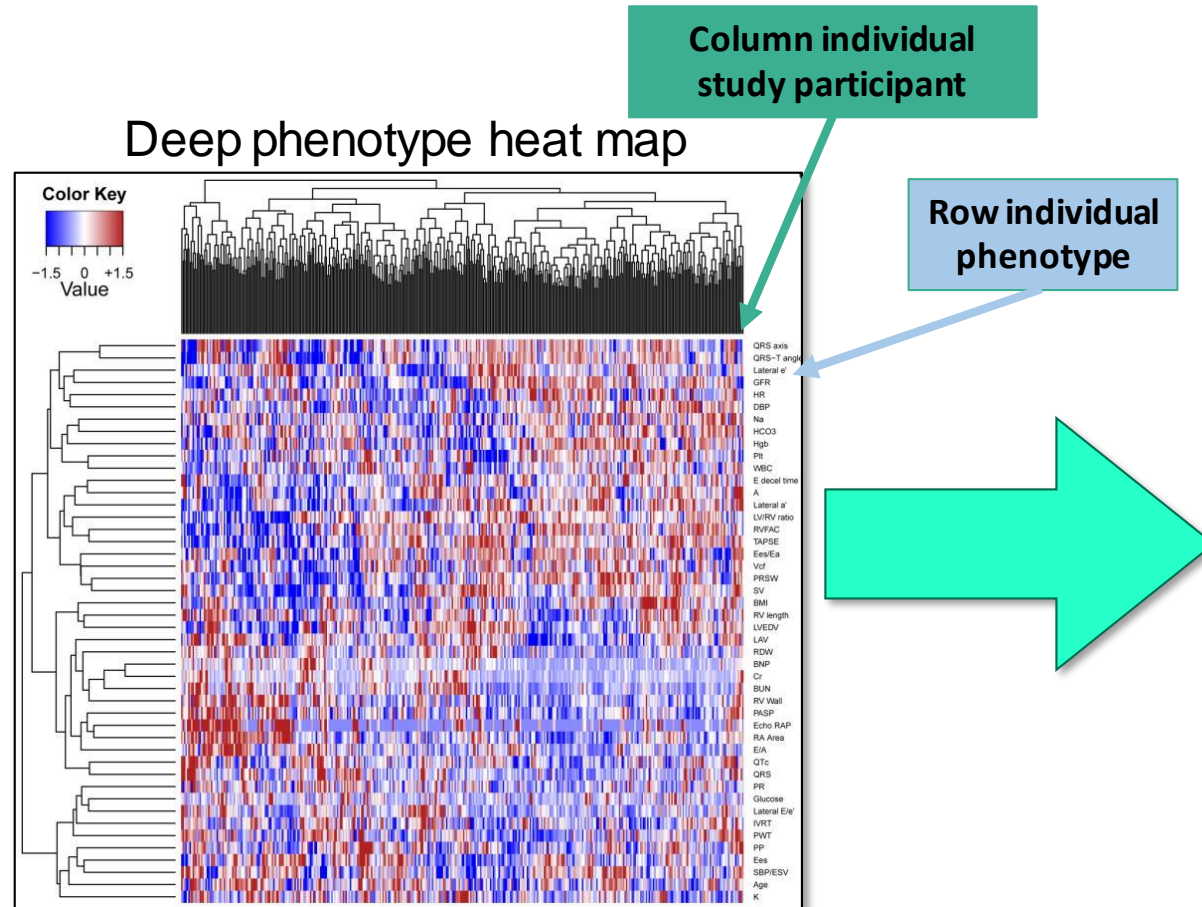


Ultrasound Anyone Anywhere

Automated diagnosis and  
treatment proposition



# Classification - New ways to