Arizona Center for Rural Health
State Office of Rural Health Webinar Series

Partners:

Arizona Telemedicine Program

Southwest Telehealth Resource Center TRC

THE UNIVERSITY OF ARIZONA
MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH
Center for Rural Health

Webinar notes:

Audience is muted during the presentation.
Please enter your questions into the chat box.
Please fill out the post-webinar survey.
Webinar is being recorded.
A link to the recording will be posted on:
AzCRH www.crh.arizona.edu

THE UNIVERSITY OF ARIZONA
MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH
Center for Rural Health

Land Acknowledgement

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

THE UNIVERSITY OF ARIZONA
MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH
Center for Rural Health

ROLE OF AI IN HEALTH CARE

Srikar Adhikari, MD

DISCLOSURES

- NIH (grant funding)
- Department of Defense (grant funding)
- Emergency Medicine Foundation grant funding
- Springer (Book Royalties)
- Consulting relationship:
  - GE Ultrasound
  - EXO Ultrasound

OBJECTIVES

- AI in Healthcare
- Benefits
- Challenges
- Ethics

AI in Healthcare

Patient-Facing

AI Chatbots
buoy, Your.MD, medwhat, GYANT, Dr.AI

Wearables & Devices
physIQ, QARDIO, sano, QUANTTUS, DietSensor, kiwi.ai, BIOSERENITY, Jodytrak, Magnea, kinsa, SCANADU, aira, AliveCor, 19 Labs, CliniCloud

Personalized Genetics
iCarbonX, rthm, CG, DAY TWO, Positive, LIFENOME, MEDICUS, 23andMe, VIAGENE, Arivale, habit, Suggestic, VIOME

Mental Health
Woebot, TOUCHKIN, BIOBEATS, Ginger.io, NeuroLex, AURA, koko

Women's Health
CYRCADIA HEALTH, bloomlife, celmatix, flutter, eva, Clue, elyse, Natural Cycles

Skin
SkinVision, skinIO, skin analytics, SCANZ, skin, DOCTOR HAZEL, FIRST DERM

Telehealth

Telemedicine
ada, SENSELY, how are you feeling today?, babylon, anamnèse, Remedy, pager, spruce

Lifestyle Management
AiCure, MedAware, ovia health, next IT Healthcare, Catalia Health, lucina, Health Next Gen, Doctella, NarrativeDx, cardiogram, Wellframe, Welltok, CareAngel

Disease Management
prognos, INFOBIONIC, HealthReveal, HEALTH FIDELITY, DIABNEXT, SENTRIAN, TEMPUS, dreamed, Healint, WIKAYA, FLASHBACK TECHNOLOGIES, RxPREDICT, BELONG

Research

Drug Discovery
Mind the Byte, SopS for Drug Discovery, DATAVANT, QUANTITATIVE MEDICINE, Standigm, ENVISAGENICS, BERG, RECURSION, BenevolentAI, Athelas, Exscientia, NuMedii, healx, transcriptic, Numerate, twoXAR, Atomwise, Better medicines faster., INSILICO MEDICINE, CloudPharmaceuticals, Globavir

Information & Clinical Trials
trials.ai, PathAI, BenchSci, CYCLICA, Mendel.ai, Qrativ, peptone, Brite Health, iPLEXUS, antidote, Plex Research, nference, RESULTCARE

Genetic Research
MolecularMatch, Blueprint Genetics, VERGE GENOMICS, NURITAS, diploid, HUMAN LONGEVITY, INC., SOPHIA GENETICS, freenome, FDNA, PATHWAY GENOMICS, deep genomics, DESKTOP GENETICS

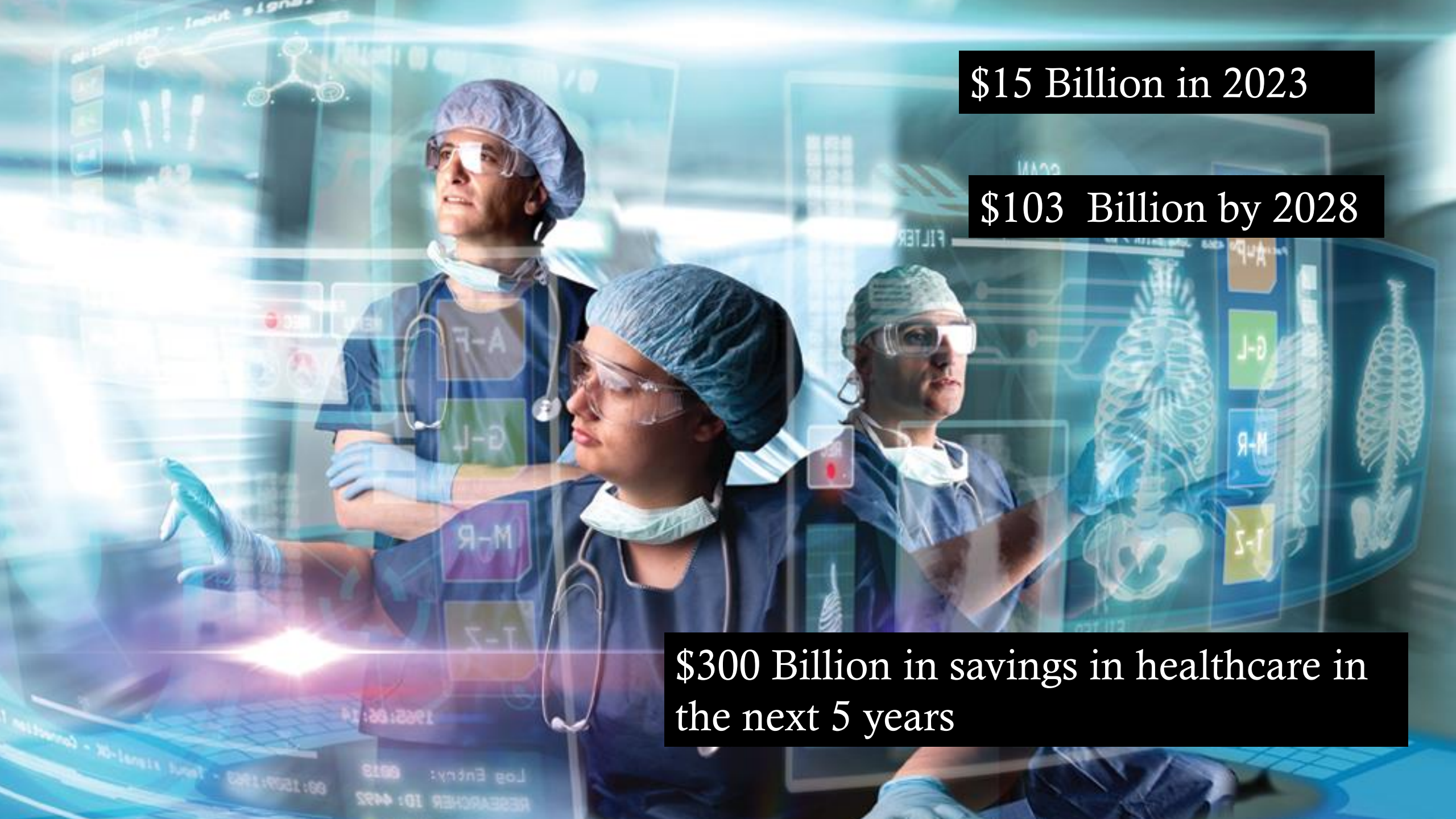
Doctor-Facing

Medical Records
APIXIO, AUGMEDIX, clinithink, MODERNIZING MEDICINE, nimblr, saykara, emr.ai, WellSheet, hCue, patientory, SANSORO HEALTH, PROTENUS, BloomAPI

Data Analytics
ZEPHYR HEALTH, burstIQ, MD.ai, Infermedica, CLOUDMEDX, jvion, flatiron, CareSkore, ROAM, Hindsait, PROFILITY, Oncora MEDICAL, lumiata, MEDALOGIX, GRAIL, ensodata, pulseData, healthcare.ai, KenSci, COMBINOSTICS, impacthealth, LYTICS

Medical Imaging
VIZ, AMARA HEALTH ANALYTICS, enlitic, zebra MEDICAL VISION, 推想科技 infervision, CureMetrix, BAYLABS, VUNO, ADVENIO, Transpiring Innovation, koios, BUTTERFLY Network, Inc., SIGTUPLE, Behold.ai, imagia, ARTERYS, Mindshare MEDICAL, aidence, IMAGEN, aidoc, Lunit, Cardiologs, Genetesis, HubMedX, DIA, SemanticMD, Blackford analysis

Hospital
FORWARD, Qventus, MedyMatch, gauss, orgo.ai, MEDASENSE pain monitoring solutions, P3d, AURIS, VERB SURGICAL, Qualaris


$15 Billion in 2023
$103 Billion by 2028
$300 Billion in savings in healthcare in the next 5 years

AI-HEALTH CARE

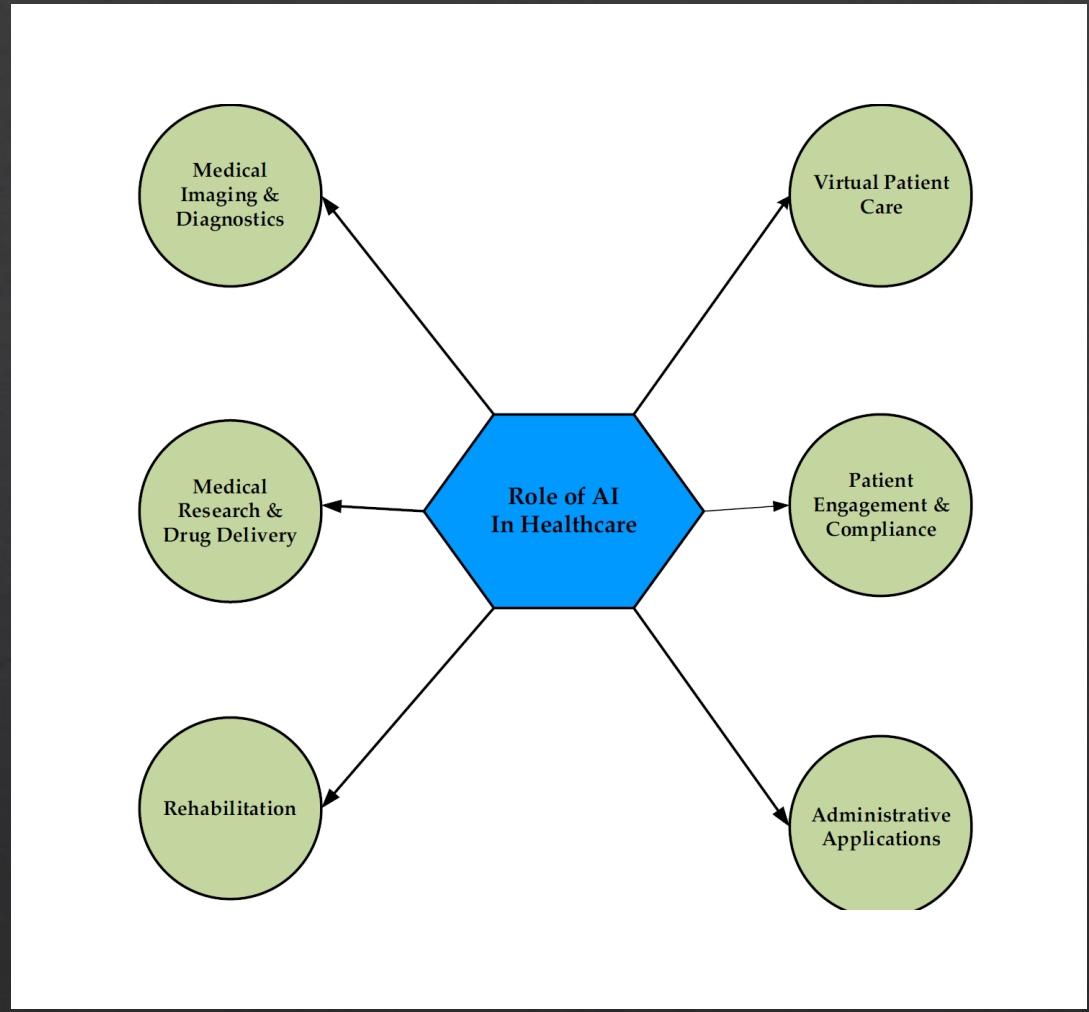
- Machine learning (neural networks & DL)
- Natural language processing
- Rule-based expert systems
- Physical robots
- Robotic process automation

AI-HEALTH CARE

- Real time analytics
- Workforce shortages
- Public health surveillance systems
- Wait times
- Improved preventive measures
- Cost savings
- Drug Discovery

AI-HEALTH CARE

- Diagnostic interpretation
- Clinical decision-making
- Workflow
- Predictive algorithms
- Health monitoring



AI-HEALTH CARE

Symptoms/Signs/Labs
Medical imagery
Drug interactions
Risk stratification
Coding

STAKEHOLDERS

- Patients and Families
- Clinician Care Teams
- Public Health Program Managers
- Business Administrators

