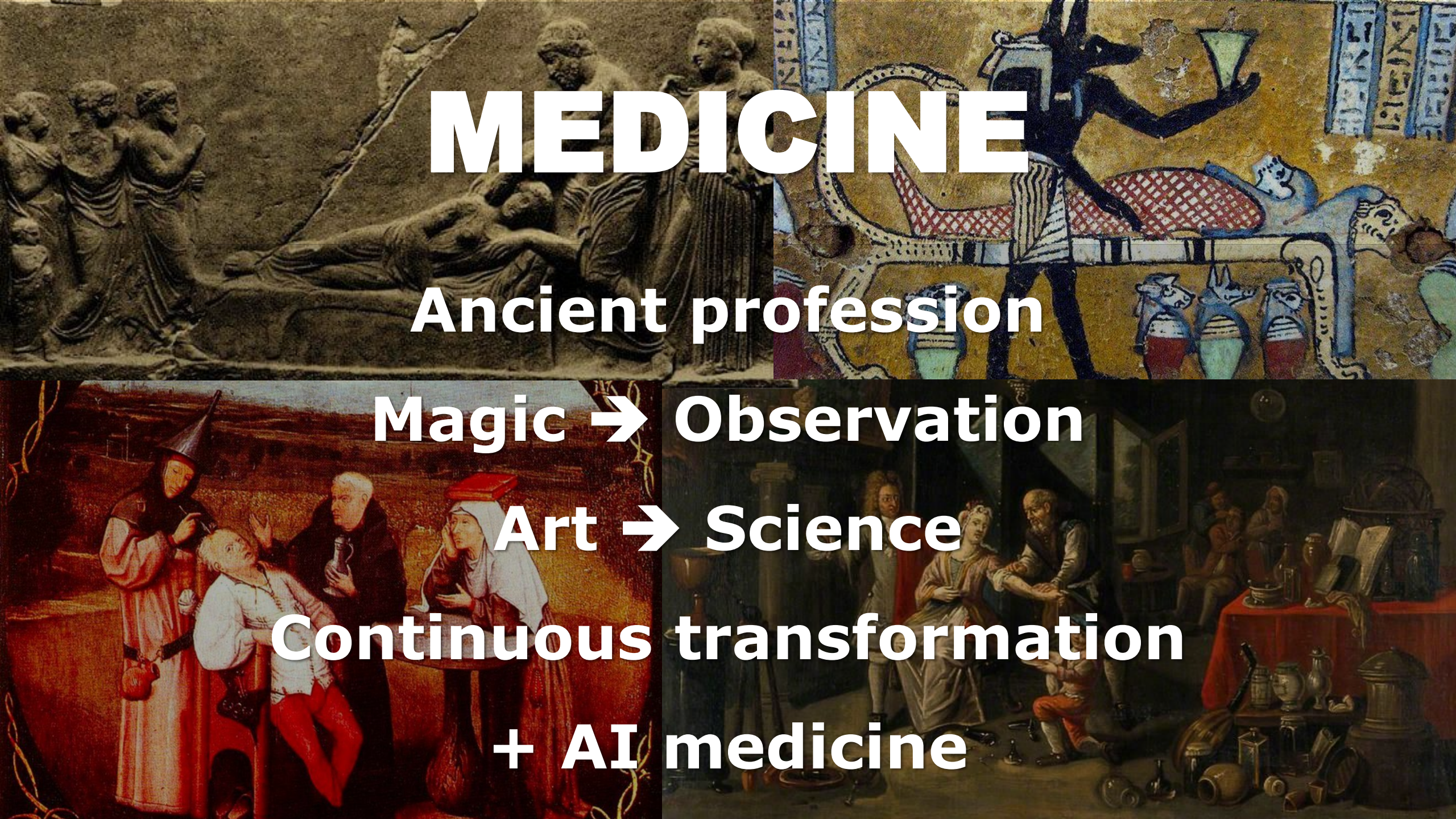
AI in CVD medicine and hypertension
Opportunities and challenges

George Stergiou, MD, PhD, FRCP
Professor of Medicine & Hypertension
President International Society of Hypertension

International Society of Hypertension



MEDICINE

Ancient profession

Magic → Observation

Art → Science

Continuous transformation

+ AI medicine

HEALTHCARE PROFESSIONALS

Great responsibility

Great expectations

Meds+Tech+Trials (how do they work?)

Observe the “individual’s” response

Must apply up-to-date knowledge

Nothing should go wrong!

Today much more demanding!

- **Too high expectations**
- **Reliable - Updated - Efficient**
- Patients' **SAFETY** + Health **IMPROVEMENT**
- **Responsibility**/sensitivity (data protection)

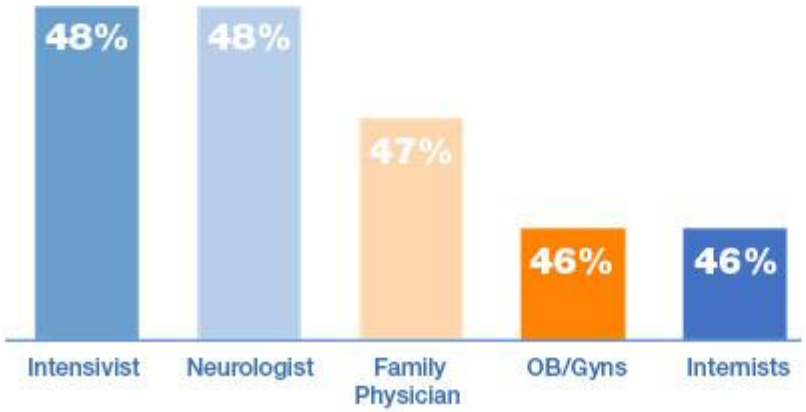
- **More patients** (*larger, older population*)
- **Lifestyle/obesity-**driven diseases
- Much more apparently **healthy** people
- **Complex Rx** *(more drugs, -tech, -info, EHRs)*
- No HC system has **enough doctors**
- **DOCTOR BURNOUT!**

Physician Burnout and Depr

42% of physicians report burnout

15% of physicians report depressio

38% of male physicians experience burnout



Source: Medscape National Physician Burnout & Depression Report 2018, www.medscape.com