categorize people/diseases, based on novel not known markers in HFpEF

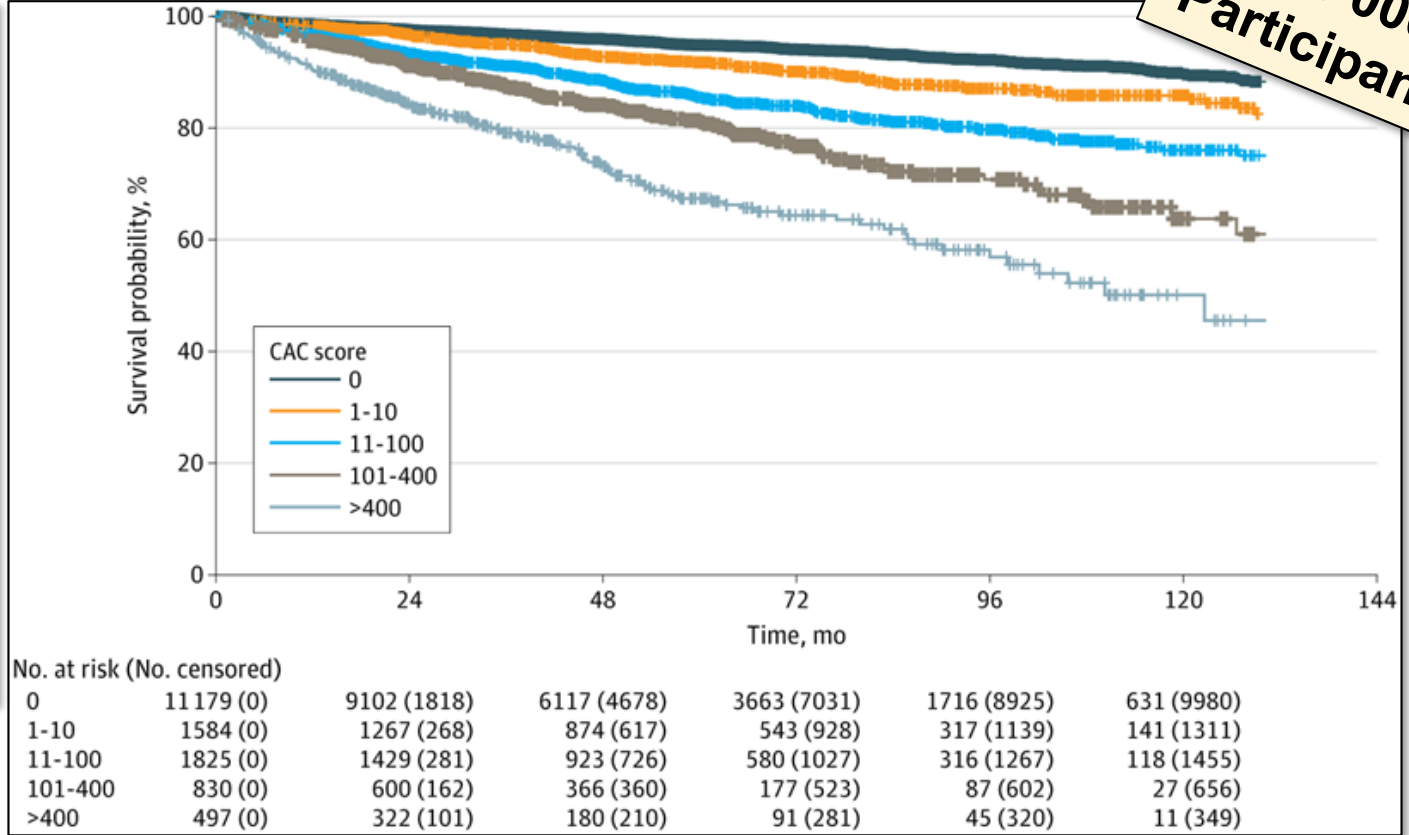
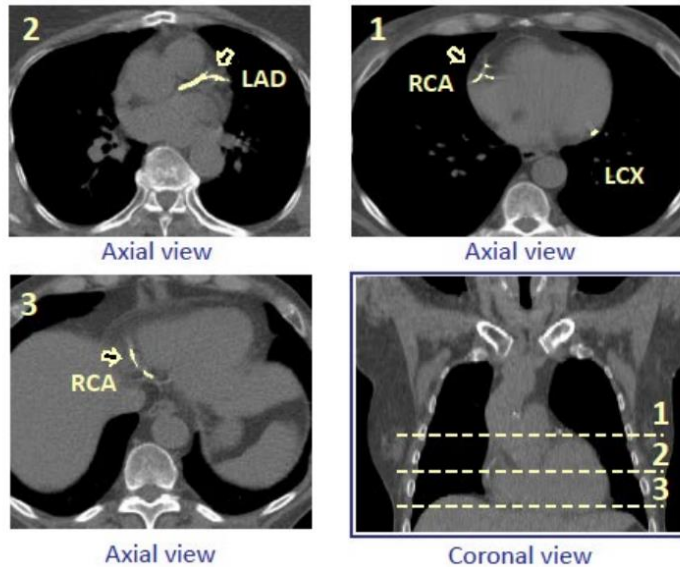


