

Strategies for Managing the Tsunami of Medical Information: AI and Beyond



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President, ACCC 2022-2023
October 6, 2023



Disclosures

Name	Employment	Funding Sources	Ownership & investments	Leadership
David R. Penberthy, MD, MBA	Penn State Health AstraZeneca Startups and Real Estate	None	CHS stock Mutual funds Startup - ROMTech Startup - OncoAI	ACCC Board of Trustees

I would like to acknowledge

K. Singh Sahni, MD
Alfred M. Strash, PhD
Faye Flemming RN, BSN, OCN
Tracey Tatum, RN, NP
Cliff Robinson, MD
Peter Diamandis, MD
Matt Devino, MPH
Mark Liu, MPH
Amy Ellis, RN
Douglas Flora, MD
Sarah McGough, PhD
John Frownfelter, MD, FACP
Rick Baehner, MD
Blythe Adamson, PhD, MPH
Kevin Davies, PhD
Michael Dake, MD
Ryan Langdale

for their assistance with this presentation



ASSOCIATION OF COMMUNITY CANCER CENTERS

LEADING EDUCATION AND ADVOCACY ORGANIZATION FOR THE
CANCER CARE COMMUNITY

- ~50 years old (founded 1974)
- Powerful network of ~34,000 multidisciplinary practitioners from over 2100 hospitals and practices nationwide in every state
- ~2/3 of the nation's cancer patients are treated by a member of ACCC

www.accc-cancer.org

Learning objectives

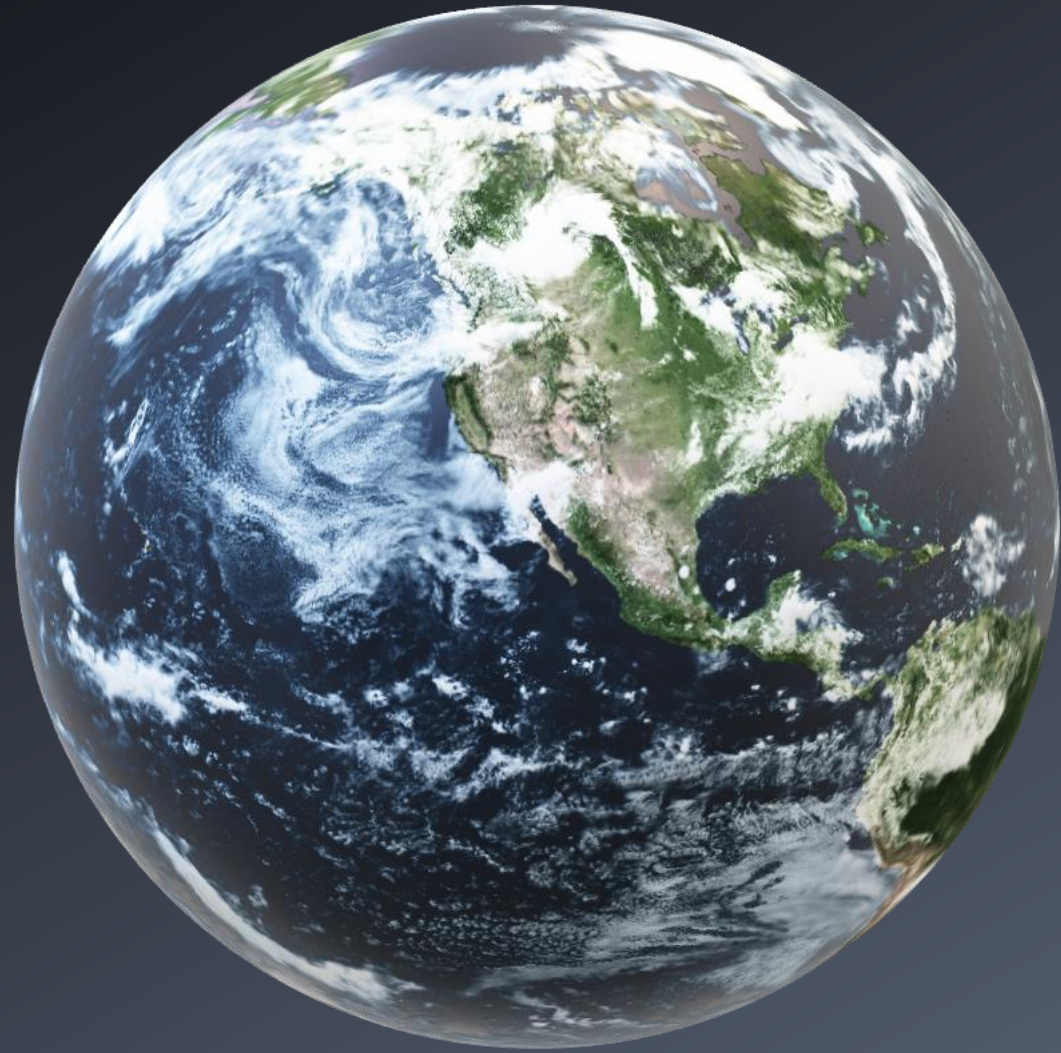
Statement of the
cancer problem

Current state of
multidisciplinary
care

AI and Future
directions



Magnitude



Estimated number of new cases from 2020 to 2040, Both sexes, age [0-85+]

All cancers

Africa + Latin America and Caribbean + Northern America + Europe + Oceania + Asia

2020



19.3M

2040



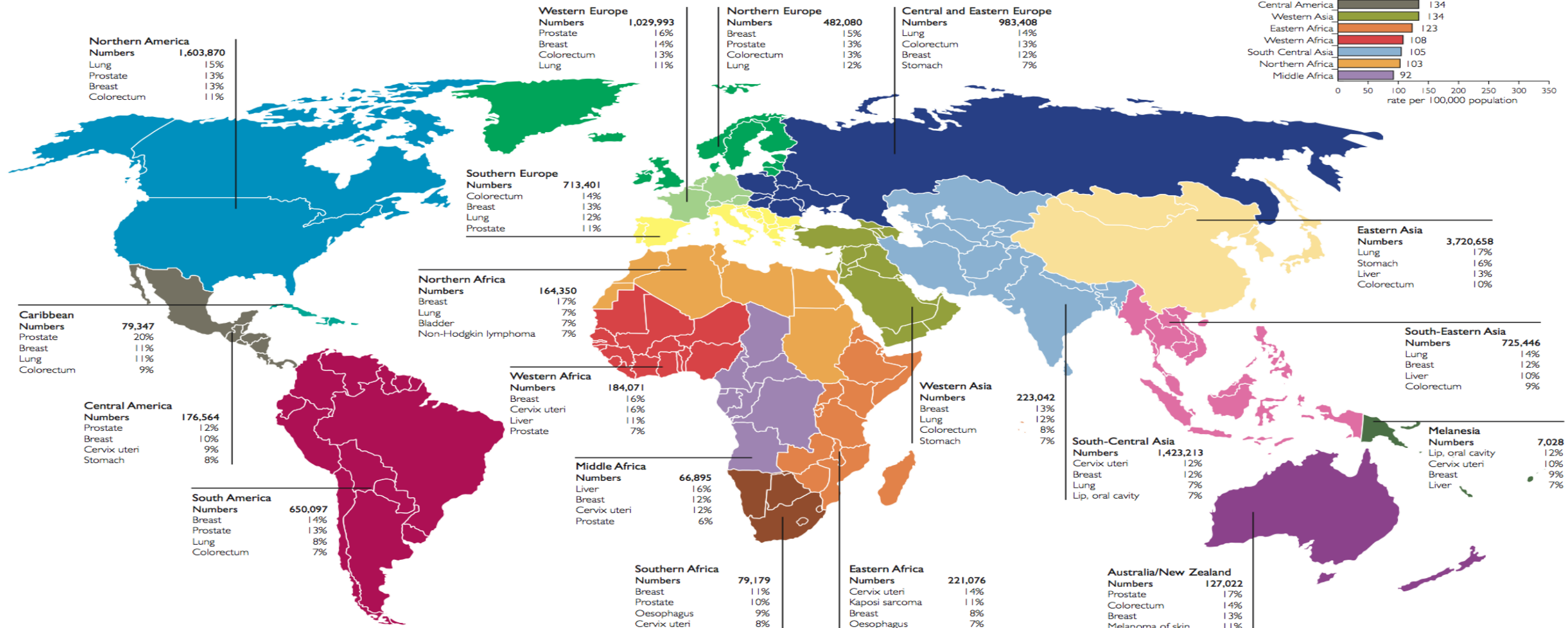
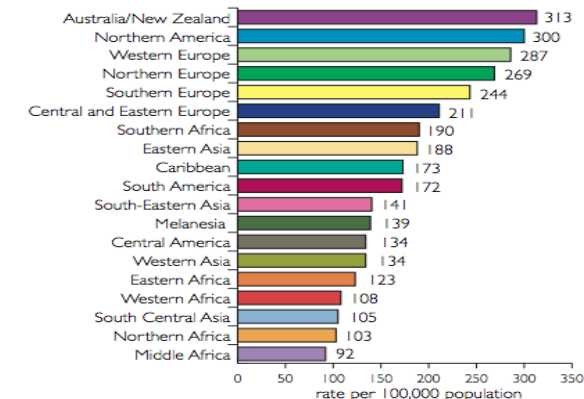
28.9M



Cancer Incidence Worldwide

Breakdown of the estimated 12.7 million new cases, World-age standardised incidence rates and the most commonly diagnosed cancers by the different regions of the world, 2008.

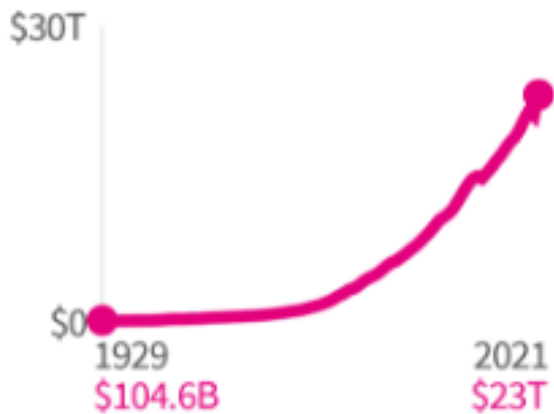
International Agency for Research on Cancer



Source: GLOBOCAN 2008, v. 1.2, Cancer Incidence and Mortality Worldwide. IARC, 2010 (<http://globocan.iarc.fr>) Map updated February 2011

<http://info.cancerresearchuk.org/cancerstats/>

GDP issues

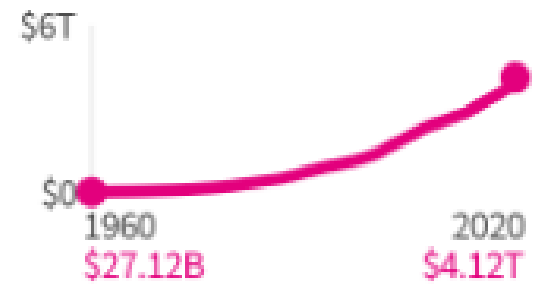


Gross domestic product

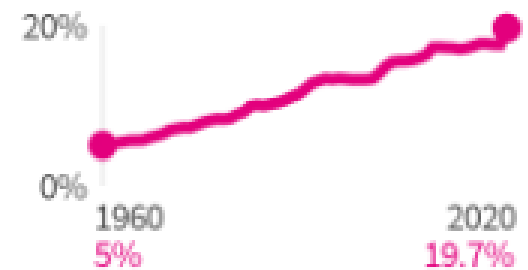
\$23 trillion

2021

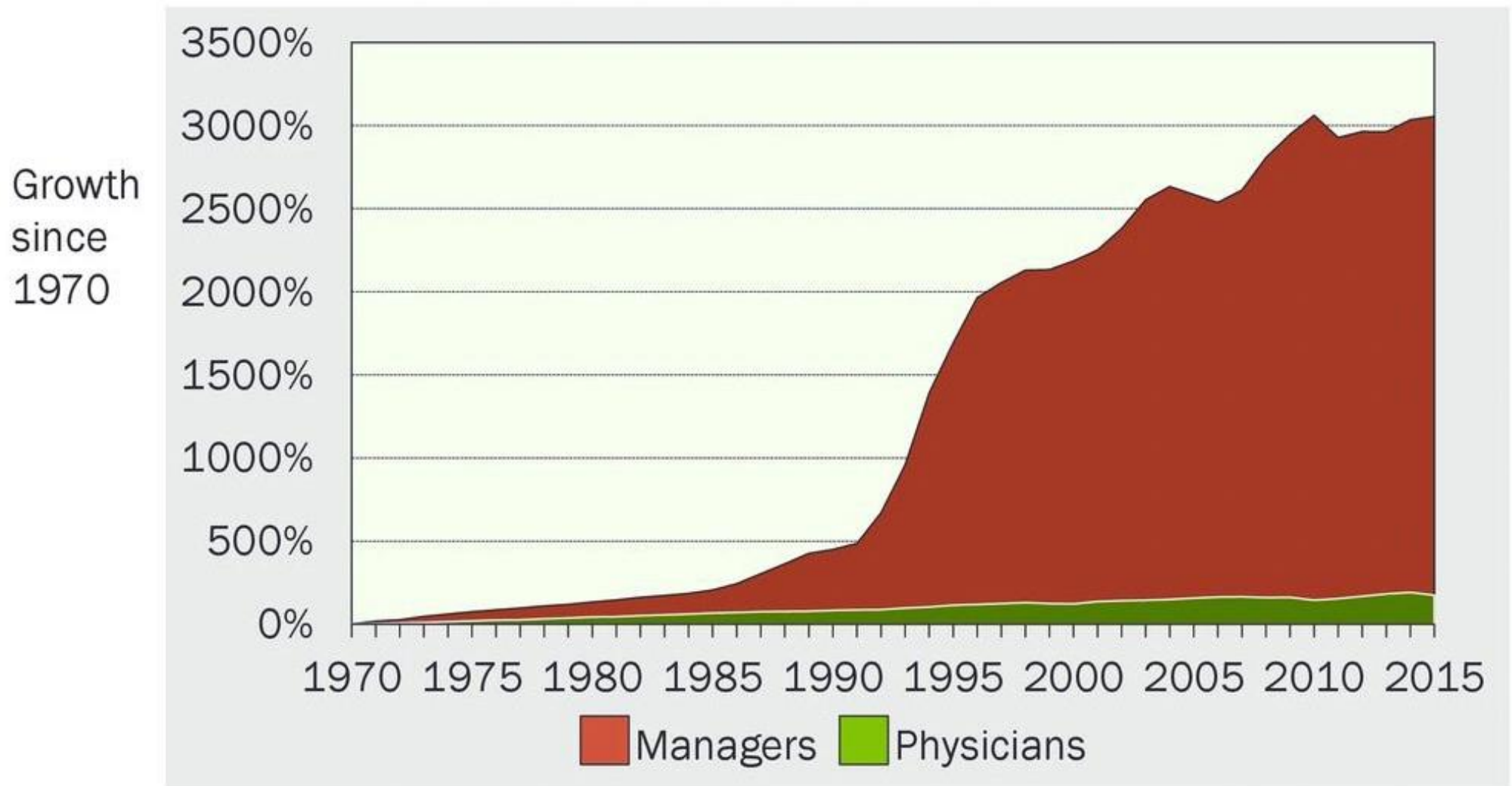
National spending on
healthcare goods and
services



Healthcare expenditures
as a percent of GDP

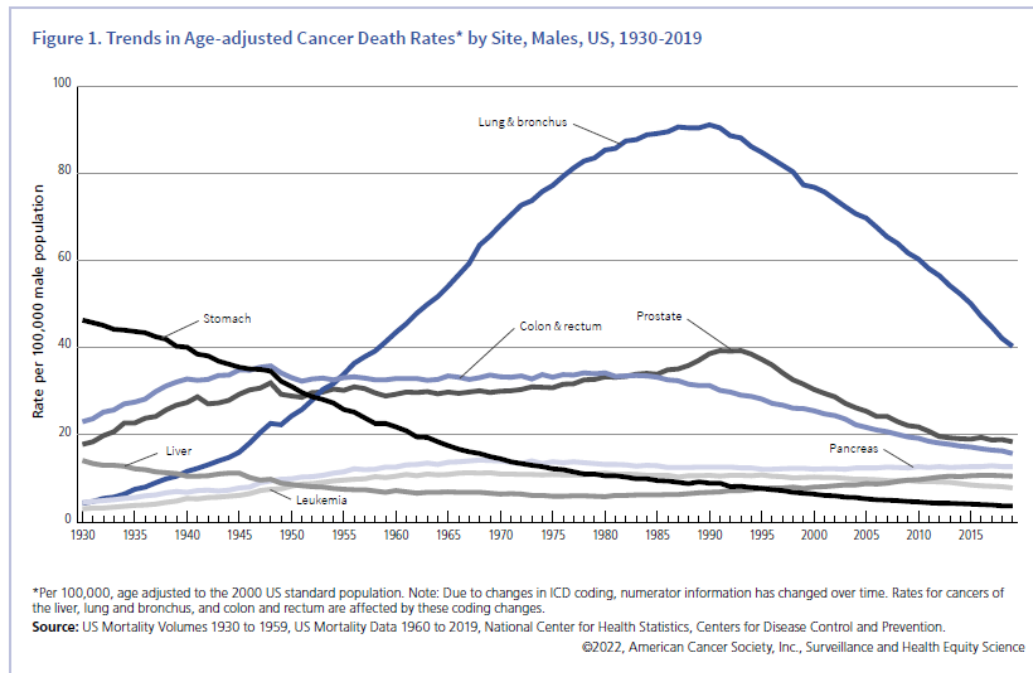


Growth of Physicians and Administrators in U.S.



Bureau of Labor Statistics; NCHS; Himmelstein/Woolhandler analysis of CPS
Managers shown as moving average of current year and two previous years

So how are we doing?



5

Takeaways from the Cancer Facts & Figures Report 2022



Lung cancer patients are being diagnosed earlier, and living longer.



In 2022, there will be an estimated 1,918,030 new cancer diagnoses, and 609,360 cancer deaths.



Cancer mortality is declining at an accelerating rate.



The racial, socioeconomic, and geographic disparities for preventable cancers are alarming.



The rate of advanced-stage prostate cancer diagnosis increased by 4%-6% each year from 2014 -2018.



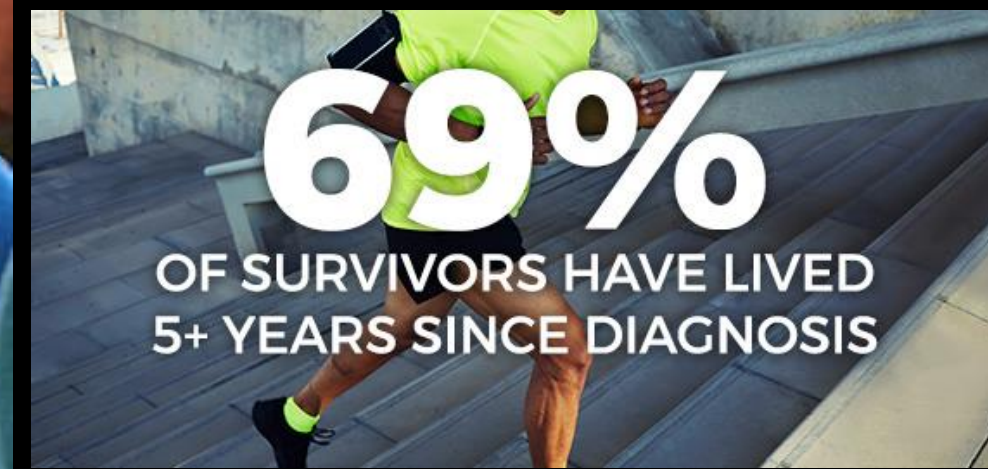
18.1

MILLION CANCER SURVIVORS



67%

OF SURVIVORS ARE 65 OR OLDER



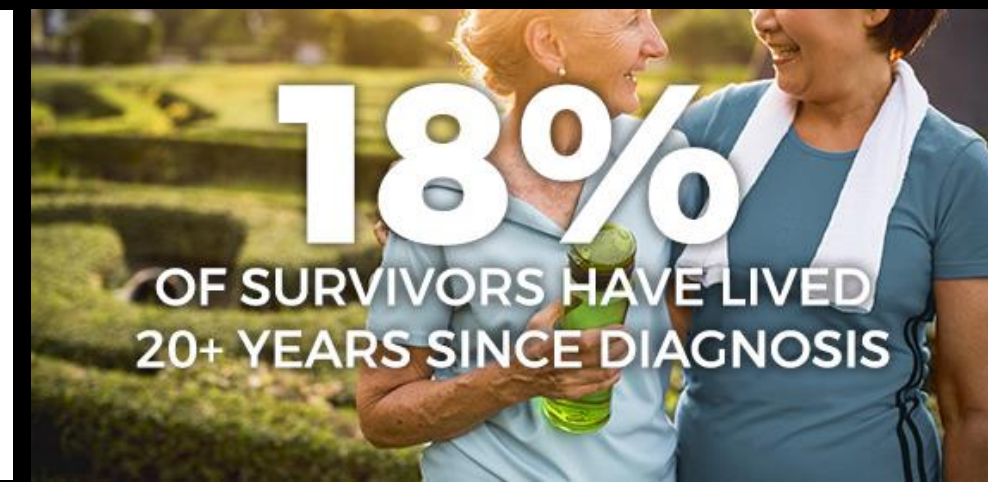
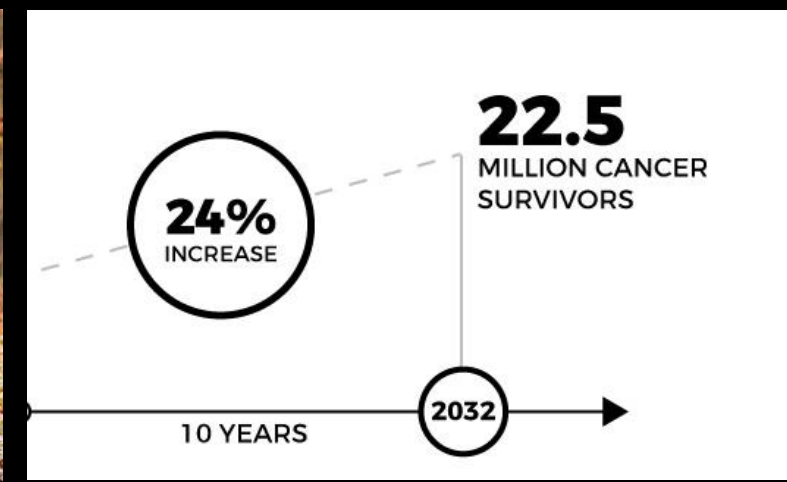
69%