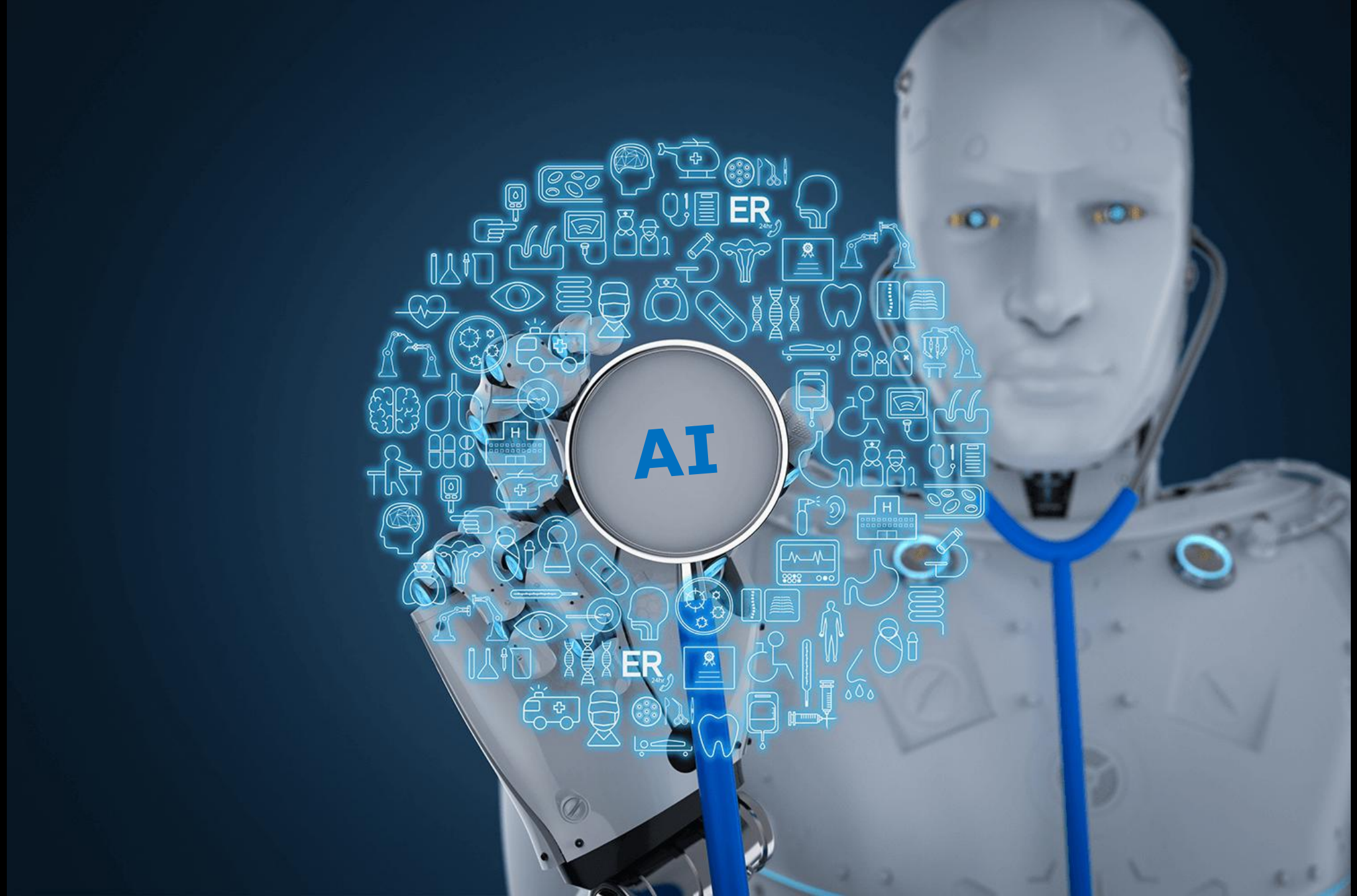
What Are the Most Common Causes of Physician Burnout?

While physician burnout often affects front-line specialties, its primary causes are present to some degree in nearly all medical practices.

- Loss of autonomy or too much micromanaging
- Excessive focus on data over patient care
- Too many government, insurance, and hospital rules
- More punishments than rewards
- Sense of powerlessness
- Complicated electronic health records

Little time to talk to patients!

Source: *Texas Heart Institute Journal*


ER
AI
ER

Clinical Review & Education

JAMA | Special Communication | AI IN MEDICINE

Will Generative Artificial Intelligence Deliver on Its Promise in Health Care?

Robert M. Wachter, MD; Erik Brynjolfsson, PhD

JAMA 2024;331(1):65-69.

National Library of Medicine
National Center for Biotechnology Information

1 Mar. 2025

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PubMed®

artificial intelligence

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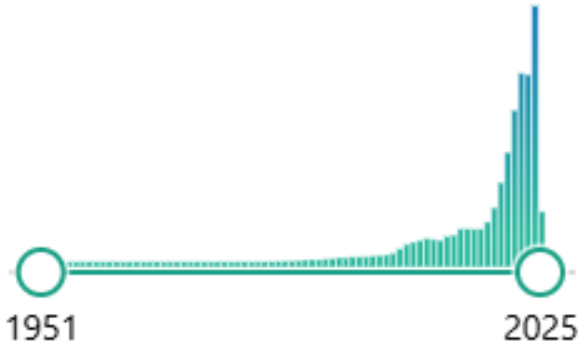
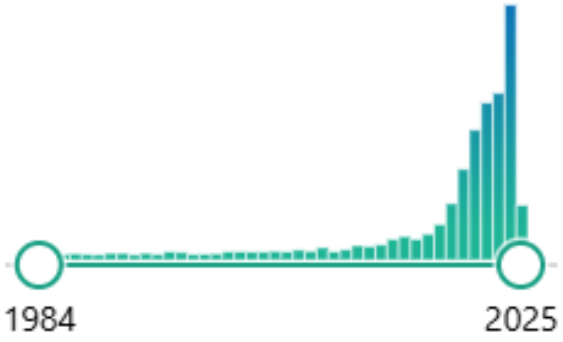


2025 Jan-Feb
11,633
190/d

2,395 results

artificial intelligence hypertension



2025 Jan-Feb
135
2/day

ABOUT

JAMA+ AI

The JAMA Network home for the latest advances in the application of artificial intelligence in medicine – from clinical practice to research and education.

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Learn more

AI at the Office!
Are Clinicians Prepared?

