

HEADLINER

Medicine, an exercise of the imagination



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Medicine: an exercise of the imagination

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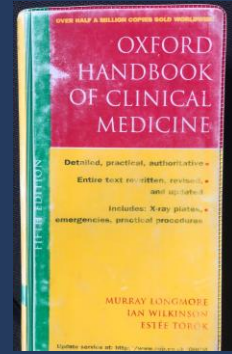
Junaid Bajwa



How it started

Medicine is the exercise of the imagination—we enter another person's suffering to end it. If there can be no respite, then we stay with our patients one eye only: keep the other focused on more distant horizons, so when you meet impossible patients in impossible nights, under whatever moon, they will feel the twinkling of a kindly countenance begin to banish their fear.

We forced this work at the bedside...



How it's going

"AI is technology's most important **priority**, and healthcare is its most **urgent application**."

—Satya Nadella
2021

"The interest in **humanity**... the **secret** of **caring** for the patient, is **caring** for the patient."

—Peabody
Harvard 1926

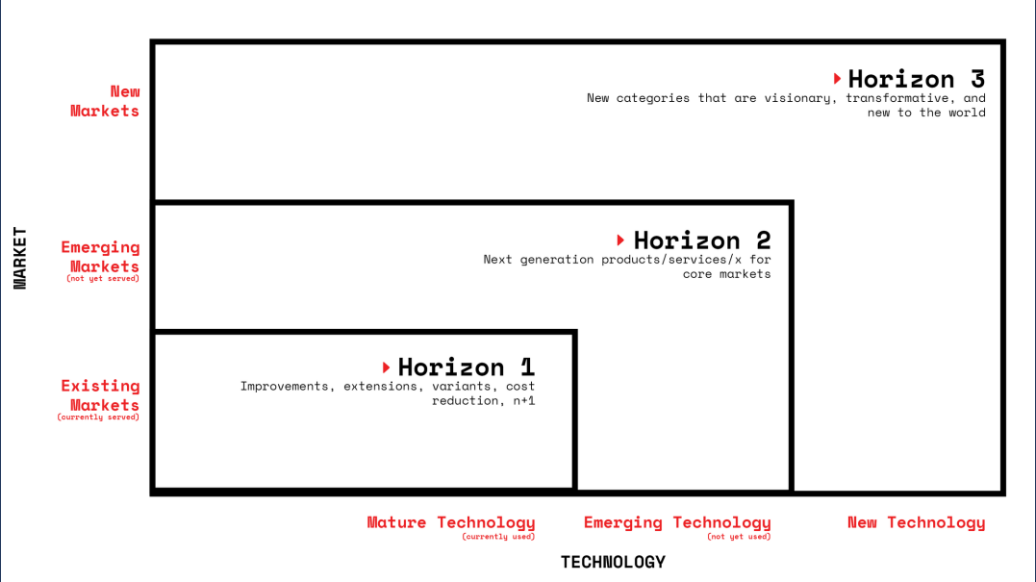
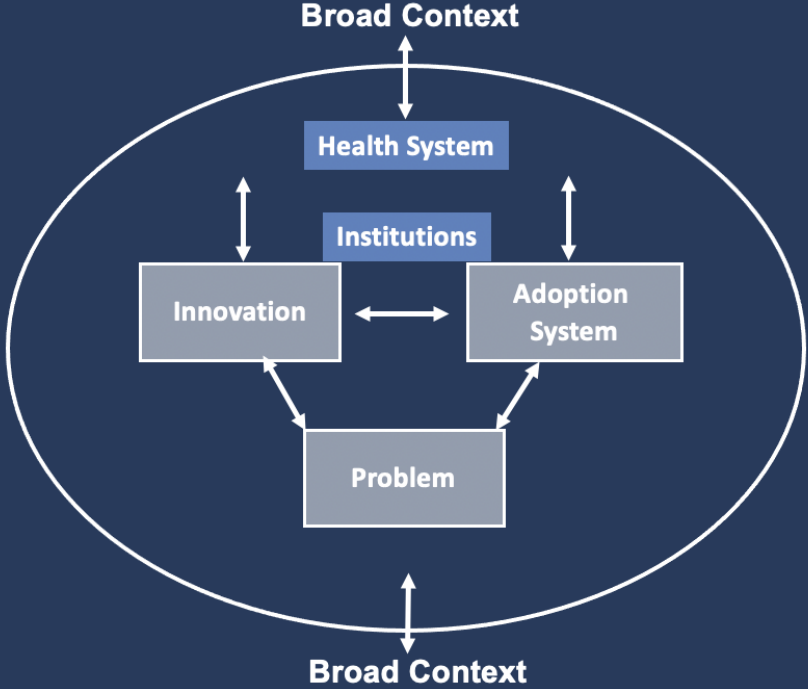


Artificial intelligence in healthcare: Transforming the practice of medicine

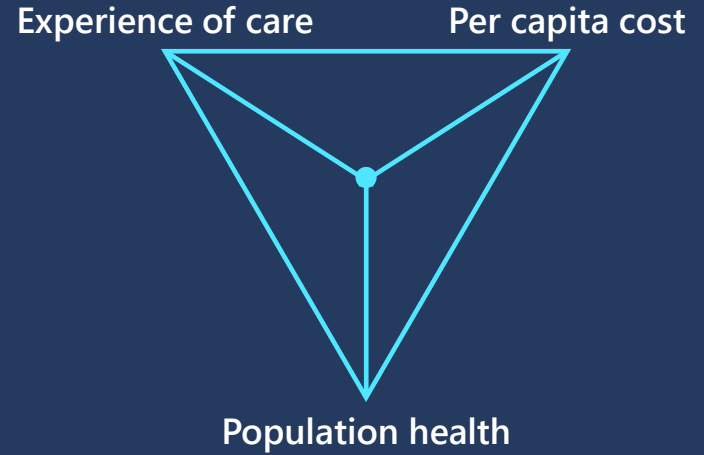
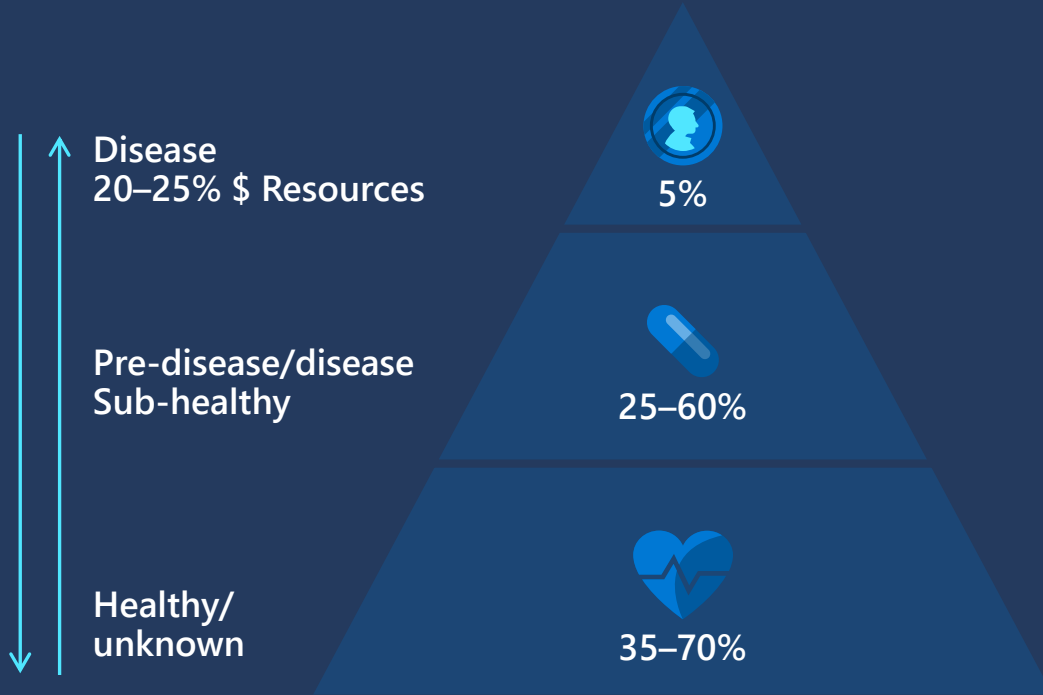
- Junaid Bajwa, Usman Munir, Aditya Nori & Bryan Williams