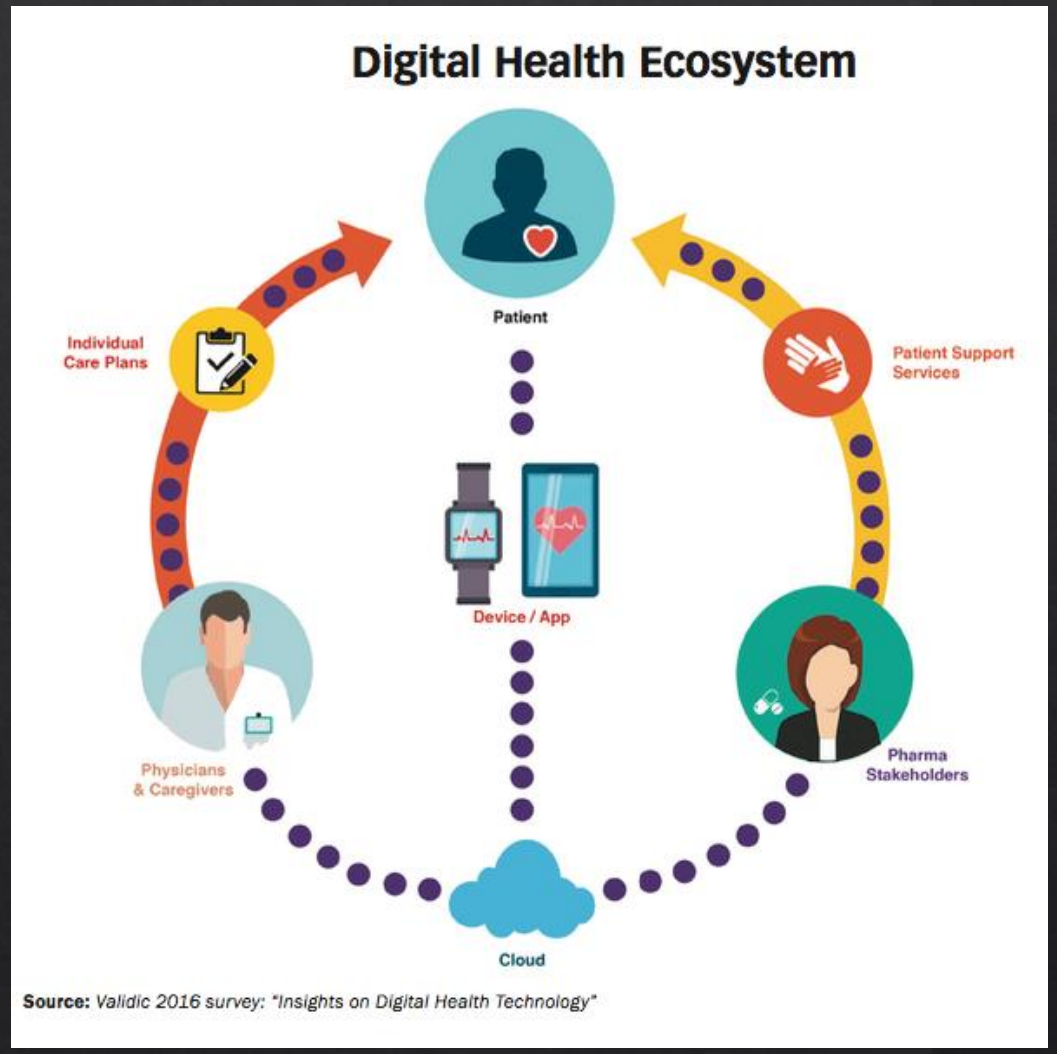
RURAL/RESOURCE LIMITED SETTINGS

- Access
- Inequities
- Higher morbidity & mortality
- Life expectancy

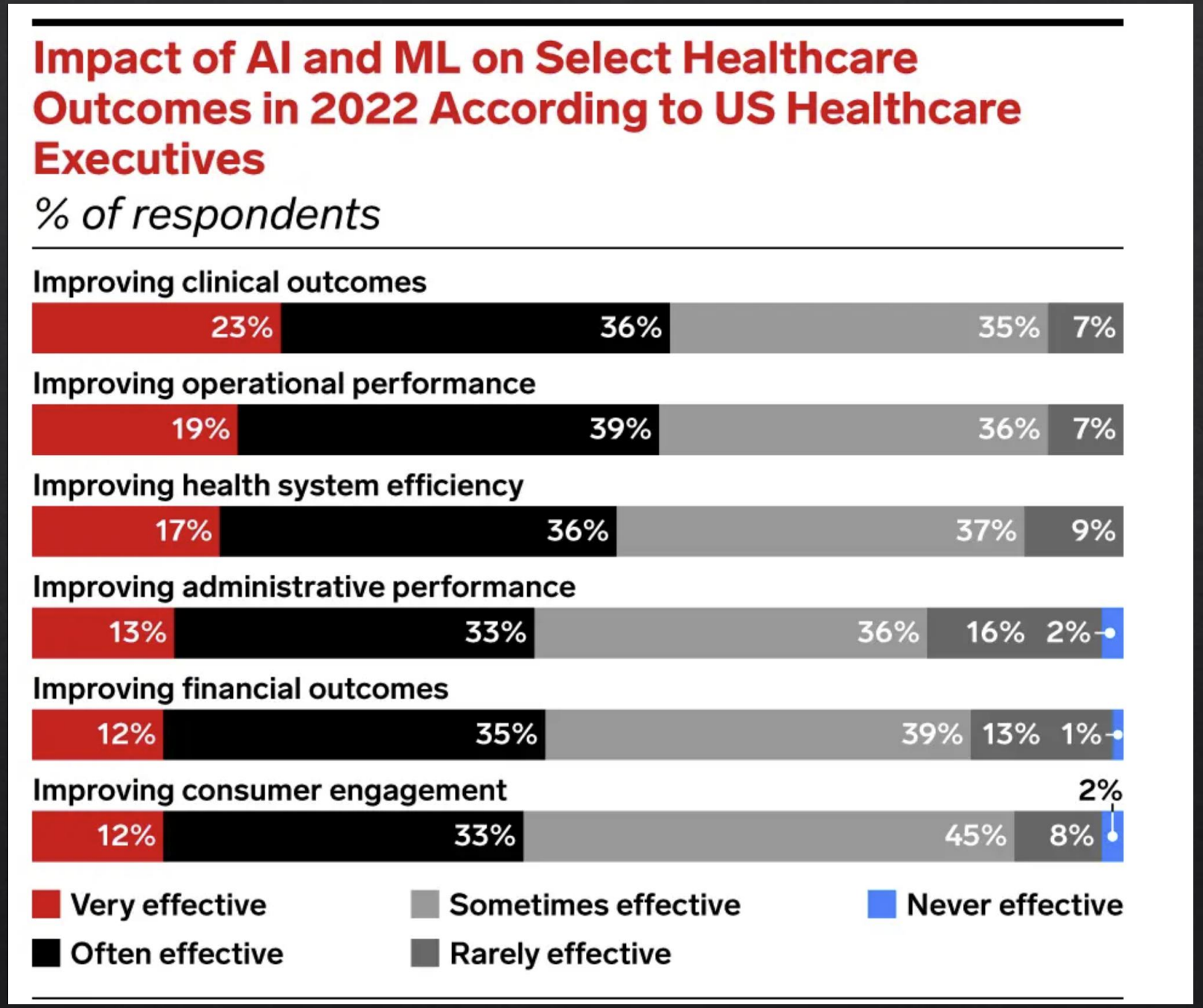
AI-FAIRNESS IN HEALTH CARE

AI-HEALTH CARE

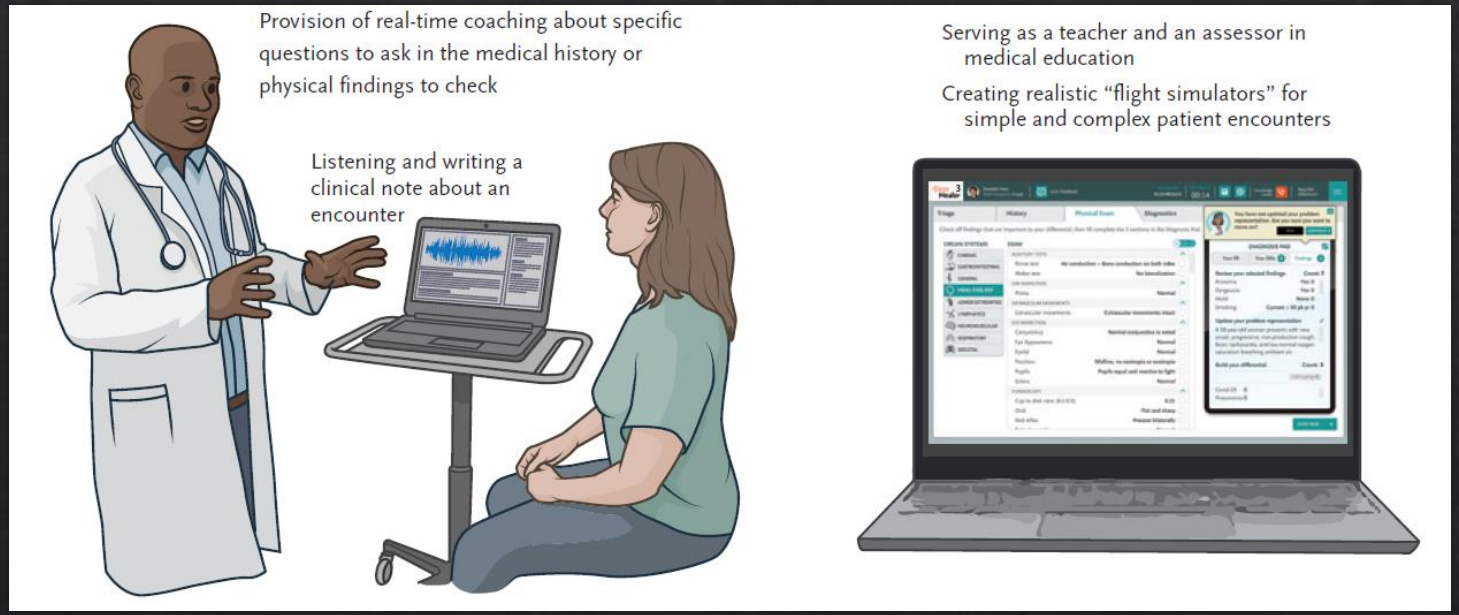
- Increased access
- Increased affordability
- Quality of health care



DIGITAL INFRASTRUCTURE EFFICIENT HEALTH ECOSYSTEM


Impact of AI and ML on Select Healthcare Outcomes in 2022 According to US Healthcare Executives
% of respondents
Improving clinical outcomes
23%
36%
35%
7%
Improving operational performance
19%
39%
36%
7%
Improving health system efficiency
17%
36%
37%
9%
Improving administrative performance
13%
33%
36%
16%
2%
Improving financial outcomes
12%
35%
39%
13%
1%
Improving consumer engagement
12%
33%
45%
8%
2%
Very effective
Often effective
Sometimes effective
Rarely effective
Never effective

- Medical diagnosis and decision-making
- Patient engagement and education
- Mental health support



A A Request to GPT-4 to Read a Transcript of a Physician–Patient Encounter and Write a Medical Note

Clinician: Please have a seat, Meg. Thank you for coming in today. Your nutritionist referred you. It seems that she and your mom have some concerns. Can you sit down and we will take your blood pressure and do some vitals?
Patient: I guess. I do need to get back to my dorm to study. I have a track meet coming up also that I am training for. I am runner.
Clinician: How many credits are you taking and how are classes going?
Patient: 21 credits. I am at the top of my class. Could we get this done? I need to get back.
Clinician: How often and far do you run for training now? You are 20, correct?
Patient: Yes. I run nine miles every day.
Clinician: Your BP is 100/50. Your pulse is 52. Meg, how much have you been eating?
Patient: I have been eating fine. I talked to the nutritionist about this earlier.
Clinician: Let's have you stand up and face me and I will back you onto the scale. Eyes on me please. Thank you, and now for a height. Ok looks like 5'5". Go ahead and have a seat.
Patient: How much? Can I please see what the scale says? I'm fat.
Clinician: Please sit up and I will listen to your heart and lungs.
Patient: Fine.
Clinician: You know that is not a positive part of your treatment. We have discussed this before. You are here today because your nutritionist and your mom are both very concerned about you. You are very ill, Meg.
Patient: I am fine. I am eating. I tell my mom what I eat. Just because I am not fat like she is.
Clinician: How have you felt? Are you feeling sad or depressed? Last time we talked, you were quite unhappy. Are you feeling suicidal?
Patient: I am busy and not concerned about happiness. I need to train and I am tired of everyone nagging me about what I eat and how much I exercise. I am the smartest in my class and one of the best runners on the team. I don't have time for all of this. I am only here to keep my mom off my back.
Clinician: When you were here last, you agreed to keep working with your nutritionist and being open with your mom and me. We need to work together to help you get well. There are irregular rhythms in your heart. And I noticed the downy hair on your back and arms.
Patient: I will work with all of you. I know. I don't want to be like this. I need to run though. It helps me.
Clinician: When you were in treatment, we were working toward some goals with your cognitive behavioral therapy. We need to revisit these goals. First thought, we need to bring your mom in and have a discussion about the next step to help you get well. I would like to do more tests to check your electrolytes and your blood count.
Patient: Ok. I do want to be better.
Clinician: I want you to feel better and be healthy. Let's have your mom come in, ok?
Patient: Yeah.
--
Please summarize this encounter in the form of the doctor's medical note.