- **AI has arrived at medical offices!**
  Whether or not clinicians feel ready for it…
- Might result in **more accurate, efficient, and cost-effective** care.
- It's possible it **could cause harm**…

- **Black box** phenomenon
- **Biased data** (sex, race, historical, other)
- **Transparency and Explainability** (trust)
- **Oversight – Audit** (FDA)

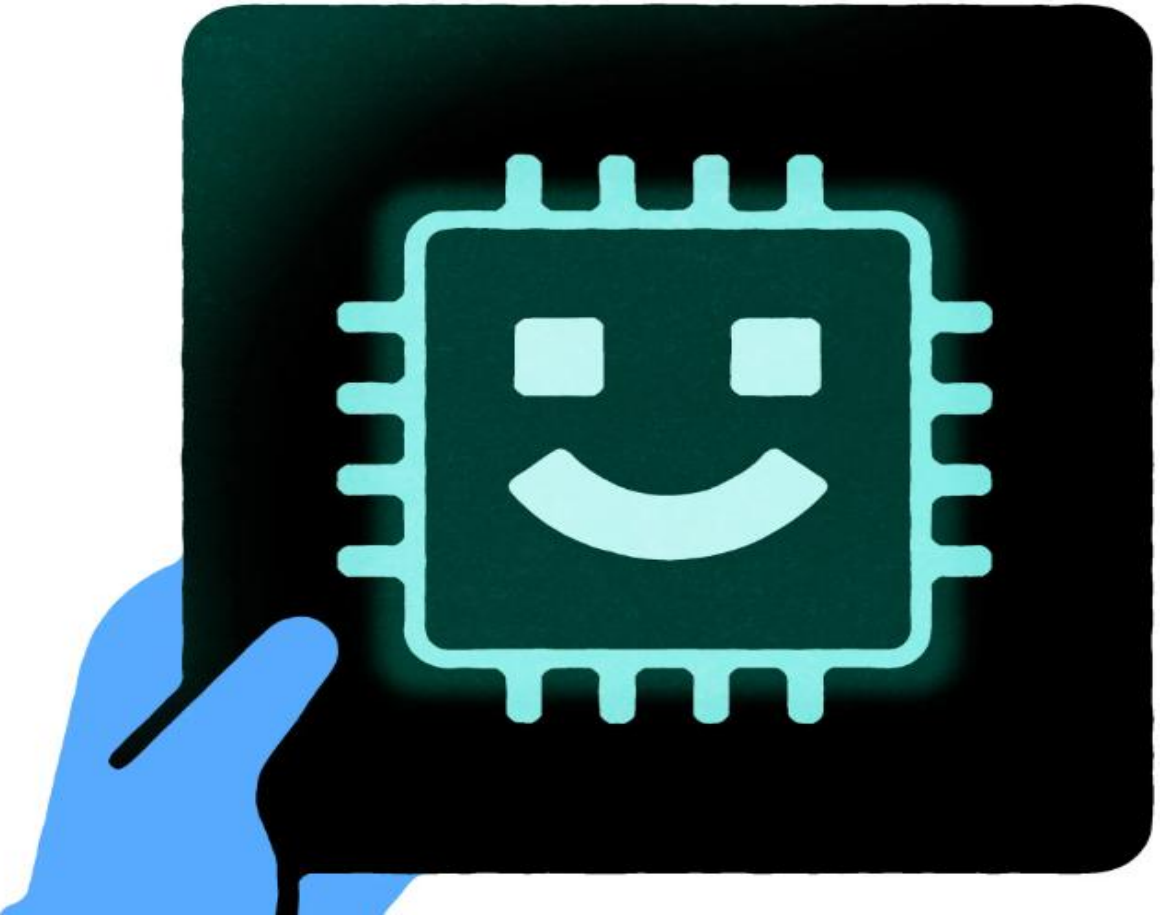
Ragan K. https://www.medscape.com/viewarticle/992057_print, 2023

The New York Times

OPINION
GUEST ESSAY

The Robot Doctor Will See You Now

Feb. 2, 2025



What kind of role

AI can and should play in HC?

Combining abilities - Doctors + AI

→ more accurate diagnoses

→ more efficient care

Assumption!

Might prove incorrect

Growing body of research suggests that

AI is OUTPERFORMING doctors!

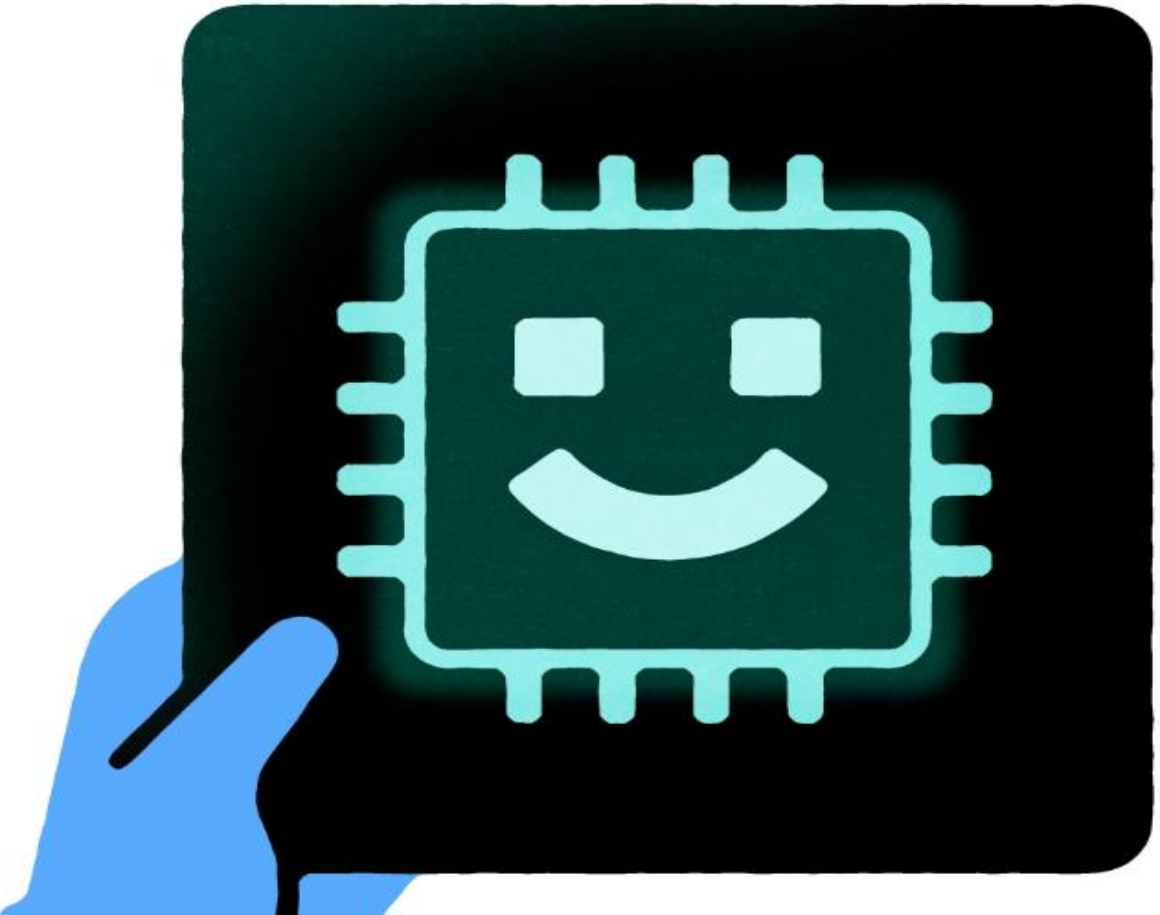
E Topol, P Rajpurkar. Feb. 4th, 2025

The New York Times

OPINION
GUEST ESSAY

The Robot Doctor Will See You Now

Feb. 2, 2025



The Future of Medicine!