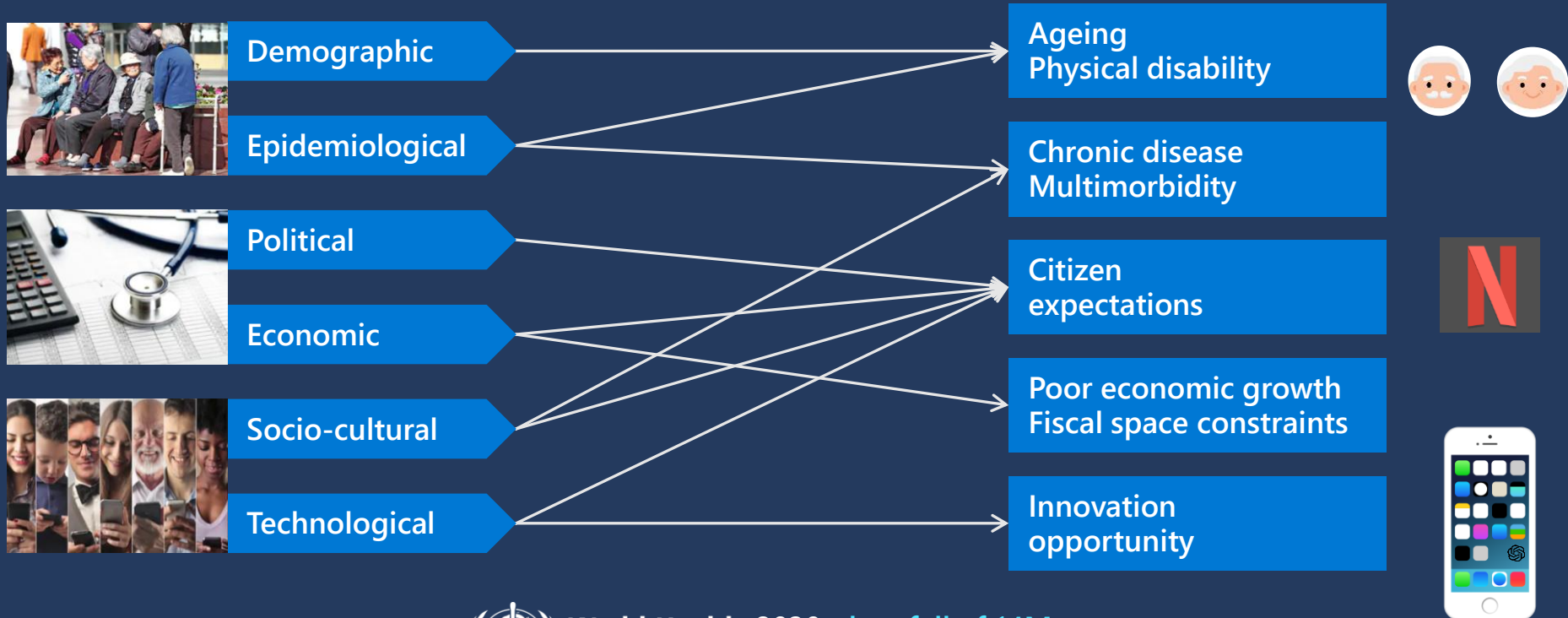
Context: adoption and diffusion of innovation



Macro: Context: every health system



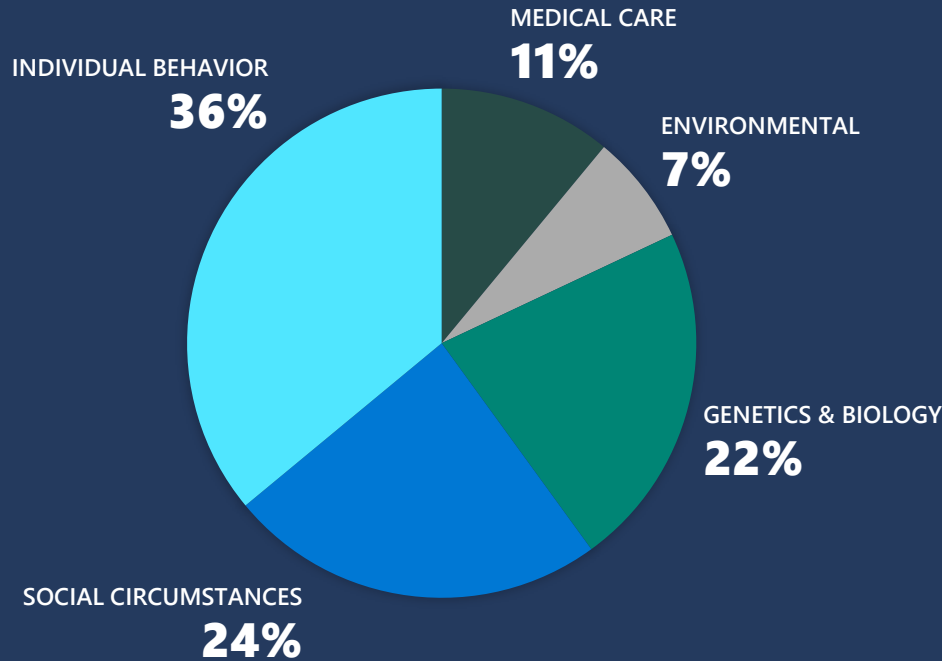
Macro: 6 factors are shaping global health systems