OF SURVIVORS HAVE LIVED 5+ YEARS SINCE DIAGNOSIS



47%

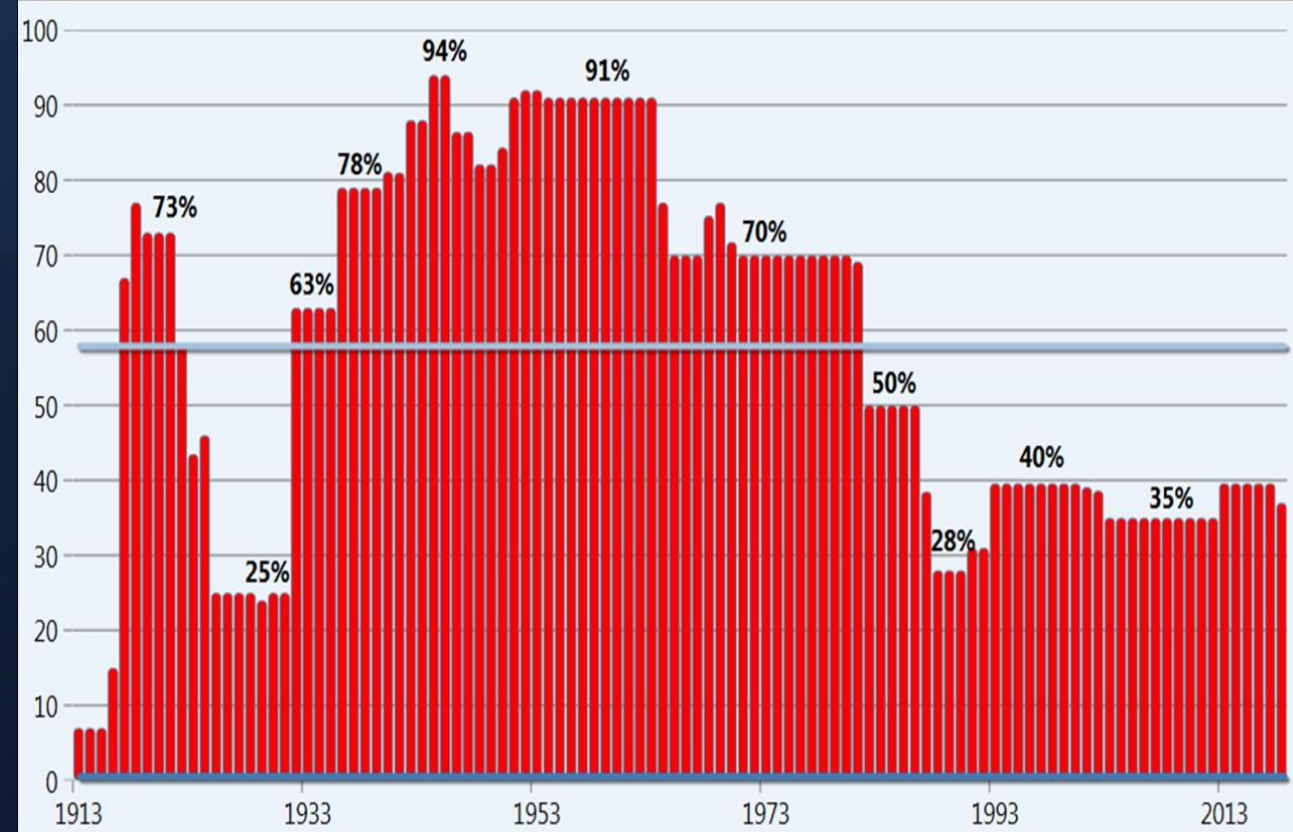
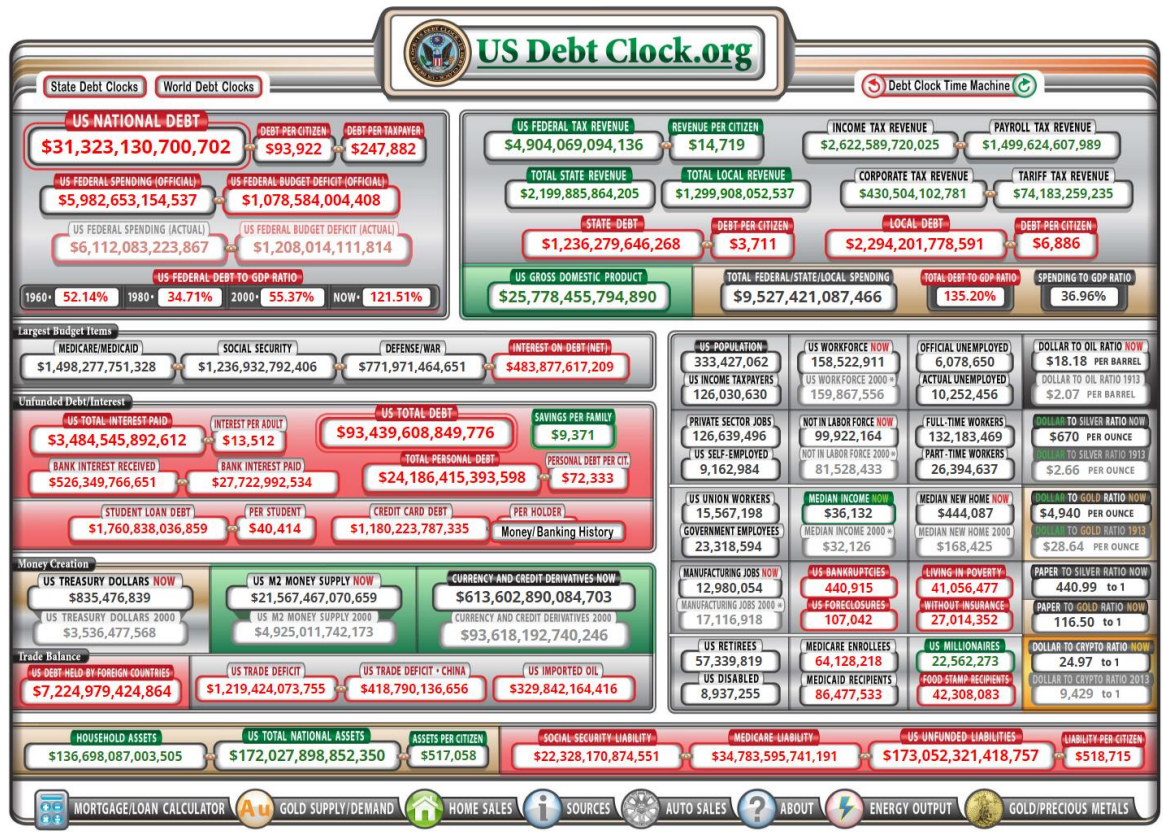
OF SURVIVORS HAVE LIVED 10+ YEARS SINCE DIAGNOSIS



18%

OF SURVIVORS HAVE LIVED 20+ YEARS SINCE DIAGNOSIS

US Debt and Taxes

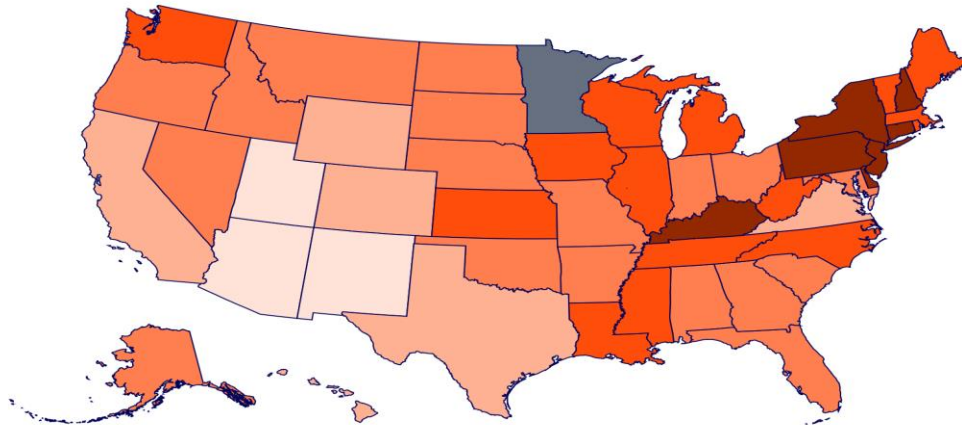


National debt \$32T and counting
www.usdebtclock.org

US CANCER INCIDENCE AND MORTALITY

Incidence rates, 2008-2012
By state, all cancer types combined
Per 100,000, age adjusted to the 2000 US standard population

392.9 - 418.4 418.41 - 443.9 443.91 - 469.4 469.41 - 494.9 494.90 - 520.4

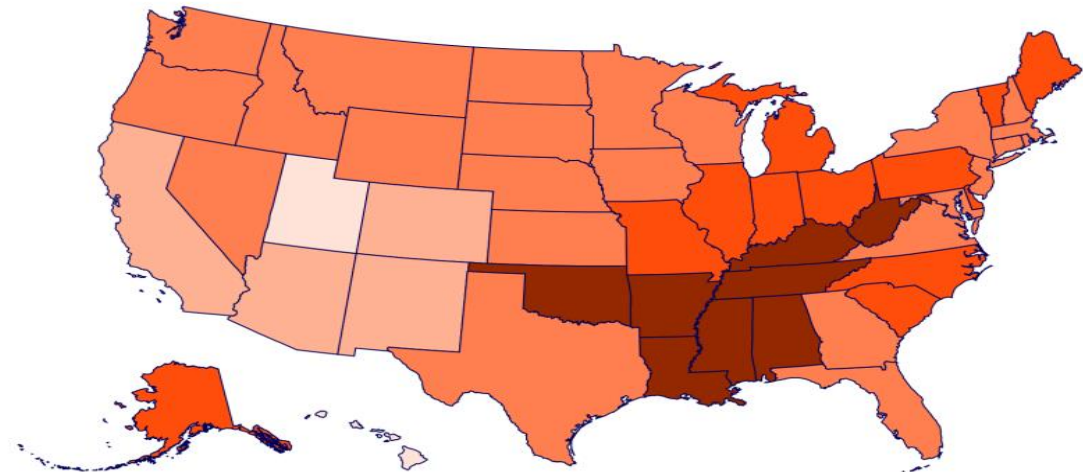


Data Source: North American Association of Central Cancer Registries (NAACCR), 2015
© 2016 American Cancer Society

Cancer5

Death rates, 2008-2012
By state, all cancer types combined
Per 100,000, age adjusted to the 2000 US standard population

127.6 - 142.96 142.97 - 158.32 158.33 - 173.68 173.69 - 189.04 189.04 - 204.4



Data Source: National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention, 2015

© 2016 American Cancer Society

CancerStatisticsCenter.org

What about
the future?



THE MEDICAL LITERATURE CHALLENGE

Pubmed

Daily: ~4,000 Weekly: ~28,000 Monthly: ~120,000

Annually: ~1.44 million articles

10% oncology related

Daily - ~400 Weekly - ~2800 Monthly - ~12,000

Annually - ~144,000

These figures only represent a fraction of the medical information being generated, as they do not account for other sources like clinical trials, patents, guidelines, conference proceedings, and more. Additionally, the growth of data in fields like genomics and digital health is further accelerating the expansion of medical information.



GROWTH OF GUIDELINES



Changes in Length and Complexity of Clinical Practice Guidelines in Oncology, 1996-2019

Benjamin H. Kann, MD; Skyler B. Johnson, MD; Hugo J. W. L. Aerts, PhD; Raymond H. Mak, MD; Paul L. Nguyen, MD

Figure 1. Page Volume of National Comprehensive Cancer Network Clinical Practice Guidelines by Disease Site, 1996-2019

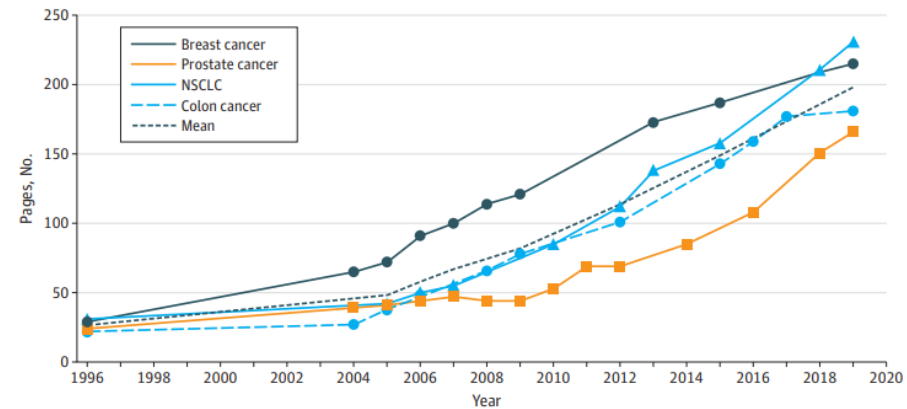
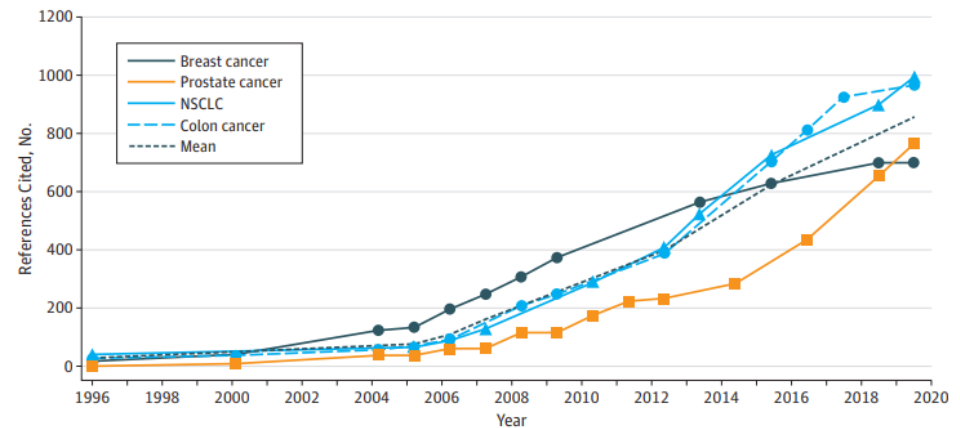


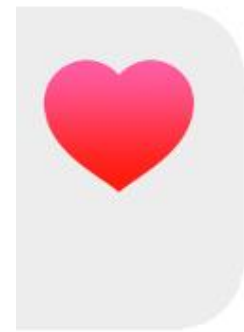
Figure 2. References Cited in National Comprehensive Cancer Network Clinical Practice Guidelines by Disease Site, 1996-2019



“Further approaches, including guideline stratification by evidence level and the use of artificial intelligence for decision support, should be investigated as ways to synthesize data and improve cancer decision-making.”



Google HEALTH



“It is often easier
(and faster) to make
something 10x better
than it would be to
make it 10% better.”

— Astro Teller



AI IN PRECISION ONCOLOGY



Business And Society

AI Won't Replace Humans — But Humans With AI Will Replace Humans Without AI

August 04, 2023

The New
World of Work
Karim R. Lakhani,
Harvard Business
School Professor

Harvard
Business
Review



WHAT IS THIS?

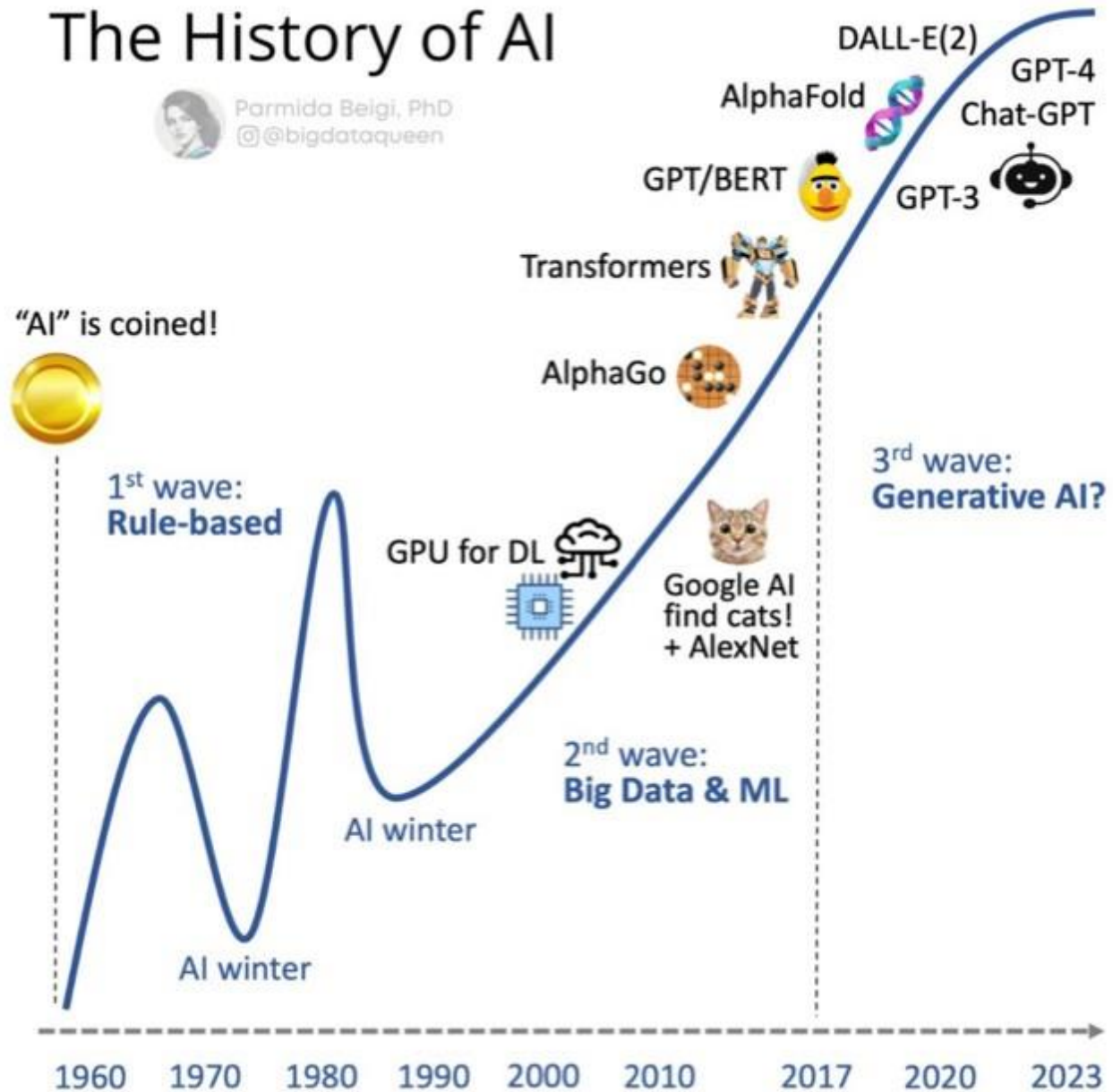
- Bell Labs scientists John Bardeen, Walter Brattain, and William Shockley invented the transistor in 1947, and won the 1956 Nobel Prize in Physics
- John McCarthy coined the term “artificial intelligence” in 1956



The History of AI

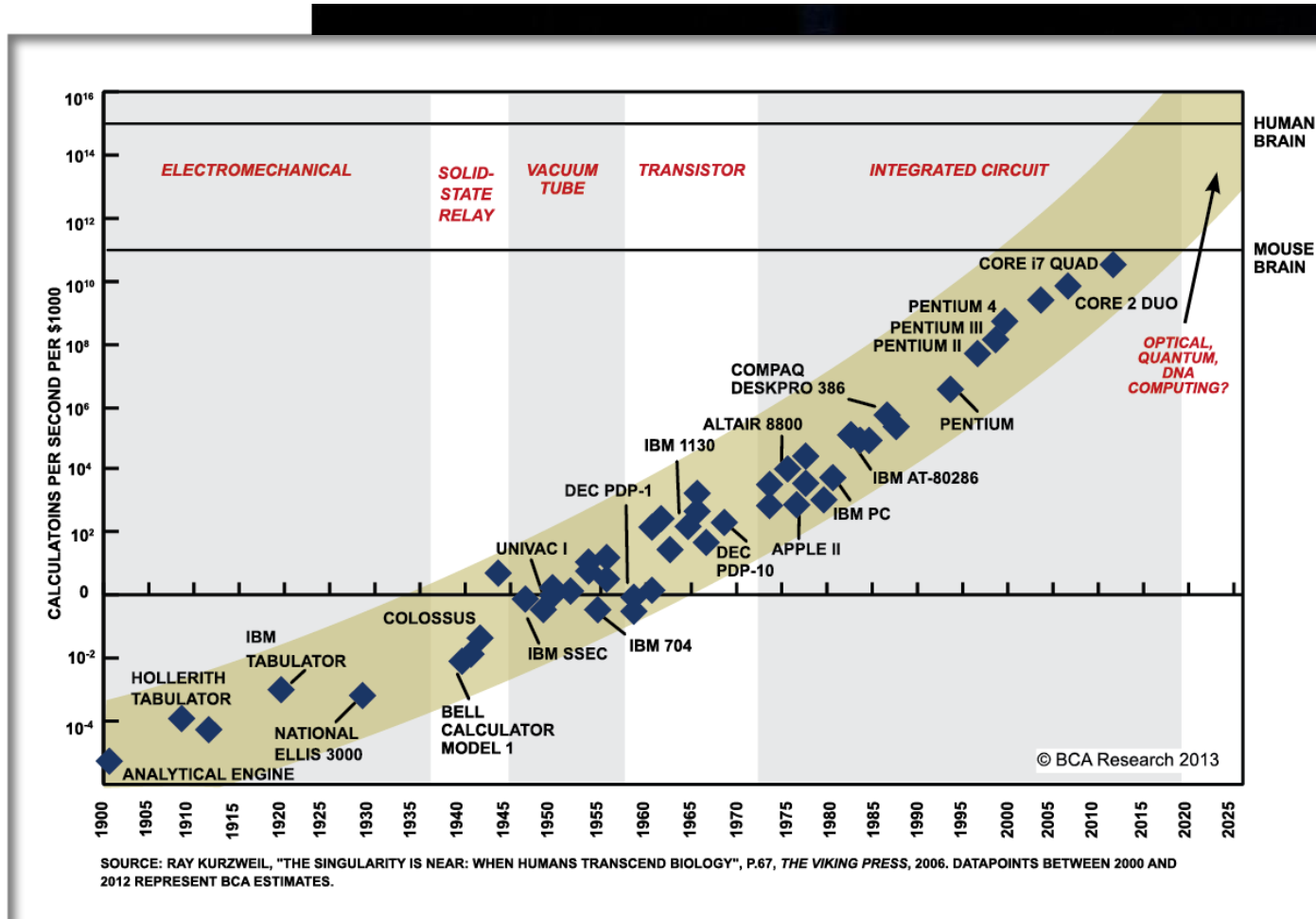


Parmida Beigi, PhD
@bigdataqueen



The robots are coming.