Optimal partnership model

Understand
Strengths & Limitations

- *Which tasks for AI?*
- *Which for humans?*
- *Which benefit from collaboration?*

Orchestrate collaboration

in ways that *truly* benefit
patient care

E Topol, P Rajpurkar. Feb. 4th, 2025

AI in Medicine: Translating AI for the Clinician

A Incorporation of artificial intelligence (AI) into clinical practice

CLINICAL INDICATIONS	EXAMPLES OF AI
Interaction with patient	Ambient voice dictation, scheduling, electronic health record inbox tools
Risk stratification (precision medicine)	Patient risk assessment tools
Diagnosis	Analysis of clinical data or imaging (eg, echocardiography)
Interpretation of laboratory results	Analysis and description of test results
Eliciting patient preferences or behavioral changes	Conversational chatbot
Procedures	Surgical assistance
Prescribing medication	Drug interaction assessment
Patient or population monitoring	Glucose monitoring, population-at-risk monitoring
Research and learning	Research participant identification and engagement
Continuing education and training	Virtual reality case simulation

B Development of clinical AI analogous to pharmacotherapies

	DRUG DEVELOPMENT	AI DEVELOPMENT
Phase 1	Pharmacokinetics and pharmacodynamics studies	Model development: Testing on large retrospective dataset
Phase 2	Collection of safety data and efficacy signals	Silent mode evaluation: Prospective performance evaluation in the clinical environment without notification to clinical teams
Phase 3	Clinical trial with outcomes assessment	Clinical deployment: AI prospectively implemented with measurement of downstream care and outcomes (consider randomized clinical trial [RCT] design for high-risk clinical indication)
Phase 4	Real-world use (postmarket registry of use in practice)	Monitoring and assurance network: Deployment in multiple environments with local monitoring of performance and outcomes

Patel MR, et al. JAMA Oct. 2024


✓ Drugs
✓ Devices
✓ Software
Software
as a Medical Device

Translating AI for the Clinician

Patel MR, et al.
JAMA Oct. 2024

SIZE OF TREATMENT EFFECT

Class I	Class IIa	Class IIb	Class III
Benefit >>> risk	Benefit >> risk	Benefit ≥ risk	No benefit or harm
Should be performed	*Reasonable to perform*	*May be considered*	*Should not be performed*

LEVEL OF EVIDENCE

Level A	Level B	Level C
Multiple populations	Limited populations	Very limited data
Data derived from multiple RCTs or meta-analyses	*Data derived from a single RCT or nonrandomized studies*	*Expert consensus of opinion, case studies, or standard of care*

Refocus of AI technology development
Closer alignment with health goals that clinicians/patients understand

Otherwise, the use of AI technologies will
struggle to gain sufficient trust

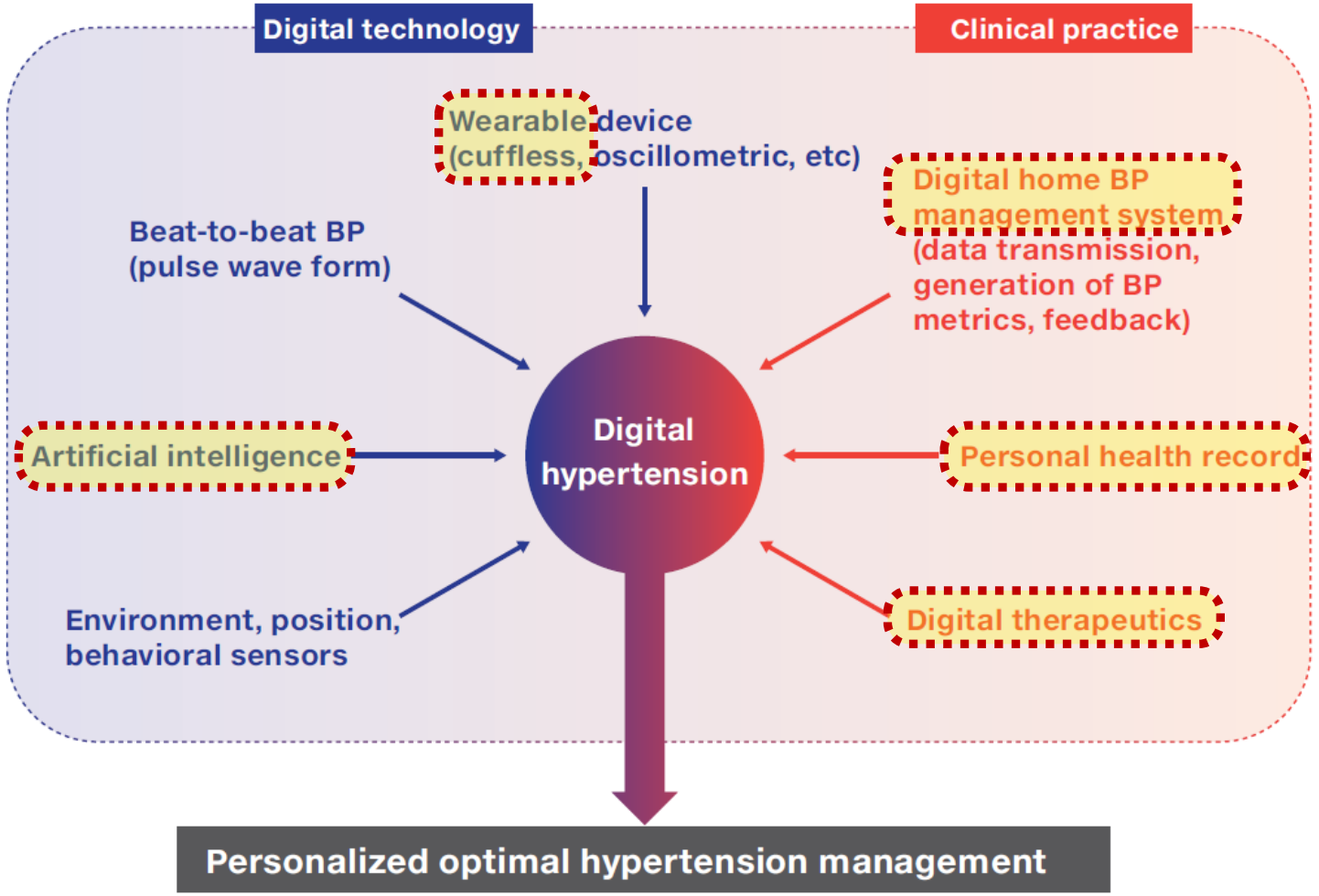
AI in Hypertension Management:
An Ace up Your Sleeve!