World Health Organization 2030: **shortfall of 14M** health workers by **2030***



Macro- > Micro: The journey to personalization



Source: determinantsofhealth.org

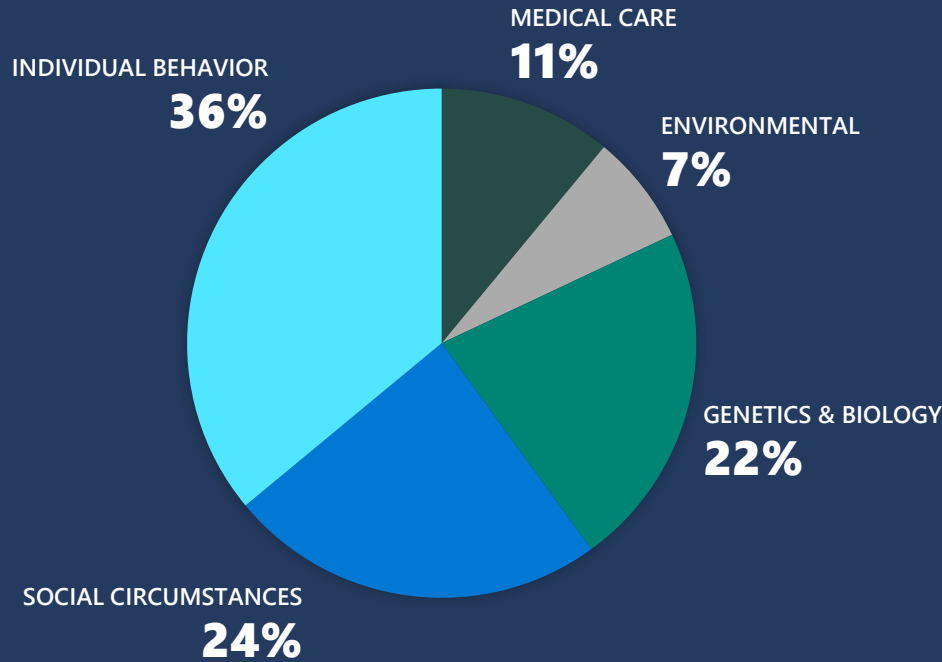


“What matters
to you?”

VS

“What’s the matter
with you?”

Macro- > Micro: The journey to personalization

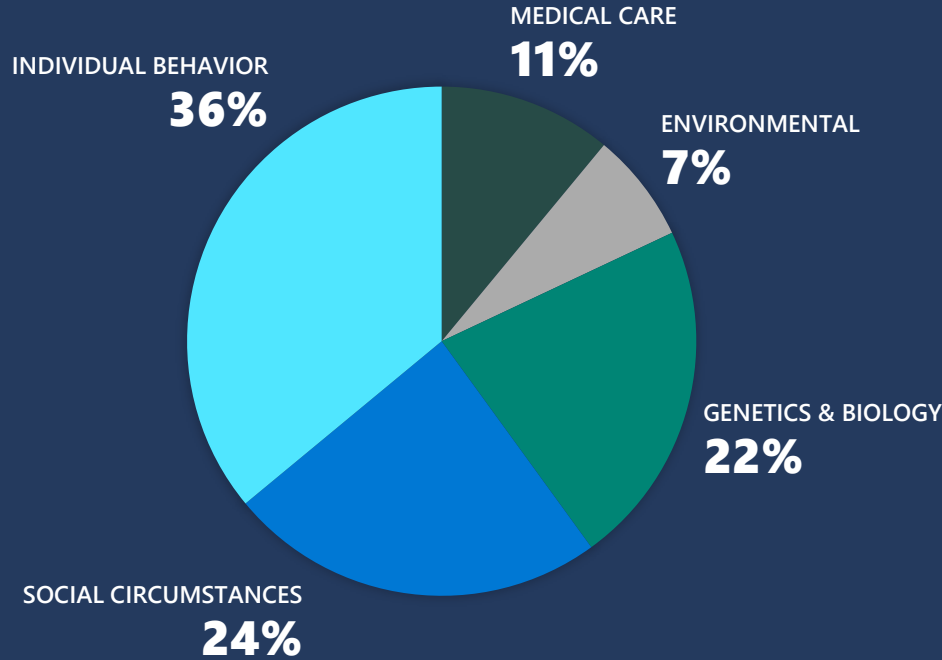


Diagnose and Treat



Recognize and Prevent

Macro- > Micro: The journey to personalization



Source: determinantsofhealth.org



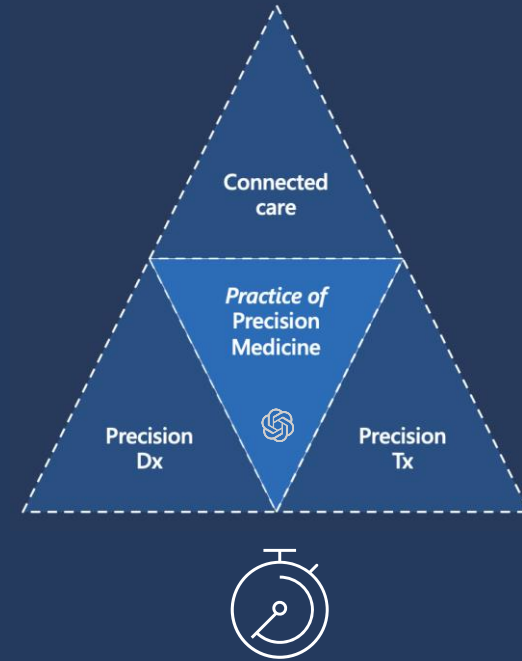
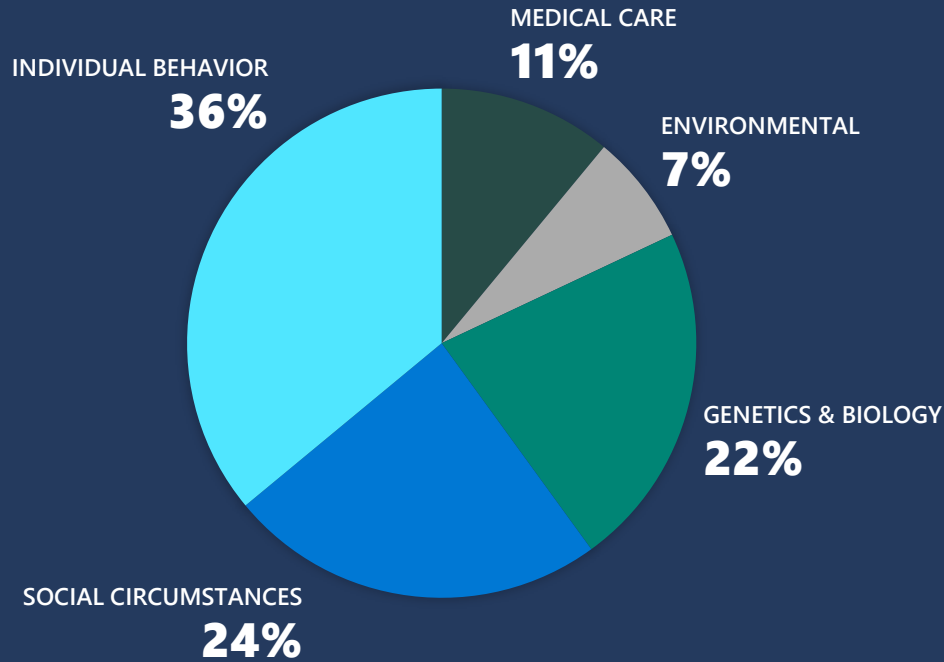
Diagnose and Treat