Ray Kurzweil c. 2006



arXiv

<https://arxiv.org> Cornell University

Free distribution service and open access for **>2.3M** articles in physics, mathematics, computer science, quantitative biology, quantitative finance, statistics, electrical engineering and systems science, and economics

~1200 daily submissions

a place of connection, linking together people and ideas, and connecting them with the world of open science



THE EVOLUTION OF ARTIFICIAL INTELLIGENCE



Artificial Intelligence (AI) – the development of computer systems able to perform tasks that typically require human intelligence, such as recognizing patterns, making decisions, and solving problems

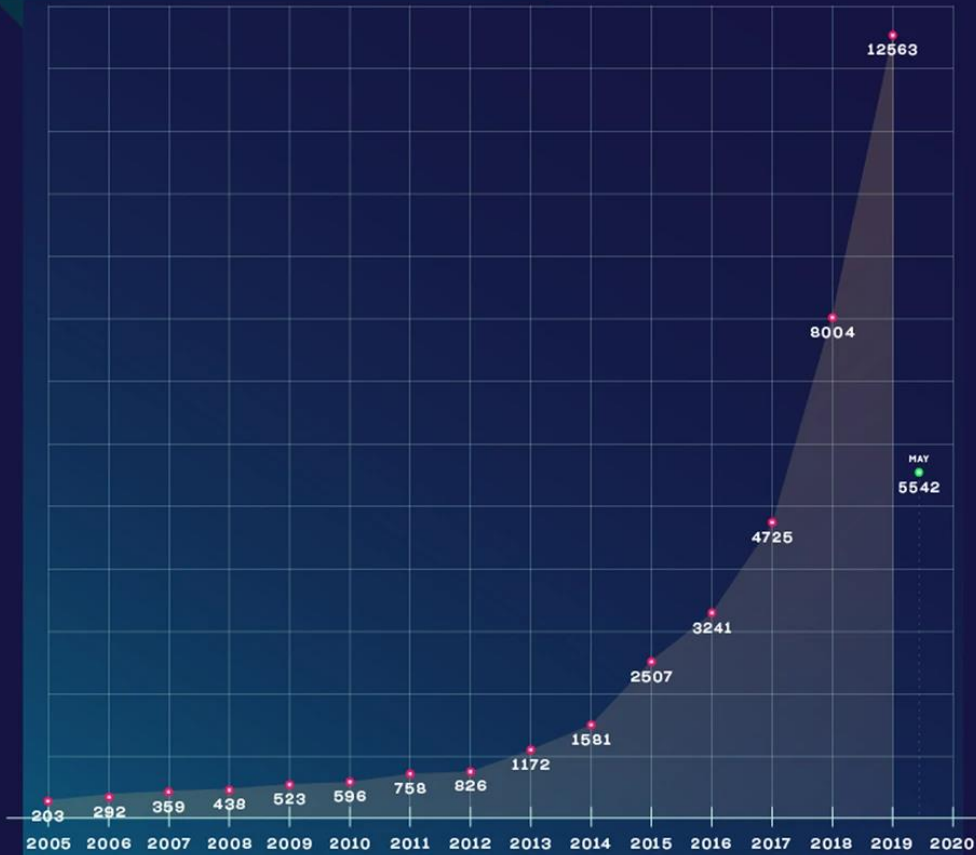
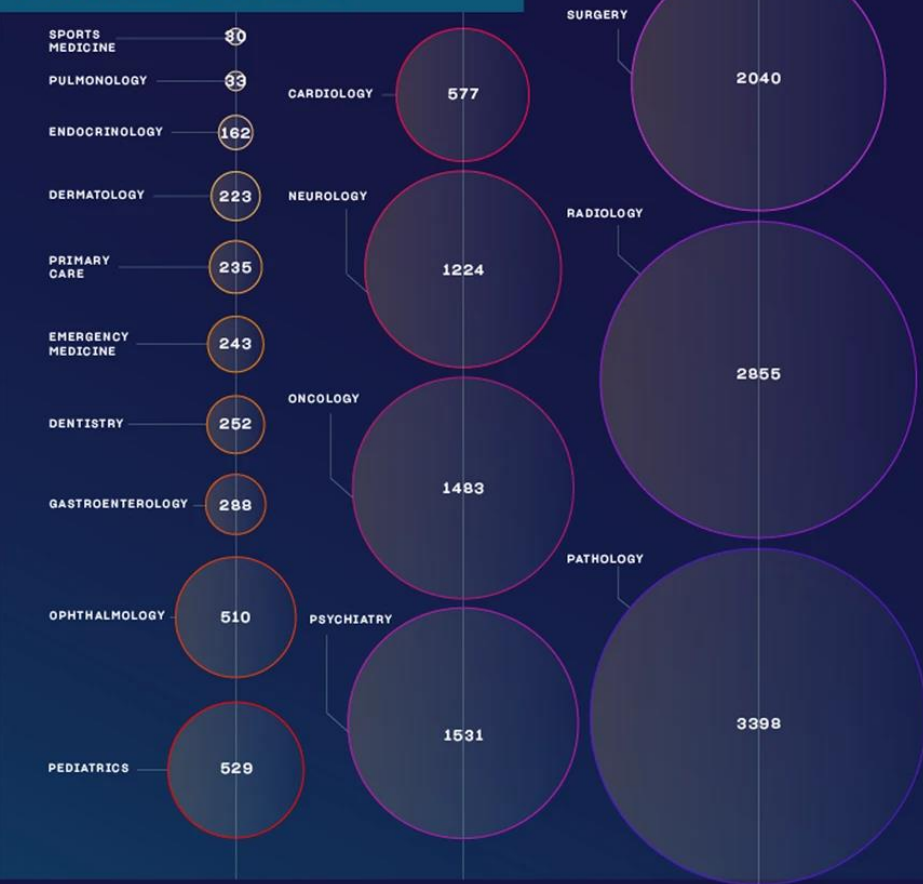
- AI has the potential to revolutionize the healthcare industry by enabling us to diagnose diseases and develop personalized treatments faster and more accurately than ever before.

DEEP BLUE – HOW AI BEAT THE WORLD CHAMPION



ALPHAGO BEAT LEE SEDOL



a**MACHINE AND DEEP LEARNING STUDIES ON PUBMED.COM****TOTAL NUMBER OF STUDIES****b****STUDIES PER SPECIALTY**

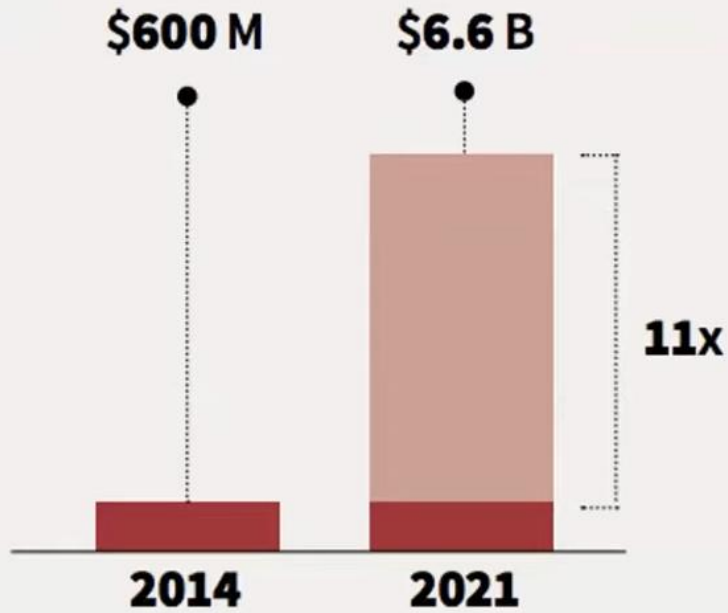
Name this country...





Technology
changes.....

Health AI Market Size 2014 - 2021



Acquisitions of AI startups are rapidly increasing while the health market is set to register an explosive CAGR of 40% through 2021.

Source: Accenture (December 2017). Artificial Intelligence in Healthcare.

GLOBAL ARTIFICIAL INTELLIGENCE IN HEALTHCARE MARKET

OPPORTUNITIES AND FORECASTS, 2017-2023



Global Artificial Intelligence in Healthcare Market is expected to reach **\$22,790 million** by 2023.

Growing at a **CAGR of 48.7%** (2017-2023)

GLOBAL ARTIFICIAL INTELLIGENCE IN HEALTHCARE MARKET BY GEOGRAPHY

● NORTH AMERICA

● EUROPE



● LAMEA

● ASIA-PACIFIC

Asia-Pacific region would exhibit the highest **CAGR of 53.4%** during 2017-2023.

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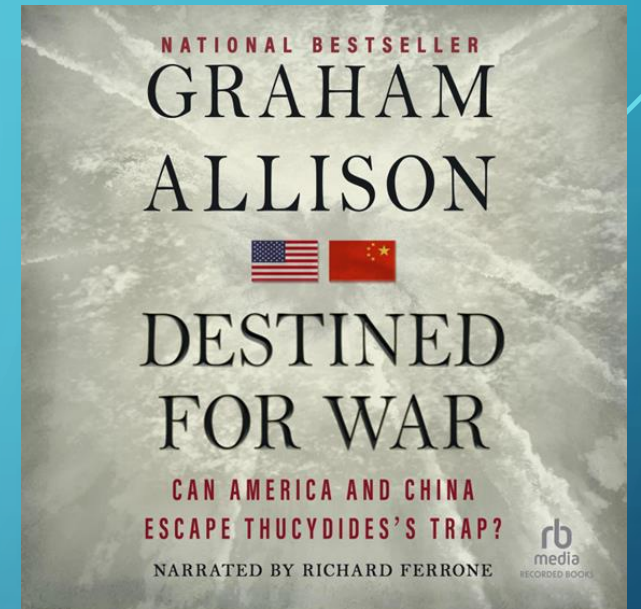
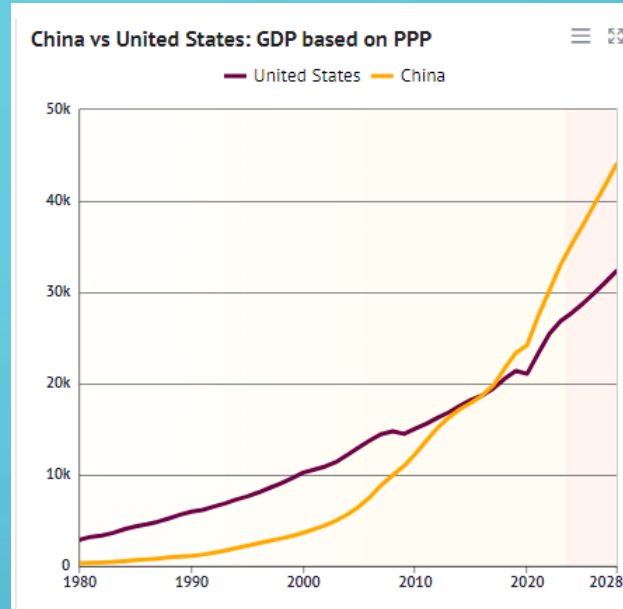
Save 40% on Unlimited [Subscribe](#)

SPACE & PHYSICS

China Reaches New Milestone in Space-Based Quantum Communications

The nation's Micius satellite successfully established an ultrasecure link between two ground stations separated by more than 1,000 kilometers

By Karen Kwon on June 25, 2020 [أعرض هذا باللغة العربية](#)



What is China's GDP as per PPP?

Economy of China

Statistics	
GDP	\$19.373 trillion (nominal; 2023 est.) \$33.014 trillion (PPP; 2023 est.)
GDP rank	2nd (nominal; 2023) 1st (PPP; 2023)
GDP growth	8.4% (2021) 3.0% (2022) 5.2% (2023f) 4.5% (2024f)

Central Intelligence Agency (.gov)
<https://www.cia.gov> > field > country-comparison

Real GDP (purchasing power parity)

Rank	Country	Real GDP (PPP)	Date of Information
1	China	\$24,861,000,000,000	2021 est.
2	United States	\$21,132,000,000,000	2021 est.
3	India	\$9,279,000,000,000	2021 est.

Shanghai 1990



Shanghai 2020



Patient-Facing

AI Chatbots



Wearables & Devices



Personalized Genetics



Mental Health



Women's Health



Skin



Telehealth

Telemedicine



Lifestyle Management



Disease Management



AI in Healthcare

Research

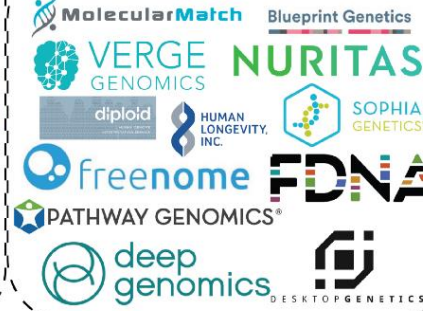
Drug Discovery



Information & Clinical Trials



Genetic Research



Doctor-Facing

Medical Records



Data Analytics



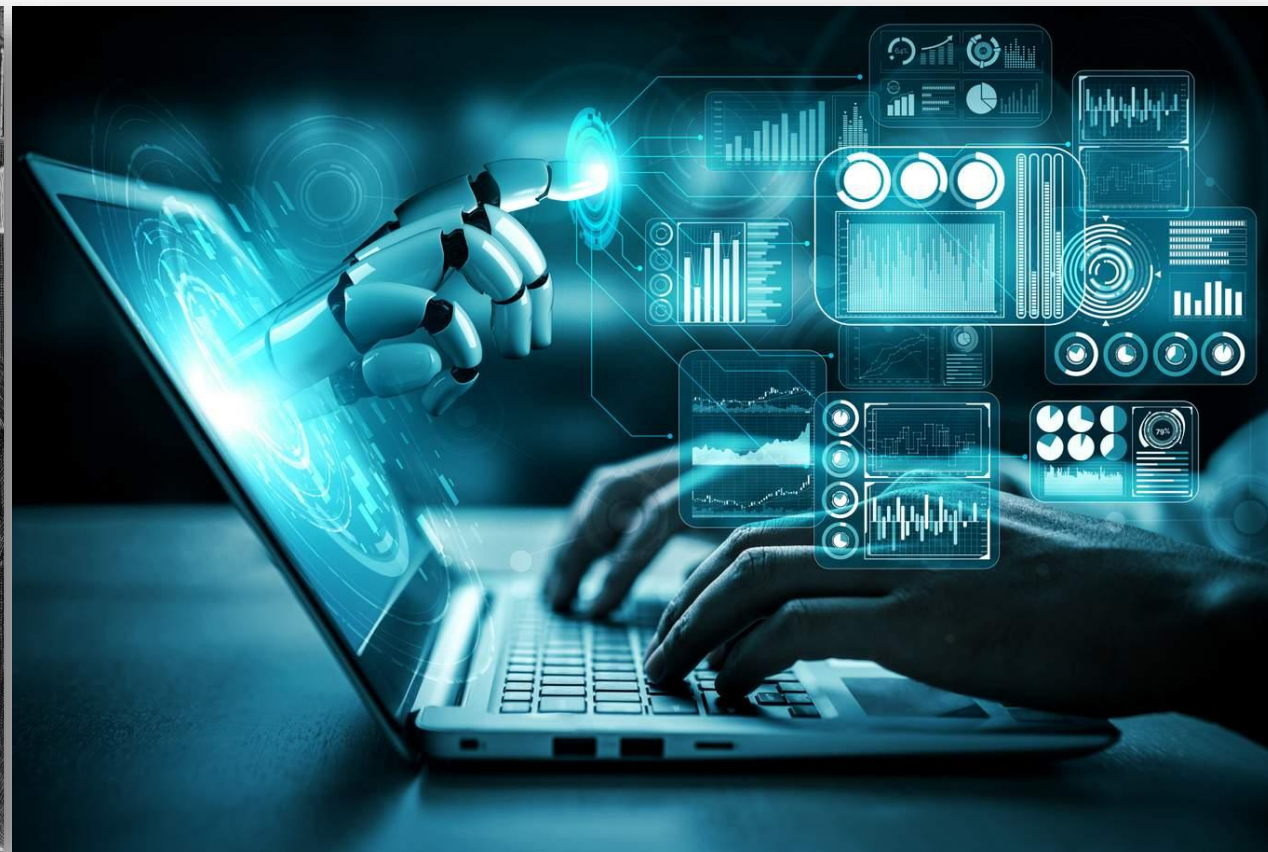
Medical Imaging



Hospital



IS THIS A GUTENBERG MOMENT?



IS THIS A GUTENBERG MOMENT?

Envisioning the Healthcare Landscape with ChatGPT

New York Medical College Explores The Opportunities And Risks Of AI On The Healthcare Industry In The Following Article Written Entirely Using ChatGPT

February 13, 2023

Opinion > Kevin, M.D.

AI in Healthcare: Meeting HIPAA Standards With ChatGPT

— Patients deserve a commitment to privacy

by Harvey Castro, MD, MBA February 11, 2023

ChatGPT Passes US Medical Licensing Exam Without Clinician Input

ChatGPT achieved 60 percent accuracy on the US Medical Licensing Exam, indicating its potential in advancing artificial intelligence-assisted medical education.



THE LANCET
Digital Health

COMMENT | [ONLINE FIRST](#)

ChatGPT: the future of discharge summaries?

Sajan B Patel • Kyle Lam [✉](#)

[Open Access](#) • Published: February 06, 2023 • DOI: [https://doi.org/10.1016/S2589-7500\(23\)00021-3](https://doi.org/10.1016/S2589-7500(23)00021-3)

New and surprising evidence that ChatGPT can perform several intricate tasks relevant to handling complex medical and clinical information

[Download PDF Copy](#)



By Neha Mathur

Reviewed by [Danielle Ellis, B.Sc.](#)

Feb 13 2023

FORBES > INNOVATION > HEALTHCARE

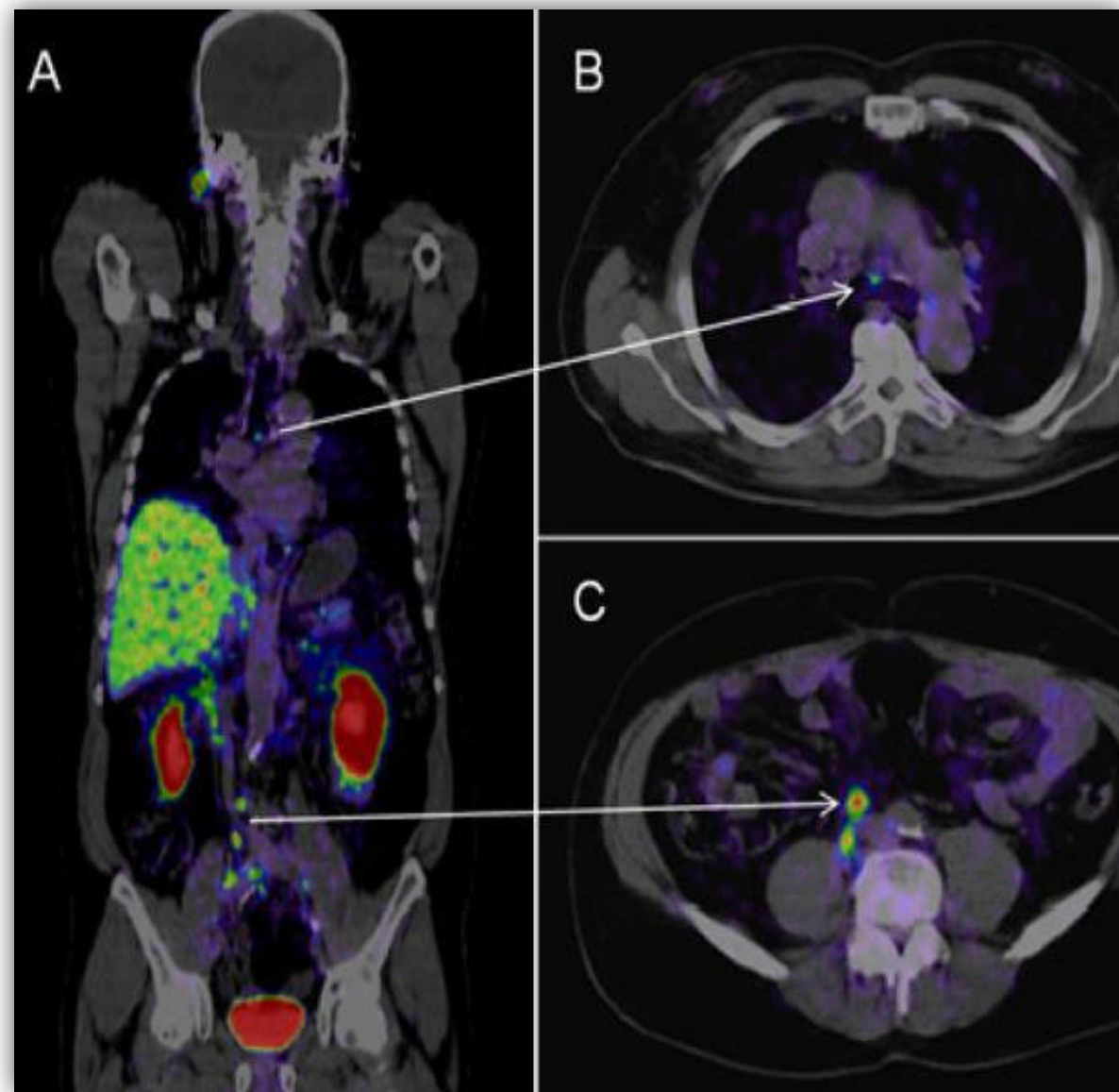
EDITORS' PICK

5 Ways ChatGPT Will Change Healthcare Forever, For Better

Robert Pearl, M.D. Contributor [Ⓞ](#)

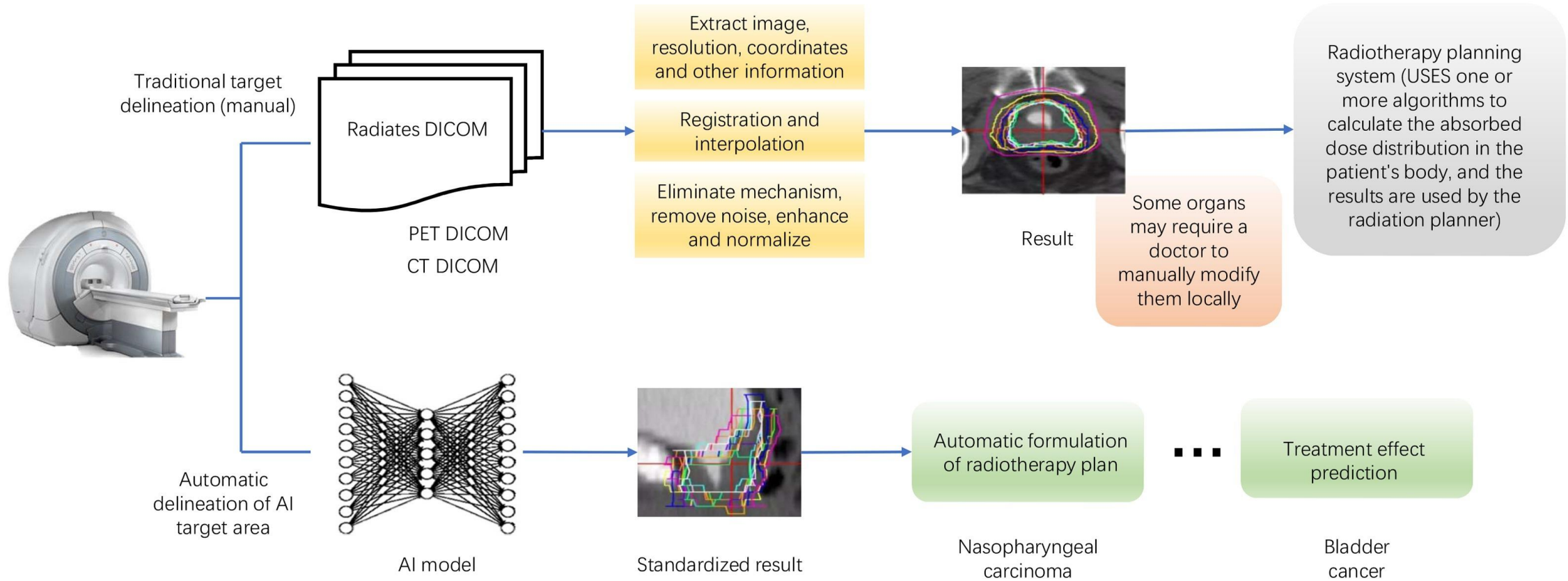
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IMPORTANCE OF AI IN ONCOLOGY



AI IN RADIATION ONCOLOGY

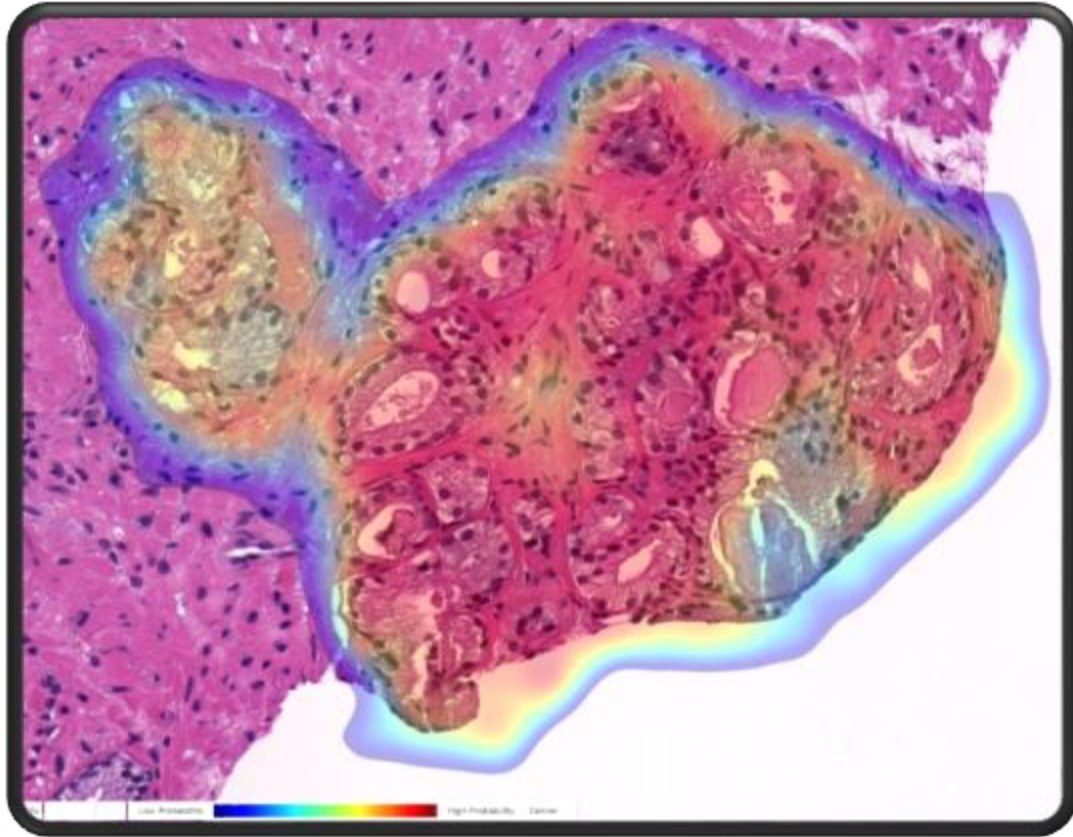
Automatic delineation of tumors and organs at risk



Comparison of sketch speed of target area:

AI takes 10-20 minutes
Manual work takes 4-5 hours

AI DETECTING PROSTATE CANCER NEAR PERFECTION



- Images from more than 1M parts of stained tissue slides from patient biopsies used to teach AI to discriminate between healthy and abnormal tissue
- Tested on 1,600 slides from 100 patients
- AI demonstrated 98% sensitivity and 97% specificity at detecting prostate cancer
- AI also flagged 6 slides not noted by expert pathologists

EFFICIENCIES FOR SYSTEMS AND PROVIDERS



LeanTaaS

Unlocking Healthcare Capacity and Access with Technology and Lean Transformation

A photograph of a man in a suit sitting at a desk, working on a laptop. A futuristic, glowing blue and white data overlay is superimposed on the scene, showing various charts and graphs.