JAMA Oncology | Original Investigation

# Identification of Risk of Cardiovascular Disease by Automatic Quantification of Coronary Artery Calcifications on Radiotherapy Planning CT Scans in Patients With Breast Cancer

>15'000  
Participants

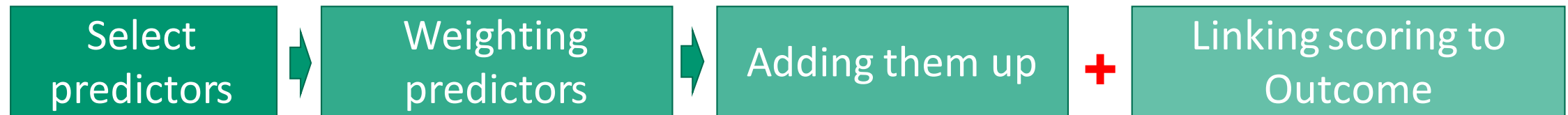
Figure 2. Examples of CAC lesions in different coronary arteries identified by the deep learning algorithm. The position of the slices within the heart is indicated in the coronal view.



No. at risk (No. censored)	0	24	48	72	96	120	144
0	11 179 (0)	9102 (1818)	6117 (4678)	3663 (7031)	1716 (8925)	631 (9980)	
1-10	1584 (0)	1267 (268)	874 (617)	543 (928)	317 (1139)	141 (1311)	
11-100	1825 (0)	1429 (281)	923 (726)	580 (1027)	316 (1267)	118 (1455)	
101-400	830 (0)	600 (162)	366 (360)	177 (523)	87 (602)	27 (656)	
>400	497 (0)	322 (101)	180 (210)	91 (281)	45 (320)	11 (349)	

