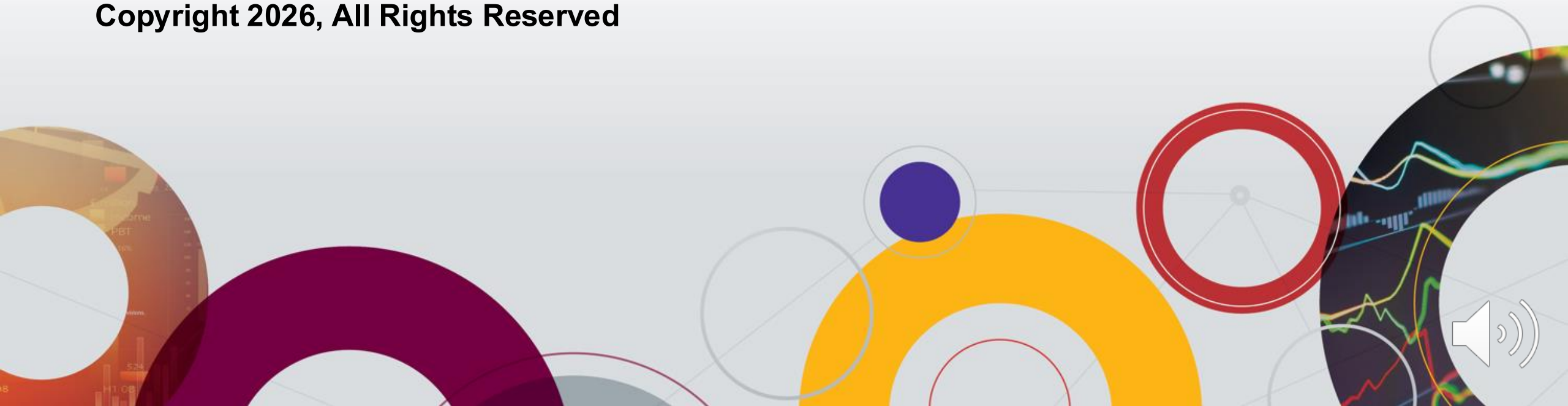


5.4a Generative Artificial Intelligence

10x10 – Introduction to Biomedical Informatics & Artificial Intelligence
William Hersh, MD, FACMI, FAMIA, FIAHSI
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Generative AI

Overview

Systems

Usage

Prompting

Uses and research results

Downsides

Impact on education

Overview

Changing so fast that overviews and books become out of date quickly, but some recent ones (Naveed, 2025; Lutkevich, 2025; Maddox, 2025; Dhamani, 2026)

Thrust into public eye with November 30, 2022 release of ChatGPT by OpenAI

- Inner workings unknown to humans (Wolfram, 2023)

Impacts in all aspects of society, not only healthcare and education but also news, politics, and more

Early experience exemplified by 2023 Dictionary.com word of year: *hallucinate* (Norlen, 2023)

- More recent words of year from 2005
 - Merriam-Webster: *slop* (Furman, 2025)
 - Collins: *vibe coding* (Quin, 2025)

Systems

Market leaders

- [ChatGPT](#) – OpenAI
- [Gemini](#) – Google
- [Claude](#) – Anthropic

Some other systems

- [Co-Pilot](#) – Microsoft
- [Perplexity](#)
- [Llama](#) – Meta
- [Grok](#) – xAI
- [DeepSeek](#)
- Many companies offer “AI” in their products, e.g., Adobe, Apple, etc.

Healthcare

- [OpenEvidence](#)
- [Epic](#)
- [ChatGPT Health](#)
- [Claude Health](#)

Research tools

- [Scite.ai](#)
- [OpenAI Deep Research](#)
- [Google Deep Research](#)
- [NotebookLM](#)

Domain-specific foundation models

Foundation models for specific biomedical domains (Khan, 2025; Wang, 2025)

- Genome sequences (Nguyen, 2024; Callaway, 2025)
- Ophthalmology (Qiu, 2024)
- Dermatology (Gui, 2024)
- DNA (Benegas, 2025)
- Imaging (Zhang, 2025; Zhao, 2025)
- Precision oncology (Xiang, 2025)
- Laryngology (Setzen, 2025)
- Medical literature mining (Wang, 2025)
- Disease diagnosis (Liu, 2025)
- EHR for adaptive risk estimation (Renc, 2025)
- Sleep (Thapa, 2026)

Usage of generative AI

How is generative AI used?