How Novant Health Optimized OR Capacity to Restore Elective Surgery & Achieve Stronger Financial Health

INTEGRATION SOLUTION

Eon is a powerful supplement to Epic.

The Eon logo is in the top right corner. A large, white, spiral graphic is positioned in the bottom right corner of the slide.

CAPACITY MANAGEMENT

LeanTaaS Overview

Silicon Valley, Charlotte and Boston based software company

- PhDs in Mathematics, Software Engineers, Product Managers, Operations Experts, Hospital Executives

\$350+ Million invested in predictive analytics platform “iQueue”

Mission: Unlock capacity of scarce assets using predictive and prescriptive analytics:

- Improve patient access
- Increase volumes and revenues
- Reduce wait time for patients
- Reduce operating costs
- Defer the need for facility expansion

6 Patents Pending

Awards & 3rd Party Validation



Gartner



605

Leading Hospitals

14 of top 20

Health Systems

175

Health Systems

46

States in the U.S.



CAPACITY MANAGEMENT

- **Achieve more effective discharge practices.**
 - Anticipate potential delays and better direct patient flow
 - Predictive modeling to improve discharge planning
- **Open and close surge units at the right time.**
 - Predict upcoming bed shortages
 - Identify departments with higher utilization to be proactive in triaging patient flow
- **Promote system-wide visibility**
 - See an accurate overview of entire system capacity
 - Allows more feasible, manageable transfers between facilities



CAPACITY MANAGEMENT



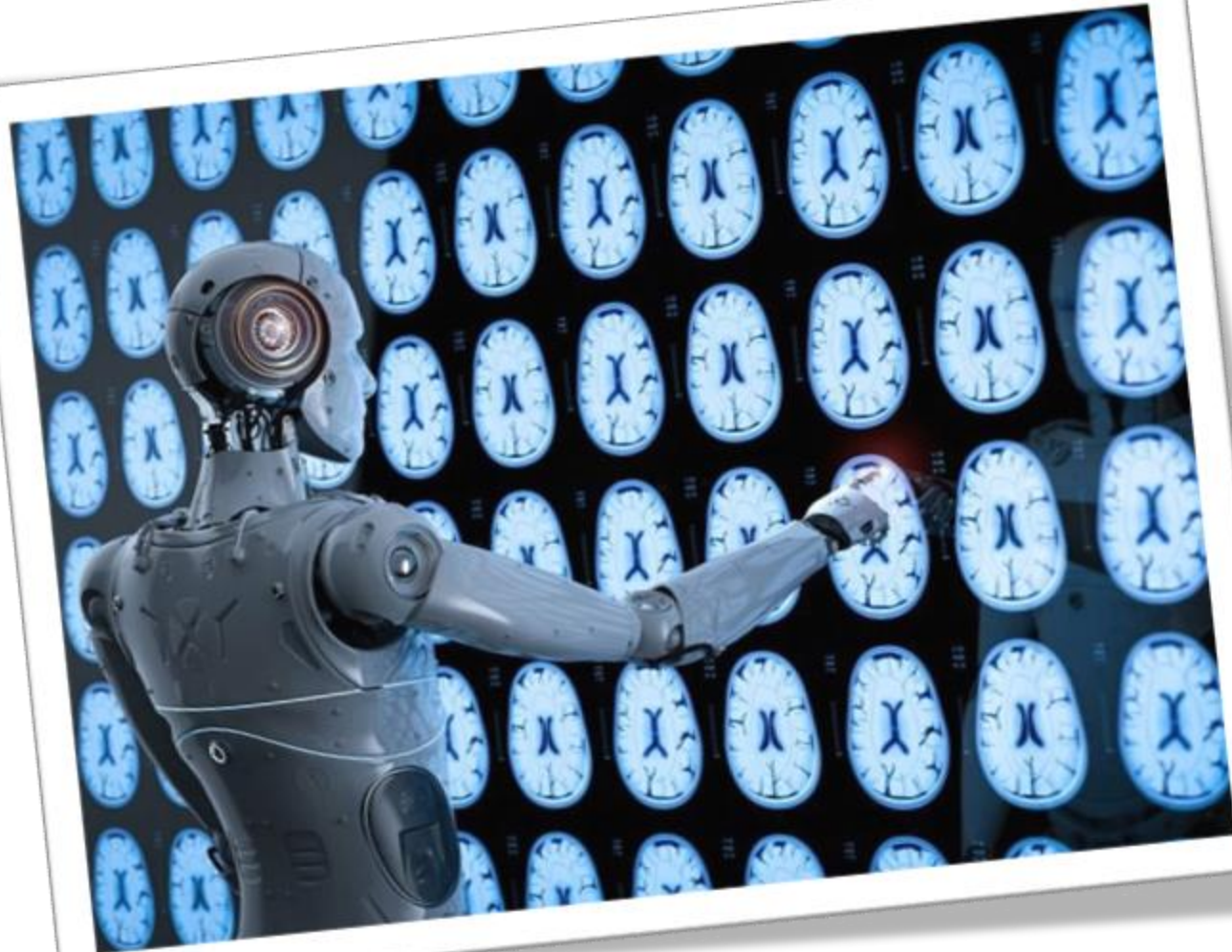
- AI powered patient flow optimization, like RTLS, ensures patients move through a facility, with the right level of care, as efficiently as possible.
- AI optimized schedule management gives clinicians more time with their patients
- AI decision support algorithms improve the ability of front-line doctors and caregivers to make more accurate diagnoses and provide better treatment.
- Immediate gains in reducing clinical errors

FASTER DEVELOPMENT OF MEDICINE

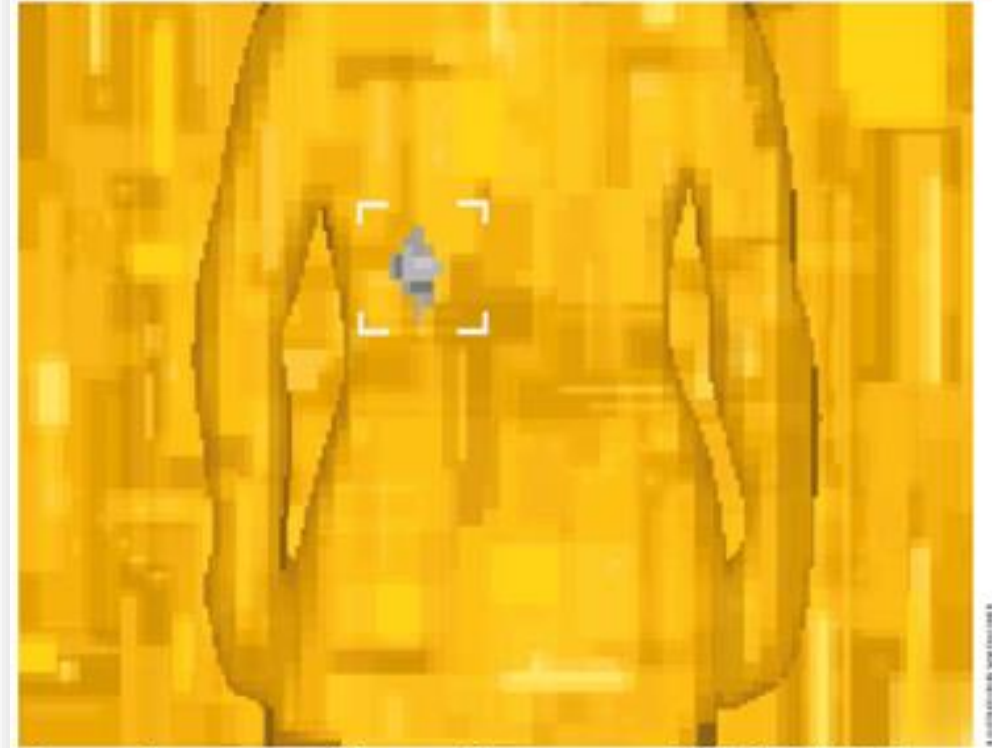


- During the 2015 West African Ebola Virus Atomwise partnered with IBM and the University of Toronto to screen the top compounds capable of binding to a glycoprotein that prevented Ebola penetration into cells.
- This AI analysis occurred in less than a day, a process that usually would have taken months or years enabling the development of the treatment for Ebola.

ANOTHER SET OF EYES



Cancer diagnosis outlook



Another set of eyes for cancer diagnostics

Artificial intelligence's ability to detect subtle patterns could help physicians to identify cancer types and refine risk prediction. **By Neil Savage**

mind, Smuderl turned to a computer. He arranged for the girls to have a full-genome methylation analysis, which checks for small hydrocarbon molecules attached to DNA. The addition of such methyl groups is one of the mechanisms behind epigenetics – when the activity of genes is altered without any mutation to the underlying genetic code – and different types of cancer show different patterns of methylation. Smuderl fed the results to an artificial-intelligence (AI) system developed by a consortium including researchers at the German Cancer Research Center in Heidelberg, and let the computer classify the tumour.

ILLUSTRATION: JONAS HENRIK

INNOVATION THAT BENEFITS PROVIDERS AND PATIENTS

MEDTECH

FDA clears Paige's AI as first program to spot prostate cancer in tissue slides

By **Conor Hale** • Sep 22, 2021 11:59am

JAMA | **Original Investigation** | INNOVATIONS IN HEALTH CARE DELIVERY

Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs

EDITORIAL

Deep Learning Algorithms for Detection of Lymph Node Metastases From Breast Cancer Helping Artificial Intelligence Be Seen

Jeffrey Alan Golden, MD

AI Partnership to Advance Brain Tumor Research, Treatment

Hackensack Meridian Health and Neosoma, Inc. have announced a collaboration aimed at tackling difficult-to-treat brain tumors through the use of artificial intelligence.

Radiology: Artificial Intelligence

Improving Breast Cancer Detection Accuracy of Mammography with the Concurrent Use of an Artificial Intelligence Tool

Serena Pacilè, PhD • January Lopez, MD • Pauline Chone, MPhil • Thomas Bertinotti, MSc • Jean Marie Grouin, PhD • Pierre Fillard, PhD

NEJM
Evidence

Published March 28, 2022

NEJM Evid 2022; 1 (5)

DOI: [10.1056/EVIDOa2100058](https://doi.org/10.1056/EVIDOa2100058)

ORIGINAL ARTICLE

AI Estimation of Gestational Age from Blind Ultrasound Sweeps in Low-Resource Settings

Teeranan Pokaprakarn, Ph.D.,¹ Juan C. Prieto, Ph.D.,² Joan T. Price, M.D., M.P.H.,^{3,4} Margaret P. Kasaro, M.D., M.P.H.,^{3,5} Ntazana Sindano, B.Sc.,³ Hina R. Shah, M.S.,² Marc Peterson, M.S.,⁴ Mutinta M. Akapelwa, B.Sc.,³ Filson M. Kapilya, B.Sc.,³ Yuri V. Sebastião, Ph.D.,⁴ William Goodnight III, M.D., M.S.,⁴ Elizabeth M. Stringer, M.D., M.Sc.,⁴ Bethany L. Freeman, M.P.H., M.S.W.,⁴ Lina M. Montoya, Ph.D.,¹ Benjamin H. Chi, M.D., M.Sc.,^{3,4} Dwight J. Rouse, M.D., M.S.P.H.,⁶ Stephen R. Cole, Ph.D.,⁷ Bellington Vwalika, M.D., M.Sc.,^{4,5} Michael R. Kosorok, Ph.D.,¹ and Jeffrey S. A. Stringer, M.D.^{3,4}

JAMA Guide to Statistics and Methods

Using Free-Response Receiver Operating Characteristic Curves to Assess the Accuracy of Machine Diagnosis of Cancer

Chaya S. Moskowitz, PhD

JAMA | **Original Investigation**

Diagnostic Assessment of Deep Learning Algorithms for Detection of Lymph Node Metastases in Women With Breast Cancer

Babak Ehteshami Bejnordi, MS; Mitko Veta, PhD; Paul Johannes van Diest, MD, PhD; Bram van Ginneken, PhD; Nico Karssemeijer, PhD; Geert Litjens, PhD; Jeroen A. W. M. van der Laak, PhD; and the CAMELYON16 Consortium

HEALTH TECH

White House unveils CancerX innovation accelerator, new funding for cancer screenings on Moonshot anniversary

INNOVATION THAT BENEFITS PROVIDERS AND PATIENTS

ChatGPT has 'great potential' to improve cancer prevention and screening, study finds



How Chatbots and Large Language Model Artificial Intelligence Systems Will Reshape Modern Medicine: Fountain of Creativity or Pandora's Box?

Li R¹, Kumar A¹, Chen JH¹

[Author information](#) ▶

JAMA Internal Medicine, 28 Apr 2023,

DOI: [10.1001/jamainternmed.2023.1835](https://doi.org/10.1001/jamainternmed.2023.1835) PMID: 37115531

JAMA Internal Medicine | [Original Investigation](#)

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

John W. Ayers, PhD, MA; Adam Poliak, PhD; Mark Dredze, PhD; Eric C. Leas, PhD, MPH; Zechariah Zhu, BS; Jessica B. Kelley, MSN; Dennis J. Faix, MD; Aaron M. Goodman, MD; Christopher A. Longhurst, MD, MS; Michael Hogarth, MD; Davey M. Smith, MD, MAS

Medicine in the Era of Artificial Intelligence: Hey Chatbot, Write Me an H&P.

Brender TD¹

[Author information](#) ▶

JAMA Internal Medicine, 28 Apr 2023,

DOI: [10.1001/jamainternmed.2023.1832](https://doi.org/10.1001/jamainternmed.2023.1832) PMID: 37115537

April 28, 2023

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

John W. Ayers, PhD, MA^{1,2}; Adam Poliak, PhD³; Mark Dredze, PhD⁴; [et al](#)

Results Of the 195 questions and responses, evaluators preferred chatbot responses to physician responses in 78.6% (95% CI, 75.0%-81.8%) of the 585 evaluations. Mean (IQR) physician responses were significantly shorter than chatbot responses (52 [17-62] words vs 211 [168-245] words; $t=25.4$; $P<.001$). Chatbot responses were rated of significantly higher quality than physician responses ($t=13.3$; $P<.001$). The proportion of responses rated as *good* or *very good* quality (≥ 4), for instance, was higher for chatbot than physicians (chatbot: 78.5%, 95% CI, 72.3%-84.1%; physicians: 22.1%, 95% CI, 16.4%-28.2%). This amounted to 3.6 times higher prevalence of *good* or *very good* quality responses for the chatbot. Chatbot responses were also rated significantly more empathetic than physician responses ($t=18.9$; $P<.001$). The proportion of responses rated *empathetic* or *very empathetic* (≥ 4) was higher for chatbot than for physicians (physicians: 4.6%, 95% CI, 2.1%-7.7%; chatbot: 45.1%, 95% CI, 38.5%-51.8%; physicians: 4.6%, 95% CI, 2.1%-7.7%). This amounted to 9.8 times higher prevalence of *empathetic* or *very empathetic* responses for the chatbot.

Conclusions In this cross-sectional study, a chatbot generated quality and empathetic responses to patient questions posed in an online forum. Further exploration of this technology is warranted in clinical settings, such as using chatbot to draft responses that physicians could then edit. Randomized trials could assess further if using AI assistants might improve responses, lower clinician burnout, and improve patient outcomes.

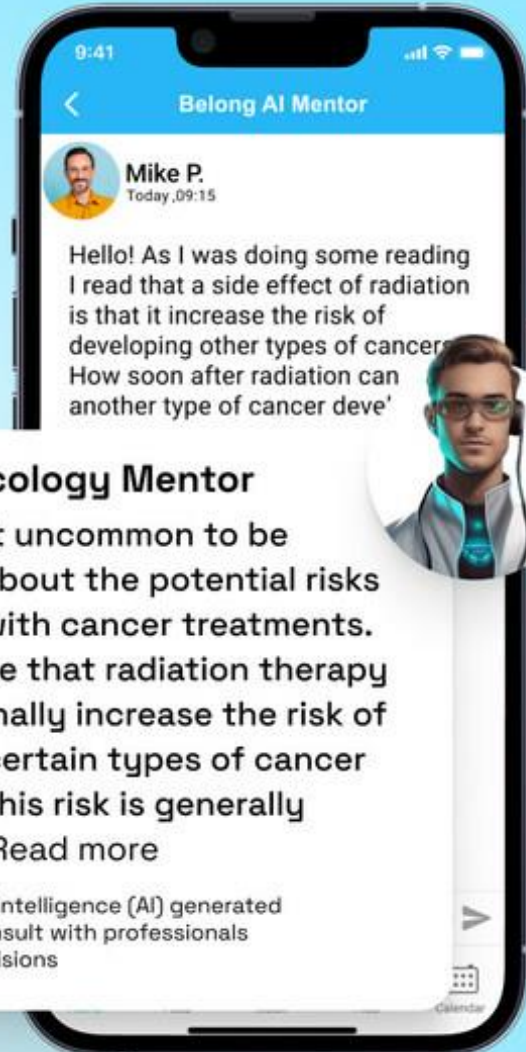
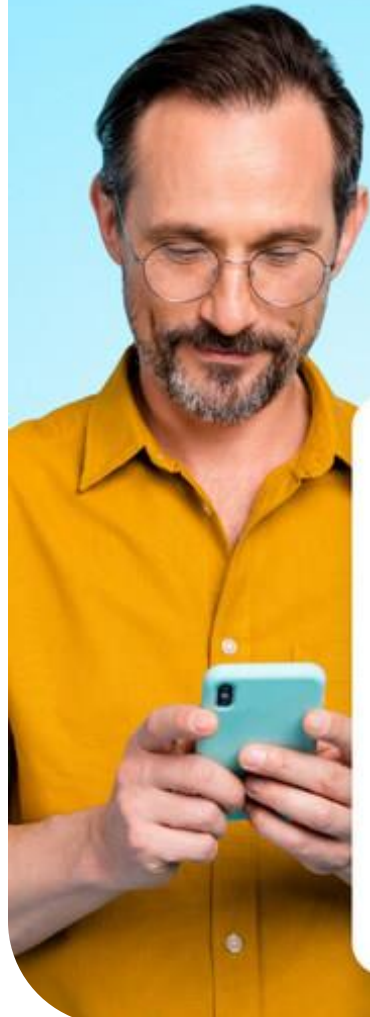
PHYSICIAN VS CHATBOT

Table. Example Questions with Physician and Chatbot Response^a

Question ^b	Physician response	Chatbot response ^c	Evaluation scores
Question about risk of dying following swallowing and ingesting a toothpick.	<p>If you've surpassed 2-6 h, chances are they've passed into your intestines. Which means it can't be retrieved easily.</p> <p>Many people can swallow razorblades and toothpicks without issue. In case you develop stomach ache, then don't hesitate seeking out an emergency room, and remember to point out the swallowed tooth pick.</p> <p>For now, they won't be doing much.</p>	<p>It's natural to be concerned if you have ingested a foreign object, but in this case, it is highly unlikely that the toothpick you swallowed will cause you any serious harm.</p> <p>Toothpicks are made of wood, which is not toxic and will not cause poisoning. However, it is possible for a toothpick to cause injury if it becomes stuck in the throat or if it punctures the digestive tract. However, this is unlikely to happen with a dull, cooked toothpick that is only 2 cm long.</p> <p>If you are experiencing any discomfort or symptoms such as abdominal pain, difficulty swallowing, or vomiting, it is important to contact a health care provider for further evaluation. However, if you are not experiencing any symptoms, it is safe to assume that the toothpick has passed through your digestive system and you do not need to be concerned.</p> <p>It's always a good idea to be cautious when consuming food and to remove any foreign objects before eating. It's understandable that you may be feeling paranoid, but try not to worry too much. It is highly unlikely that the toothpick will cause you any serious harm.</p>	<ul style="list-style-type: none"> • 100% preferred the chatbot • 4.67 mean quality score (chatbot) • 3.33 mean quality score (physician) • 4.33 mean empathy score (chatbot) • 2.00 mean empathy score (physician)
Question about needing to see a physician following injury that occurred by hitting head on a metal bar while running, resulting in lump on head, headache, and sore neck.	<p>Things that signify you should see a doctor:</p> <ul style="list-style-type: none"> • Nausea/vomiting • Dizziness • Severe or worsening headache • Loss of consciousness • Confusion • Neck stiffness • Problems with vision • Limb weakness <p>If you develop any of these in the next 24 h, rush to the emergency room.</p>	<p>It's always best to err on the side of caution when it comes to head injuries. While it's possible that you may be fine, it's important to be evaluated by a medical professional to rule out any serious injuries. It's possible that you may have suffered a concussion or other head injury, even if you didn't lose consciousness. Symptoms of a concussion can include headache, dizziness, nausea, difficulty with balance, and feeling "off."</p> <p>The location of the impact and the apparent force of the injury could potentially make a difference in the severity of the injury. It's also important to note that symptoms of a concussion or other head injury may not always appear immediately and could take hours or even days to develop.</p> <p>It's important to seek medical attention as soon as possible if you experience any of the following symptoms after a head injury:</p> <ul style="list-style-type: none"> • Loss of consciousness, even if it's just for a few seconds • Severe or worsening headache • Nausea or vomiting • Slurred speech • Difficulty with balance or coordination • Seizures • Changes in behavior or personality • Clear fluid draining from the nose or ears <p>It's also a good idea to see a doctor if you experience neck pain after a head injury, as this could be a sign of a neck injury.</p> <p>In the meantime, try to rest and avoid activities that could potentially cause further injury to your head, such as contact sports or activities that involve high speeds or heights. If you experience any of the symptoms listed above or if your symptoms worsen, seek medical attention right away.</p>	<ul style="list-style-type: none"> • 100% preferred the chatbot • 4.33 mean quality score (chatbot) • 4.67 mean quality score (physician) • 4.67 mean empathy score (chatbot) • 2.33 mean empathy score (physician)

WORLD'S FIRST REAL-TIME CONVERSATIONAL AI ONCOLOGY MENTOR FOR CANCER PATIENTS

Dave - Belong AI Oncology Mentor



Dave AI Oncology Mentor

Hello. It's not uncommon to be concerned about the potential risks associated with cancer treatments. While it's true that radiation therapy can occasionally increase the risk of developing certain types of cancer later in life, this risk is generally quite small. Read more

This is an Artificial Intelligence (AI) generated answer. Always consult with professionals before making decisions

"*Dave* provides smart, personalized and accessible information instantaneously, which can greatly improve the quality of care and life for millions of patients worldwide," said Elikan Malki, Co-founder and CEO of Belong.Life. "Belong is currently developing additional conversational AI mentor and companion platforms for other health indications and organizations."