# Risk prediction

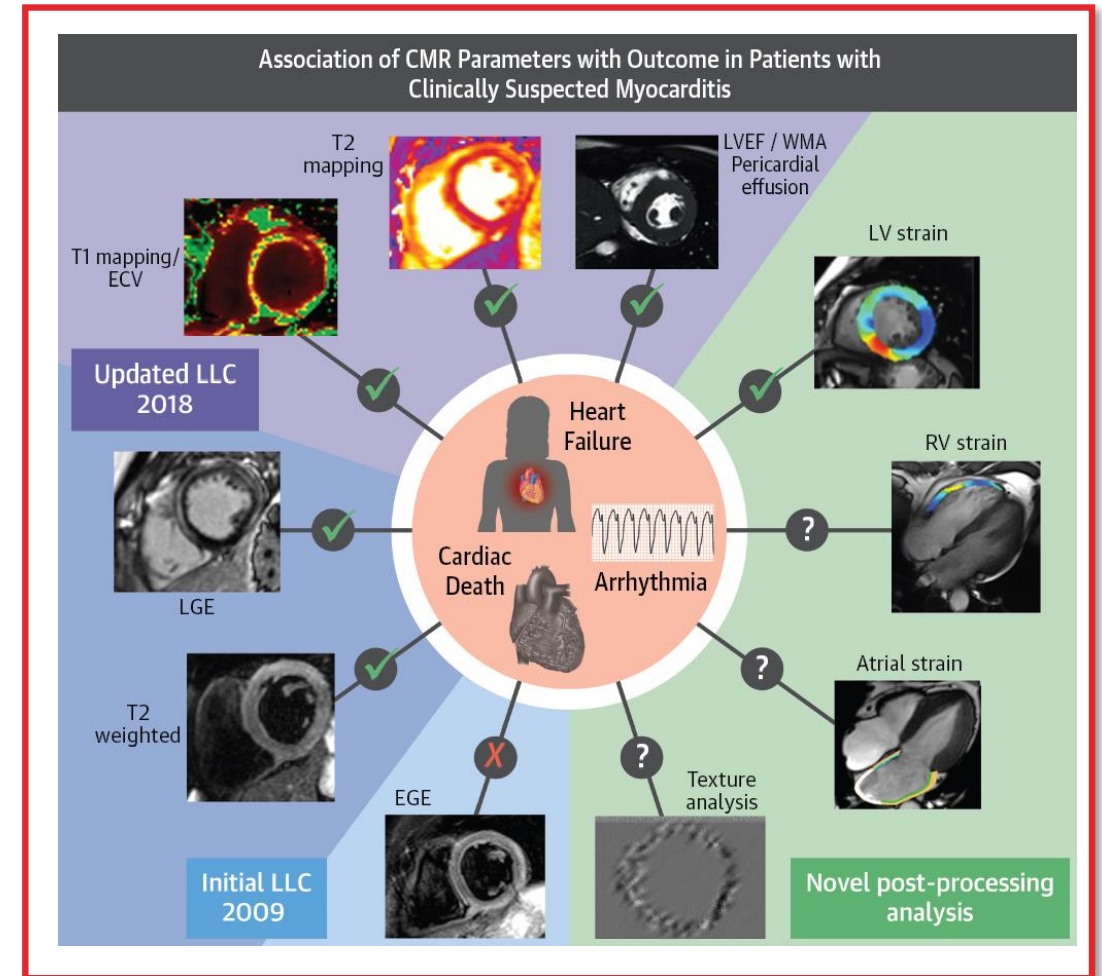
How is a traditional risk prediction model built?



- Sudden cardiac often “first cardiac event” and is not well predictable
- Conversely, >80% of patients with implantable defibrillator per current guideline recommendations → never received shocks