- General population
- Specific to biomedicine and health

Worldwide usage substantial but are we in

- “Trough of disillusionment” (Economist, 2025)?
- AI bubble (Heath, 2025)?
- Low (5%) return on investment (Challapally, 2025)?

How do we balance myriad of models with different sizes, speeds, capabilities, etc. (Hitzel, 2025)?

Usage – general

US adults

- 39% overall; 24% use for work at least once a week and 10% every day (Bick, 2024)
- 21% use in job; higher for those with baccalaureate degrees (Lin, 2025)

US older adults (Brewer, 2025) – 55% over 50; 46% have questions of trust

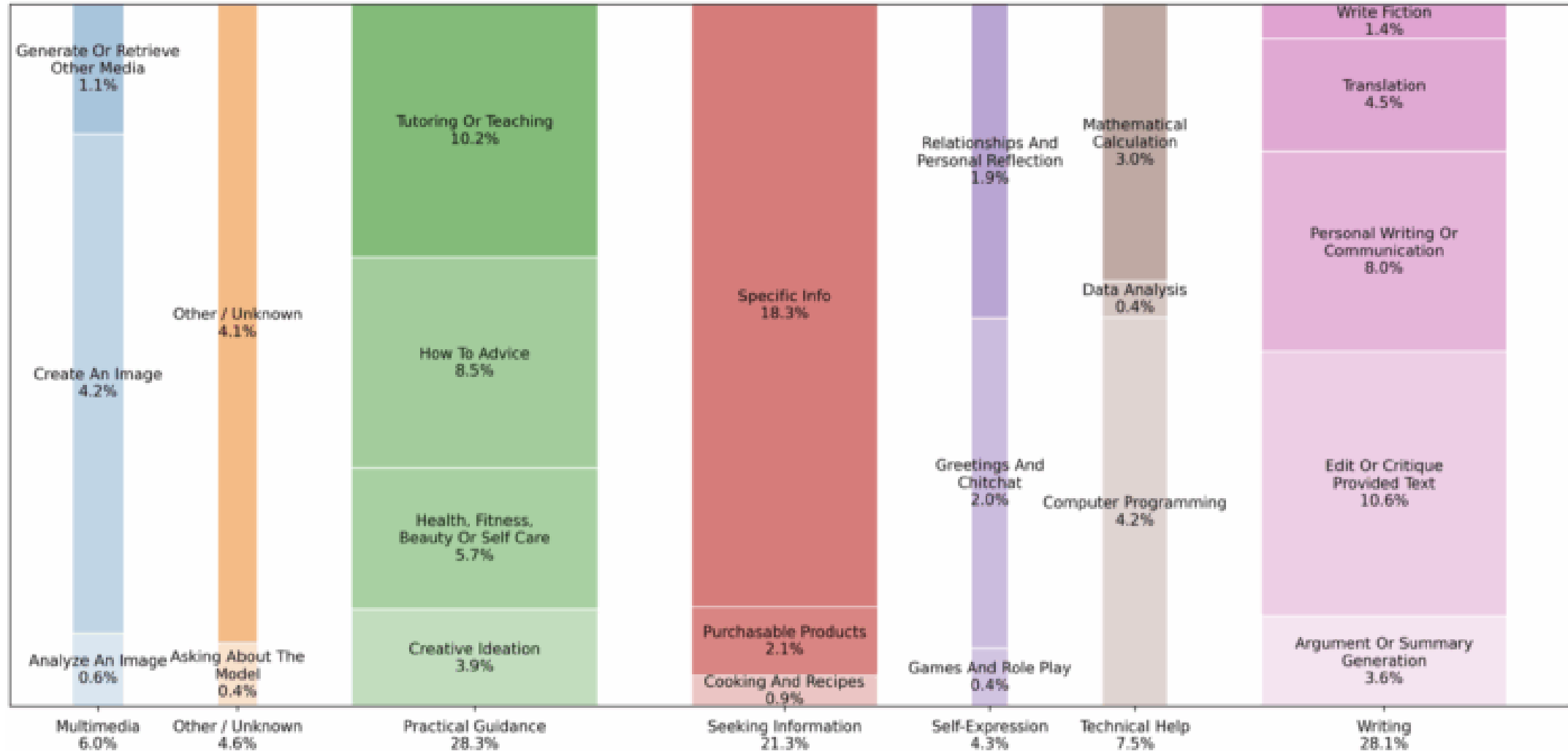
US teenagers

- 64% ever used; 28% daily (Faverio, 2025)
- 26% for homework (Sidoti, 2025)