	Applications	Benefits
Measuring BP	Estimate BP by analyzing PPG signal with ML and DL algorithms.	Self-monitoring BP for hypertension
Predicting AH development	Predict the risk of developing AH by using genetics, medical data, and behavioral, environmental, and socioeconomic factors.	Timely intervention
Diagnosing AH	Accurately diagnosing AH by using CV risk factors, anthropometric data, vital signs, and laboratory data.	Precision diagnosis
Predicting AH treatment success	Identify factors contributing to treatment success.	Personalized treatment plan
Predicting AH prognosis	Stratify patients and predict CV outcomes.	Treatment plan adjustment

Visco V, et al. *J Cardiovasc Dev Dis.* 2023,10,74.

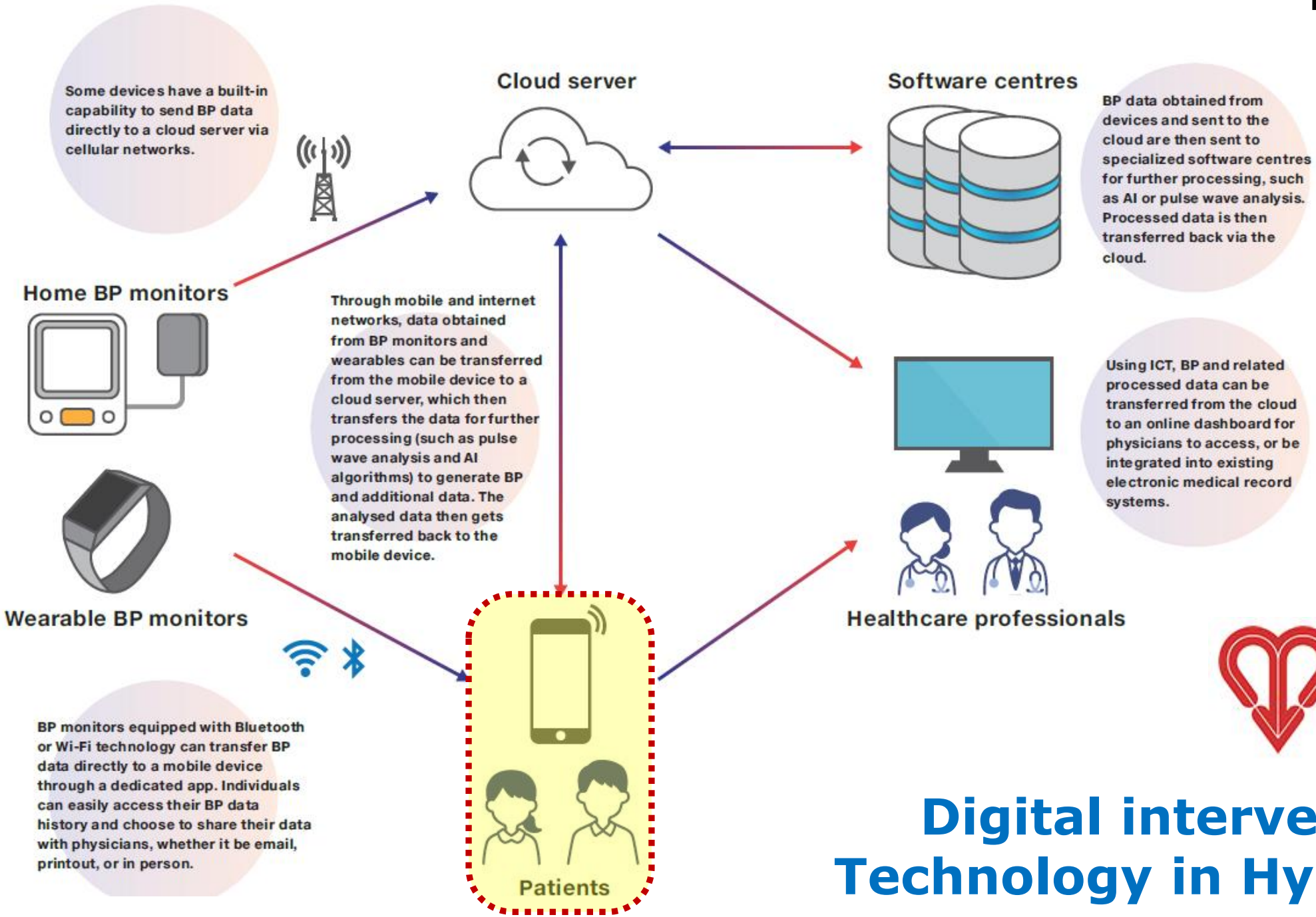
International Society of Hypertension

Innovations in BP measurement and reporting technology



Kario K, ... , Stergiou G. *J Hypertens*. 2024 Nov.;42:1874-88.

Kario K,...., Stergiou G
J Hypertens
2024 Nov



International Society of Hypertension

Digital interventions and Technology in Hypertension

NHLBI Workshop 29-30 Mar. 2023

National Heart, Lung, and Blood Institute

Objective ➔ Assess the potential of AI technologies in improving diagnosis/management of HTN

Ultimate Goal ➔ Identify important research questions, barriers, opportunities

Transforming Hypertension Diagnosis and Management in The Era of Artificial Intelligence: A 2023 National Heart, Lung, and Blood Institute (NHLBI) Workshop Report

Daichi Shimbo,* Rashmee U. Shah,* Marwah Abdalla, Ritu Agarwal, Faraz S. Ahmad, Gabriel Anaya, Zachi I. Attia, Sheana Bull, Alexander R. Chang, Yvonne Commodore-Mensah, Keith Ferdinand, Kensaku Kawamoto, Rohan Khera, Jane Leopold, James Luo, Sonya Makhni, Bobak J. Mortazavi, Young S. Oh, Lucia C. Savage, Erica S. Spatz, George Stergiou, Mintu P. Turakhia, Paul K. Whelton, Clyde W. Yancy, Erin Iturriaga

Hypertension. 2025 Jan;82:36-45.

Transforming Hypertension Diagnosis and Management in The Era of Artificial Intelligence: A 2023 National Heart, Lung, and Blood Institute (NHLBI) Workshop Report

- ✓ **Privacy and Security Principles**
- ✓ **High-Priority and Crosscutting Research Questions**
- ✓ **Research Barriers to AI Use**
- ✓ **High-Priority Opportunities**

National Heart, Lung, and Blood Institute

Hypertension. 2025 Jan;82:36-45.

JAMA Cardiology | Original Investigation

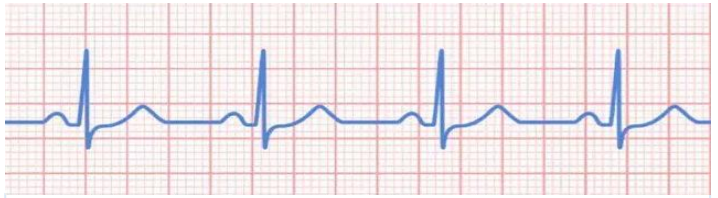
Sau A, et al. *JAMA Cardiol*. Jan, 2025.