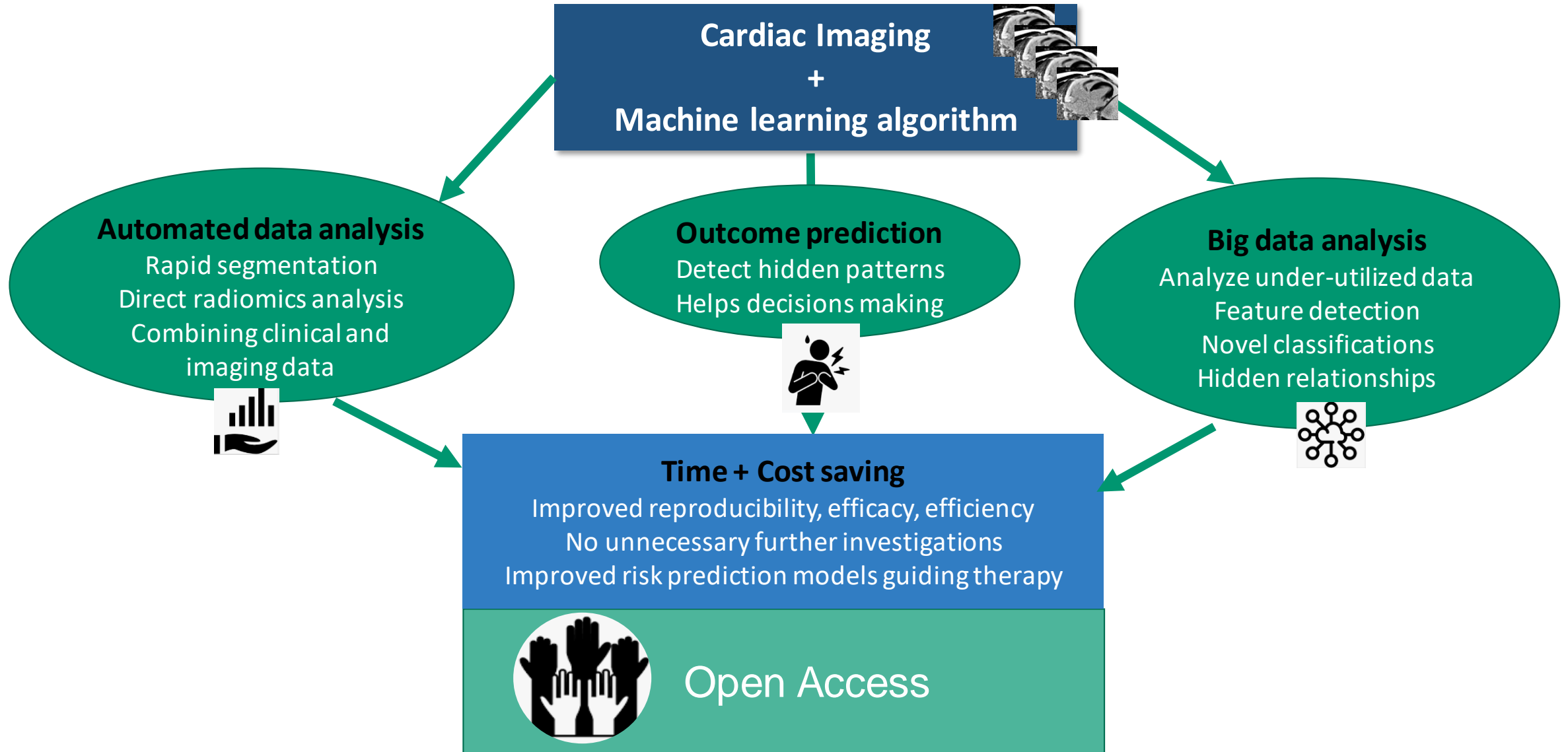
# Improve risk stratification by AI

- Find hidden features / associations
- Combine clinical and imaging data
  - Better phenotyping
  - Individualized risk stratification