GPT-4: *Patient is a 20-year-old female with a history of anorexia nervosa and depression. She was referred by her nutritionist and accompanied by her mother. She is taking 21 credits at college and is a competitive runner. She is in denial of her illness and has poor insight into her condition. She is resistant to treatment and intervention. She reports eating fine, but she is severely underweight (BMI 14.8) and has signs of malnutrition and cardiac complications. She denies feeling suicidal, but expresses low mood and lack of interest in happiness. She has a strong attachment to running and believes it helps her cope. She agreed to work with her nutritionist, her mother, and me, but she needs more support and monitoring. I ordered some blood tests and suggested a review of her cognitive behavioral therapy goals. I discussed with her and her mother the possibility of hospitalization or intensive outpatient treatment if her condition does not improve.*

B Use of GPT-4 to Review and Validate a Proposed Medical Note

Clinician: Can you check the proposed note and identify any facts in it that don't appear explicitly in the transcript?
<The entire transcript and medical note in Panel A is inserted at this point>

GPT-4: *There are a few facts in the proposed note that are not explicitly stated in the transcript, such as:*
- *The patient's BMI, which is calculated from her weight and height, but not revealed to her or mentioned by the clinician. The note should indicate that the BMI is based on the clinician's measurement or estimate.*
- *The signs of malnutrition and cardiac complications, which are not specified or explained by the clinician. The note should list the signs that the clinician observed or inferred, such as the downy hair, the irregular rhythms, the low blood pressure, or the low pulse.*
- *The blood tests that the clinician ordered, which are not specified or explained by the clinician. The note should mention what tests were ordered and why, such as electrolytes, blood count, or liver function.*

Clinician: Thanks. The patient's weight was 87 lb. For the blood test, I ordered a CBC with RBC and peripheral smear. Can you revise the note accordingly?

GPT-4: *Sure. Here is a possible revision:*
Patient is a 20-year-old female with a history of anorexia nervosa and depression. She was referred by her nutritionist and accompanied by her mother. She is taking 21 credits at college and is a competitive runner. She is in denial of her illness and has poor insight into her condition. She is resistant to treatment and intervention. She reports eating fine, but she is severely underweight (we measured her weight at 87 lb and her height at 5'5", resulting in a BMI of 14.8) and has signs of malnutrition (lanugo on her back and arms) and cardiac complications (irregular heart rhythms, low blood pressure, and low pulse). She denies feeling suicidal, but expresses low mood and lack of interest in happiness. She has a strong attachment to running and believes it helps her cope. She agreed to work with her nutritionist, her mother, and me, but she needs more support and monitoring. I ordered a CBC with RBC and peripheral smear to assess her anemia and possible bone marrow suppression. I suggested a review of her cognitive behavioral therapy goals. I discussed with her and her mother the possibility of hospitalization or intensive outpatient treatment if her condition does not improve.

Clinician: I have a patient with a history of chronic obstructive pulmonary disease (COPD) who is experiencing shortness of breath. What should I be looking for to determine whether this patient is having an exacerbation?

GPT-4: *As a health care provider, when evaluating a patient with a history of COPD who presents with shortness of breath, you should be looking for signs and symptoms of an exacerbation. An exacerbation of COPD is defined as an acute worsening of respiratory symptoms beyond the patient's usual day-to-day variation and is typically characterized by increased cough, increased sputum production, and increased dyspnea.*

Some of the key clinical features that suggest an exacerbation of COPD include:

1. *Increased shortness of breath, cough, and sputum production.*
2. *Increased wheezing, chest tightness, and chest discomfort.*
3. *Changes in the color, amount, and thickness of the sputum.*
4. *Increased use of rescue medication, such as short-acting bronchodilators.*
5. *Fatigue, confusion, or altered mental status.*
6. *Cyanosis, a bluish discoloration of the skin or lips, due to inadequate oxygenation.*

It is important to note that other medical conditions can mimic an exacerbation of COPD, such as congestive heart failure or pulmonary embolism. Therefore, it is essential to perform a thorough evaluation, including a detailed history, physical examination, and diagnostic testing, to confirm the diagnosis and identify any potential underlying causes.

Prompt recognition and appropriate management of COPD exacerbations are critical to minimizing their impact on the patient's quality of life and overall prognosis. If you suspect that your patient is having an exacerbation, you should consult with a pulmonologist or respiratory therapist to develop an appropriate treatment plan, which may include oxygen therapy, inhaled bronchodilators and corticosteroids, and antibiotics for suspected bacterial infections.

Clinician: There is no sputum production. But the patient reports fatigue and there is evidence of cyanosis.

GPT-4: *If your patient with a history of COPD is experiencing shortness of breath and fatigue with evidence of cyanosis, this could indicate a severe exacerbation of COPD, which requires urgent medical attention. In this case, it is important to assess the patient's oxygen saturation levels, which can be done with a pulse oximeter, and to provide supplemental oxygen therapy as necessary to maintain a target oxygen saturation level of at least 90%.*

The absence of sputum production does not rule out the possibility of an exacerbation of COPD, as not all patients with COPD produce sputum during an exacerbation. However, it is still important to evaluate the patient for any other signs of worsening respiratory distress, such as increased respiratory rate, accessory muscle use, and worsening oxygenation.

In addition to providing supplemental oxygen, the patient may benefit from inhaled bronchodilators and corticosteroids to help relieve symptoms and reduce inflammation in the airways. Antibiotics may also be necessary if there is evidence of a bacterial infection. Close monitoring of the patient's vital signs, oxygen saturation levels, and overall clinical status is important to guide further management and ensure a timely response to any changes in the patient's condition.

It is important to remember that exacerbations of COPD can be life-threatening, and prompt recognition and treatment are essential to improving outcomes for the patient. Therefore, it is advisable to seek the input of a pulmonologist or respiratory therapist for further management and monitoring.