In higher education, widespread and growing (O'Connell, 2025)

- In US, 65% (Primary Research Group, 2025) to 79% (Maxwell, 2025)
- In UK, 92% (HEPI, 2025)

How people use ChatGPT (Chatterji, 2025)



Usage – healthcare

Kaiser Family Foundation (KFF) US adult health-related use of AI (Presiado, 2024)

- Several times a day – 11%
- About once a day – 8%
- Several times a week – 14%
- Less often – 30%
- Never – 35%

Survey of AI use among 1000 US physicians (Offcall, 2025)

- Usage 67% daily, 89% weekly
- 84% improved work
- 81% dissatisfied with employer speed of adoption
- 71% no influence with employer

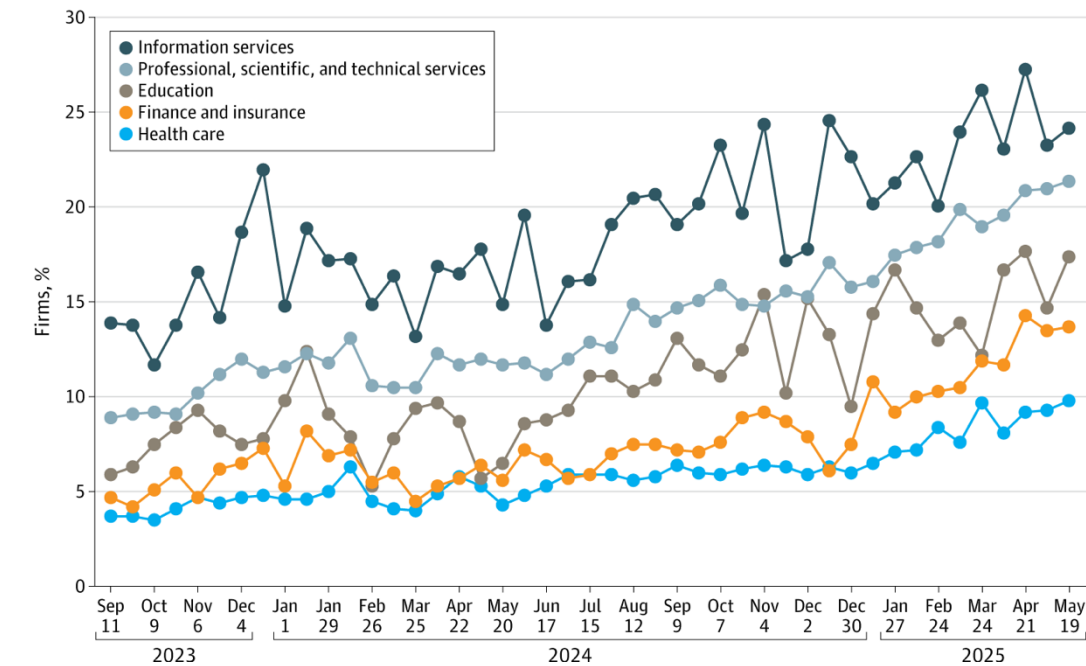
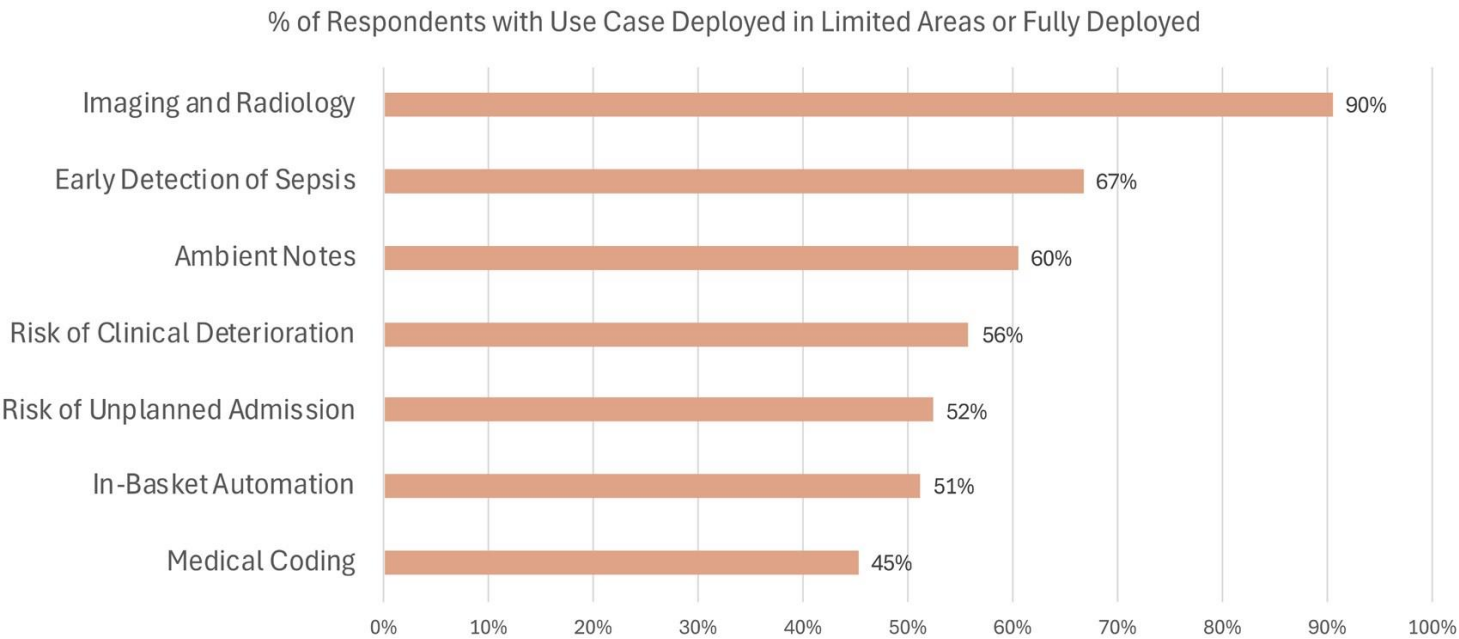
Uptake of generative AI integrated with EHR in US hospitals (Everson, 2025)