Artificial Intelligence–Enhanced Electrocardiography for Prediction of Incident Hypertension

AI-ECG risk estimator

Predict incident hypertension

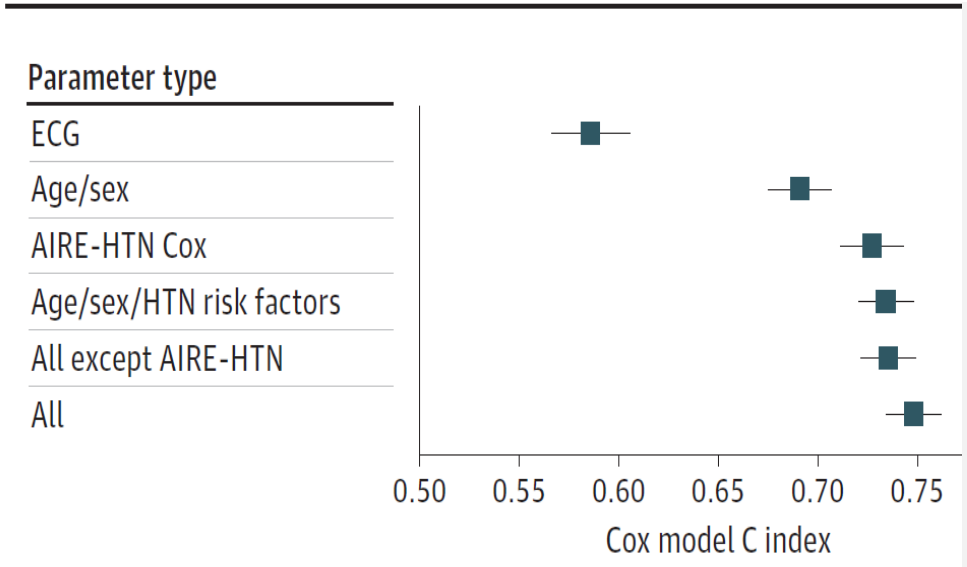
Stratify risk for outcomes



AI-ECG model trained on **>1 mil ECGs** (190,000 patients)

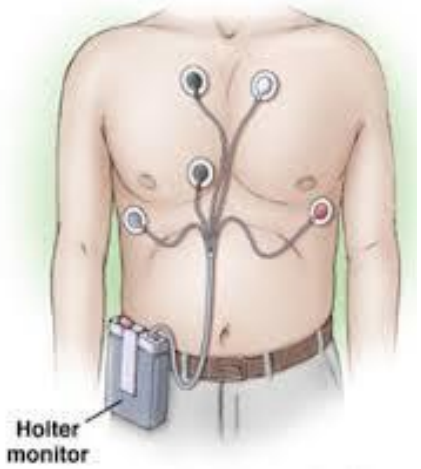
- ✓ **Predicted** incident hypertension
- ✓ **Identified** patients at risk of events

Figure 2. Cox Models for Prediction of Incident Hypertension

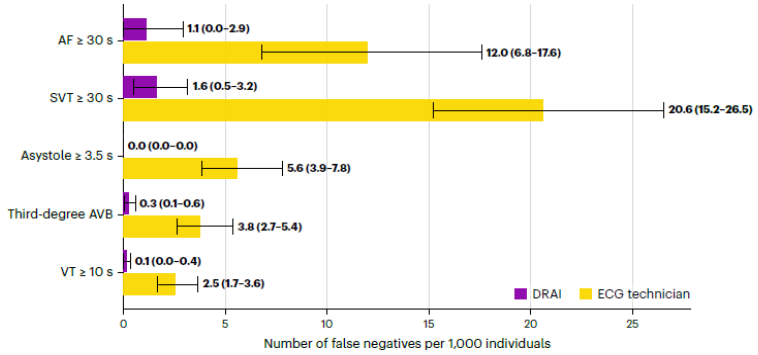


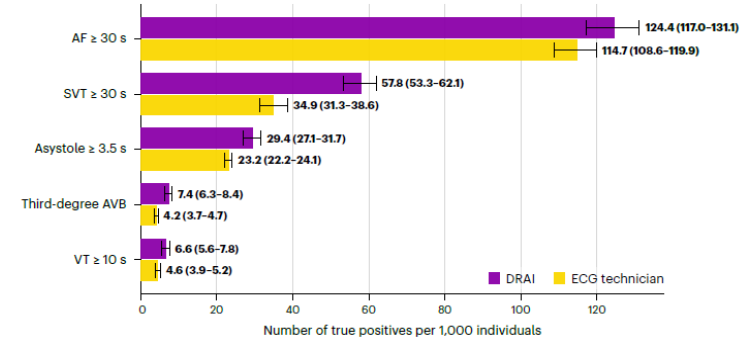
- ✓ **Beyond conventional** clinical risk factors
- ✓ Good performance **without LVH** and in “**normal” ECG**

AI for direct-to-physician reporting of 24h ECG



~100.000 beats



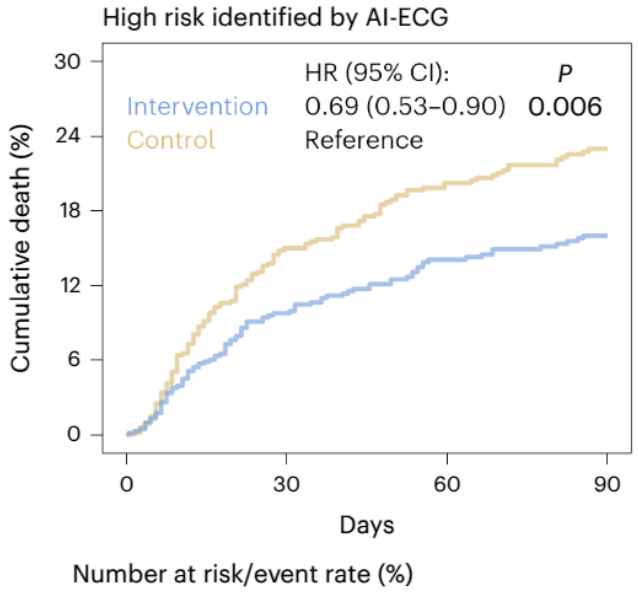


Much fewer false-negatives for critical arrhythmias
Few more false-positives - AI reporting to physician can reduce **costs** - improve **access/outcomes**

Johnson LS, et al. *Nat Med* 2025, Feb 10.

AI-enabled ECG alert and all-cause mortality

Continuous beat-to-beat



Detecting what humans miss..
Early signs of deterioration often difficult to identify

Lin CH, et al. *Nat Med* 2024;30:1461-70.