Recognize and Prevent

Personalization

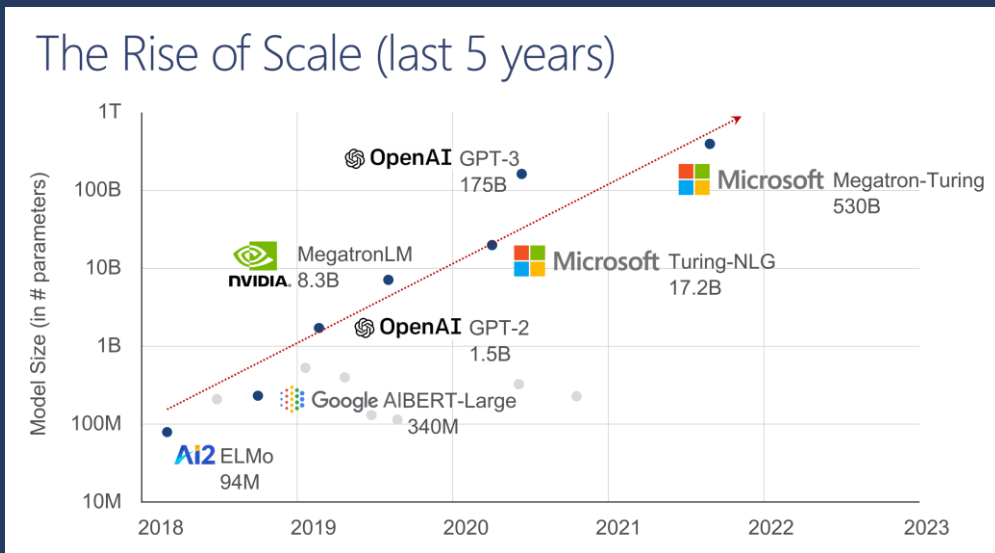
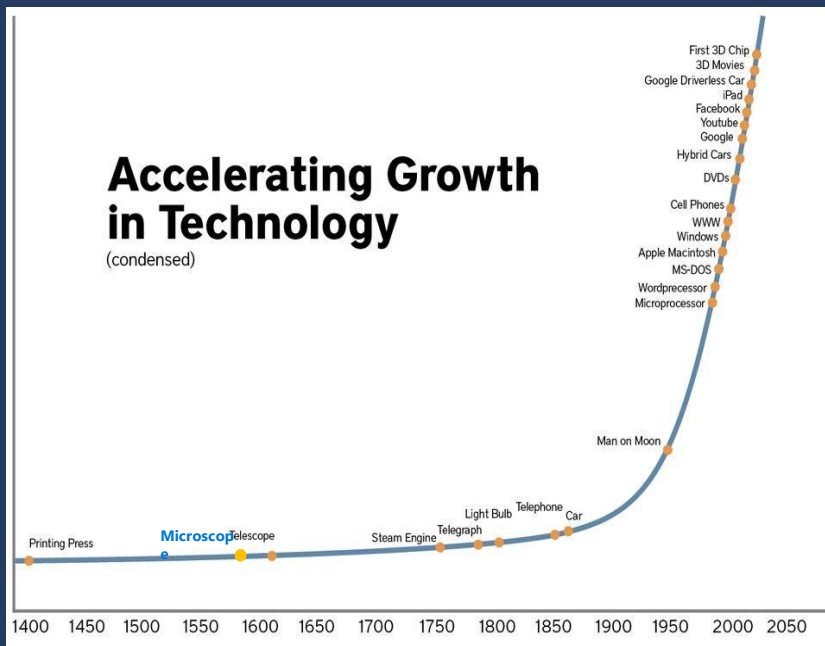
Macro-→ Micro: The journey to personalization



The future of healthcare
will be more data
driven, accurate,
predictive and precise.



Innovation, Acceleration... and AI



More intelligent AI is now “simply” a matter of scale
(more data, more compute, more *parameters*)!

Innovation, Acceleration... and AI

Language and image recognition capabilities of AI systems have improved rapidly

Our World
in Data

Test scores of the AI relative to human performance

+20

0 ← Human performance, as the benchmark, is set to zero.

-20

-40

-60

-80

-100

2000

2005

2010

2015

2020

Handwriting recognition

Speech recognition

Image recognition

Reading
compre-
hension

Language understanding

AI systems perform better than
the humans who did these tests

AI systems perform worse

The capability of each AI system is normalized
to an initial performance of -100.

Data source: Kiela et al. (2021) - Dynabench: Rethinking Benchmarking in NLP
OurWorldinData.org - Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Max Roser

What is metformin?

Metformin is a prescription medication used to treat type 2 diabetes and sometimes prediabetes. It works by decreasing the amount of glucose produced by the liver and improving insulin sensitivity in muscle and fat cells.

Can anyone with type 2 diabetes take it?

Most people with type 2 diabetes can take metformin, but it may not be suitable for some individuals. For example, people with kidney disease, liver disease, or certain other medical conditions may not be able to take metformin. It is important to talk to a healthcare professional who can determine if metformin is appropriate based on an individual's medical history and current health status.

Are there alternatives?

Yes, there are many alternative medications for treating type 2 diabetes if metformin is not suitable or effective. Other medications include sulfonylureas (e.g., glipizide, glyburide), thiazolidinediones (e.g., pioglitazone, rosiglitazone), DPP-4 inhibitors (e.g., sitagliptin, linagliptin), GLP-1 receptor agonists (e.g., liraglutide, exenatide), and SGLT2 inhibitors (e.g., dapagliflozin, canagliflozin). Insulin injections may also be prescribed if oral medications are not effective. The choice of medication depends on the individual's medical history, current health status, and other factors.

Yeesh! That seems complicated! I don't know what to do.