- 31.5% using and 24.7% planning in coming year
- More likely in hospitals with predictive AI use and Epic
- Less likely in independent hospitals and with high Medicaid population

GPs in UK (Kumpunen, 2025)

- 28% using in clinical practice, with about half of tools provided and half used independently
- Most common uses clinical documentation (57%), professional development (45%), administrative tasks (44%), support clinical decision-making (28%)

Usage in US health systems (Poon, 2025) and healthcare sector (Nguyen, 2025)



Usage

AMA survey of physicians (2025)

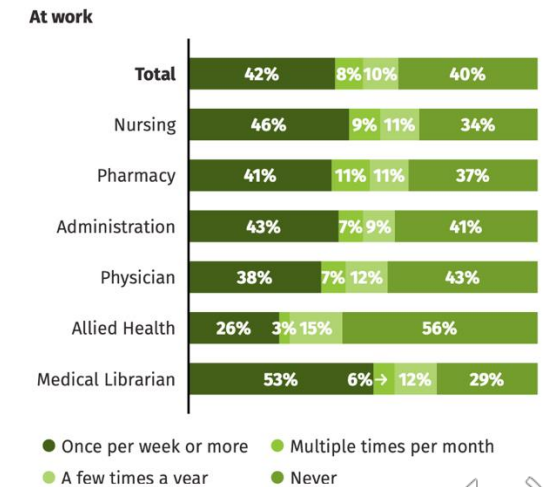
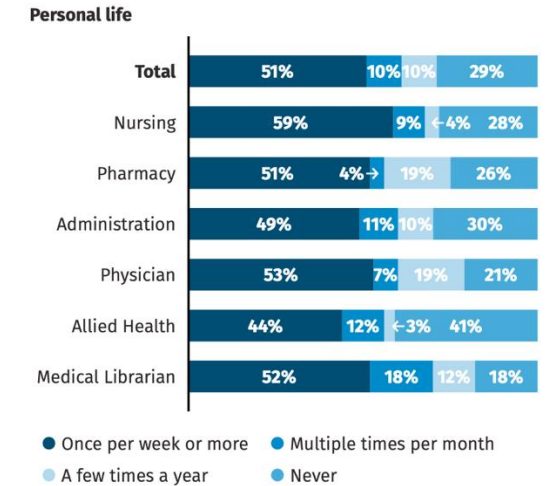
- 66% usage in practice
- Top area of opportunity – addressing administrative burden through automation (57%)
- Top attributes required to advance physician adoption of AI tools
 - Designated feedback channel - 88%
 - Data privacy assurances - 87%
 - EHR integration - 84%