CONVERSATIONAL AI

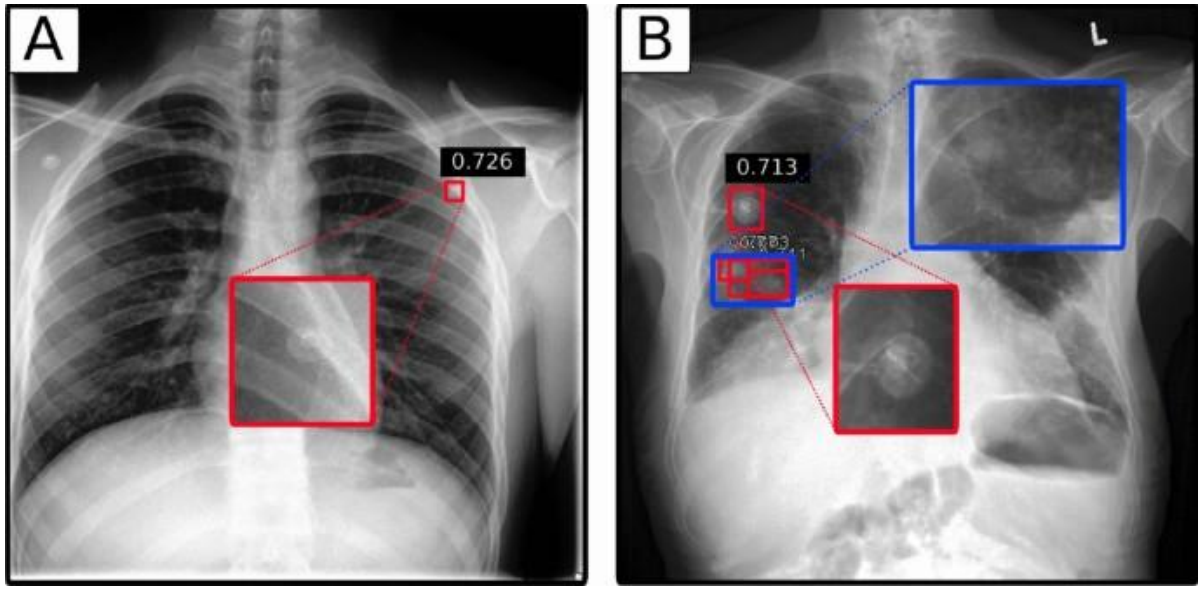
VIRTUAL ASSISTANTS AND AI CHATBOTS

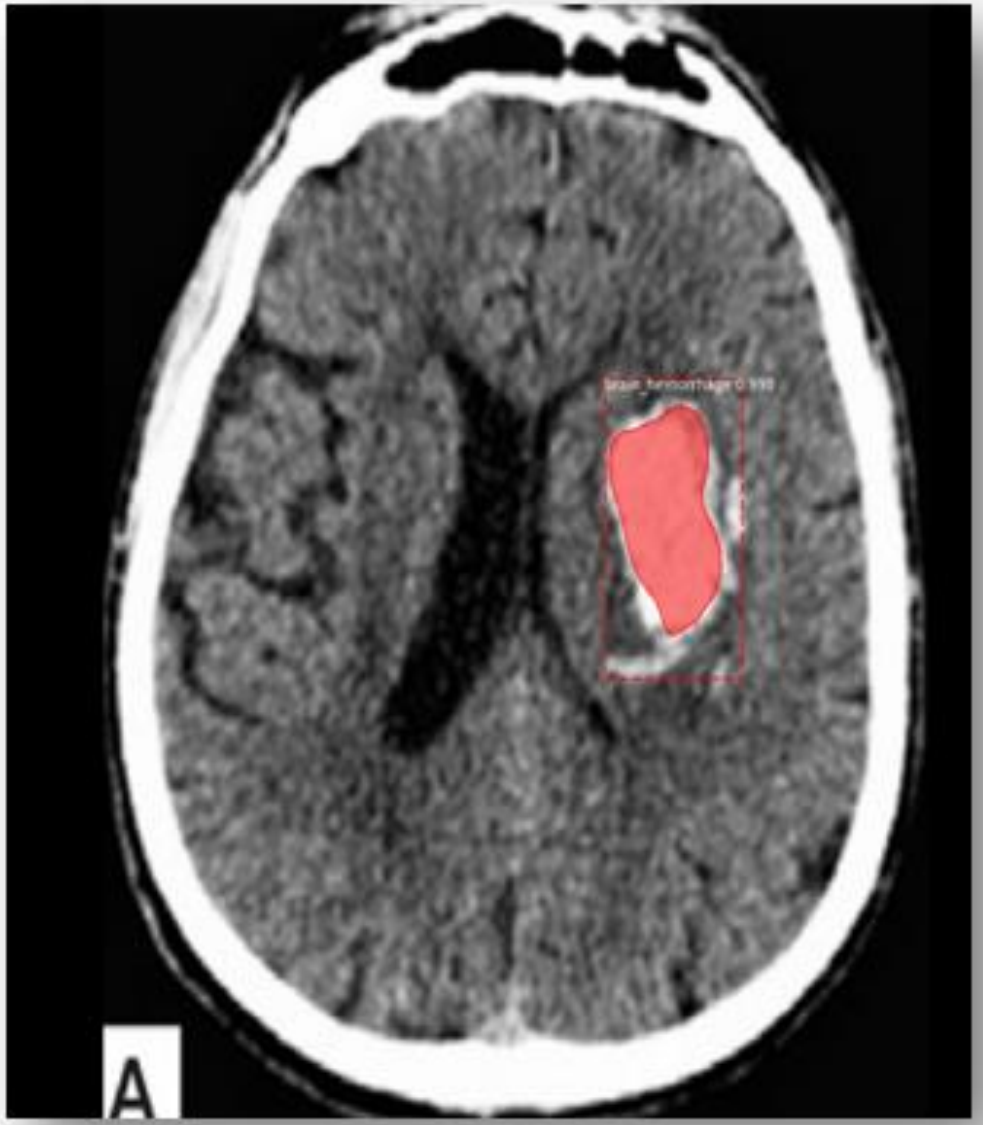
ADA

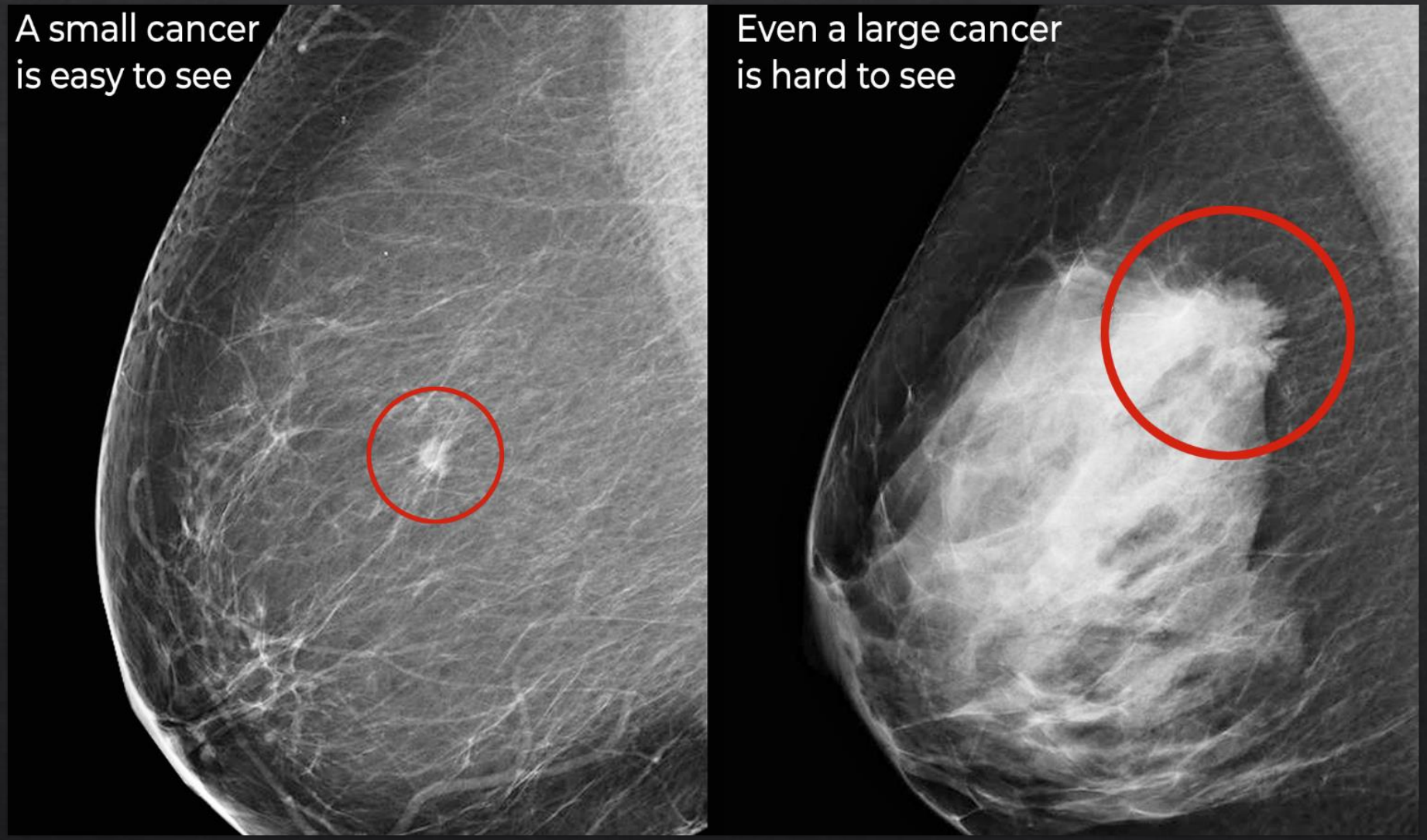

verily

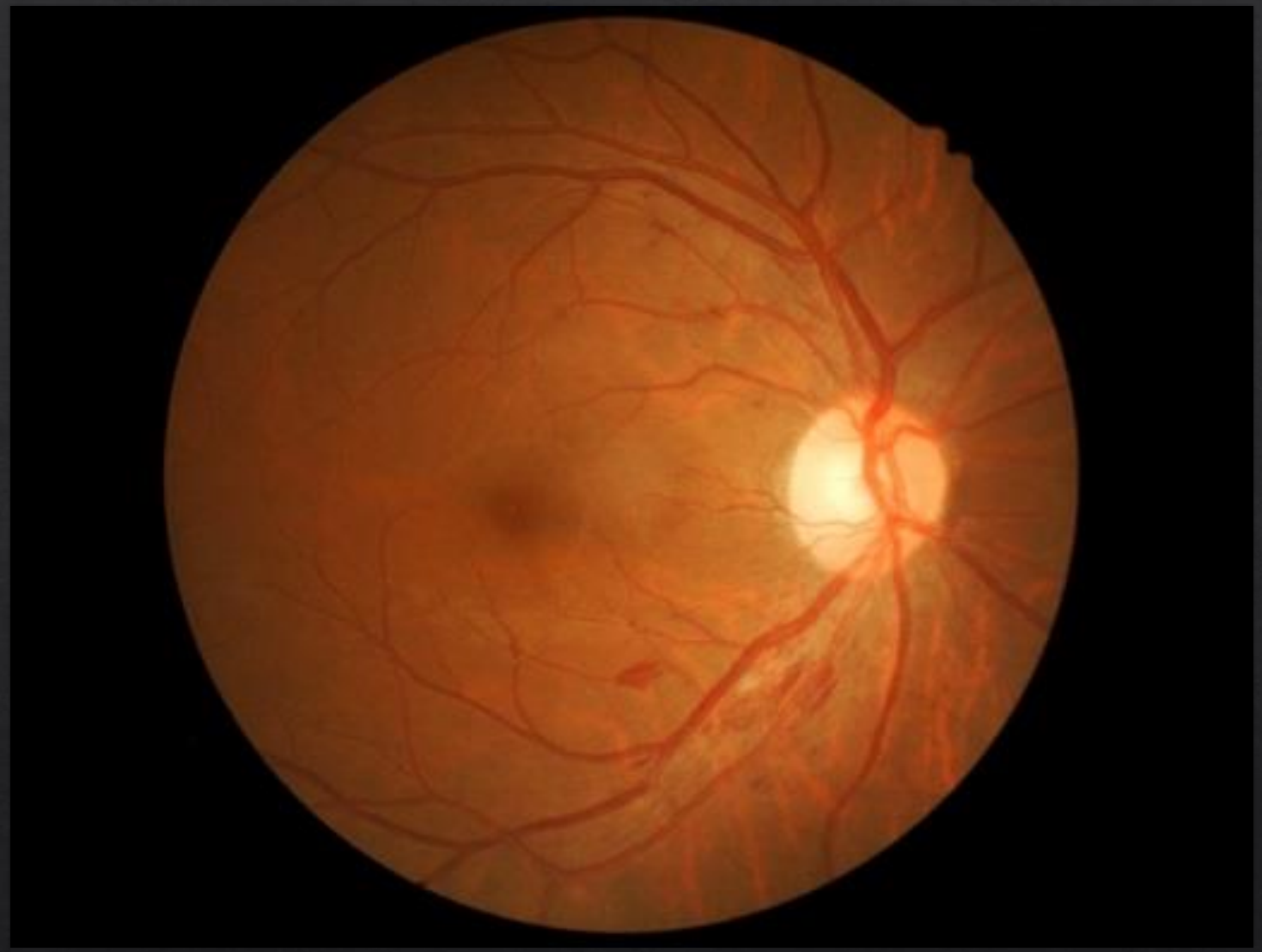
MENTAL HEALTH

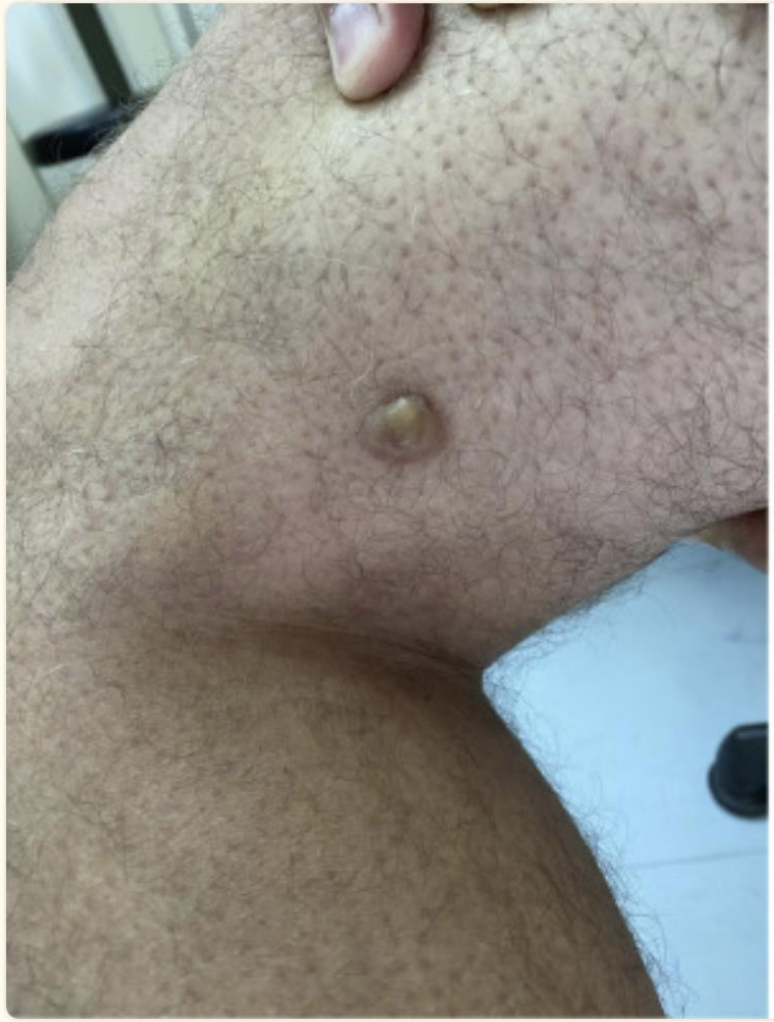
MEDICAL IMAGING

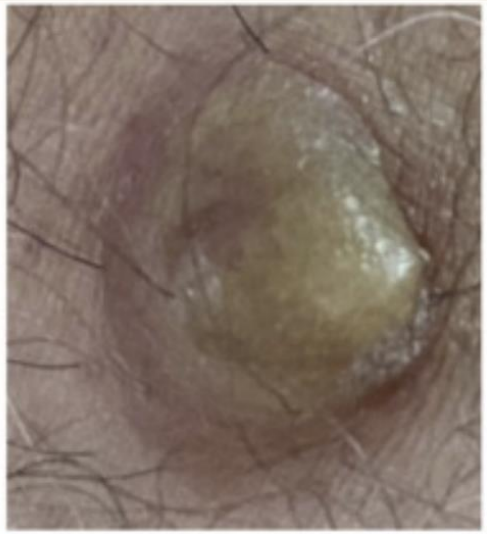


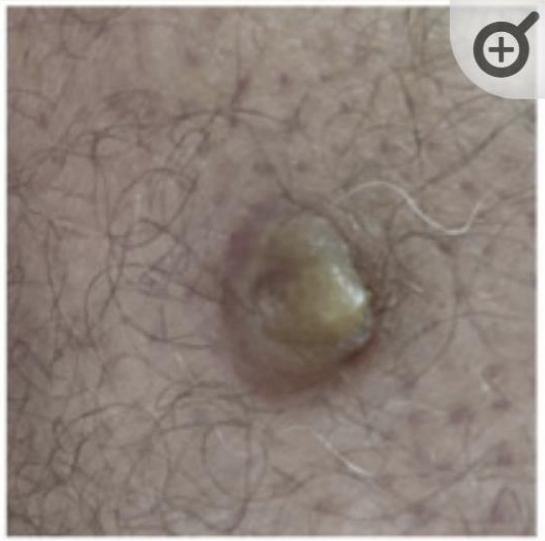

A


A small cancer
is easy to see
Even a large cancer
is hard to see









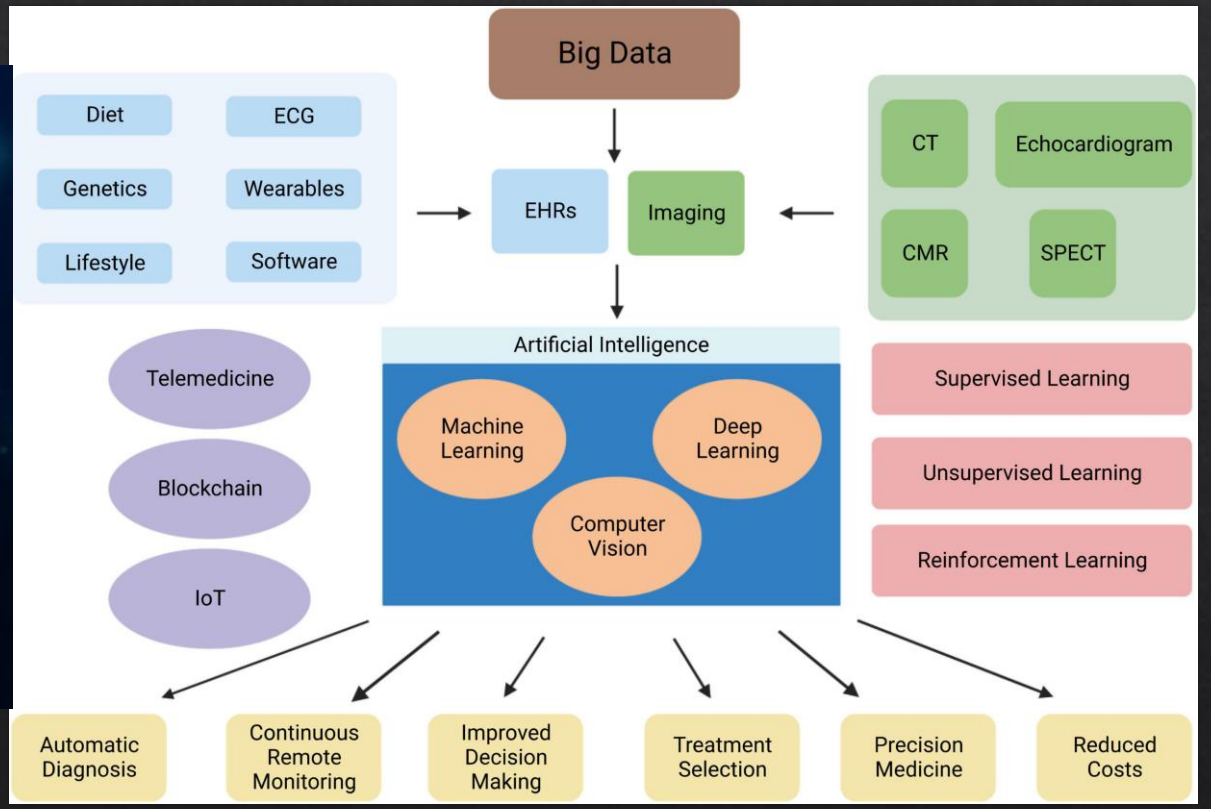
Epidermal cyst (0.25)
Actinic keratosis (0.16)
Steatocystoma multiplex (0.11)