# How AI in cardiac imaging can be implemented into routine



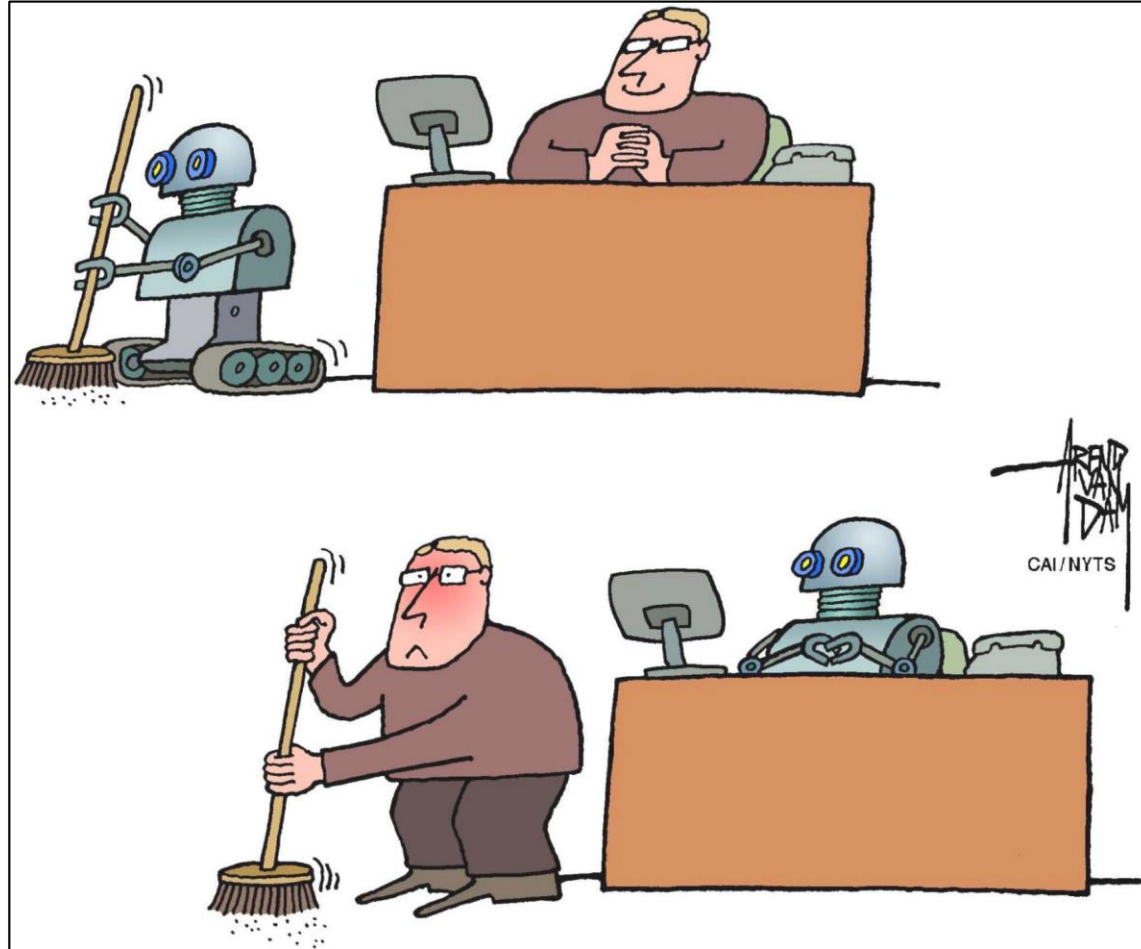
# Unmet needs (I)

- What are our references? (gold-standard, outcome)
- Standardization? Reproducibility/validation?
- Access to the Algorithms?
- How do we handle good/bad image quality?

## Unmet needs (II)

- What if AI is wrong, who is responsible?
- What if there is disagreement between AI and experts?
- Re-imburement for AI? More information available and who is seeing the patient?
- Ethical issues/data protection? Analysis/AI models far away outside of the institution?

# Will AI replace clinicians (I)?





# Will AI replace clinicians (II)?

## How Will Artificial Intelligence Create More Jobs by 2025?

By Akshad Tambekar / Updated on Oct 10, 2022 / 4830



Home > Tech

## AI Will Create 97 Million Jobs, But Workers Don't Have The Skills Required (Yet)

It's time to upskill workers; a World Economic Forum report states that 97 million new jobs will be created by 2025 due to AI.

by **Emma Ascott** — November 19, 2021 in **Tech** Reading Time: 6 mins read

AA



## Don't fear AI. It will lead to long-term job growth.

Oct 26, 2020

- COVID-19 has accelerated the automation of many tasks, leading some to fear artificial intelligence (AI) will take their jobs.
- But AI will create more jobs than it destroys.
- To embrace this change, companies and governments must focus on upskilling and reskilling.

# Forbes

CAREERS

## AI Creates Job Disruption But Not Job Destruction

**You won't lose your job to  
a computer**

You'll lose it to a human who is  
better at using a computer

# ChatGPT: new kid on the block!

ChatGPT gibt ausführliche Antwort

Tiefere Krankenkassen-Prämien durch KI

«ChatGPT könnte die Facharztprüfung bestehen.»