Wolters Kluwer survey of health professionals (2025)

- Frequent use across all health professionals

ChatGPT as “healthcare ally” for consumers (OpenAI, 2026)

- About 5% of all prompts healthcare-related
- Over 40 million prompts per day
- From US, 1.6-1.9 million prompts per week about health insurance; 600K from rural communities



Prompting

Two main approaches

- Web interface or app, e.g., ChatGPT
- Application programming interface (API)

Much advice and education on “prompt engineering” available – books, articles, Web sites, courses, etc. – some general ones

- [OpenAI](#) and [Google](#)
- For students (Mollick, 2023) and instructors (Mollick, 2024)

May be a “poor user interface” (Morris, 2024)

Prompt engineering “dead” due to improvement in LLMs (Gupta, 2025)?

Prompting in biomedicine and health

Prompting for medical professionals
(Meskó, 2023)

Should be CLEAR (Lo, 2023)

- Concise
- Logical
- Explicit
- Adaptive
- Reflective

SPECIFIC PROMPT RECOMMENDATIONS

1. The more specific your prompt is, the more accurate the response is likely to be.

Example

Less specific:
"Tell me about heart disease."
More specific:
"What are the most common risk factors for coronary artery disease?"

2. Describe your setting and provide the context!

Example

I'm writing an article about tips and tricks for ChatGPT prompt engineering for people working in healthcare. Can you please list a few of those tips and tricks with some specific prompt examples?"

3. Experiment with different prompt styles!

Example

Direct Question:
"What are the symptoms of COVID-19?"
Request for List:
"List all the potential symptoms of COVID-19."
Request for Summary:
"Summarize the key symptoms and progression of COVID-19."
"Explain the symptoms of COVID-19 like I'm five."

4. Identify the overall goal of your prompt first!

Example

"I'd like to get a short list of 5 ideas for a Youtube video on the future of healthcare AI."

5. Ask ChatGPT to play roles!

Example

"Act as a Data Scientist and explain Prompt Engineering to a physician."
"Act as my nutritionist and give me tips about a balanced Mediterranean diet."

6. Iterate and refine your question and ask ChatGPT to modify the output based on its previous response.

Example

Initial prompt:
"How are you feeling today?"
Refined prompt:
"On a scale of 1-10, how would you rate your stress levels today and what specific event contributed to it?"

7. Use threads

You can easily go back to a specific discussion by clicking on the proper thread in the left column. This way, you don't have to start all over again but can just continue a discussion you already had with ChatGPT.

8. Ask Open-ended Questions as those often yield more comprehensive responses.

Example

Closed question:
"Is exercise important for patients with osteoporosis?"
Open question:
"How does regular physical activity benefit patients with osteoporosis?"

9. Request specific examples

If there is something you are not satisfied with or don't understand based on its response, first of all, tell ChatGPT that you don't understand the answer and ask it to provide an example.

Initial prompt:
"Could you explain the common side effects of this medication?"
Refined prompt:
"I'm not clear about the side effects of this medication. Can you provide specific examples of common side effects patients have experienced?"

10. If you're asking about a process or timeline, specify that in your prompt.

Example

Without time reference:
"Describe the healing process after knee surgery."
With time reference:
"What can a patient typically expect during the first six weeks of healing after knee surgery?"