- AI Metrics
Malignancy : 15
Steroids : 0
Antibiotics : 23
Antivirals : 0
Antifungals : 3

Furuncle (0.66)
Folliculitis (0.12)
Epidermal cyst (0.07)

- AI Metrics
Malignancy : 13
Steroids : 0
Antibiotics : 86
Antivirals : 0
Antifungals : 0

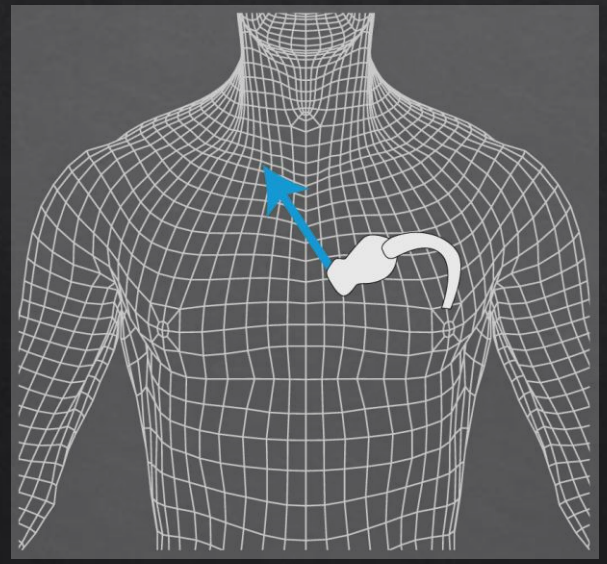

01
02


Big Data
Diet
ECG
Genetics
Wearables
Lifestyle
Software
EHRs
Imaging
CT
Echocardiogram
CMR
SPECT
Telemedicine
Blockchain
IoT
Artificial Intelligence
Machine Learning
Deep Learning
Computer Vision
Supervised Learning
Unsupervised Learning
Reinforcement Learning
Automatic Diagnosis
Continuous Remote Monitoring
Improved Decision Making
Treatment Selection
Precision Medicine
Reduced Costs