Medical News & Perspectives | AI IN MEDICINE

Study Finds People Prefer AI Over Clinician Responses to Questions in the Electronic Medical Record

JAMA Network Open™

Research Letter | Health Informatics

Perspectives on Artificial Intelligence–Generated Responses to Patient Messages

Jiyeong Kim, PhD, MPH; Michael L. Chen, BA; Shawheen J. Rezaei, MPhil; April S. Liang, MD; Susan M. Seav, MD; Sonia Onyeka, MD; Julie J. Lee, MD, MPH; Shivam C. Vedak, MD, MBA; David Mui, MD, MBA; Rayhan A. Lal, MD; Michael A. Pfeffer, MD; Christopher Sharp, MD; Natalie M. Pageler, MD, MEd; Steven M. Asch, MD, MPH; Eleni Linos, MD, DrPH

JAMA Network Open. **2024;7(10):e2438535.**

Study Finds People Prefer AI Over Clinician Responses to Questions in the Electronic Medical Record

	AI[a]					Clinicians				
Division	Assessments, No.	Satisfaction estimate (SE)[b]	No. of characters, mean (SD)	Satisfaction and the length of response		Assessments, No.	Satisfaction estimate (SE)[b]	No. of characters, mean (SD)	Satisfaction and the length of response	
				Standardized β[c]	*P* value				Standardized β[c]	*P* value
Overall	213	3.96 (0.09)	1470.77 (391.83)	0.10	.16	195	3.05 (0.09)	254.37 (198.85)	0.23	.002
Cardiovascular	78	4.09 (0.14)	1559.04 (424.83)	0.068	.58	75	3.25 (0.14)	306.36 (221.09)	0.29	.02
Internal medicine	87	3.82 (0.13)	1314.72 (347.11)	0.037	.72	78	2.94 (0.14)	146.31 (109.43)	0.0056	.96
Endocrinology	48	4.00 (0.19)	1610.19 (330.87)	0.25	.08	42	2.90 (0.20)	362.21 (200.79)	0.31	.09

JAMA Network Open. 2024;7(10):e2438535.

Medical News & Perspectives | AI IN MEDICINE

Study Finds People Prefer AI Over Clinician Responses to Questions in the Electronic Medical Record

- Can increase efficiency of clinical team - Reduce physician burnout
- Win-win situation for patient/clinician → efficiency
- AI more detailed/longer responses
- AI messages rated highly on empathy!

Linos E
Stanford Center
for Digital Health

✓ **Constantly improving (every year)**
✓ **Transforming HC very quickly**

- **Even one medical mistake can brake this!**
- **Side effects? Complications? Negative effects?**

Technology

Watch: AI robot attacks' participant at Chinese festival

At a Chinese festival, AI robot moved toward the crowd, causing panic. Security intervened amid malfunction concerns

NEWS DESK | February 23, 2025

Terrifying scenes unfolded at a festival in **China** when a **robot lost control and began attacking attendees**. It was powered by artificial intelligence, something the organisers have described as **"a simple robot failure"**.

Video grab shows an AI robot attacking on spectator. PHOTO: YOUTUBE VIDEO


✓ Drugs
✓ Devices
✓ Software
Software
as a Medical Device

FROM THE HEART

AI IN CARDIOLOGY

Echoes of Concern—AI and Moral Agency in Medicine

Medicine is being transformed before our eyes

Fast increasing tech power for diagnosis/treatment

Physicians will gain from tech
but should be bound by the same **deeply personal obligation to serve their patients**

When we ourselves get sick

we hope that someone will worry about us
as we have worried about those entrusted to our care

Hull SC, Fins JJ. *JAMA Cardiol,* Nov. 2024

Robert Harrington Urges Caution With AI 'Bad Actors'

Cornell University

The whole thing depends upon

- ***Reliable data***
- ***Reliable information***

(Meanigful information)

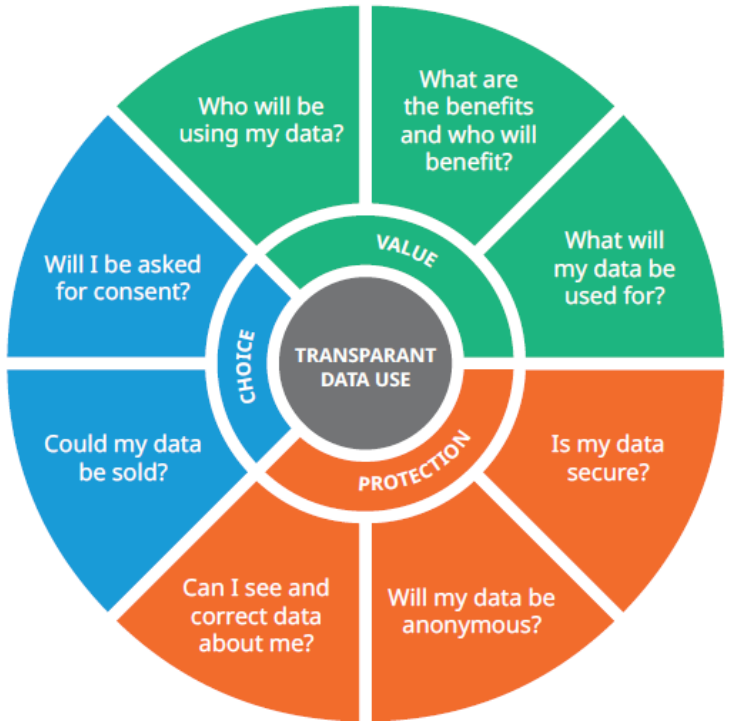
Robert Harrington

Dean of Weill Cornell Medicine
and the Provost for Medical Affairs
Cornell University

Feb. 2025

Health data ecosystem

Elements of transparent data use



World Health Organization

16 May 2023

WHO calls for safe and ethical AI for health

WHO is enthusiastic about the potential of AI, but call for caution in using it for HC

- **Concerns over how AI will be used**
  to improve access to health information,
  as decision-support tool + to improve diagnoses

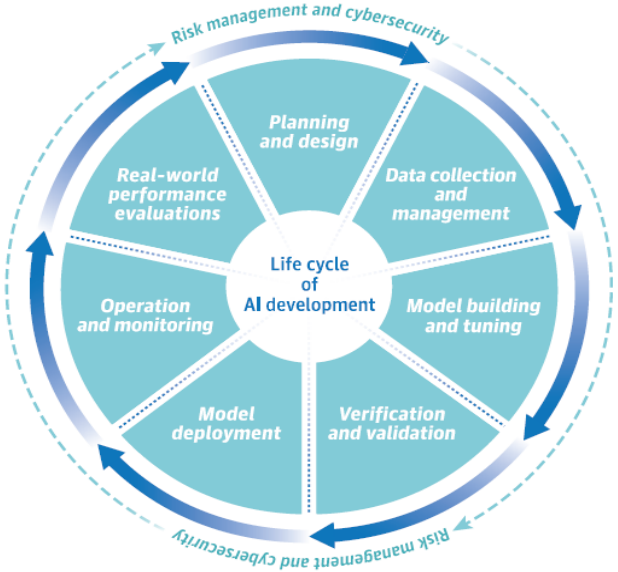
- **The data used to train AI may be biased**
  Generate inaccurate/misleading info
  Models can be misused to generate disinformation