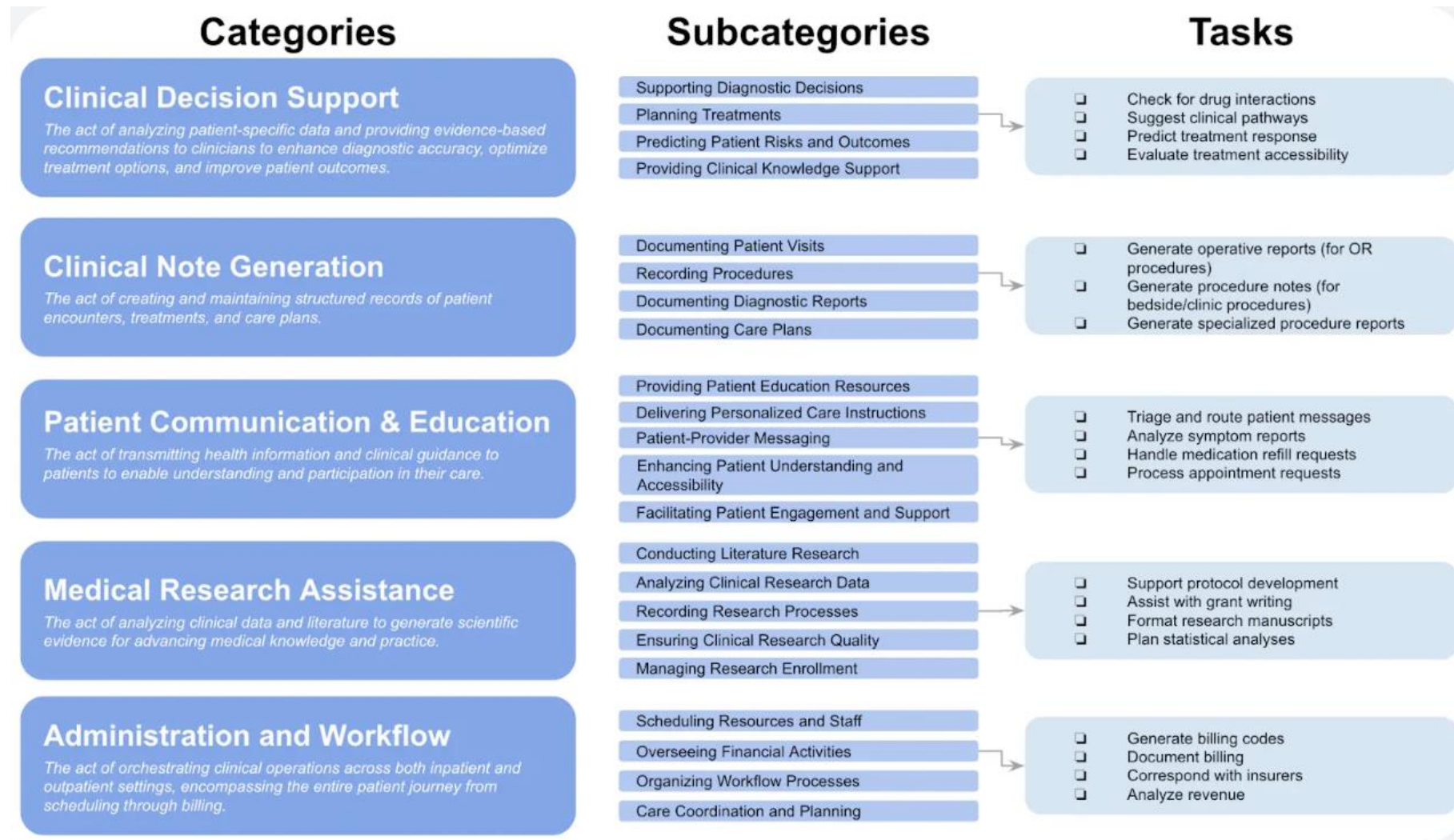
+1 And the +1, Set Realistic Expectations:

Example

Unrealistic Prompt:
"What's the latest research published this month about Alzheimer's?"
Realistic Prompt:
"What were some of the major research breakthroughs in Alzheimer's treatment up until 2021?"



Uses and research results – generative AI in healthcare (Shah, 2025; Bedi, 2026)



Specific research results

Clinical decision support

- Passing medical board exams
- Answering clinician questions
- Solving clinical cases
- Prediction

Clinical note generation

- Summarization
- Assisting documentation

Patient communication and education

- Answering patient questions
- Summarization
- Drafting replies to communications