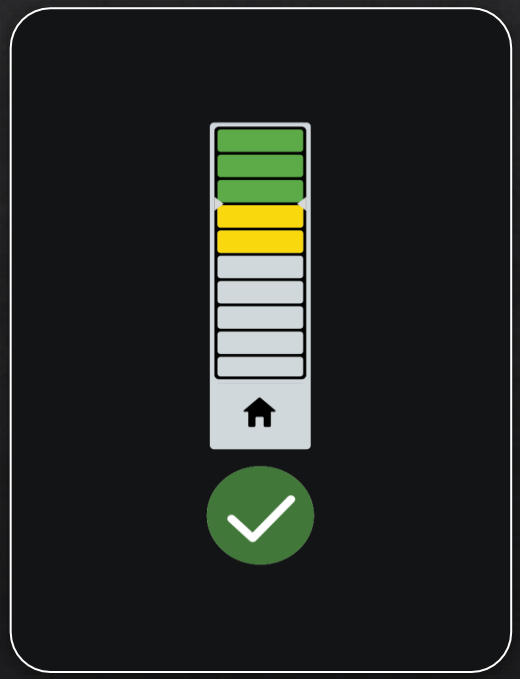
POINT-OF-CARE ULTRASOUND

CARDIAC ULTRASOUND IMAGE ACQUISITION

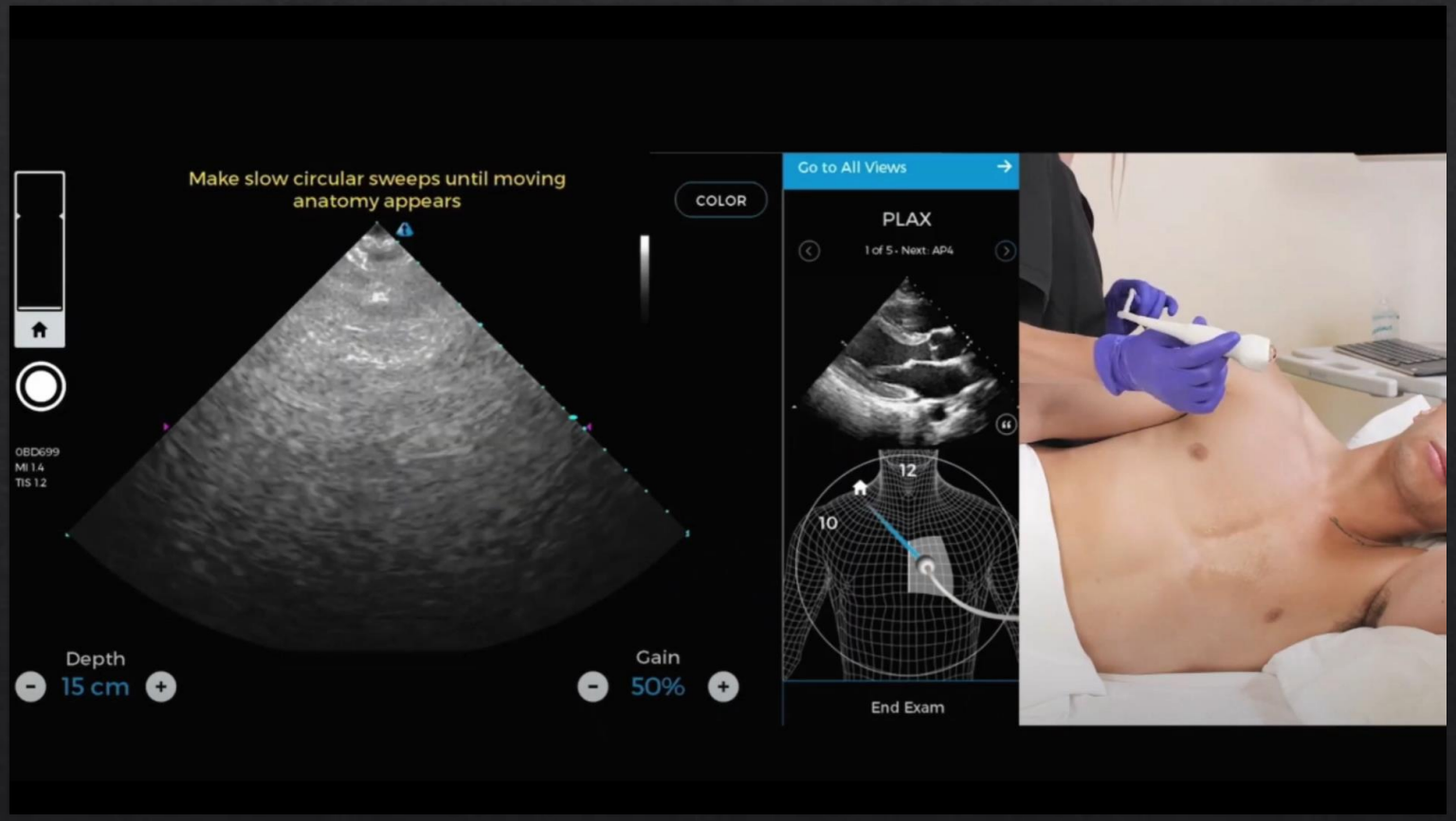
Expert Guidance

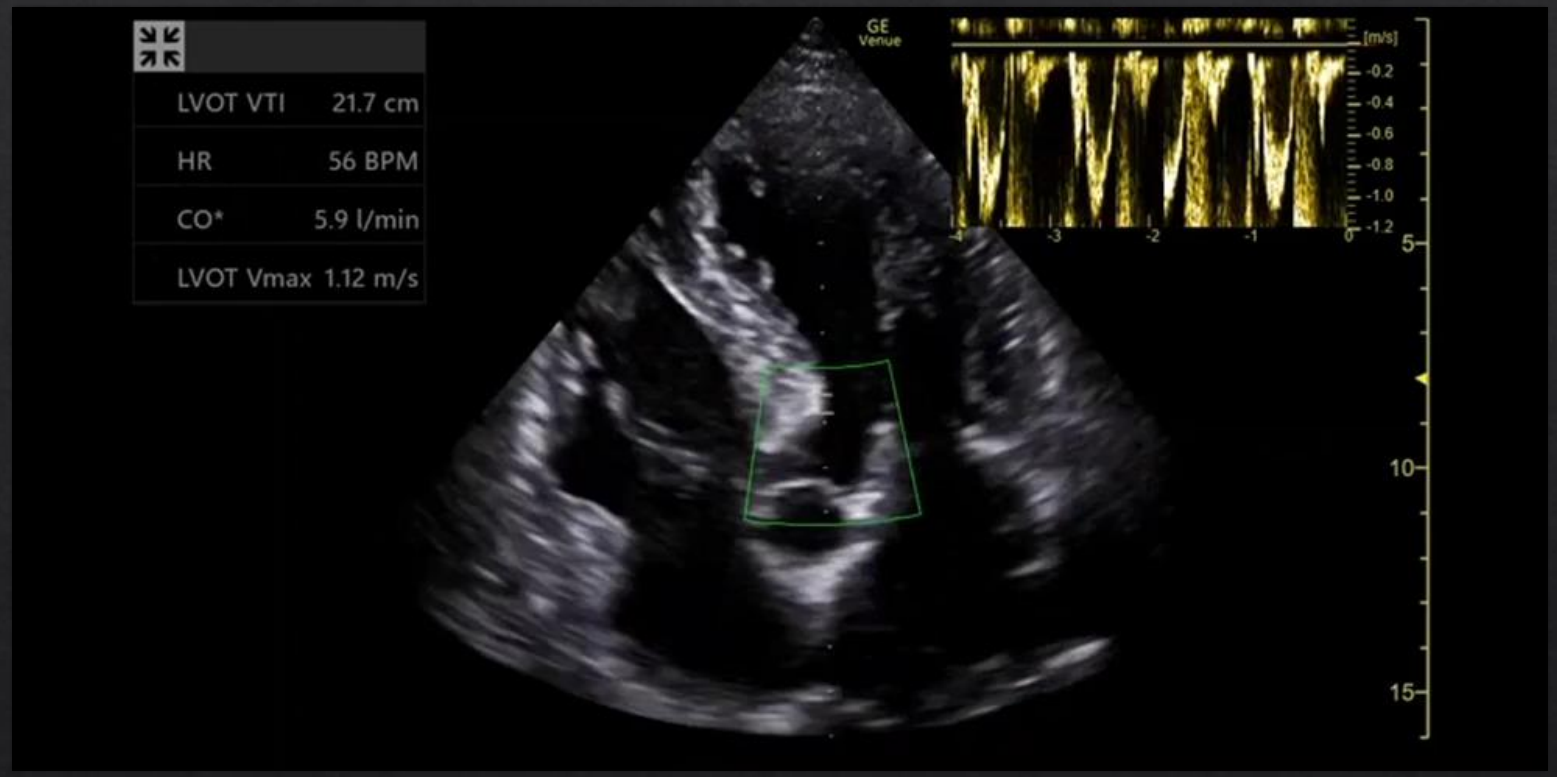


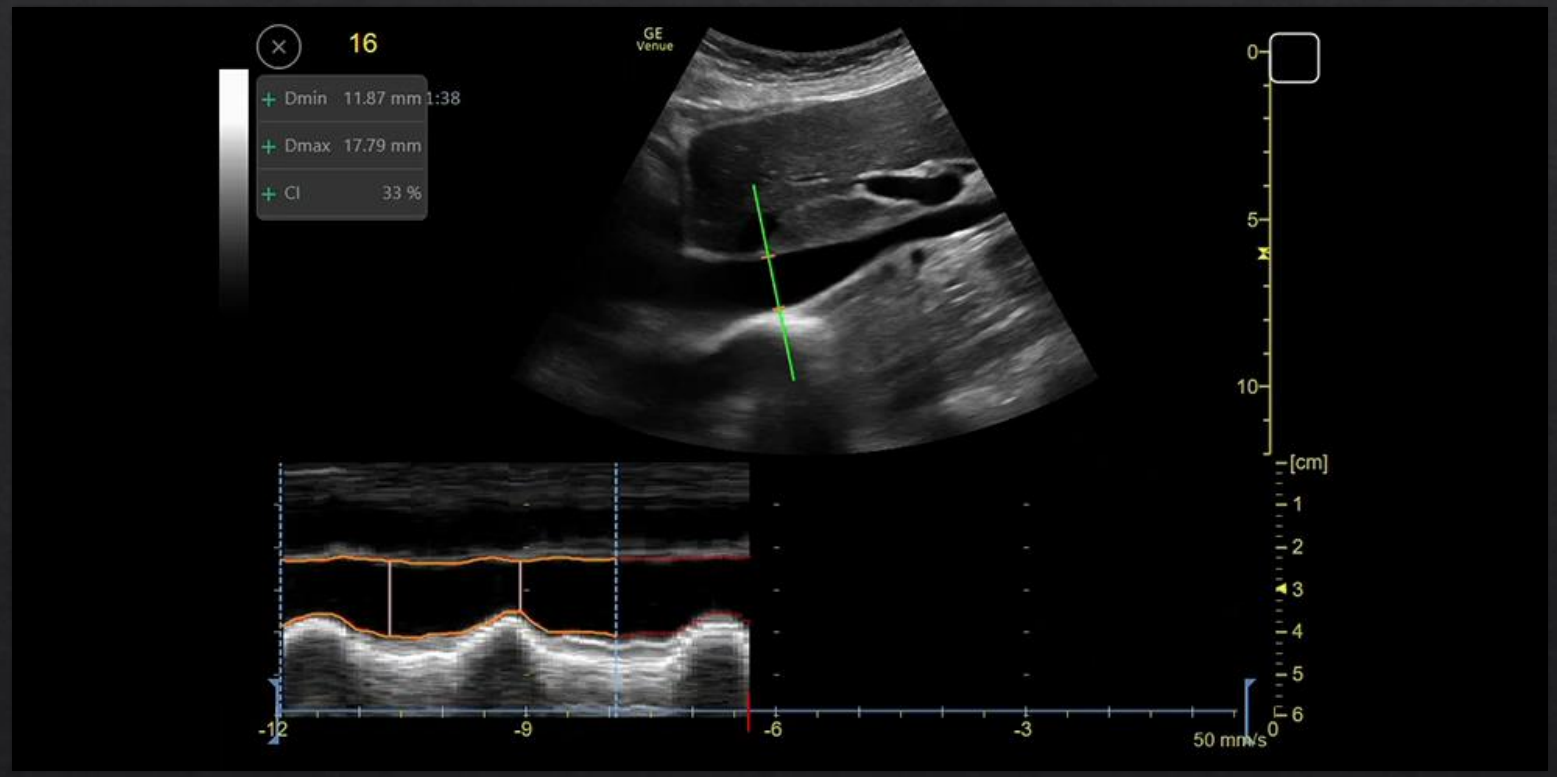
Automated Quality Assessment

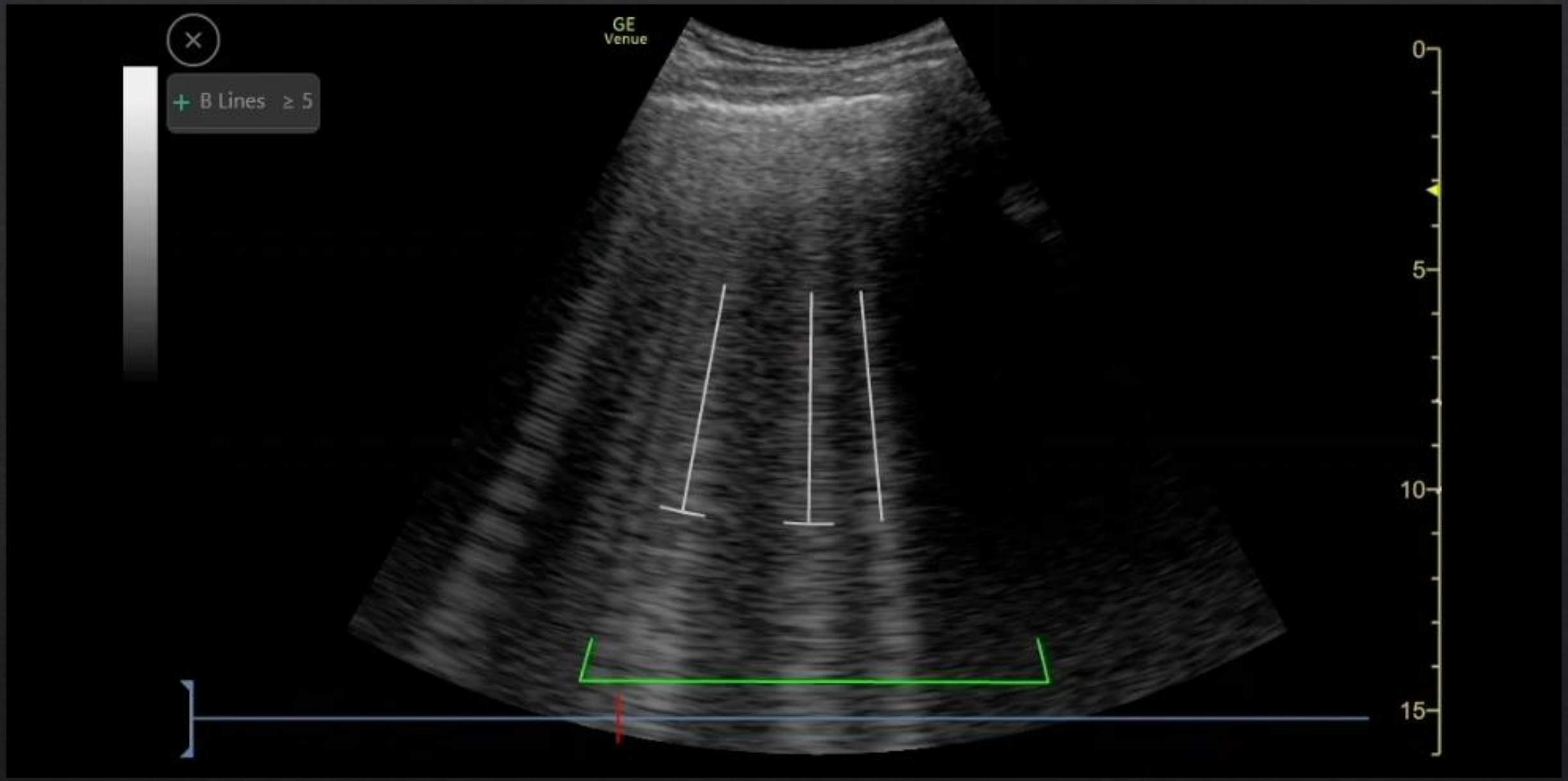


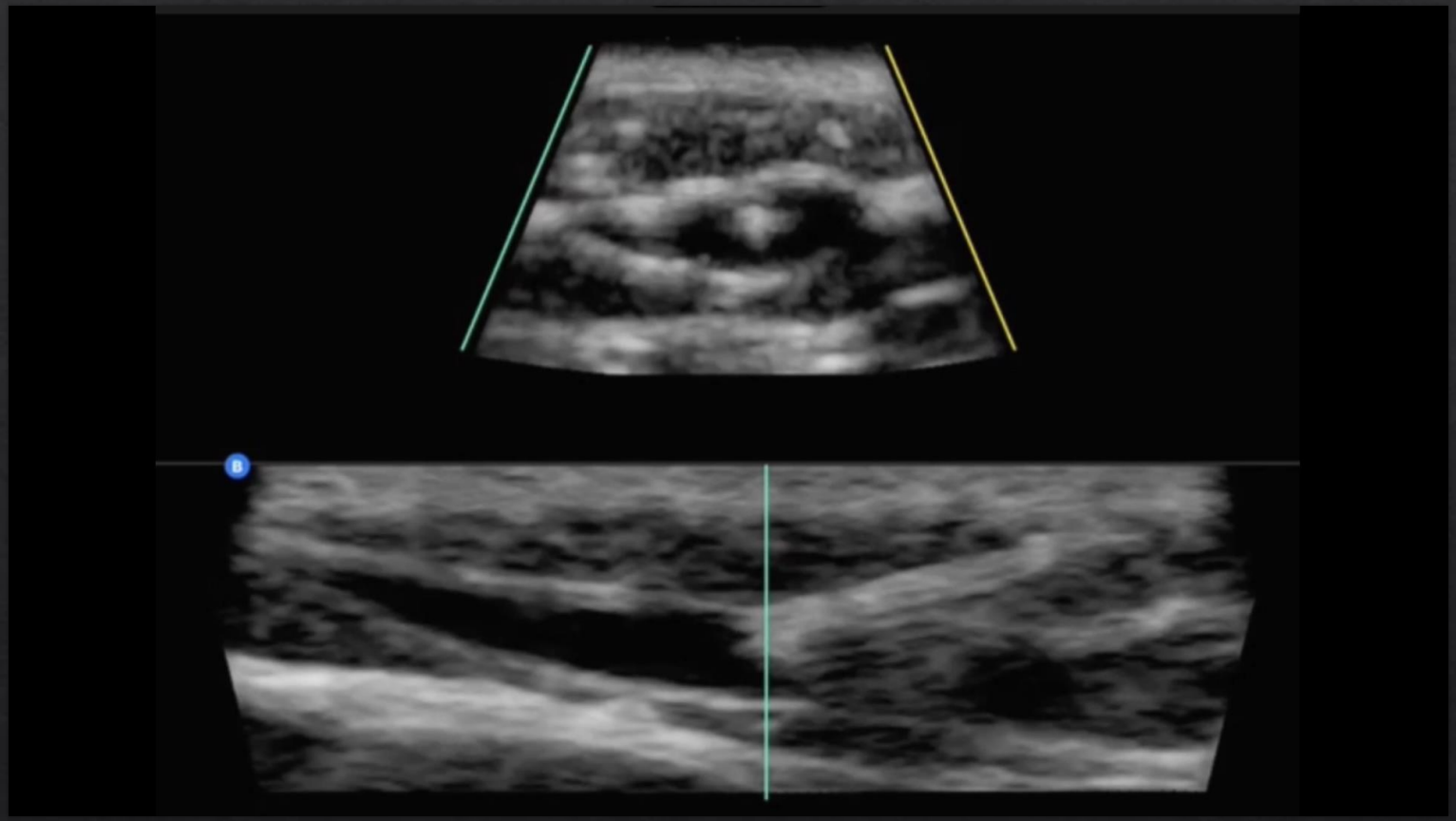
Intelligent Interpretation


Make slow circular sweeps until moving anatomy appears
COLOR
0BD699
MI 1.4
TIS 1.2
Depth
15 cm
Gain
50%
Go to All Views
PLAX
1 of 5 - Next: AP4
12
10
End Exam

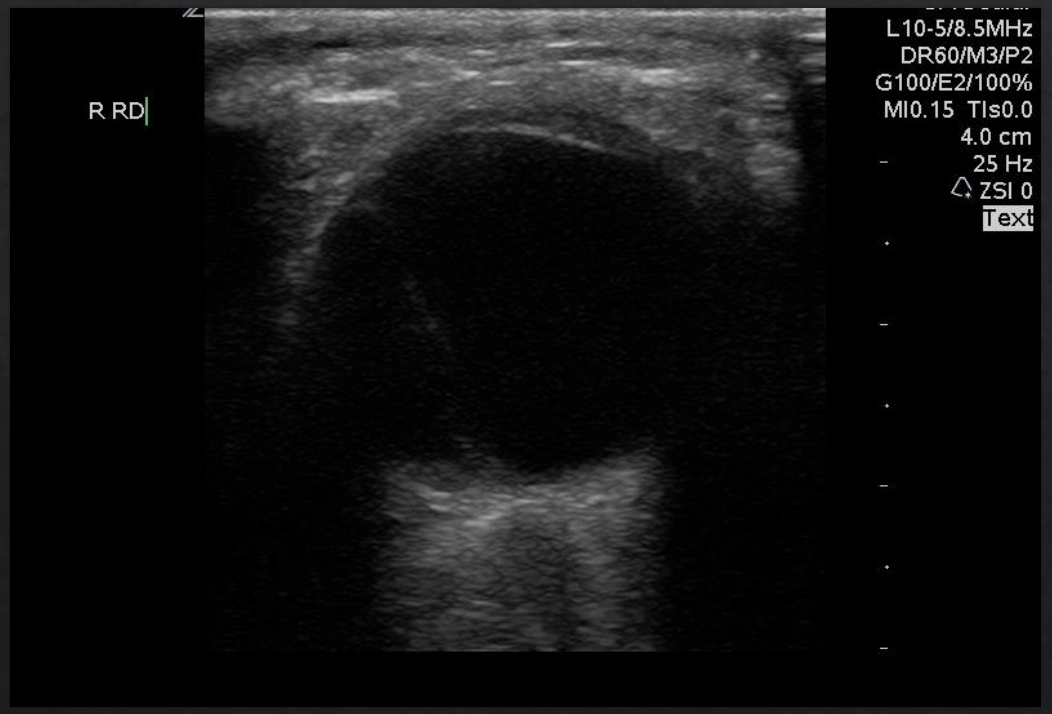

LVOT VTI 21.7 cm
HR 56 BPM
CO* 5.9 l/min
LVOT Vmax 1.12 m/s
GE
Venue
[m/s]
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-4
-3
-2
-1
5
10
15