Managing type 2 diabetes can seem overwhelming, but there are healthcare professionals who can help. It's important to work closely with a doctor, nurse, or other healthcare professional who can guide you through the process of choosing the right treatment plan for your individual needs. They can explain the different medication options, help you understand how to monitor your blood sugar levels, and provide support and guidance for making lifestyle changes to help manage your diabetes.

A 12-year-old girl is brought to the emergency department by her mother because of a 1-week history of worsening swelling in her legs. The patient also noticed blood in her urine yesterday. The bleeding has not recurred. She had an upper respiratory tract infection and sore throat 1 week ago that caused her to miss several days of school. Medical history is otherwise unremarkable and she takes no routine medications. Menarche has not yet occurred. BMI is 20 kg/m². Vital signs are temperature 37.0°C (98.6°F), pulse 78/min, respirations 12/min, and blood pressure 136/84 mm Hg. Pulse oximetry on room air shows an oxygen saturation of 100%. Physical examination discloses erythema of the posterior pharynx, mild cervical lymphadenopathy, and 3+ pitting edema to both knees.

Results of urinalysis are shown:

Protein	150 mg/dL
Blood	Positive
Leukocyte esterase	Positive
Nitrite	Negative
WBCs	5–10/hpf
RBCs	10–25/hpf
Casts	1–2/lpf

Results of which of the following laboratory studies are most likely to be abnormal in this patient?

- (A) Bleeding time
- (B) Erythrocyte count
- (C) Serum concentration of C3
- (D) Serum IgA concentration
- (E) Serum rheumatoid factor assay

I would choose (C) Serum concentration of C3 as the most likely abnormal laboratory finding in this patient.

I would choose (C) Serum concentration of C3 as the most likely abnormal laboratory finding in this patient.

This patient presents with a history of recent upper respiratory tract infection, hematuria, proteinuria, and edema. These findings are suggestive of post-streptococcal glomerulonephritis (PSGN), an immune-mediated kidney disease that can develop after a streptococcal infection, such as a sore throat.

In PSGN, immune complexes containing streptococcal antigens deposit in the glomeruli, leading to inflammation and damage. The activation of the complement system, which can lead to decreased levels of C3.

The other options are less likely in this case:

- (A) Bleeding time: There is no indication of a bleeding disorder in this patient.
- (B) Erythrocyte count: Although hematuria is present, a significant change in erythrocyte count is not expected.
- (D) Serum IgA concentration: An elevated level is characteristic of IgA nephropathy.
- (E) Serum rheumatoid factor assay: Elevated levels are characteristic of rheumatoid arthritis, which doesn't match this patient's presentation.

arXiv > cs > arXiv:2303.13375

Computer Science > Computation and Language

[Submitted on 20 Mar 2023]

Capabilities of GPT-4 on Medical Challenge Problems

Harsha Nori, Nicholas King, Scott Mayer McKinney, Dean Carignan, Eric Horvitz

No specialized training!

What do you think the girl described in this problem might be thinking and feeling?

As an AI language model, I can't directly assess a person's thoughts and feelings, but I can make an educated guess based on the information provided.

The 12-year-old girl in this scenario might be feeling worried or scared due to the recent changes in her health, such as the swelling in her legs and the blood in her urine. She might be anxious about the severity of her condition and the potential long-term consequences. The discomfort from her symptoms, including the sore throat, cervical lymphadenopathy, and edema, may also cause her some physical distress.

She might also be concerned about missing school and falling behind in her studies. Additionally, she could be feeling embarrassed about discussing her symptoms, particularly those related to menstruation and urinary issues, with healthcare professionals.

It's essential for the healthcare team to address her concerns and provide reassurance, as well as explain the diagnosis and treatment plan in an age-appropriate manner. This will help alleviate her anxiety and ensure she feels comfortable asking questions and discussing her symptoms.

The girl's name is Meg. If you were Meg's doctor, what would you say in order to provide comfort and support?

If I were Meg's doctor, I would take a compassionate and empathetic approach to address her concerns and provide comfort and support. Here's an example of what I might say:

"Hi Meg, I understand that you might be feeling worried or scared about the symptoms you've been experiencing lately. I want to reassure you that we're here to help you get better. Based on your symptoms and the tests we've done, it looks like you have a condition called post-streptococcal glomerulonephritis, which can happen after an infection like the sore throat you had recently. The good news is that most people with this condition recover fully, and we're going to closely monitor your progress and provide the appropriate treatment to help you feel better.

If you have any questions or concerns at any time, please don't hesitate to ask me or any of the other healthcare professionals involved in your care. We're here to support you and make sure you understand what's happening with your body. And don't worry about missing school - your health is the top priority right now, and we can work with your school to ensure you catch up on your studies when you're feeling better.

Remember, it's okay to feel scared or worried, but know that we're here to help and support you every step of the way. If you need anything or have any questions, just let us know."

I'm training to be a doctor. Please play-act the role of Meg, and I will be her doctor. Let's have a conversation as though she has come to me in my office. I'll start:

Hi, Meg. Your mother tells me that you've been having some swelling in your legs. Can you tell me how you are feeling?

Hi, Doctor. Yes, I've noticed that my legs have been swelling up, especially around my knees. It's been getting worse over the past week, and it feels a bit uncomfortable. I'm also worried because I saw some blood in my urine yesterday. I had a sore throat and a cold last week, but I didn't think it would cause these problems. I'm really scared and don't know what's happening to me.

Ok, I see. Well, let's see if we can get to the bottom of this. Let me first look over your vital signs that the nurse took. Hmm, that all looks fine. So then let's take a look at your knees. Can you sit up here?

Sure, Doctor. Here, let me sit up on the examination table. I hope you can figure out what's causing the swelling and the other issues I've been having. It's been really distressing for me. ...