Medical research assistance

Administration and workflow

Other areas

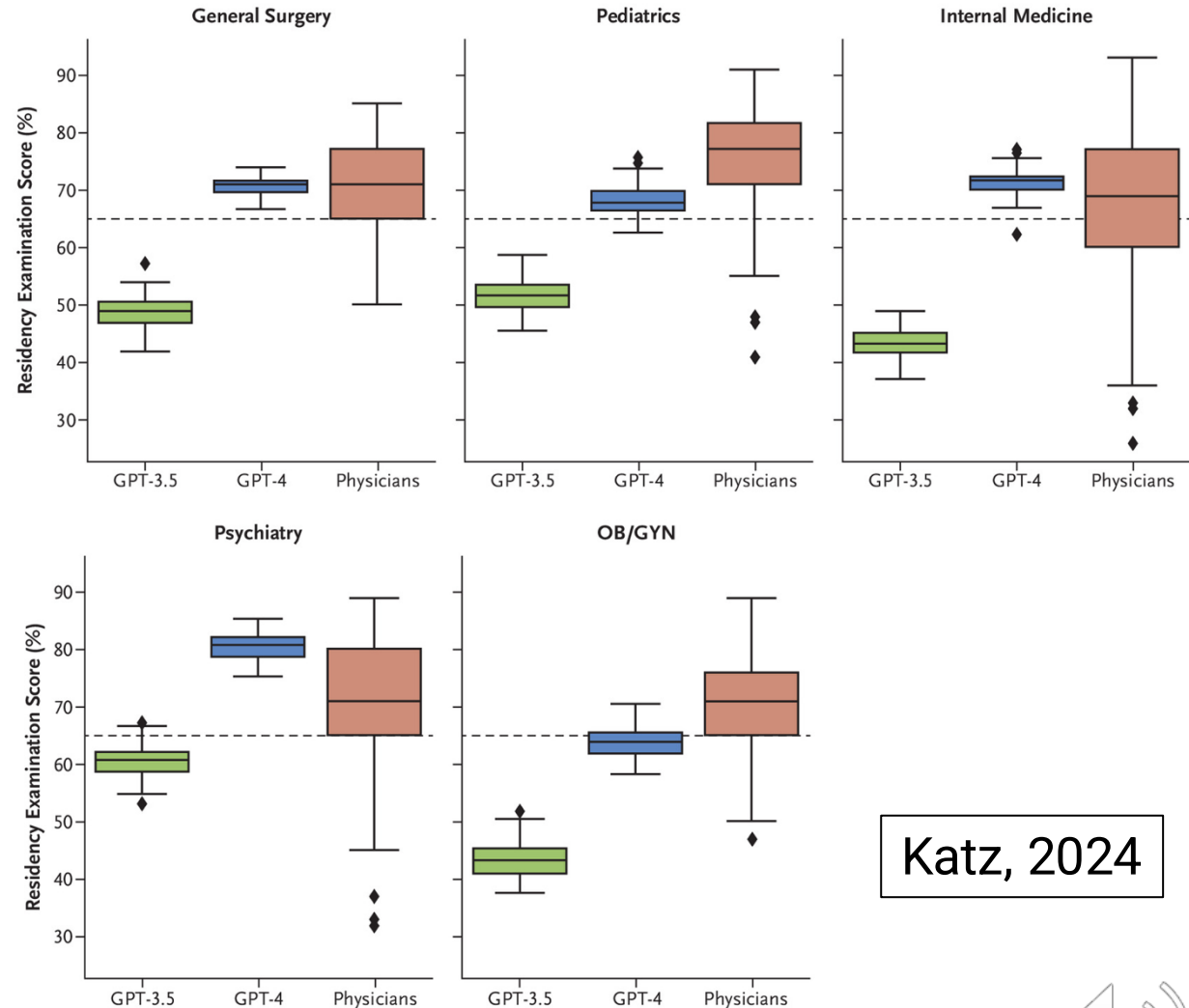
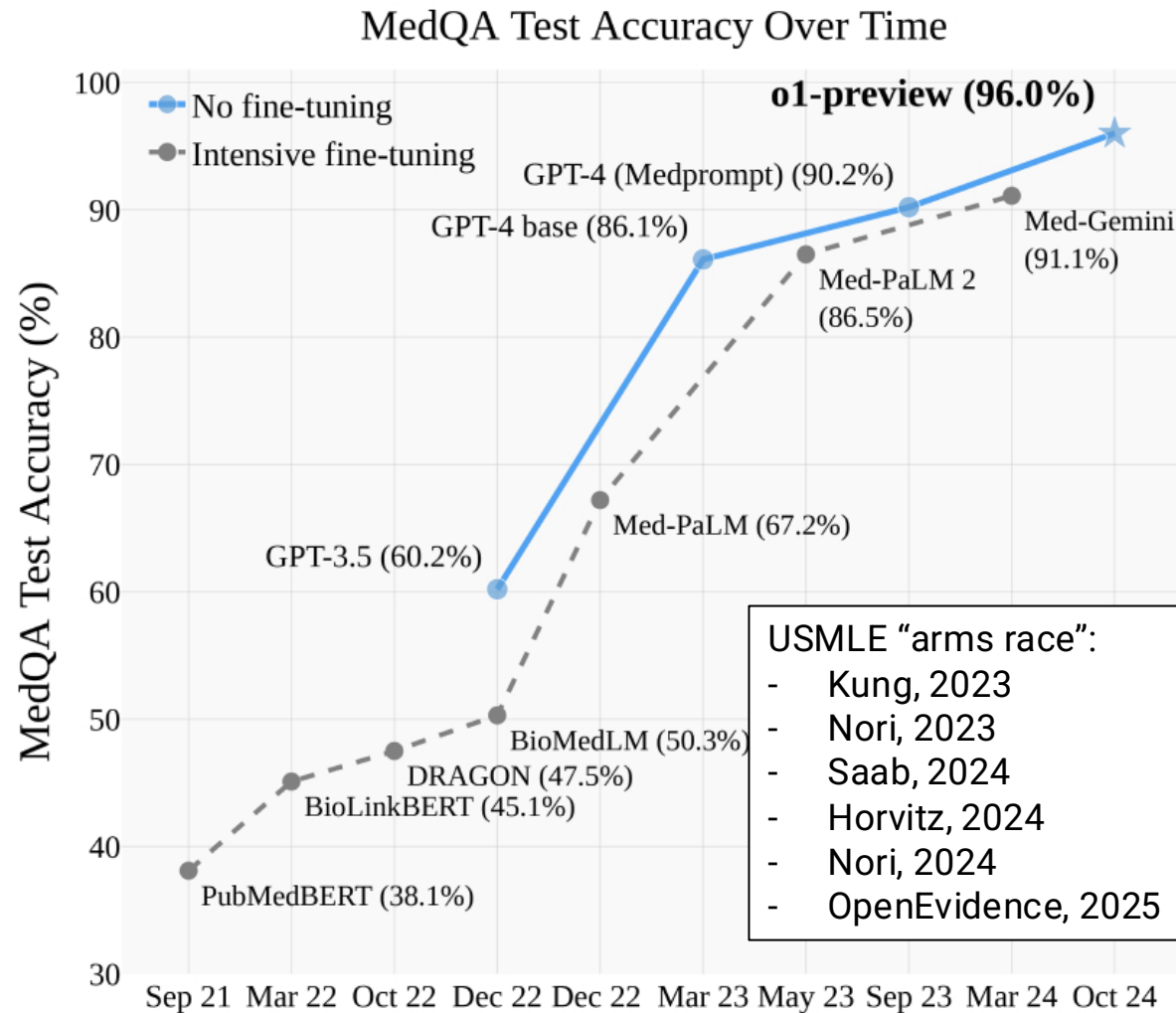
- Educational assessment
- Beyond healthcare
 - Work productivity
 - Educational use