Davey Smith, Universität Kalifornien

FORBES > INNOVATION > ENTERPRISE TECH

## Revolutionizing Healthcare: The Top 14 Uses Of ChatGPT In Medicine And Wellness

Bernard Marr Contributor @

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Mar 2, 2023, 02:39am EST

HOME > WISSENSCHAFT > INTERNATIONAL-SCIENCE > CHAT GPT ALS ARZT: DIE KI BESTEHT EXAMEN – UND GIBT DIAGNOSEN

## Kann Chat GPT Arzt sein? Wie der Bot das Examen bestand und Krankheiten diagnostizierte

Hilary Brueck

🕒 10 Apr 2023



# Computer and empathy?

The image shows a screenshot of a social media post with two comments. The post is enclosed in a red rectangular border. The first comment is from a user named 'Kachina', dated 03.05.2023, 09:54. The comment text is 'Chat GPT ist der intelligenteste und einfühlsamste Gesprächspartner, den ich je hatte.' Below the text is a bar with three colored segments (dark blue, purple, light blue) and the number '6'. To the right of the bar is a button that says 'Kommentar melden'. Below the bar is the text 'LOVE IT (3 Lesende)'. The second comment is from a user named 'Arhus', dated 03.05.2023, 09:24. The comment text is 'Ich gehöre noch der Generation an, die mit Menschen und nicht mit Maschinen sprechen will. Diese KI Geschichte wird der Menschheit noch starkes Kopferbrechen bereiten.' Below the text is a bar with three colored segments (dark blue, purple, light blue) and the number '15'. To the right of the bar is a button that says 'Kommentar melden'. Below the bar is the text 'LOVE IT (12 Lesende)'. The background of the screenshot is white with a light gray border.

**Kachina**  
03.05.2023, 09:54  
Chat GPT ist der intelligenteste und einfühlsamste Gesprächspartner, den ich je hatte.  
6  
Kommentar melden  
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**Arhus**  
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Ich gehöre noch der Generation an, die mit Menschen und nicht mit Maschinen sprechen will. Diese KI Geschichte wird der Menschheit noch starkes Kopferbrechen bereiten.  
15  
Kommentar melden  
LOVE IT (12 Lesende)



Original Investigation

ONLINE FIRST FREE

April 28, 2023

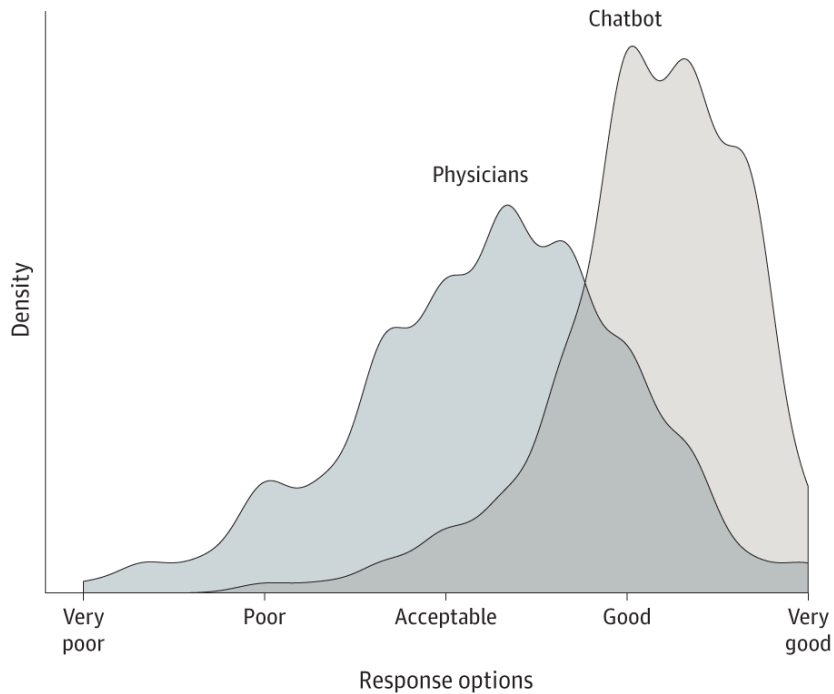
# Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum

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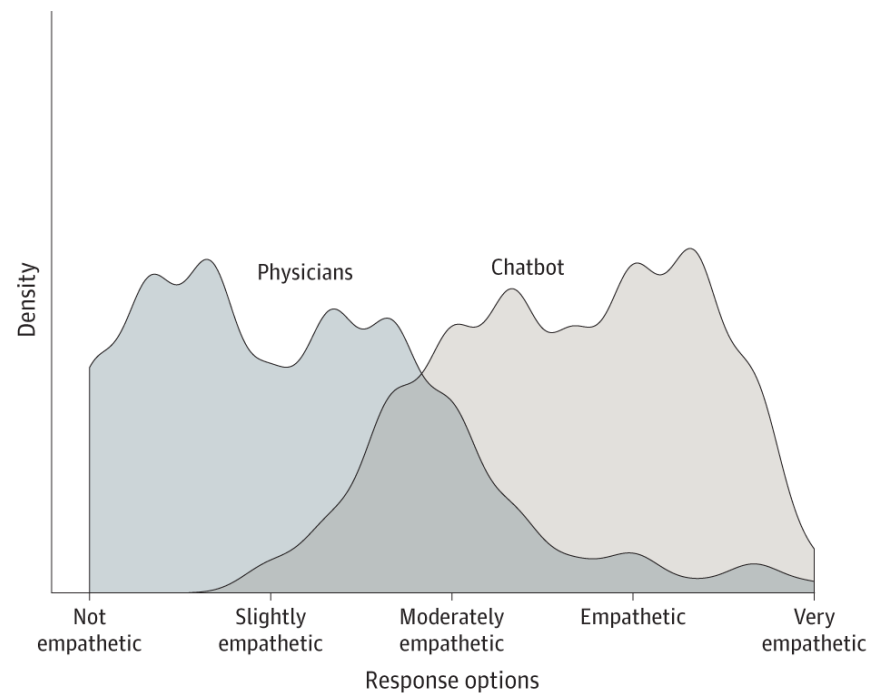
[» Author Affiliations](#) | [Article Information](#)

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**A** Quality ratings



**B** Empathy ratings



The image shows a browser window displaying the OpenAI blog post 'Introducing ChatGPT'. The browser's address bar shows the URL 'https://openai.com/blog/chatgpt'. The page header includes the OpenAI logo and navigation links for 'Research', 'Product', 'Developers', 'Safety', and 'Com'. The main heading is 'Introducing ChatGPT' in a large, bold, black font. Below the heading, the text reads: 'We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.' At the bottom of the visible text, there are two buttons: 'Try ChatGPT' and 'Read about ChatGPT Plus'. A yellow arrow with a red outline points to the 'Try ChatGPT' button.

OpenAI Research Product Developers Safety Com

# Introducing ChatGPT

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.

[Try ChatGPT](#) [Read about ChatGPT Plus](#)

# How will ChatGPT transform Cardiology?

**C** How will ChatGPT change Cardiology in the future?



As an AI language model, ChatGPT can provide a wealth of information and knowledge in the field of cardiology. Its ability to process and analyze large amounts of data can assist healthcare professionals in making informed decisions regarding patient care, as well as aid in the development of new treatments and therapies.

ChatGPT can also help bridge the gap between patients and healthcare providers by providing accessible and understandable information about heart health and disease prevention. It can help educate patients about risk factors and lifestyle modifications, empowering them to take an active role in their own health and well-being.

Moreover, with advancements in natural language processing and machine learning, it is possible that in the future, ChatGPT may even be able to provide personalized medical advice and treatment recommendations based on individual patient data.

Overall, ChatGPT has the potential to significantly impact the field of cardiology by improving patient care, facilitating research, and promoting patient education and empowerment.

# AI in cardiac Imaging - Take Home Message

## ✓ AI currently in cardiac imaging:

- Segmentation (speed), accuracy (reproducibility), risk-stratification

## ✓ AI in cardiac imaging will rise:

- Increase in computational power, labelled data available, combining clinical data + imaging data, improved algorithms

## ✓ Unmet needs:

- Reference, validation, reproducibility, open access, ethics, reimbursement

## ✓ Physicians are still needed:

- Maybe needed more than ever?!

## ✓ ChatGPT:

- Great potential for assisting physician, patient counselling, personalized risk prediction and novel treatment development



**Thank you for your attention**