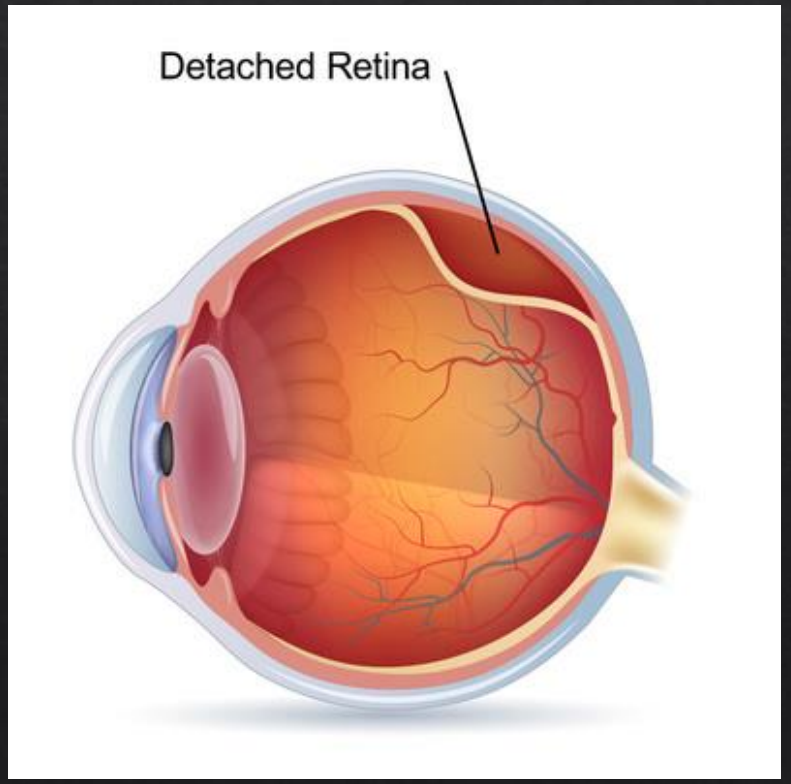

16
Dmin 11.87 mm 1:38
Dmax 17.79 mm
CI 33 %
GE
Venue
0
5
10
[cm]
1
2
3
4
5
6
-12
-9
-6
-3
0
50 mm/s


GE
Venue
B Lines ≥ 5
0
5
10
15

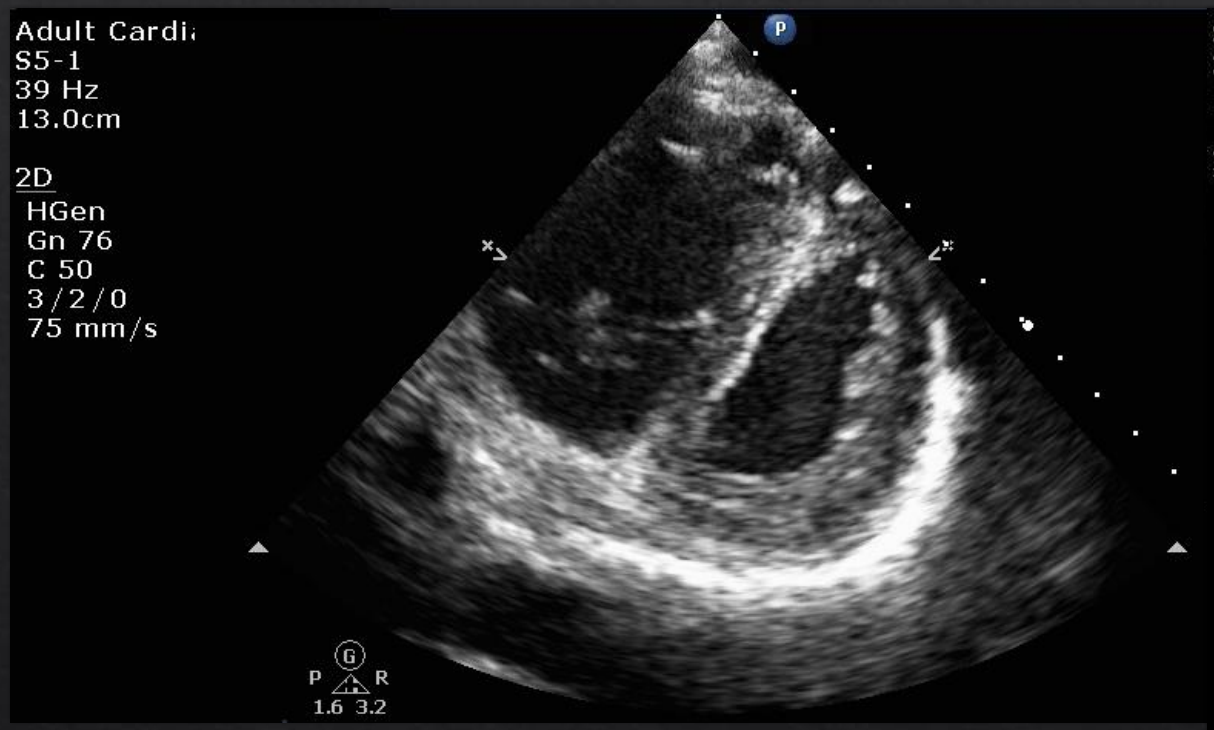

B

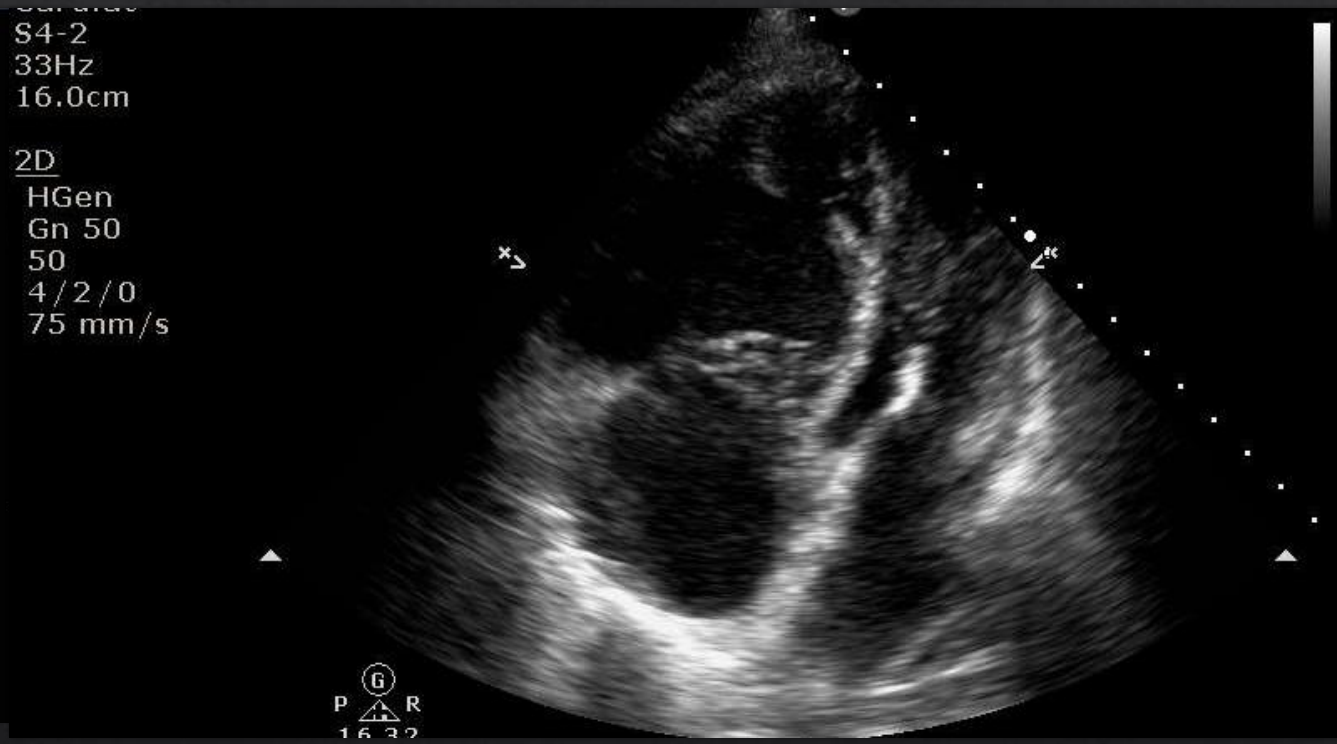
AI-RETINAL DETACHMENT

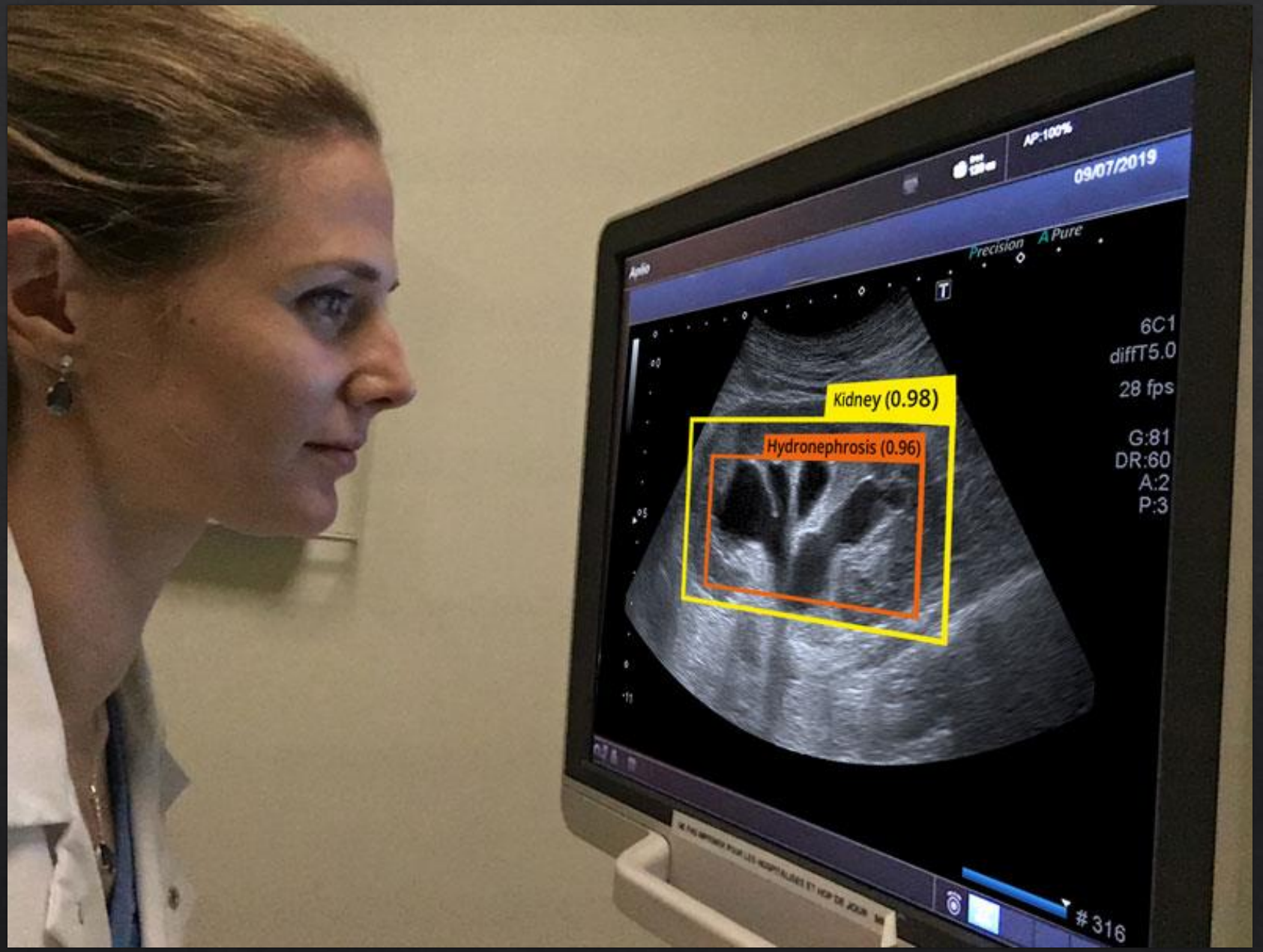




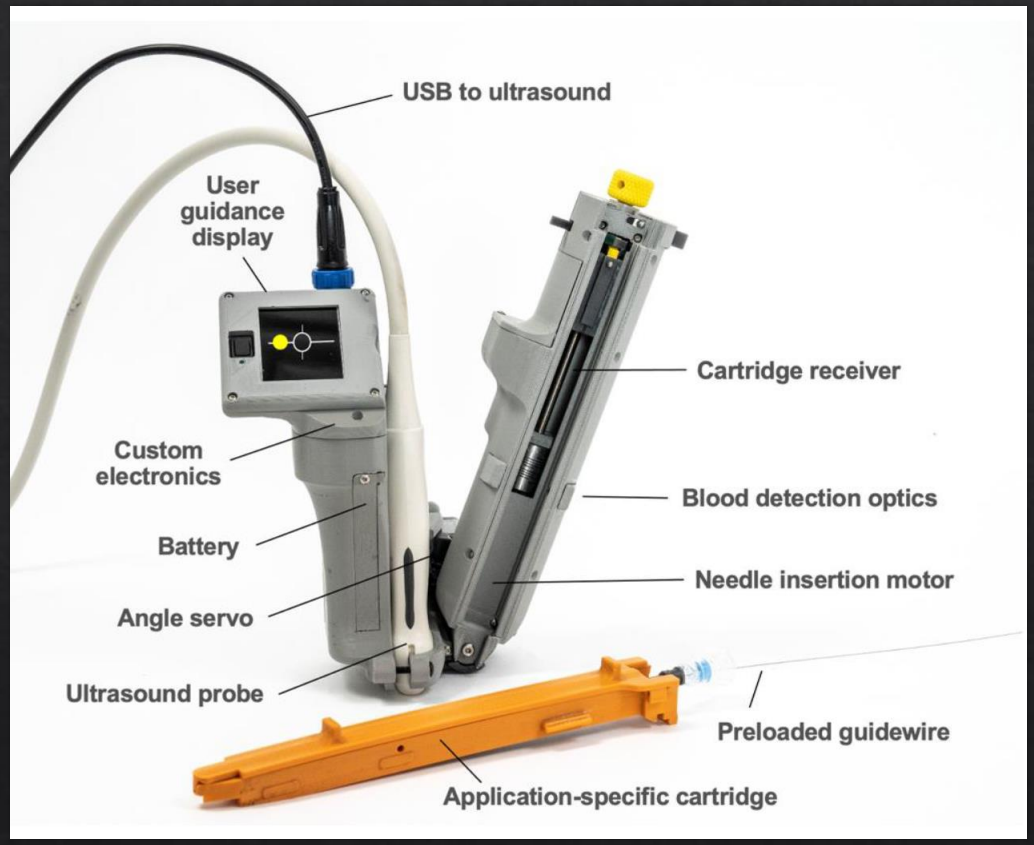
PULMONARY EMBOLISM






AP:100%
09/07/2019
Precision
A Pure
6C1
diffT5.0
28 fps
G:81
DR:60
A:2
P:3
Kidney (0.98)
Hydronephrosis (0.96)
316