Microsoft's AI Principles



Fairness



Reliability
& Safety



Privacy &
Security



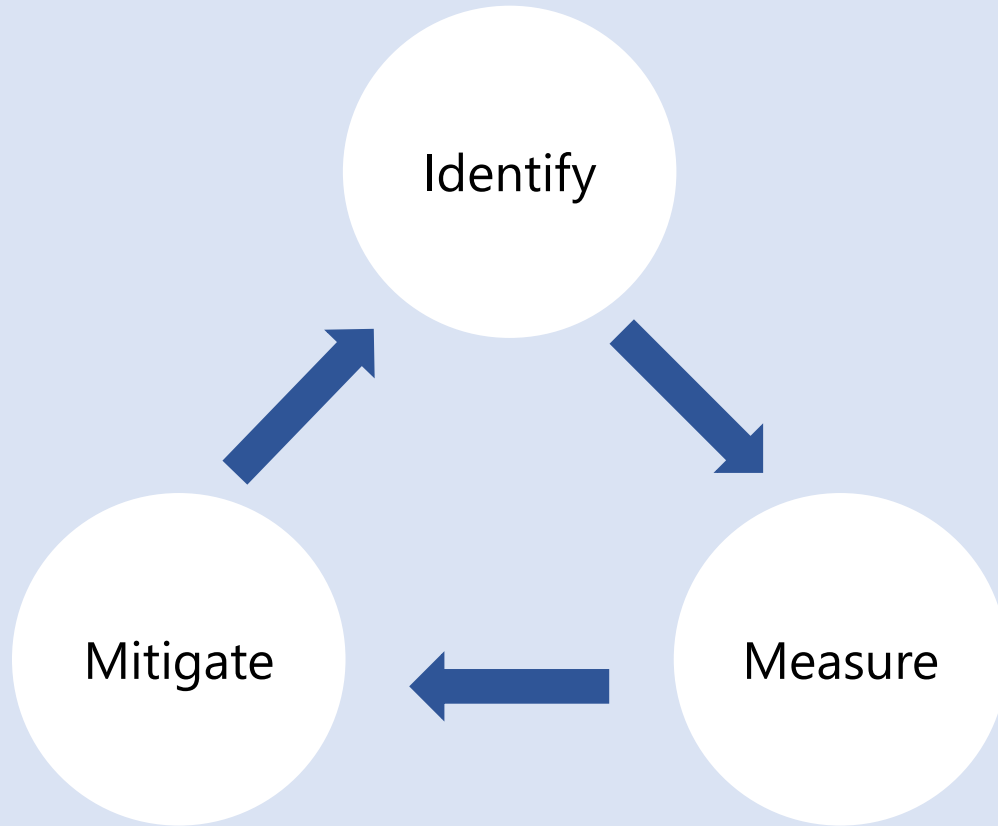
Inclusiveness



Transparency



Accountability



Can you tell me about using olanzapine in treating anorexia nervosa?

✓ Searching for: **olanzapine anorexia nervosa treatment**

✓ Generating answers for you...

Olanzapine is an atypical anti-psychotic drug that has been proposed for the treatment of anorexia nervosa. Despite the presence of some contradictory studies, olanzapine treatment has been found beneficial in anorexia nervosa ¹. In addition, analysis reveals that statistically significant beneficial effect of olanzapine treatment is used at high doses and for short duration ¹. Olanzapine showed efficacy in the treatment of AN with an increased BMI at the end of treatment in adults. However, the effect of olanzapine as adjuvant treatment in adolescents remains unclear ².

Is there anything else you would like to know?

Learn more: [1. ejnpn.springeropen.com](https://ejnpn.springeropen.com) [2. pubmed.ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov) [3. researchgate.net](https://researchgate.net)

1 of 20 ●

COMPLETE BLOOD COUNT

TEST	RESULT	REFERENCE RANGE
Haemoglobin	15.5	male : 14 - 16 g% Female : 12 - 14 g%
RBC Count	4.6	14 - 16g%
PCV	37.8	35 - 45 %
RBC INDICES		
MCV	82.17	80 - 99 fl
MCH	33.70	28 - 32 pg
MCHC	41.01	30 - 34 %
RDW	10.2	9 - 17 fl
TOTAL WBC COUNT		
Total WBC Count	5500	4000 - 11000 / cu.mm
Neutrophils	60	40 - 75 %
Lymphocytes	30	20 - 45 %
Eosinophils	5	00 - 06 %
Monocytes	5	00 - 10 %
Basophils	0	00 - 01 %
PLATELETS		
Platelet Count	155500	150000 - 450000 / cu.mm
Platelets on Smear	Adequate On Smear	
PERIPHERAL BLOOD SMEAR		
RBC Morphology	Hypochromia (+), Microcytosis (+), Anisocytosis (+)	
WBCs on PS	Normal	

I received this report from the medical lab on my recent physical exam. Can you explain in simple terms if there is anything I need to be concerned about?

- ✓ Searching for: **lab report interpretation**
- ✓ Searching for: **lab report abnormal values**
- ✓ Generating answers for you...

COMPLETE BLOOD COUNT

TEST	RESULT	REFERENCE RANGE
Haemoglobin	15.5	male : 14 - 16 g% Female : 12 - 14 g%
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TOTAL WBC COUNT		
Total WBC Count	5500	4000 - 11000 / cu.mm
Neutrophils	60	40 - 75 %
Lymphocytes	30	20 - 45 %
Eosinophils	5	00 - 06 %
Monocytes	5	00 - 10 %
Basophils	0	00 - 01 %
PLATELETS		
Platelet Count	155000	150000 - 450000 / cu.mm
Platelets on Smear	Adequate On Smear	
PERIPHERAL BLOOD SMEAR		
RBC Morphology	Hypochromia (+), Microcytosis (+), Anisocytosis (+)	
WBCs on PS	Normal	

Hi, this is Bing. I'm glad you're taking care of your health. 😊

A lab report is a document that summarizes the results of an experiment and its interpretations ¹. It usually includes a title page, an introduction, a method section, a result section, a discussion section and a reference list ².

To understand your lab results, you need to compare them with the reference values that indicate what is normal or abnormal for your age, sex and health condition ³ ⁴. The reference values may vary depending on the laboratory that performed the test ⁵.

Based on your lab report, I noticed some values that are outside the reference range:

- Your hemoglobin level is 15.5 g%, which is slightly higher than the normal range for males (14-16 g%) ⁶.
- Your MCH level is 33.70 pg, which is higher than the normal range (28-32 pg) ⁶.
- Your MCHC level is 41.01 %, which is higher than the normal range (30-34 %) ⁶.
- Your RBC morphology shows hypochromia (+), microcytosis (+) and anisocytosis (+), which means your red blood cells have less color, smaller size and irregular shape than normal ⁶.

These values suggest that you may have some form of anemia or iron overload disorder ⁷. However, this is not a definitive diagnosis and you should consult your doctor for further evaluation and treatment.

I hope this helps you understand your lab report better. Please let me know if you have any questions or concerns. 🙌