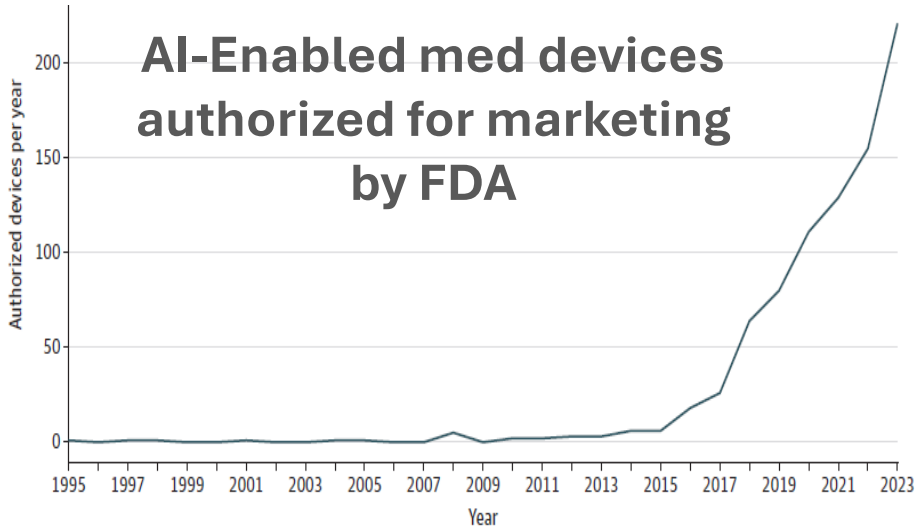
JAMA | Special Communication | AI IN MEDICINE

FDA Perspective on the Regulation of Artificial Intelligence in Health Care and Biomedicine

Haider J. Warraich, MD; Troy Tazbaz, BS; Robert M. Califf, MD

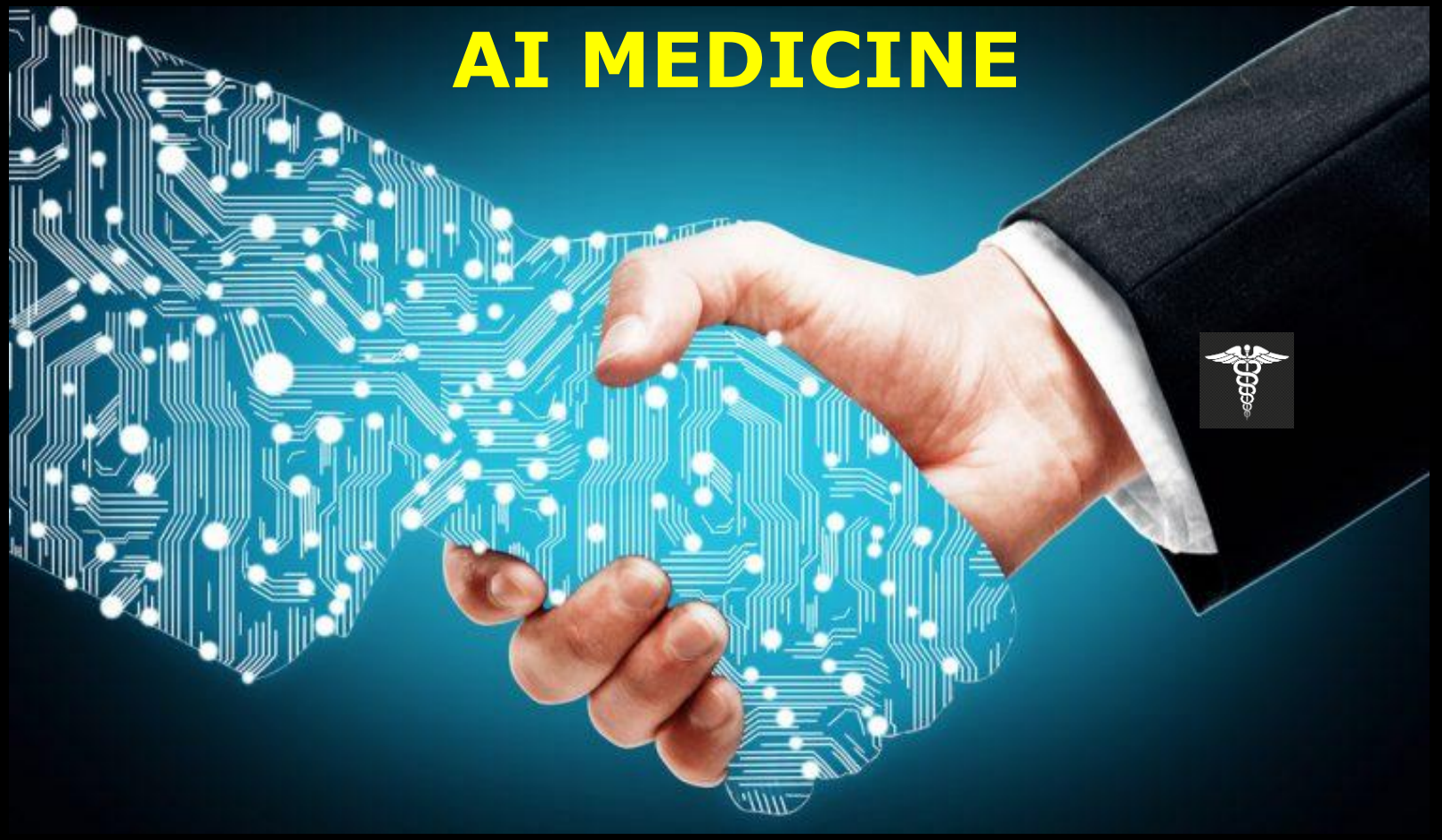
- **FDA will continue to play a central role** in ensuring safe, effective, trustworthy AI tools to improve the lives of patients and clinicians
- Strong FDA oversight **protects the long-term success of industries** Focus on evaluation to advance regulated technologies that improve health
- Involved entities need to **attend to AI with the rigor** this transformative technology merits





JAMA, Oct. 2024

The future is now!



"With a little help from my friends"

Med Engineers

George Stergiou, 2025

AI in CVD medicine and hypertension
Opportunities and challenges

George Stergiou, MD, PhD, FRCP
Professor of Medicine & Hypertension
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International Society of Hypertension