CURRENT OPPORTUNITIES AND CHALLENGES

PROBLEMS



- Workforce Shortages
- Equipment Shortages
- Drug Shortages
- Poor Data Collection and Utilization Practices

AI APPLICATIONS



- Portable Diagnostics
- Clinical Decision Support
- On-demand knowledge for specialty tasks, image interpretation, failure trend prediction, and troubleshooting
- Population Health – data for cause and effect analysis and policy-making
- Health Registries and Data Aggregation

CHALLENGES



- AI Literacy
- AI Talent
- Regulations
- Funding
- Infrastructure
- Data Privacy and Security
- Algorithmic Bias
- Lack of Transparency
- Ethical Considerations

CURRENT LIMITATIONS AND CHALLENGES

Healthcare Algorithms Are Biased, and the Results Can Be Deadly

Deep-learning algorithms suffer from a fundamental problem: They can adopt unwanted biases from the data on which they're trained. In healthcare, this can lead to bad diagnoses and care recommendations.

How Bias Can Creep into Health Care Algorithms and Data

Health care is rife with bias. Without careful attention, AI will perpetuate those inequities.

Amazon Still Pushing Biased Facial-Recognition Software To Law Enforcement, MIT Researcher Contends

Biases in Artificial Intelligence Led to Healthcare Disparities
Researchers from the US and China note that several biases found in artificial intelligence design perpetuate healthcare disparities.

Racial bias in a medical algorithm favors white patients over sicker black patients

A US government study confirms most face recognition systems are racist



ETHICAL IMPLICATIONS IN MEDICAL DIAGNOSIS & TREATMENT

ETHICAL

Regulation

Privacy

Mitigation of Bias

Transparency

Relevance



LEGAL

Governance

Confidentiality

Liability

Accuracy

Decision Making

TANGIBLE BENEFITS AND ROI



Improves
Data
Analysis



Better
Diagnosis and
Treatment
Predictions



Frees Medical
Staff from
Administrative
Burdens

Contrary to fears that machines will replace human workers, AI in healthcare may help “re-humanize” healthcare

CHANGING THE HEALTHCARE LANDSCAPE

Streamlining Workflows

Reducing Costs

Improving Collaboration

Advancing Research

Empowering Patients

AI STANDARDS AND ADOPTION

FUTURE TRENDS AND INNOVATIONS

Equity

Evidence

Sustainability

Policy

Education

“People Analytics” and Large Scale Databanks: Blurring the Boundaries Between Medical Research, Clinical Care and Daily Life

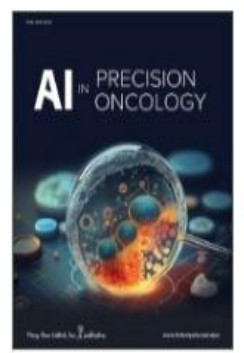
- every monitored event (clinical and non-clinical) is a potential data point
- every individual is a data node
- every individual is a research asset
- every individual is their own control



AI IN PRECISION ONCOLOGY

The only peer-reviewed research journal dedicated to the advancement of artificial intelligence applications in clinical and precision oncology

ABOUT THIS PUBLICATION



AI in Precision Oncology

Editor-in-Chief: Douglas Flora, MD

ISSN: 2993-091X | Online ISSN: 2993-0928 | Published Bimonthly

The only peer-reviewed research journal dedicated to the advancement of artificial intelligence applications in clinical and precision oncology

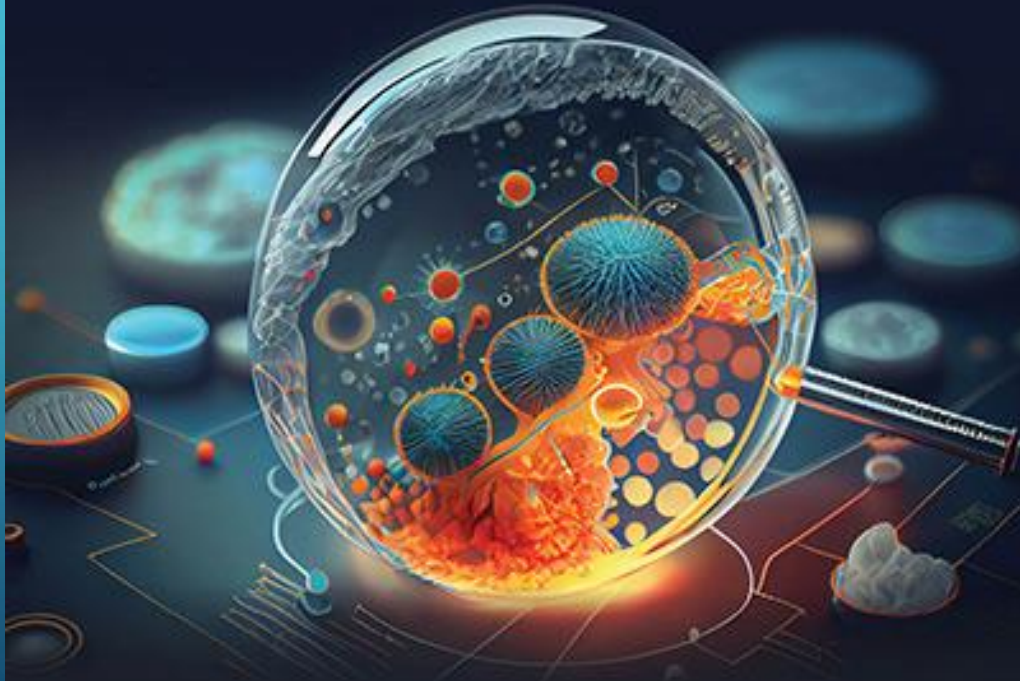
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**AI-Driven
Precision Oncology
Summit**

NASDAQ World Headquarters
New York, Sept. 26TH 2023



The future is bright!



ACCC 2022-2023 PRESIDENT'S THEME

Leveraging Technology to Transform Cancer Care Delivery and the Patient Experience

David R. Penberthy, MD, MBA

Associate Professor of Radiation Oncology
Penn State Health Milton S. Hershey Medical Center
Hershey, Pennsylvania



ASSOCIATION OF COMMUNITY CANCER CENTERS (ACCC)

ACCC 2022-23 President's Theme Tech Talk #1
The Home as a New Site of Cancer Care

Thursday, July 14, 2022



ASSOCIATION OF COMMUNITY CANCER CENTERS (ACCC)

ACCC 2022-2023 President's Theme Tech Talk #2
Technology Solutions to Mitigate the
Workforce Shortage

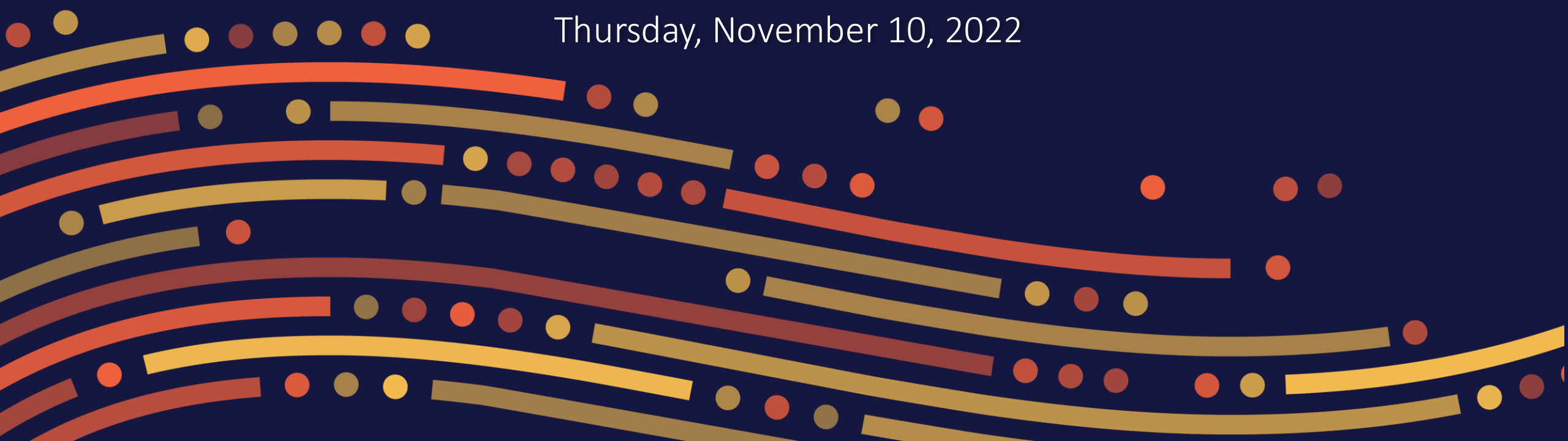
Thursday, August 18, 2022



ASSOCIATION OF COMMUNITY CANCER CENTERS (ACCC)

ACCC 2022-2023 President's Theme Tech Talk #3
Applying a Health Equity Lens to
Implementing Remote Patient Monitoring

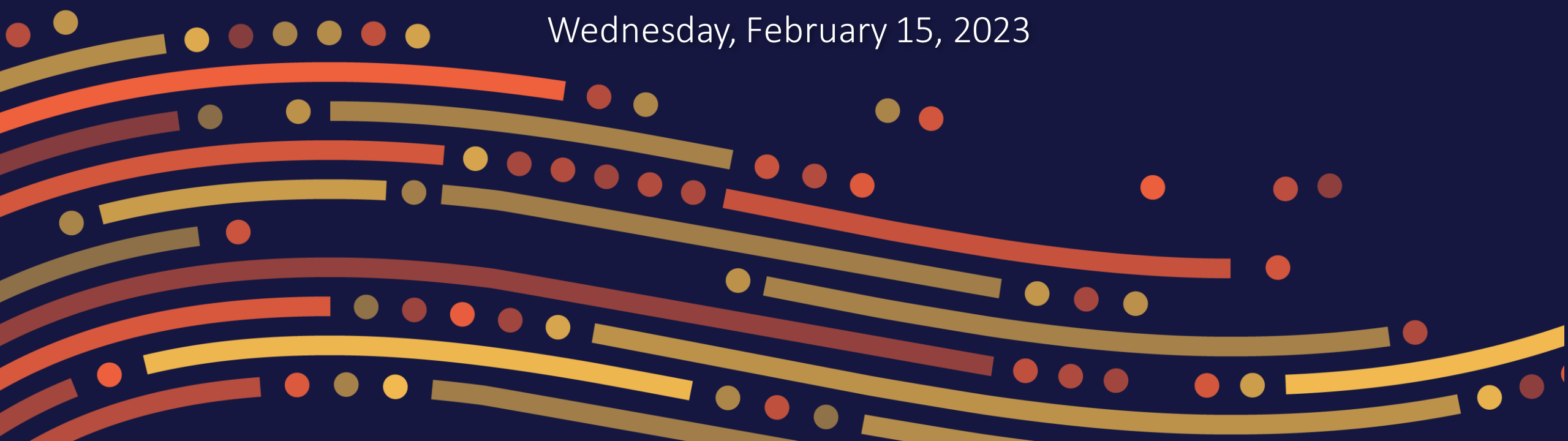
Thursday, November 10, 2022



ASSOCIATION OF COMMUNITY CANCER CENTERS (ACCC)

ACCC 2022-2023 President's Theme Tech Talk #4
The Impact of Big Data and Artificial
Intelligence on Oncology

Wednesday, February 15, 2023



TECH TALK SPEAKERS



Amy Ellis

Chief Operating Officer
Northwest Medical Specialties, PLLC
Tacoma, Wash.



Douglas Flora, MD, LSSBB

Executive Medical Director, Oncology Services
St. Elizabeth Healthcare
Edgewood, Ky.

Susan Ford

Chief Executive Officer
Michiana Hematology Oncology
South Bend, Ind.



Matt Devino, MPH

Director, Cancer Care Delivery and Health Policy
Association of Community Cancer Centers
Rockville, M.D.



TECH TALK SPEAKERS



Rick Baehner, MD
Chief Medical Officer, Precision Oncology
Exact Sciences
Redwood City, Calif.

Blythe Adamson, PhD, MPH
Principal Scientist
Flatiron Health
New York, N.Y.



Sarah McGough, PhD
Principal Data Scientist
Genentech
San Francisco, Calif.

John Frownfelter, MD, FACP
Lead, Data Driven Healthcare
NTTData
Highland, Mich.



Introducing Digital Human

Digital Human:

- Is lifelike animated avatar
- Can be customized exterior and interior
- Can recognize real-time situations
- Can react them like human

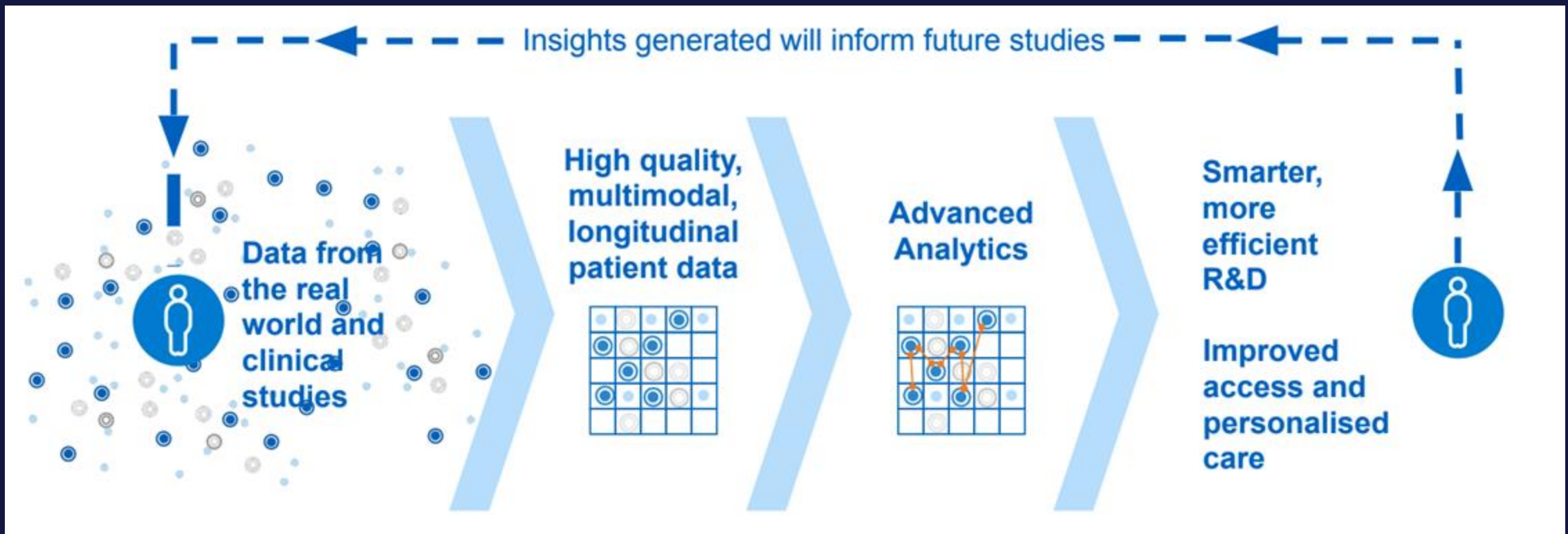


Type of Digital Human

	Interactive	Not Interactive
Non-Existing Character	Auto Reception/ Auto Kiosk/ Digital Assistant	Virtual Model/ Influencer
Existing Character	Digital Clone of Specialist	Video Guide for Museum

Oncology Insights in Drug Development: Machine Learning from an Industry Perspective

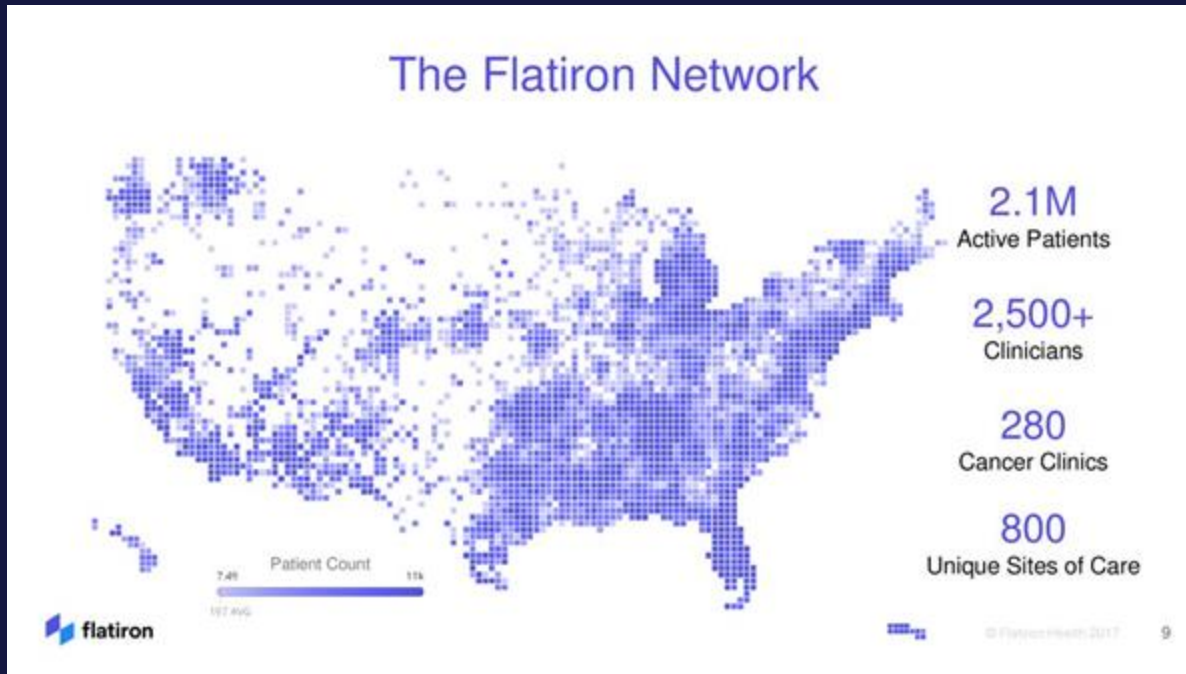
At Genentech/Roche, **data & advanced analytics** are key enablers to transform healthcare



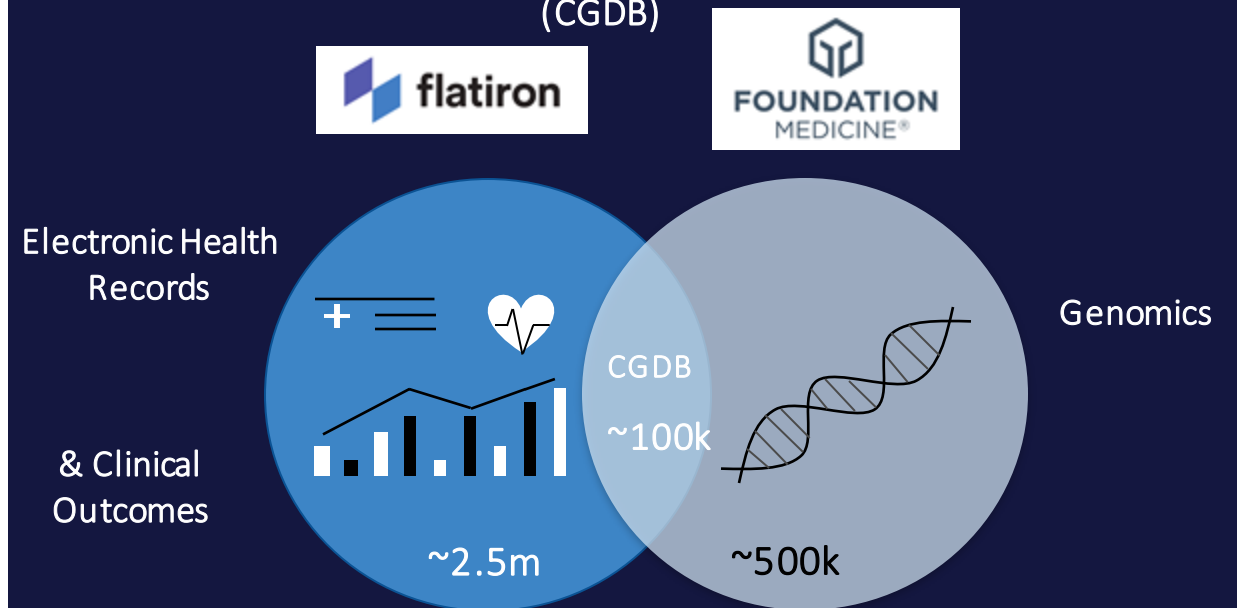
Focus: Applying advanced analytics will enable understanding of patient and disease heterogeneity and its relevance to clinical outcomes at an unprecedented resolution

Oncology Insights in Drug Development: Machine Learning from an Industry Perspective

Real-world data enables us to capture a larger & broader population of patients with cancer



Flatiron-Foundation Medicine Clinico-Genomic Database (CGDB)



Spotlight on: Disease & Patient Insights

Cultivating **tumor-agnostic** insights in light of the evolving paradigm of anti-cancer treatment

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PRECISION ONCOLOGY NEWS

Business & Policy Biomarkers Cancer Specialties Oncology Trends Resources

Home » Disease Areas » Cancer


Industry Interest in Pan-Cancer Indications Growing With FDA Support Despite Challenges

May 29, 2019 | [Turna Ray](#)

FDA NEWS RELEASE

FDA approves third oncology drug that targets a key genetic driver of cancer, rather than a specific type of tumor


13




BIOPHARMADIVE Deep Dive Library Events Topics

Roche cancer drug the 3rd approved for pan-tumor use

Published Aug. 15, 2019 • Updated Aug. 15 2019, 3:15 p.m. PDT

 **Ned Pagliarulo**
Lead Editor

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Spotlight on: Clinical Trial Design

How can we create broader and more inclusive clinical trials without compromising estimates of treatment effects?