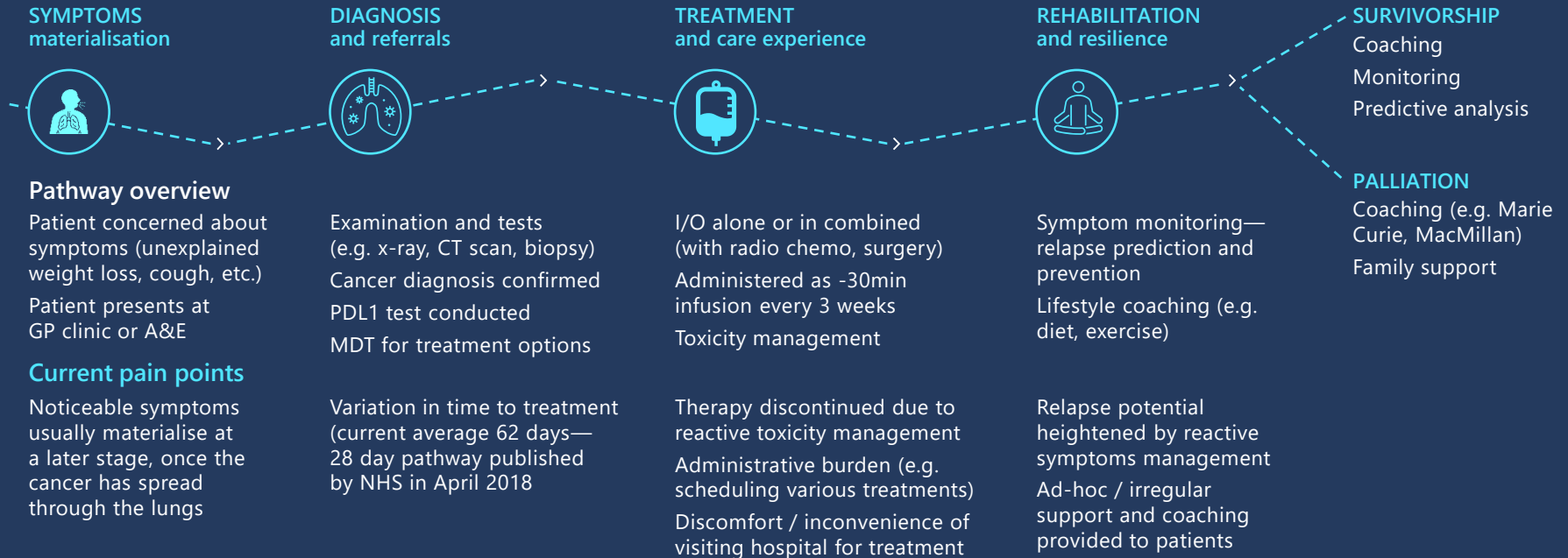
**Any sufficiently advanced technology is
indistinguishable from magic**

- Arthur C. Clarke (3rd law)

Context and problem statement:

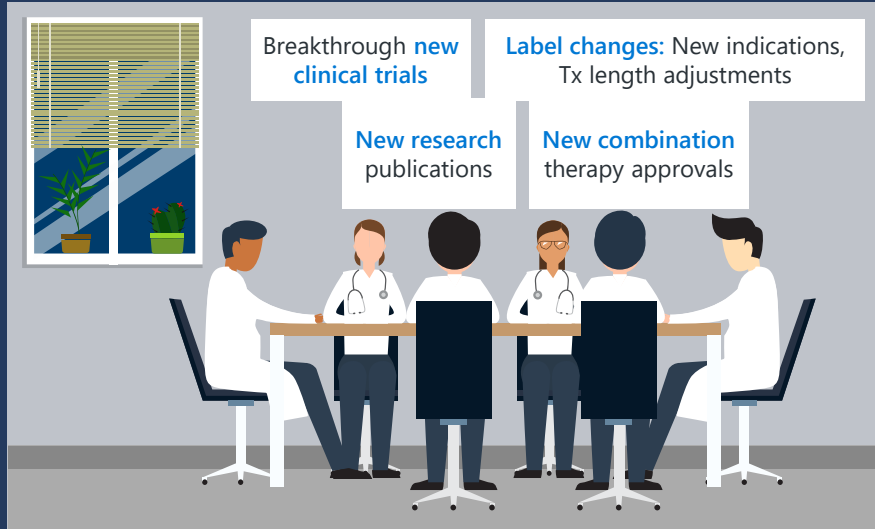
Oncology patient journeys are becoming longer, leading to more complicated care coordination processes, which may lead to decreased Tx adherence

Case example: Non small cell lung cancer patient journey in the UK

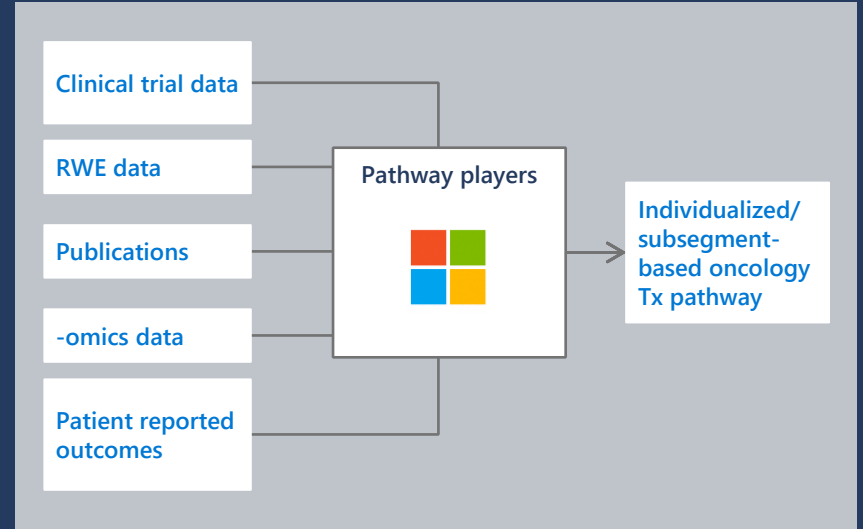


Complexity of oncology treatments: Personalizing outcomes paradox

Oncologists/tumor boards trying to keep up with explosion of complexity of Tx paradigms and increasing speed of innovation...



...different players are taking ownership of shaping Tx pathways



- A medical article is published every 30s; **4000** new papers on PubMed **everyday** (experts can curate ~ 10)
- 50m medical publications in public databases (not all publications necessarily of the same quality/ inherent biases),
- Medical knowledge **doubles** every 73 days

..... What if healthcare and computing “spoke the same language” and this information could be democratized and lead to actionable insights?



[Journal List](#) > [Oncotarget](#) > [v.7\(20\); 2016 May 17](#) > PMC5045374

Oncotarget

Open Access Impact Journal

[Oncotarget](#). 2016 May 17; 7(20): 29011–29022.

PMCID: PMC5045374

Published online 2016 Mar 31. doi: [10.18632/oncotarget.8508](#)

PMID: [27049722](#)

Brigatinib, an anaplastic lymphoma kinase inhibitor, abrogates activity and growth in ALK-positive neuroblastoma cells, *Drosophila* and mice

[Joachim T. Siaw](#),^{#1} [Haiying Wan](#),^{#1} [Kathrin Pfeifer](#),¹ [Victor M. Rivera](#),² [Jikui Guan](#),¹ [Ruth H. Palmer](#),¹ and [Bengt Hallberg](#)¹

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Associated Data

▶ [Supplementary Materials](#)

Abstract

[Go to:](#) ▶

Anaplastic lymphoma kinase (ALK) is a tyrosine kinase receptor which has been implicated in numerous solid and hematologic cancers. ALK mutations are reported in about 5-7% of neuroblastoma cases but the ALK-positive percentage increases significantly in the relapsed patient population. Crizotinib, the first clinically approved ALK inhibitor for the treatment of ALK-positive

Is brigatinib effective in ALK-positive neuroblastoma?