AI-GUIDED ROBOTIC DEVICES




EHR

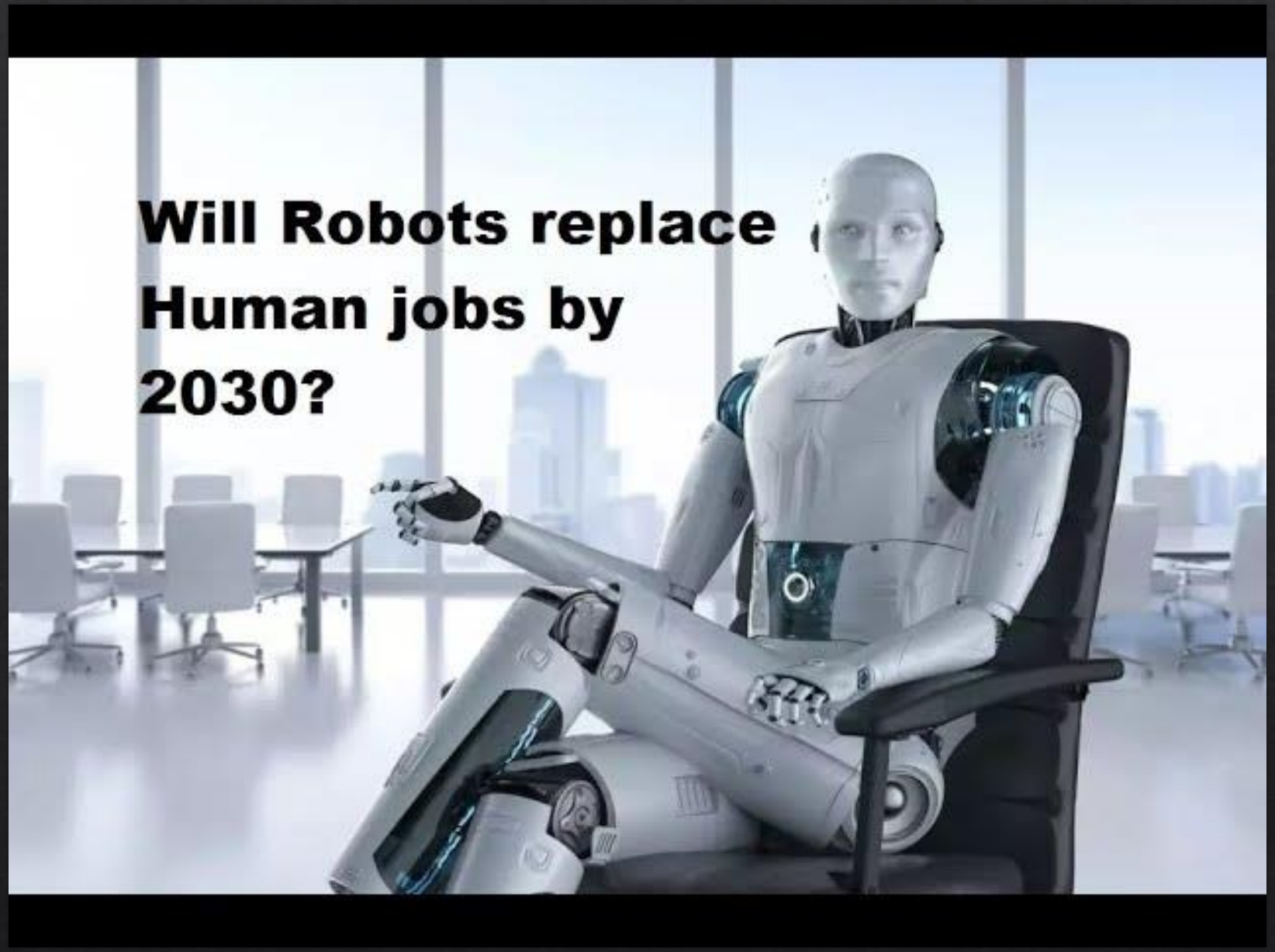

EHR


Activity
256
CAL

EMERGENCY DEPARTMENT

AI-EMERGENCY MEDICINE

AI-CHALLENGES


Will Robots replace
Human jobs by
2030?

AUTOMATION OF JOBS

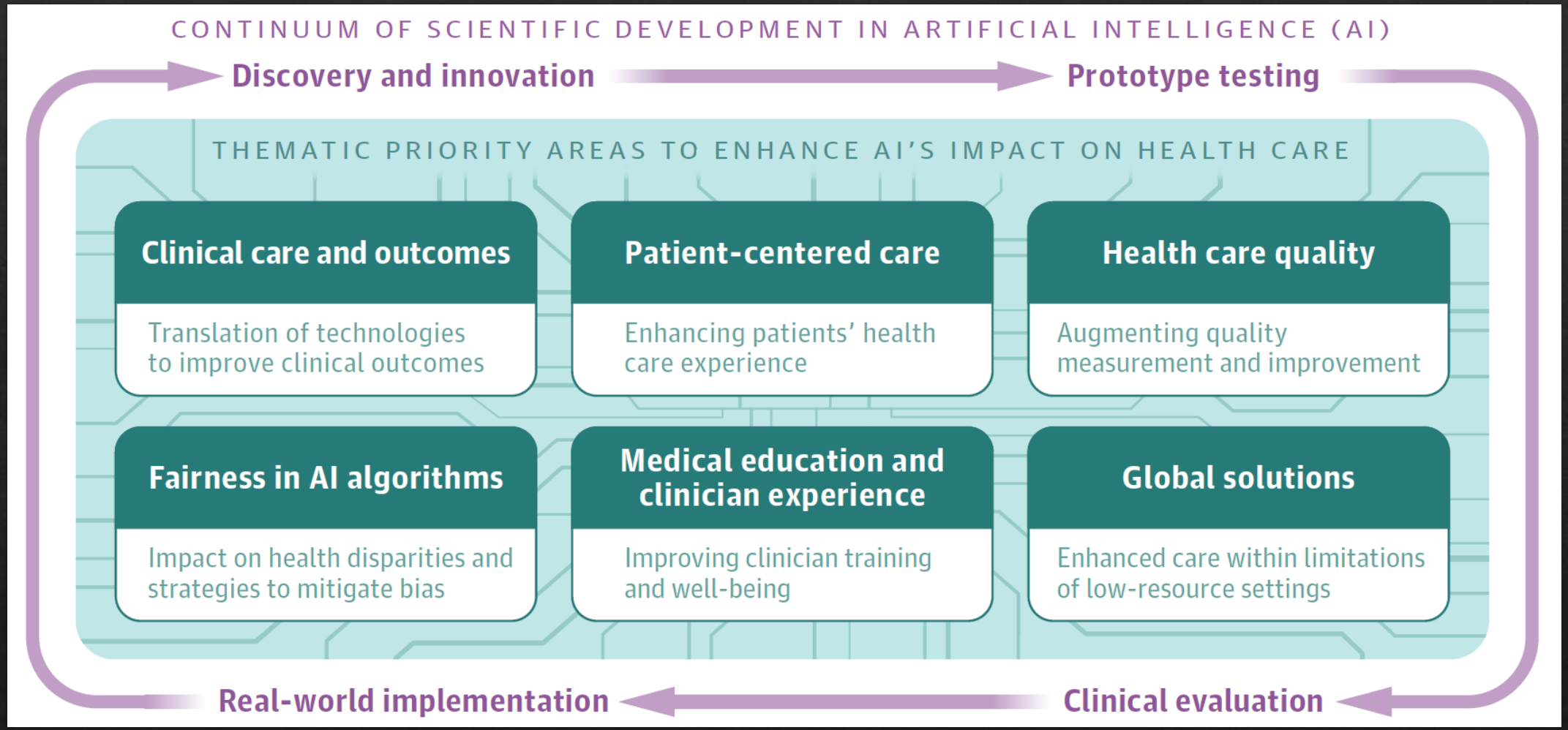
AI-CHALLENGES

- Bias
- Privacy
- Security
- Surveillance

BIAS

- Data bias
- Algorithmic bias
- AI–clinician interactions
- AI–patient interactions

INTEGRATION & IMPLEMENTATION


CONTINUUM OF SCIENTIFIC DEVELOPMENT IN ARTIFICIAL INTELLIGENCE (AI)
Discovery and innovation
Prototype testing
THEMATIC PRIORITY AREAS TO ENHANCE AI'S IMPACT ON HEALTH CARE
Clinical care and outcomes
Translation of technologies to improve clinical outcomes
Patient-centered care
Enhancing patients' health care experience
Health care quality
Augmenting quality measurement and improvement
Fairness in AI algorithms
Impact on health disparities and strategies to mitigate bias
Medical education and clinician experience
Improving clinician training and well-being
Global solutions
Enhanced care within limitations of low-resource settings
Real-world implementation
Clinical evaluation

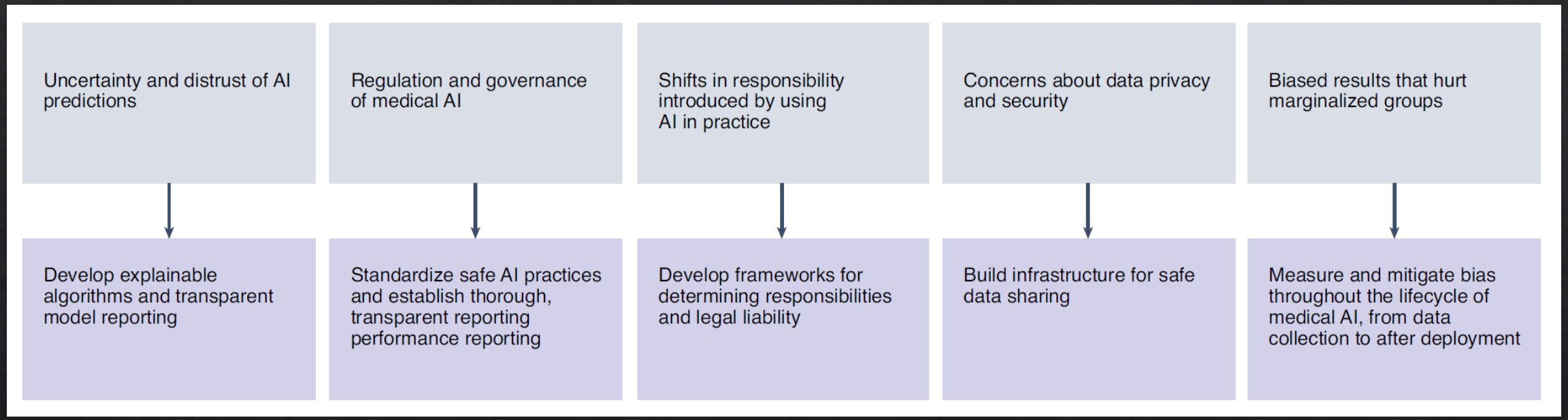
ETHICS

- Protecting autonomy
- Promoting human well-being, safety, and public interest
- Ensuring transparency, explainability, and intelligibility
- Fostering responsiveness and accountability
- Ensuring inclusiveness, and equity
- Promoting AI that is responsible and sustainable

CONSUMERS' PERSPECTIVES

Table 1 Operationalization of variables

Construct	Construct definition
Perceived performance anxiety	The degree to which an individual believes that AI-based tools and their features exhibit pervasive technological uncertainties.
Perceived communication barriers	The degree to which an individual feels that AI devices may reduce human aspects of relations in the treatment process.
Perceived social biases	The degree to which a person believes that data used in the AI devices may lead to societal discrimination to a certain patient group (e.g., minority groups).
Perceived privacy concerns	The extent to which individuals concern about how AI-based devices collect, access, use, and protect their personal information
Perceived mistrust in AI mechanisms	The degree to which an individual believes that AI models and AI-driven diagnostics and recommendations in health care are still not trustworthy.
Perceived unregulated standard	The extent to which an individual believes that regulatory standards and guidelines to assess AI algorithmic safety are yet to be formalized.
Perceived liability issues	The extent to which an individual is concerned about the liability and responsibility of using AI clinical tools.
Perceived risks	The extent to which an individual believes that, in general, it would be risky for patients to use AI-based tools in health care.
Perceived benefits	The extent to which an individual believes that AI-based tools can improve diagnostics and care planning for patients.
Intention to use AI-based tools	The extent to which an individual is willing to use AI-based services for diagnostics and treatments.


Uncertainty and distrust of AI predictions
Develop explainable algorithms and transparent model reporting
Regulation and governance of medical AI
Standardize safe AI practices and establish thorough, transparent reporting performance reporting
Shifts in responsibility introduced by using AI in practice
Develop frameworks for determining responsibilities and legal liability
Concerns about data privacy and security
Build infrastructure for safe data sharing
Biased results that hurt marginalized groups
Measure and mitigate bias throughout the lifecycle of medical AI, from data collection to after deployment

AI IN HEALTH CARE

End-users vs. Educated

Protect patients and other stakeholders

Inaccuracies

Pitfalls and inappropriate application of ML

Unethical and unwanted use of ML

SUMMARY

- Clinical Practice
- Stakeholders
- Workflow
- Efficiency
- Equity
- Safety
- Economic impact