Clinical Trials

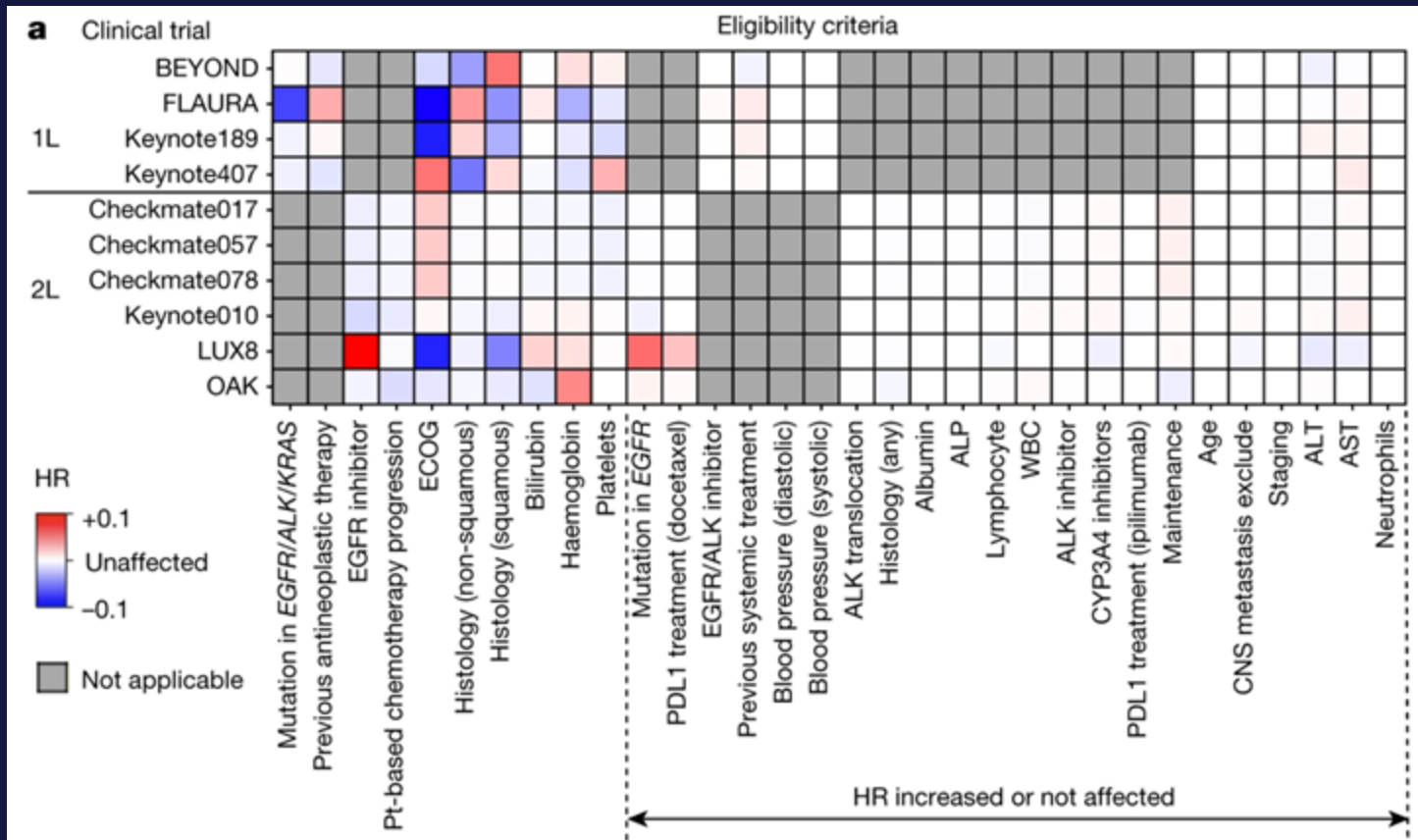


Real World



Spotlight on: Clinical Trial Design¹⁵

Training predictive models to **optimize** data-driven set of **eligibility criteria**



Data-driven criteria enlarges pool of eligible patients by **107%** on average, without compromising treatment effect.

Relaxing thresholds for key labs like bilirubin, hemoglobin, platelets, and ALP yields no impact on trial conclusions, while making trials **more inclusive**.

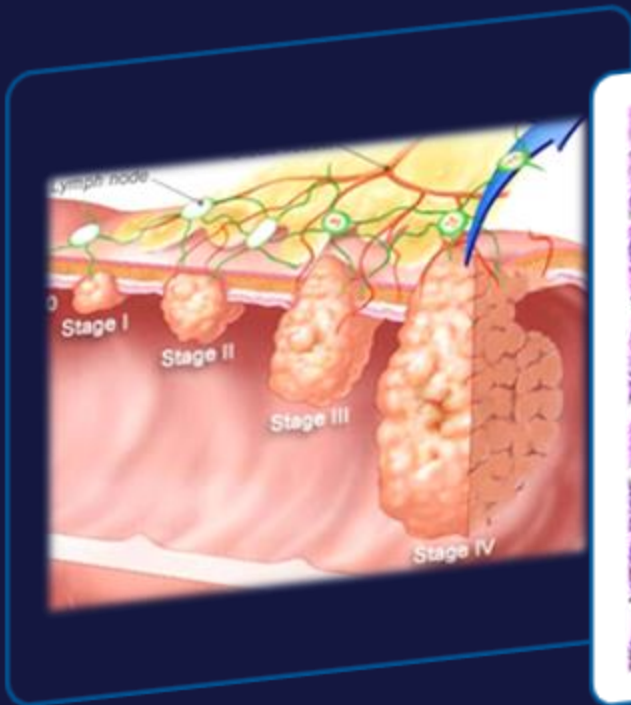
The Horizon: What's Next for Big Data & Machine Learning in Industry?

- **Scaling** insights
- **Operationalizing** tools—embedding data-driven analytics in clinical practice
- Weighing **ethics** and **risk to patient** **interpretation, fair models**

Forbes AI 50 2023
\$27B funding!

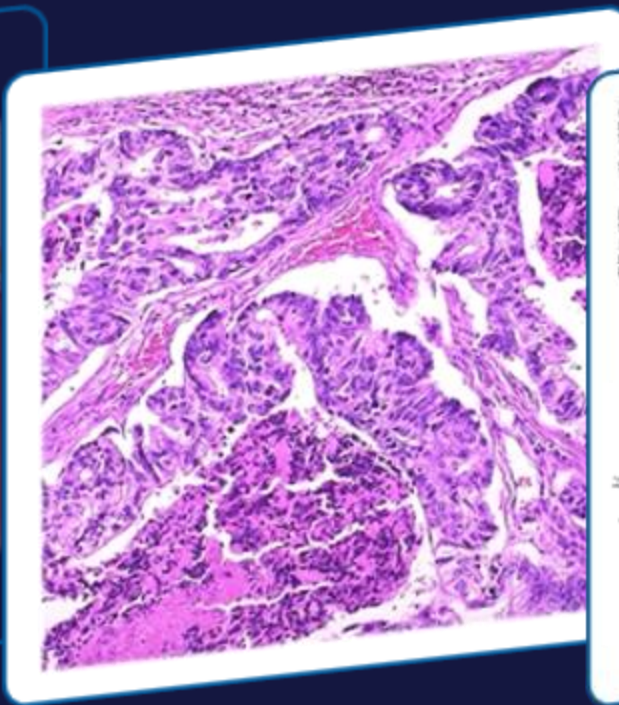


Value of Multiomics: Addition of Orthogonal Prognostic and/or Predictive Information to Baseline ctDNA Results



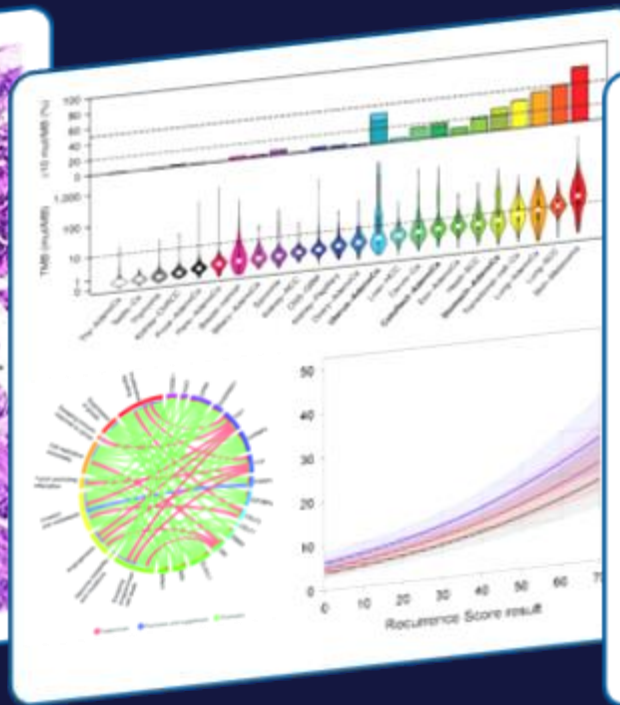
Clinico-pathologic factors

- Number of nodes examined
- T-Stage
- Number of positive nodes



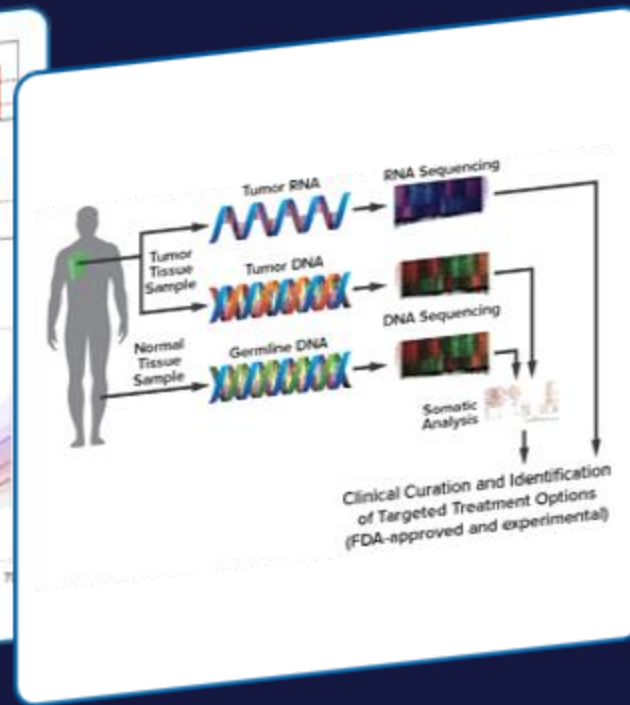
H&E analysis

- Artificial intelligence/machine learning
- Prognostic/predictive signatures



Tissue derived genomic data

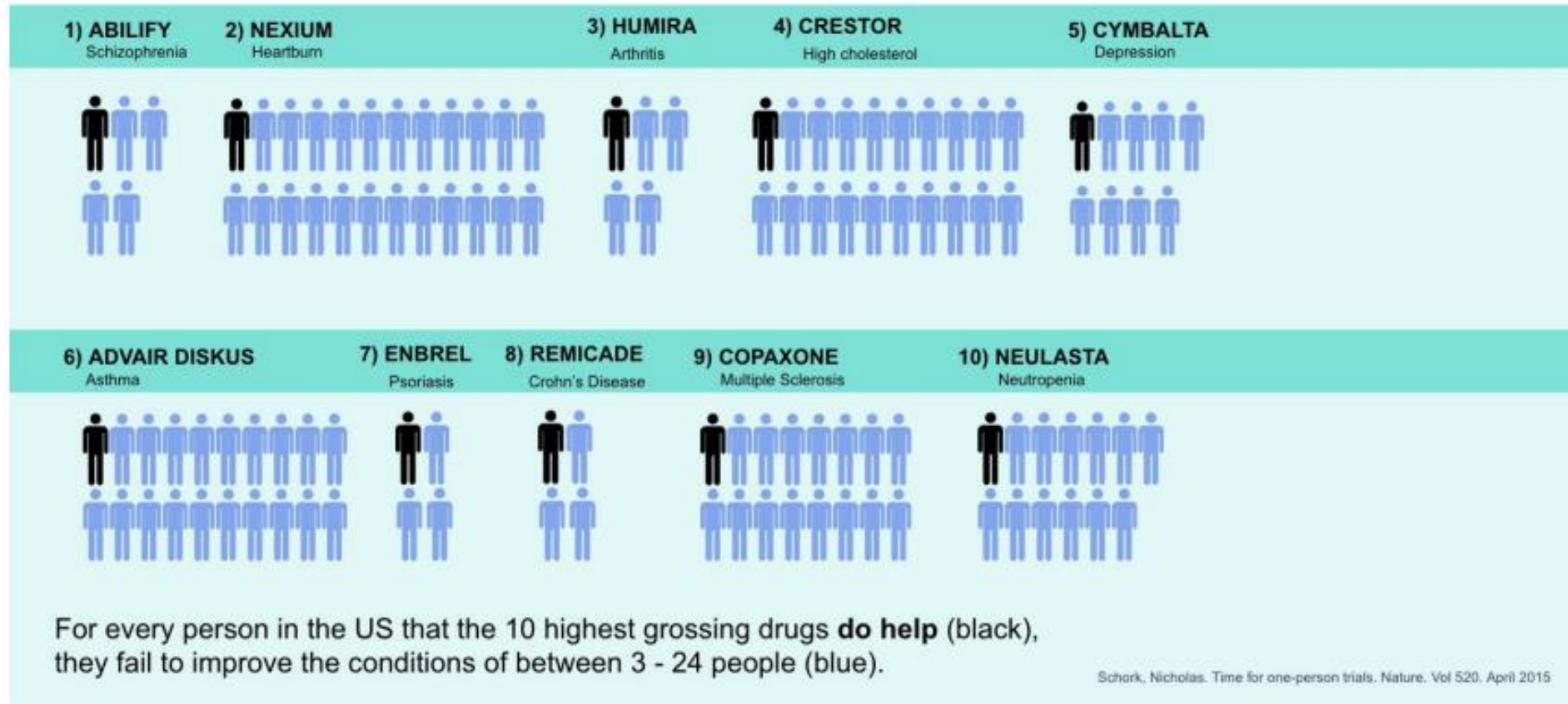
- Transcriptomic signatures, tumor microenvironment
- TMB, MSI, TCR, HLA LOH, neoantigens
- Minimal residual disease



Germline toxicity variants

- Dihydropyrimidine dehydrogenase (DPYD)
- Thymidylate synthase (TYMS)

Phenome (WGS + LPR) cohorts can *stratify* diseases, from first principles.



Source: Schork, Nicholas. [Personalized Medicine: Time for one-person trials](#). Nature. Vol 520, April 2015.

The Phenomics Revolution is coming.

The Phenomics Revolution

Science is poised to shift the focus of health care to well care—the prediction and prevention of disease rather than just treating the sick

BY DAVID EWING DUNCAN

In 2017, I got a call from Ginger Hultin, my brand-new health data coach. She was concerned, she said, about my TMAOs.

"My what?" I asked.

"Your TMAOs," she repeated, referring to trimethylamine-N-oxide, a metabolite that's excreted by bacteria in the stomach that at high-er-than-average levels can increase a person's risk for heart disease.

Who knew?

Not to worry, said Hultin in a soothing, upbeat voice. I could reduce my score by cutting back on red meat, which TMAO-secreting bacteria love to gorge on.

Trimethylamine-N-oxides were part of a battery of tests I had taken a few weeks earlier when Hultin's employer, a Seattle start-up called Arivale that had collected copious amounts of my blood, saliva, and stool to test hundreds of biomarkers. These included DNA markers, proteins, metabolites, lipids like cholesterol, and the microbiome in my gut.

The company had also sent me a Fitbit to measure steps, sleep, and heart rate. Online they had asked endless questions about my health, medical history, happiness, stress, and more to add to my digital health report card; information that was integrated with my other data using advanced computers and algorithms to produce the report that Hultin and I were discussing. The goal was for me, a basically hale and hearty man in my fifties, to find out just how healthy I really was—both then and in the future.

Still on the phone, Hultin asked me to scroll to a section called "Genes" in my online Arivale profile. "Do you see the finding about vitamin D?" she asked. "Yep" I said, checking my result for a gene called VDR. It indicated that I had a mutation that makes it difficult for my body to absorb vitamin D. "This is probably why your vitamin D level is low," she said, referring to yet another section of my profile. Not dangerously so, though she suggested that I start taking a vitamin supplement.

I was impressed. I had spent years as a reporter trying out hundreds of newfangled tests like these to see what they might reveal about the health of an actual human, findings that I had chronicled in my

2009 book *Experimental Man* and in dozens of articles before and after, including a 2017 story in *NEO LIFE*, "The Radical Idea of Avoiding Sickness." Most of them, however, had been too new, experimental, and incomplete to tell me much.

Arivale's data and analysis was different. It seemed more scientifically sound; and, more important, it seemed believable.

Yes, the company was testing just a small number of bio-data points, a few hundred out of the thousands that might be influencing, say, my risk for heart disease. Nor was TMAO likely to have an immediate influence—or much influence at all compared to other risk factors—on whether my heart would keep happily beating, or would one day seize up. Yet the report was telling me things that few people hear about who take standard exams. I also was being given choices based on my own specific data about how to intervene in my own healthcare—for instance, to rein in the burgers and BBQ pulled pork sandwiches or face the consequences.

I remember feeling like I had just gotten a check-up from the future...

At the time, I remember feeling like I had just gotten a check-up from the future, something that scientists and entrepreneurs had repeatedly promised me during my experimental man project, but seldom delivered on. This wasn't surprising given the complexity of human biology and the newness of the science, although I had been wondering when all of this would finally come together to

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Digital Tools in Cancer Care

RPM Technologies Survey Findings

FULL REPORT

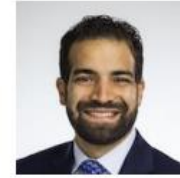
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Senior Vice President, Enterprise
Radiation Oncology
Jefferson Health
Philadelphia, PA

Methodology

Patients and Caregivers:

Online survey (n=162)



- 90 cancer patients
 - currently undergoing treatment or treated in last 3 years



- 72 caregivers
 - caregivers to patients with cancer currently undergoing treatment or treated in last 3 years

Fielded January 4 – 23, 2023



Providers:

Online survey (n=128)

- Distributed by ACCC
- n=58 from SERMO
- N=70 from ACCC

Fielded December 21, 2022 – January 23, 2023

Methodological Limitations:

Potential sampling bias among patients & caregivers

- 1% of sample had concerns around access to a smartphone or computer as a potential barrier

Subgroups for Analysis

Patients	Caregivers	Urban	Suburban	Rural	Patient age <65	Patient age 65+	Person of Color	Not POC
n=90	n=72*	n=45	n=83	n=34	n=65	n=97	n=63*	n=98

*Caregivers and persons of color skewed younger.

Providers	Community	Academic/NCI	Private	Admin	Physicians	Nurses	Urban	Suburban	Rural	Implemented/Implementing RPM	Considering/Planning/Pilot RPM	Not considering RPM
n=128	n=51	n=49	n=26*	n=23*	n=67	n=23*	n=74	n=38	n=16*	n=36	n=51	n=36

▲ ▼ Denotes statistically significantly higher/lower than adjacent comparison group @90% CL

▲ ▼ Denotes statistically significantly higher/lower than adjacent comparison group @95% CL

*sample sizes below n=30 are considered extremely small and should be viewed with caution

Key Findings: Patients and Caregivers

1

Open to using digital tools to report symptoms

- Most patients and caregivers are **open to using technology to report symptoms** during cancer treatment
- More than half report either using technology already or considering its use
- **Caregivers are more likely to already use technology** to report symptoms and share symptoms that normally wouldn't come up during an appointment.

2

See the value in reporting symptoms

- Patients, caregivers, and providers agree that **keeping the healthcare team up to date and alerting if medical treatment is necessary** are the top reasons to use technology
- Providers also see improving outcomes and reducing hospitalizations as top benefits – a potential opportunity area to educate patients on additional benefits

3

Need in-person tech support and privacy/cost concerns addressed

- **Patients and caregivers feel that meeting in-person to help set-up technology is the most helpful**, particularly among rural and older respondents
- Patients and caregivers are **most concerned about the privacy of health data and cost of using technology**
- **Clear gap** between what patients want for technology support and what providers are offering

Key Findings: Cancer Programs

1

Concerns around confidence and accuracy

- While providers see benefits to RPM, they also **express only weak confidence in their own use of digital technology as well as cautious about the accuracy of data provided** by patients and caregivers
- Perceptions of benefits are lower among practices not considering RPM suggesting there is outreach and education to do

2

Admin as RPM advocates & disconnect between training and use

- **Admins appear to be greatest advocates for RPM** – encouraging adoption and expressing concern about patient accessibility
- Does not appear that training is happening consistently
- **While nurses are identified as key roles for monitoring RPM data, they report the least experience with it**

3

Great momentum and resulting need for RPM implementation support

- **Most cancer programs (7 in 10) reported at least early planning for RPM, with 3 in 10 programs having already implemented the technology**
- Many are already using EHR patient portals and/or text messaging to communicate
- **Implementation support needed** includes strategies for funding/reimbursement, business case examples, training, and success stories.

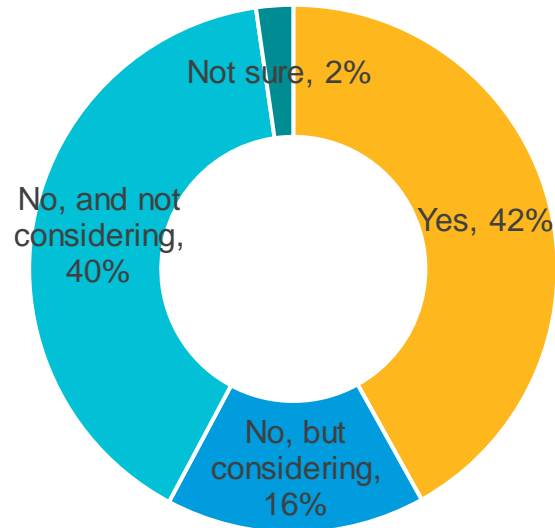
Use of Technology

Across Patient, Caregiver, and Provider audiences, there are groups of respondents who have embraced technology and others who are not planning to adopt it.

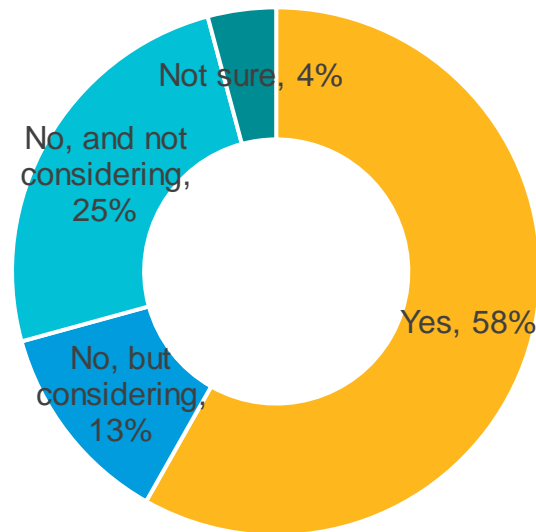
Use Technology to Track Health Information During Cancer Treatment



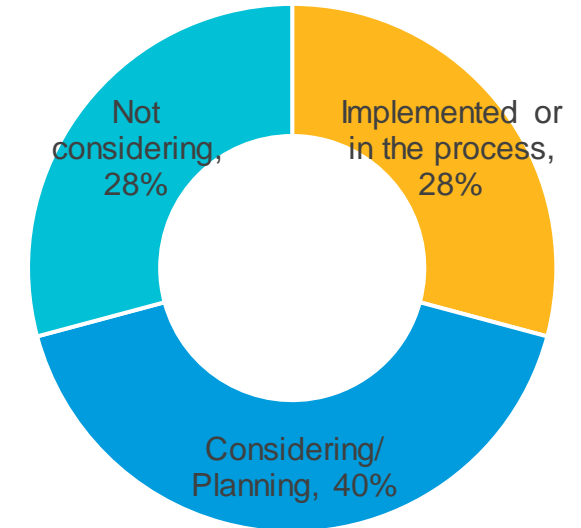
Patients



Caregivers



Providers





ChatGPT: What Did You Just Say?

- Generative Artificial Intelligence
 - Text-based and visual **artificial intelligence** tools
 - Goal of solving problems, accomplishing tasks with human-like responses and answers
 - These algorithms can answer almost any question, generate text, audio, music, video, images, art, code, music, make arguments, form ideas, and much more
 - GPT stands for **Generative Pre-Trained Transformer**—this is a natural language processing model

[Midjourney.com](https://www.midjourney.com)

[Openai.com/dall-e-2](https://openai.com/dall-e-2)

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What Can A Quantum Computer Do Better?

Quantum computing will solve a class of problems that are unsolvable today, opening up a new realm of applications.