According to this study, brigatinib appears to be effective in inhibiting ALK activity in ALK-positive neuroblastoma cell lines, biochemical assays, as well as in mouse and *Drosophila* models. In particular, the researchers found that brigatinib was more efficient in inhibiting ALK activity than crizotinib, a first-generation ALK inhibitor. Further studies will be needed to determine if brigatinib is effective in clinical settings for patients with ALK-positive neuroblastoma.

Can brigatinib suppress ALK activity in lung cancer with EML4-ALK fusion?

Yes, previous studies have shown that brigatinib is able to suppress ALK activity in lung cancer with the EML4-ALK fusion. For example, this study (<https://...>) found that brigatinib demonstrated "potent and durable activity" against EML4-ALK lung cancer in preclinical experiments as well as in a phase I/II clinical trial with patients.

Oncology treatment planning: Project Inner Eye [democratizing AI]

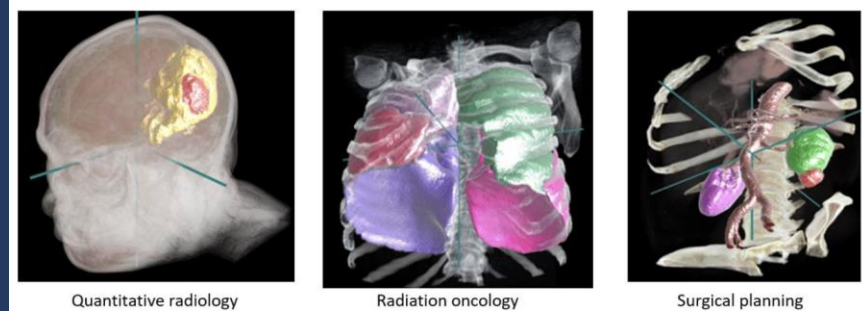
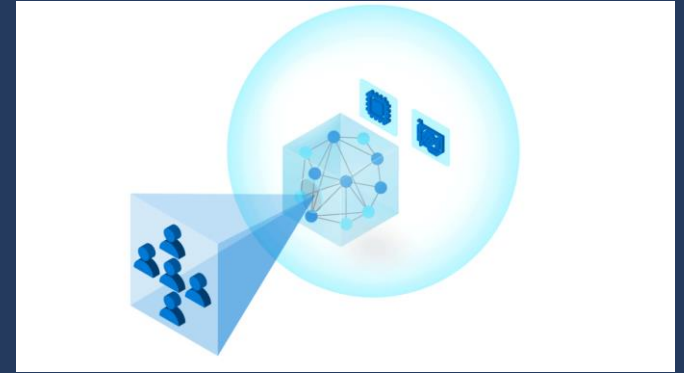
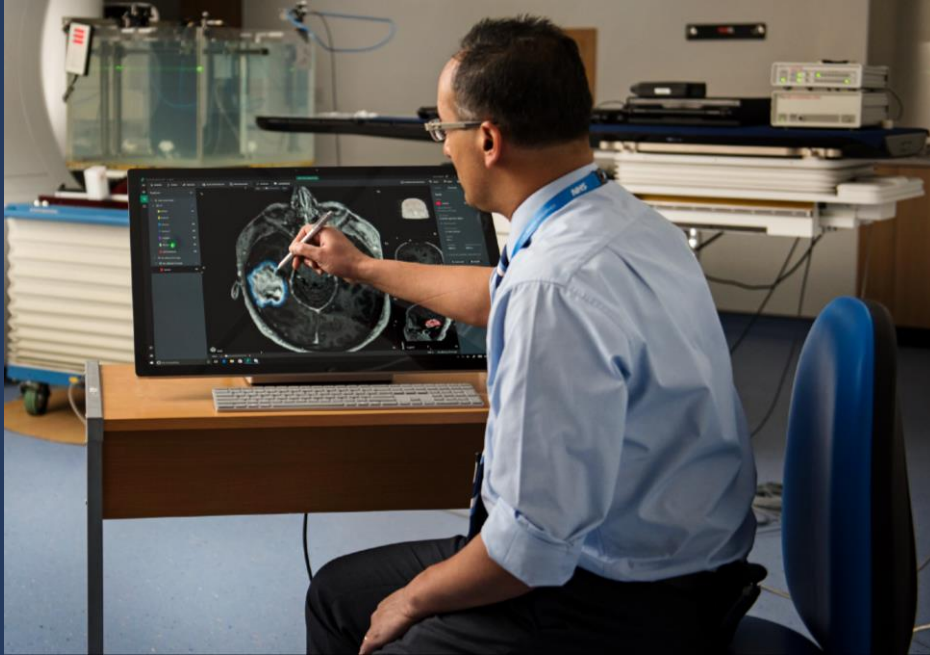


Figure 1: Potential applications for the InnerEye Deep Learning Toolkit include quantitative radiology for monitoring tumor progression, planning for surgery, and radiotherapy planning.

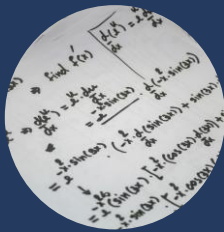
>40yrs of accelerated health technology innovation

1980's/90's



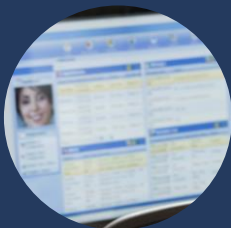
Evidence-based
medicine

2000's



Hand-crafted models
& scarce data

2010's



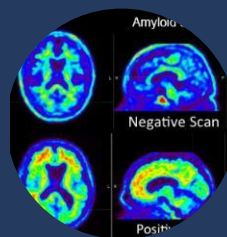
Electronic
Health Records
and Big Data

2010's



Models start to be
learned from fuller
data

2020's



Multimodal AI
(unstructured text +
imaging)

2020's



Personalization
& well-being

Privacy & bias

2020's



Population Health
& Smart Cities

Clinical Audit/Governance
1-way: research → practice

Learning Health Systems
2-way: research ↔ practice

Precision and Population Health Systems
360-degree view of the patient

'He who studies medicine without books sails an unchartered sea, but he who studies medicine without patients does not go to sea at all'

William Osler 1849-1919

The word 'patient' occurs frequently throughout this book.

Do not skim over it lightly.

Rather pause and doff your metaphorical cap, offering due respect to those who by the opening up of their lives to you, become your true teachers.

Without your patients, you are a technician with a useless skill.

With them, you are a doctor.

**The only way of discovering the limits of
the possible is to venture a little way past
them into the impossible
- Arthur C. Clarke (2nd law)**

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INTELLIGENT HEALTH UK 2023

Breaking down the barriers
between tech and healthcare