SEARCHING BIG DATA



DESIGNING BETTER DRUGS
& NEW MATERIALS



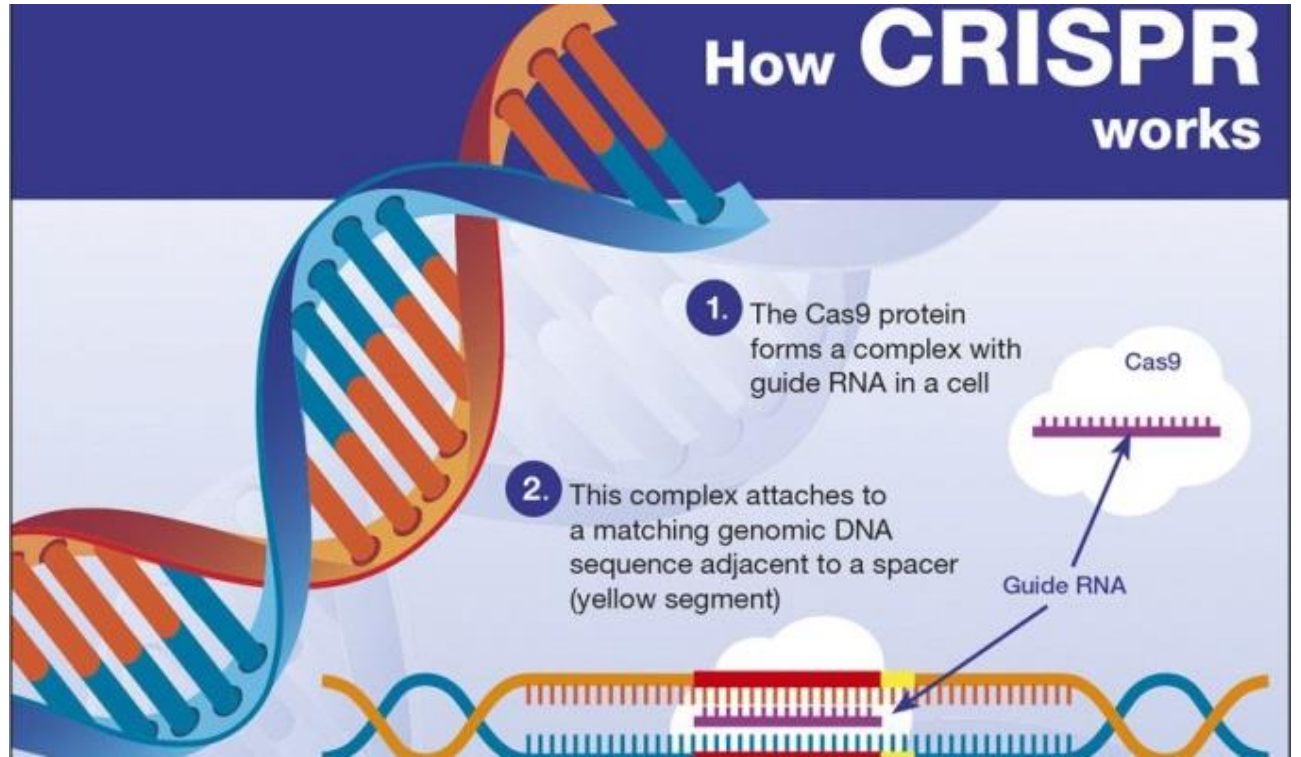
MACHINE LEARNING



How CRISPR works

1. The Cas9 protein forms a complex with guide RNA in a cell

2. This complex attaches to a matching genomic DNA sequence adjacent to a spacer (yellow segment)



illumina

bioinformatics

genetics

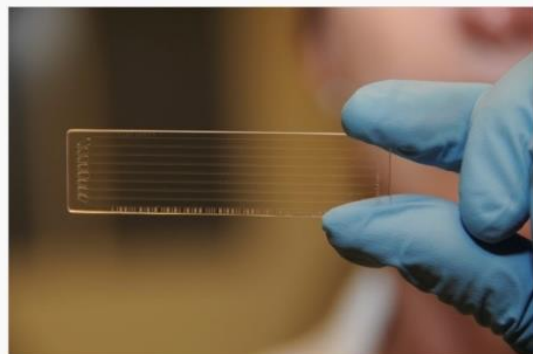
Bio

Popular Posts

illumina wants to sequence your whole genome for \$100

Posted Jan 10, 2017 by Sarah Buhr (@sarahbuhr)

Next Story



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OVERVIEW
At Illumina, their goal is to apply innovative technologies and revolutionary assays to the analysis of genetic variation and function, making studies

The first sequencing of the whole human genome in 2003 cost roughly \$2.7 billion, but DNA sequencing giant Illumina has now unveiled a new machine that the company says is "expected one day" to order up your whole genome for less than \$100.

Buttcrup is a risqué image site that pays creators

Snap CEO Evan Spiegel got a \$637 million bonus last year

Blockchain is entering the valley of despair phase, and that's a m...

SpaceX misses catching Falcon 9 rocket fairing with a giant net on a big ship



In 2012, scientists at the University of Leicester decided to print out a complete version of the human genome. When they were done, they had a 130-volume monument to humanity's essence—a seemingly endless sequence of As, Ts, Cs, and Gs in four-point type. Curiously, the printing project's costs already exceeded the costs of actually sequencing the genome anew. Since then, the price differential has only grown. Cas Kramer (Univ. Leicester) »

editas
MEDICINE

Intellia
THERAPEUTICS

CRISPR
THERAPEUTICS

Beam
THERAPEUTICS

verve
THERAPEUTICS

GRAPHITE BIO

CARIBOU
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Mammoth
Biosciences

scribe
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CHROMA
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EXCISION
BIOTHERAPEUTICS

Tome
BIOSCIENCES

SPOTLIGHT
THERAPEUTICS

TUNE
THERAPEUTICS



DIAGNOSTIC/ SURGERY



IMMUNO- THERAPY



TARGETED THERAPY



RADIATION THERAPY

NOW

- MR, PET, CT
- Procedural biopsy
- Next-gen sequencing
- Robotic surgery (DaVinci)

- Checkpoint inhibitors (PD-L1)
- Autologous ACT (CAR-T)
- Bispecific antibodies
- Cell/viral vaccines

- Fecal transfer
- TKIs (RET, MET, EGFR)
- Antibody drug conjugates
- Proteasome inhibitors (PARP)

- Adaptive therapy (MRLinAc)
- Pencil-beam proton
- Radiopharma (α / β)
- Theranostics

NEXT

- Nano-tech imaging
- Photoacoustic tomography
- Liquid biopsy (cfDNA)

- Next-gen ICIs (TIGIT, LAG-3)
- Off-the-shelf ACT (CAR-T, TIL, NIK)
- Multi-specific antibodies

- Engineered bacteria
- Intratumoral microbiomics
- Gene editing (CRISPR)

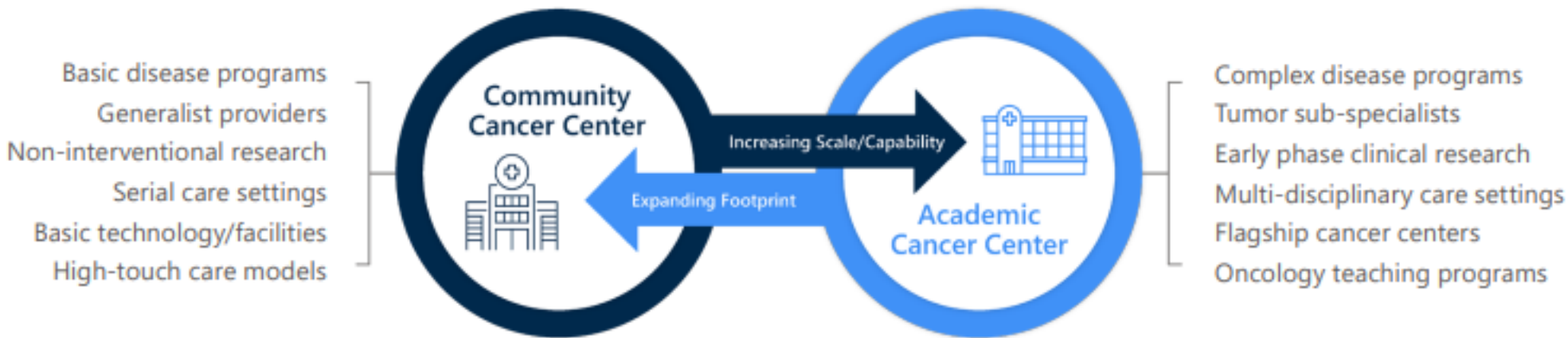
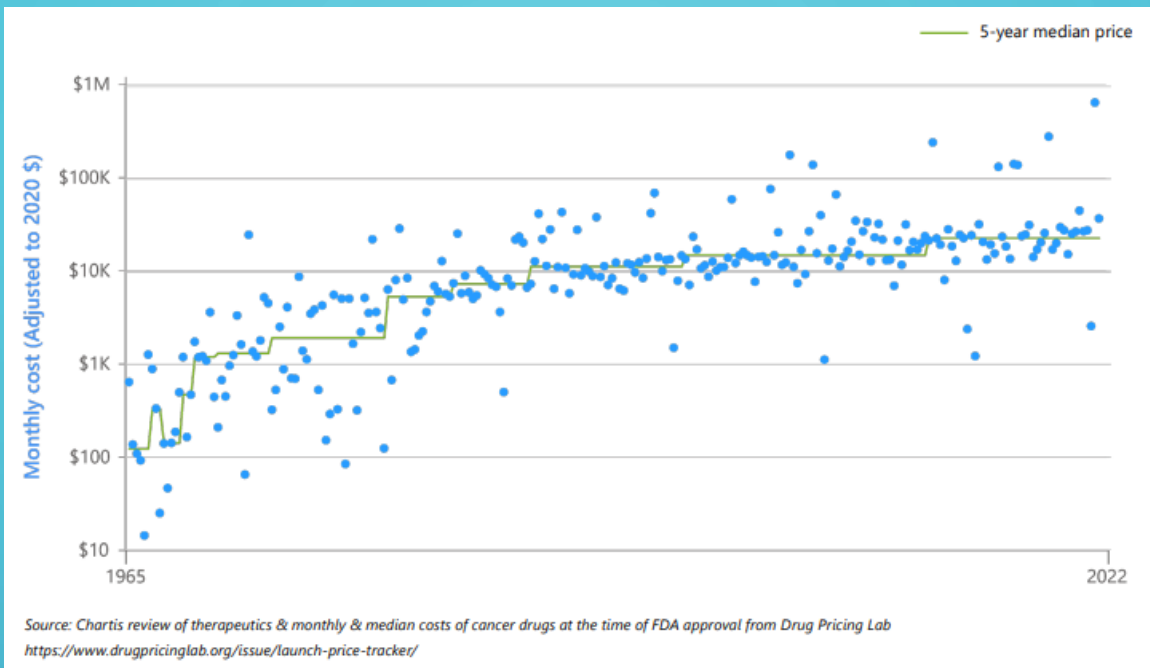
- Radiation immune modulation
- FLASH (Ultra high-doserate therapy)
- Heavy particle (carbon ion)

- Full "omics" panel
- AI smart robotics
- Intra-op navigation

- Polypeptide conjugates
- RNA-based vaccines (mRNA, siRNA, miRNA)

- Combination TKIs
- Nanoparticle delivery
- Immune + PARP

- α -Immunotherapy, combination PARP/ICIs



FUTURE FORCE IN ONCOLOGY

- 1** **Prevention and treatment advances will redefine the cancer “consumer”**
- 2** **Rapid innovation will remake the requirements of contemporary care**
- 3** **Unsustainable costs will prompt intervention across the value chain**
- 4** **Traditional provider identities will blur, creating new ecosystems of care**
- 5** **New entrants will accelerate disruption and innovation in the care continuum**

WHAT CANCER CENTERS NEED TO DO

Excel in the spaces before and after cancer, addressing the needs of millions of cancer “pre-vivors” and survivors.

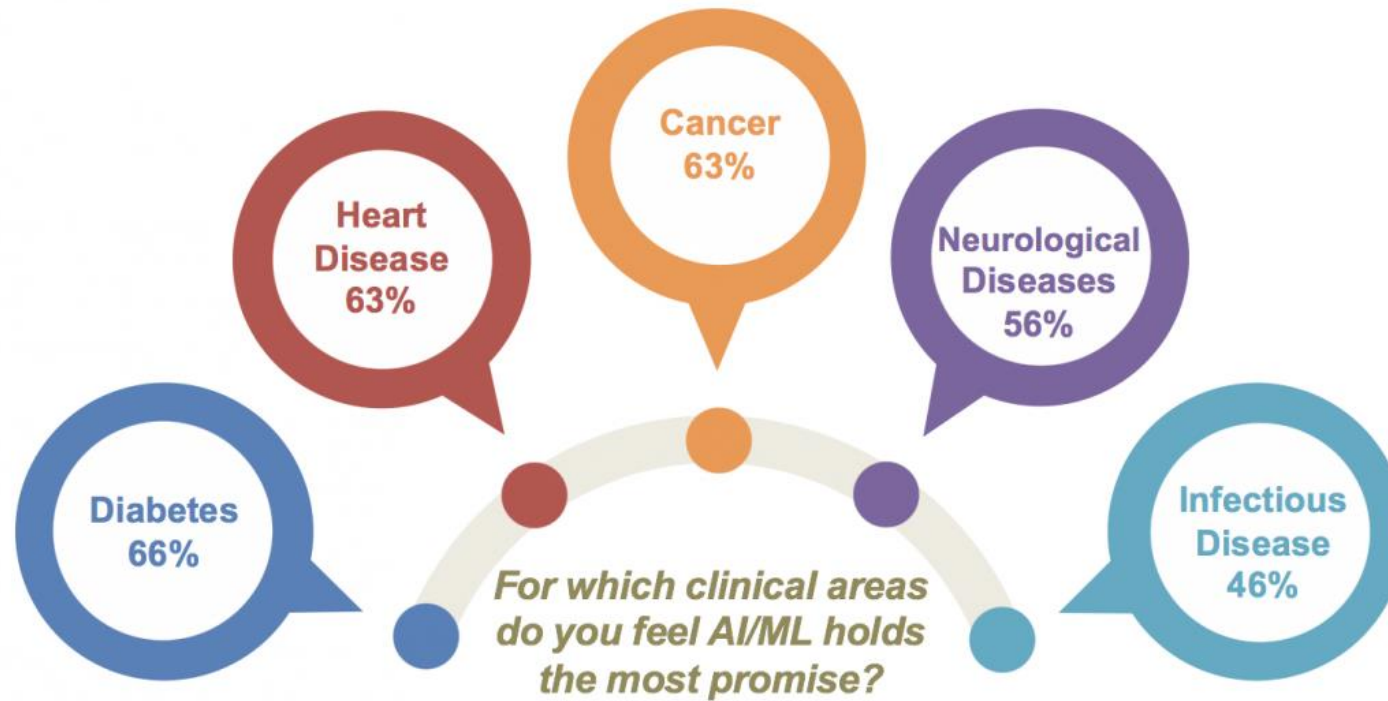
Build care models that reflect the complexity of the disease, capable of adapting to high-velocity clinical innovation.

Diversify the business model and create value-based competence, preparing for challenges to today’s onco-economics.

Redefine target patient segments and the role of partnerships in a marketplace of fungible community and academic roles.

Assemble the expertise and capabilities required to modernize the experience of cancer care.

CHRONIC HEALTH CONDITIONS EXPECTED TO BENEFIT MOST FROM AI/ML



Data curation and retrieval, not retention

THE PROMISE OF AI & ML IN HEALTHCARE



PREDICTIVE ANALYTICS

- Deep phenotyping – large scale data and prediction of Complex traits with disease risk
- Outcomes data and socio-behavioral parameters
- Mapping genetic overlap between different diseases involving shared pathogenic elements and comorbidity risks
- Cardiovascular, autoimmunity, psychiatric disorders

“If you’re teaching today what you were five years ago; either the field is dead or you are.”



-- Noam Chomsky

21st century curricular emphasis

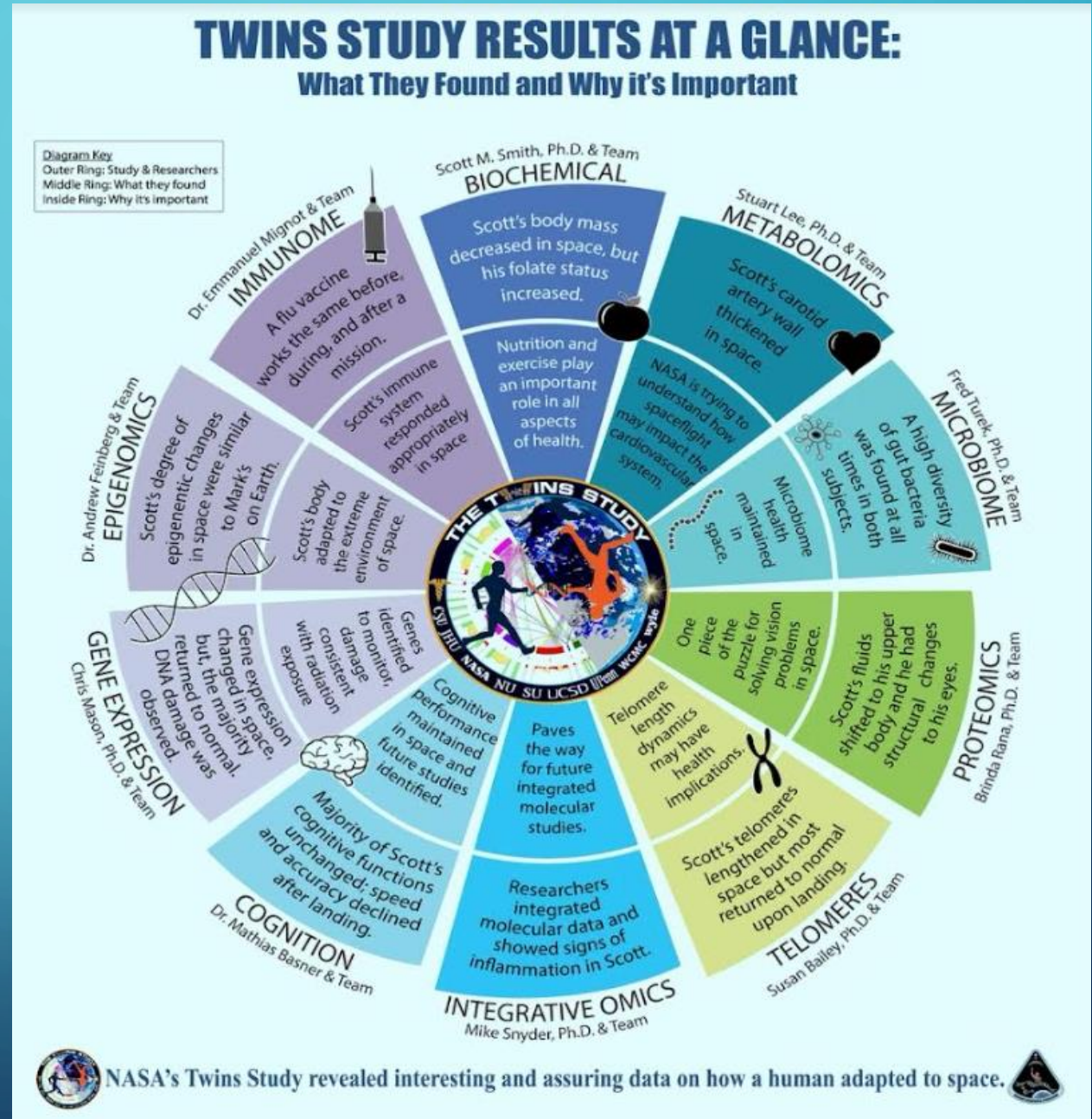
- **Knowledge capture and curation:** Teaching students to distinguish between information and knowledge. Stresses knowledge capture and curation not information retention.
- **Deep understanding of probabilistic reasoning:** understanding probabilities and communicating and applying them meaningfully
- **Collaboration with and management of AI applications**
- **Cultivation of empathy and compassion**

CASE STUDY #1

Real-world example of successfully managing medical information using AI and other technologies

NASA Twin Study of Mark and Scott Kelly who spent 340 days (at one time) on ISS

Total time in space was 520 days



NASA's Twins Study revealed interesting and assuring data on how a human adapted to space.



CASE STUDY #2

Importance of embracing AI and other technologies

Beauty of AI – may/can/will yield insights not initially obvious

These are early days!

The screenshot shows a web page from the Stanford Medicine News Center. The header includes navigation links for Health Care, Research, Education, Give, and About, along with social media icons for Facebook, Twitter, YouTube, LinkedIn, and Instagram. A search bar is located in the top right. The main article title is "Stanford Medicine researchers measure thousands of molecules from a single drop of blood". The byline is "January 19, 2023 - By Hadley Leggett". The article text describes a new multi-omic microsampling technique. A red callout box states: "A single drop of blood can yield measurements for thousands of proteins, fats and other biomarkers, researchers at Stanford Medicine found. fizes/Shutterstock.com". The article continues with details about the research, including a quote from Michael Snyder, PhD, and a video player at the bottom with the title "New treatment for COVID loss of smell" and "90 SECONDS WITH LISA KIM".

Health Care | Research | Education | Give | About

Stanford MEDICINE News Center

Menu Search News...

Stanford Medicine / News / Blood drop yields lots of data

share

Stanford Medicine researchers measure thousands of molecules from a single drop of blood

Using a new technique called multi-omic microsampling, Stanford Medicine researchers can measure thousands of protein, fat and metabolic molecules from a single drop of blood.

January 19, 2023 - By Hadley Leggett

Researchers at Stanford Medicine have shown they can measure thousands of molecules — some of which are signals of health — from a single drop of blood.

The new approach combines a microsampling device — a tool used to self-administer a finger prick — with “multi-omics” technologies, which simultaneously analyze a vast array of proteins, fats, by-products of metabolism and inflammatory markers.

“Even more importantly, we’ve shown you can collect the blood drop at home and mail it into the lab,” said Michael Snyder, PhD, director of the Center for Genomics and Personalized Medicine and senior author on the research, which was published in *Nature Biomedical Engineering* on Jan. 19.

Unlike finger-prick testing for diabetes, which measures a single type of molecule (glucose), multi-omics microsampling gives data about thousands of different molecules at once.

The research sounds similar to a well-known approach promoted in the past for testing a single drop of blood, but there are important differences: While the earlier approach was based on replicating existing diagnostic tests, multi-omic microsampling uses a different type of data analysis based on a technology called mass spectrometry, which sorts molecules based on their mass and electronic charge. In addition, the data analysis is performed in a lab, not in a portable box.

Less blood, more insights

Instead of focusing on any single protein, metabolite or inflammatory marker, the growing field of “omics” research takes a broader, systems-biology approach: analyzing the whole spectrum of proteins (the proteome), fats (the lipidome) or the by-products of metabolism (the metabolome). Although recent advances have made this data analysis more robust and efficient, the real-world usefulness of multi-omics research has been limited by the difficulties of sample collection, among other challenges. To measure someone’s response to a food or medication, many samples in a short time span may be needed; currently, sampling requires traveling to a clinic for an intravenous blood draw of 10 to 50 milliliters.

“For the study, we asked participants to take blood samples five times in just four hours,” said Snyder, the Stanford W. Ascherman, MD, FACS Professor in Genetics. “Traditionally that would have meant putting in a catheter and pulling out a lot of blood each time. By the fifth draw, your participants would have less iron and fewer red blood cells.”

The researchers wanted to know whether they could drastically reduce the volume of blood used for multi-omics analysis, but still profile thousands of molecules. After testing a variety of microsampling devices, they chose one called the Mitra, a portable finger-stick device that draws 10 microliters of blood into a gel matrix. They then tested multiple extraction techniques to separate out the proteins, lipids and metabolites. A second separate microsample was used to measure inflammatory markers.

“It wasn’t at all expected that we’d be able to do this kind of analysis on such a small sample,” said Ryan Kellogg, PhD, post-doctoral researcher in genetics and one of four co-lead authors on the paper. The other three co-lead authors are Stanford postdoctoral scholars Xiaotao Shen, PhD, Daniel Panyard, PhD, and Nasim Bararpour, PhD.

In a pilot study of two test subjects, the researchers were able to measure the levels of 128 proteins, 1,461 metabolites and 776 lipids from each microsample. They then monitored the samples for stability when they were stored at a variety of temperatures.

“Overall, only four proteins were unstable, regardless of temperature,” Snyder said. “Some of the lipids and

Related News

May 24, 2021
Smartwatch data can predict blood test results, study reports
Stanford researchers found that data from smartwatches can flag early signs of some health conditions and predict the results of simple blood tests.

May 28, 2020
Stanford Medicine study details molecular effects of exercise

Topics

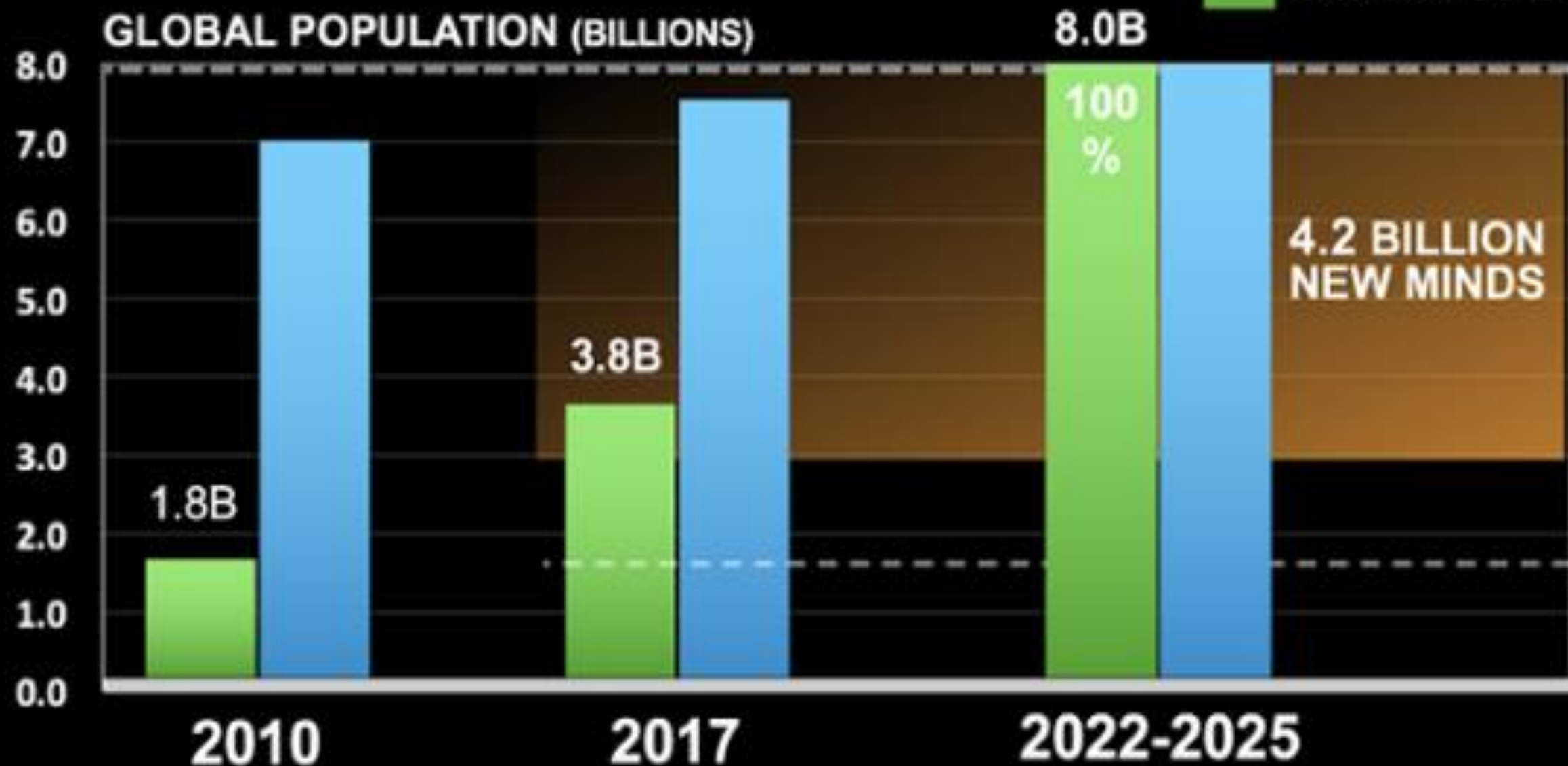
Genetics
Biochemistry
All Topics

STANFORD MEDICINE MAGAZINE
M E D I C I N E
2023 ISSUE 1
Real-world health
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New treatment for COVID loss of smell
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GLOBAL UBIQUITOUS CONNECTIVITY

Global Population
Internet Users



It's not just people being connected...

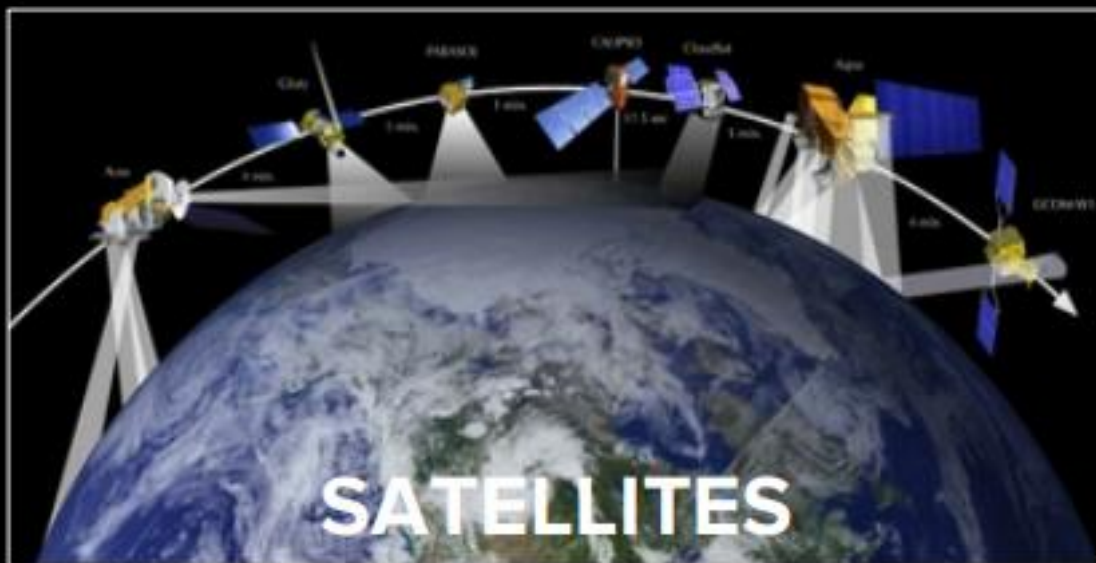
Global Connectivity will connect everything, everywhere, always → **The Internet of Everything.**

- **2015: 15 Billion** (adding: 7 mil /day or 2.5 Billion/year)
- **2020: > 50 Billion devices & 1 Trillion Sensors**
- **2030: > 500 Billion devices & 100 Trillion Sensors**

“Create a future of perfect knowledge, you can know anything you want, anytime, anywhere...

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Know Anything, Anytime, Anywhere





AI CONSIDERATIONS & STRATEGY

TELEMEDICINE AND REMOTE MONITORING
CHATBOTS AND VIRTUAL HEALTH ASSISTANTS
ETHICS AND PRIVACY CONCERNS
AI LIMITATIONS AND CHALLENGES
BEYOND AI: OTHER TECHNOLOGIES
BLOCKCHAIN TECHNOLOGY
INTERNET OF MEDICAL THINGS (IOMT)
AUGMENTED AND VIRTUAL REALITY (AR/VR)
BIG DATA ANALYTICS
CLOUD COMPUTING
DATA INTEGRATION AND INTEROPERABILITY
DEVELOPING A COMPREHENSIVE STRATEGY
EDUCATION AND TRAINING
COLLABORATIONS AND PARTNERSHIPS
FUNDING AND INVESTMENTS

Educate

Innovate

Advocate

MEDICAL IMAGING

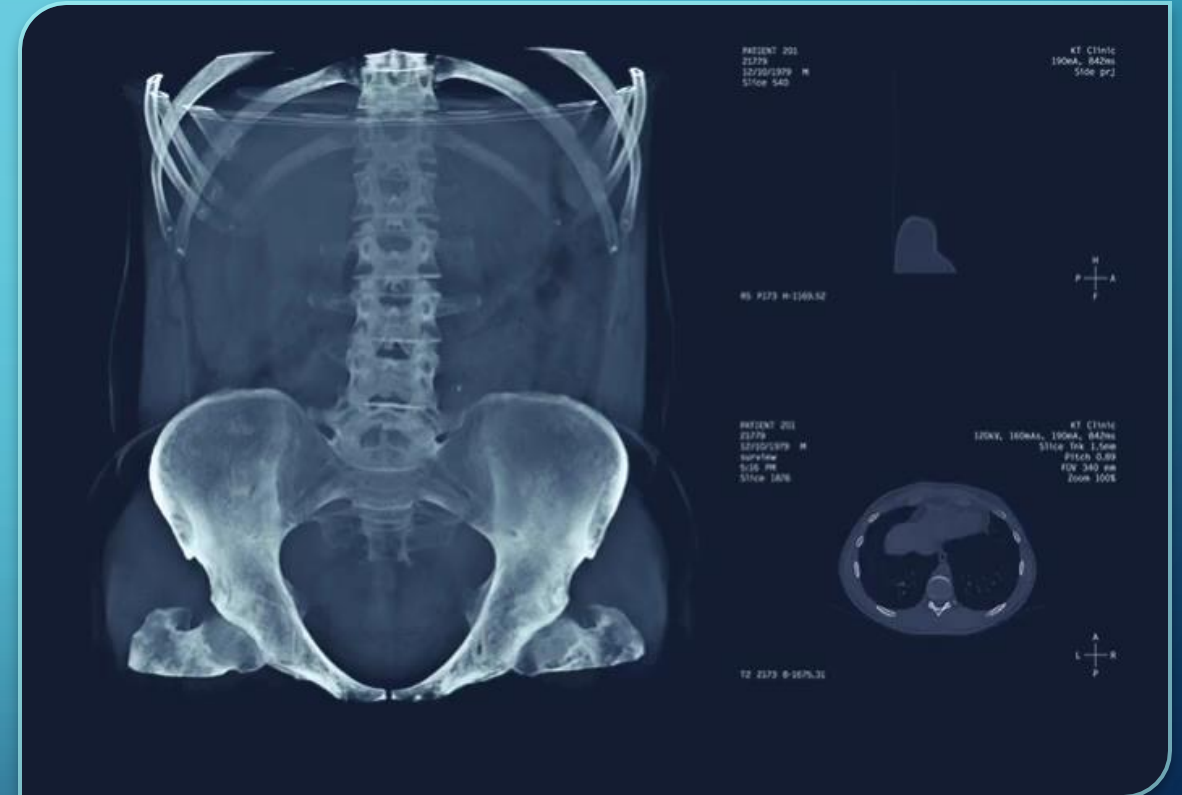
- Role of AI in medical imaging analysis
- Improved diagnostics and efficiency

- Artera.AI

- AI Doc

- AI rad companion

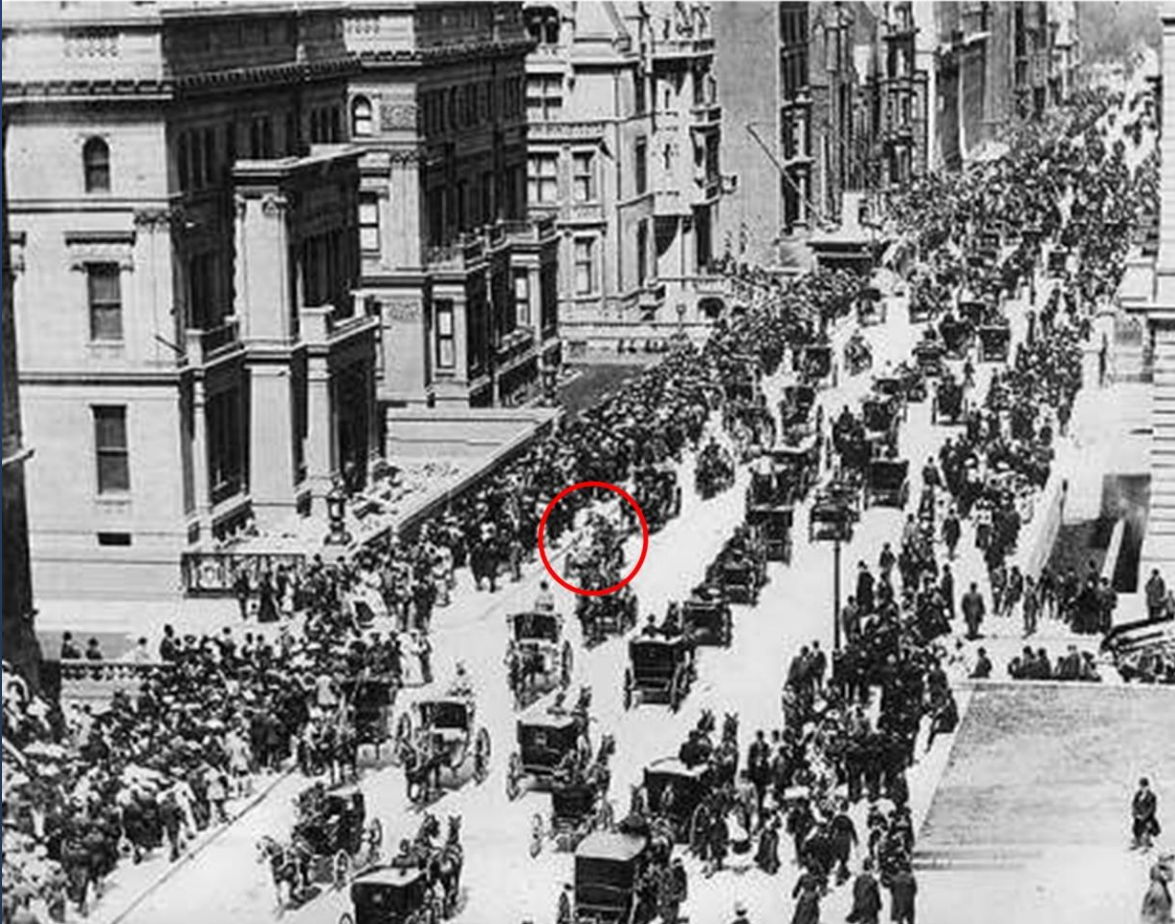
- <https://f.hubspotusercontent40.net/hubfs/5748396/Website%20Assets/video/video%20for%20website%201.6.mp4>



Easter Parades in New York City

Year 1900: One Motor Vehicle

Year 1913: One Horse & Carriage



2529-9

Change is accelerating

Stay alert

Stay engaged

Be open to possibilities

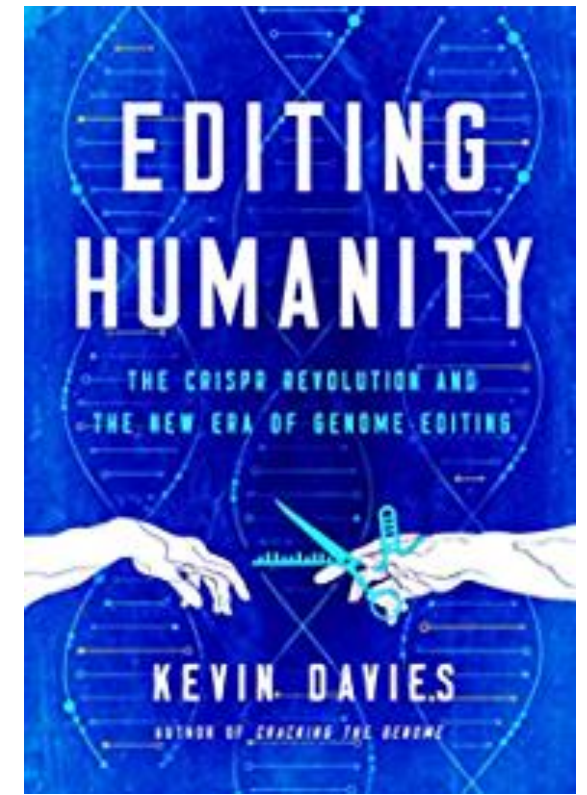
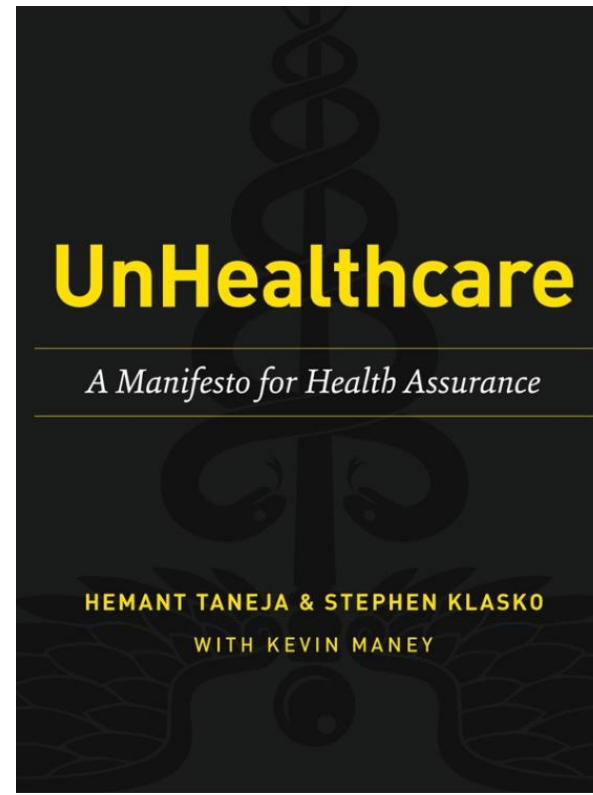
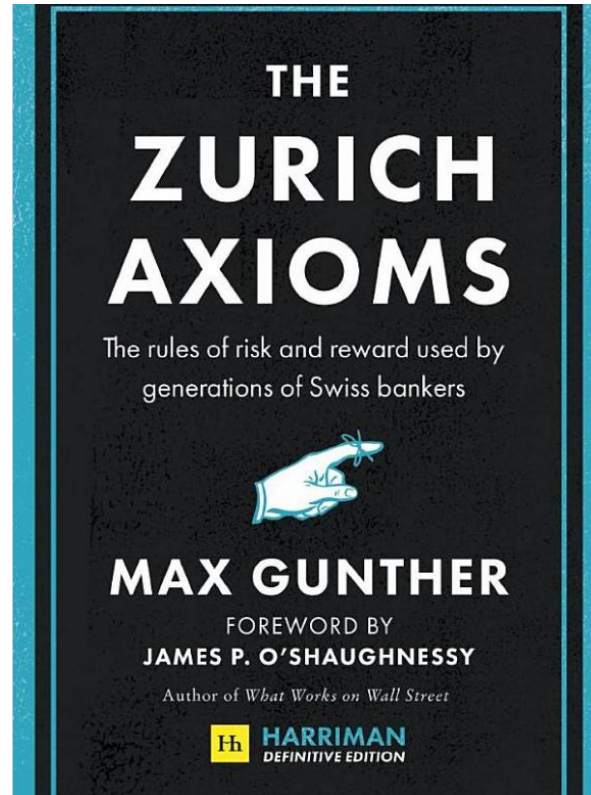
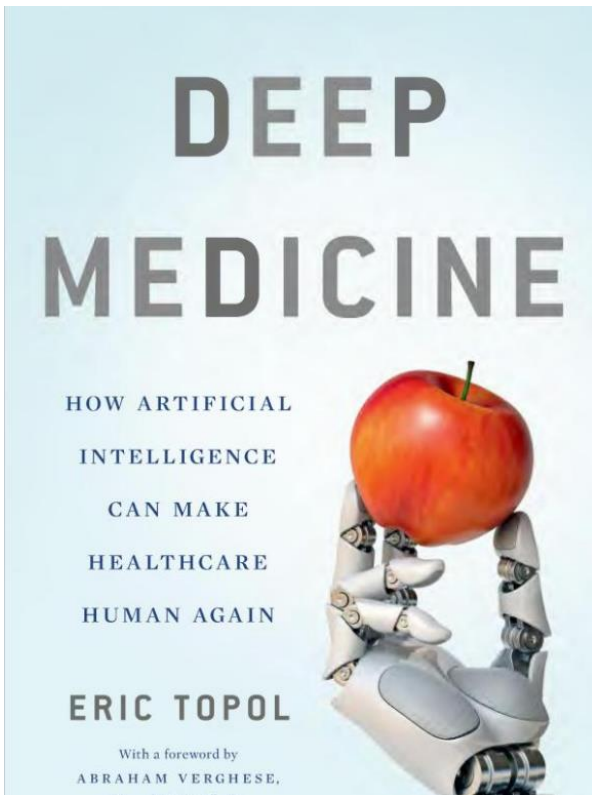
Buckle up!



Q & A



Additional suggested reading



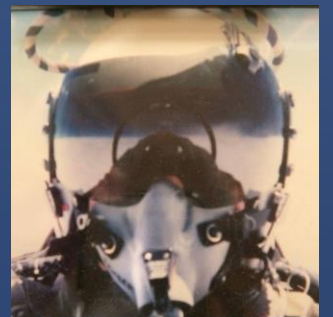
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Navy
times

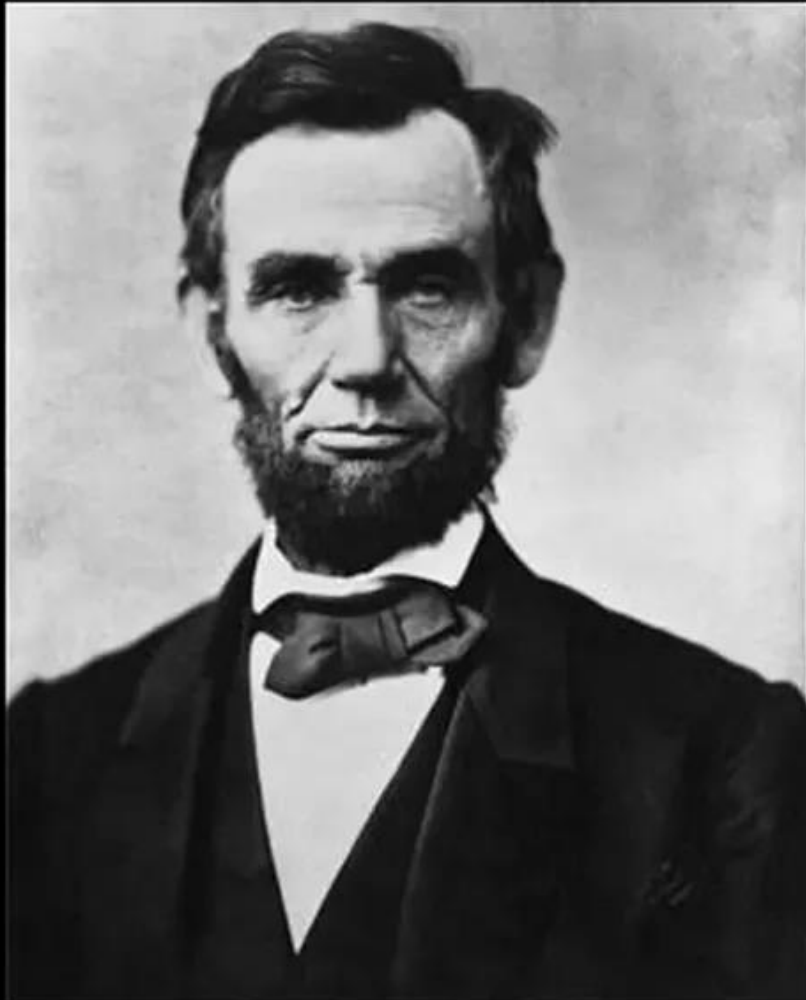




Thank you!

TO THE BEACH

A hand-drawn sign on a white rectangular board, hanging from a tree branch with white rope. The sign features the text "TO THE BEACH" in a playful, hand-painted font. The words "TO" and "THE" are in black, while "BEACH" is in blue. To the right of the text are hand-drawn illustrations: a yellow sun with black rays, blue wavy lines representing water, and several small black birds in flight. The sign is set against a background of dense green foliage.



“Don’t believe everything you read on the Internet just because there’s a picture with a quote next to it.”

—Abraham Lincoln