Passing medical board exams – started with USMLE

MedQA dataset based on sample multiple-choice questions (12,273 in English, more in Chinese) from three-part medical exam required for licensing in US (Jin, 2021)

Question	A 27-year-old male presents to urgent care complaining of pain with urination. He reports that the pain started 3 days ago. He has never experienced these symptoms before. He <i>denies gross hematuria or pelvic pain</i> . He is sexually active with his girlfriend, and they consistently use condoms. When asked about recent travel, he admits to recently returning from a “boys’ trip” in Cancun where he had <i>unprotected sex</i> 1 night with a girl he met at a bar. The patient’s medical history includes type I diabetes that is controlled with an insulin pump. His mother has rheumatoid arthritis. The patient’s temperature is 99 °F(37.2 °C), blood pressure is 112/74 mmHg, and pulse is 81/min. On physical examination, there are no lesions of the penis or other body rashes. No costovertebral tenderness is appreciated. A urinalysis reveals no blood, glucose, ketones, or proteins but is <i>positive for leukocyte esterase</i> . A urine microscopic evaluation shows a <i>moderate number of white blood cells</i> but no casts or crystals. A urine culture is negative. Which of the following is the most likely cause for the patient’s symptoms?
Options	A: Chlamydia trachomatis , B: Systemic lupus erythematosus, C: Mycobacterium tuberculosis, D: Treponema pallidum
Evidence	At least one-third of male patients with <i>C. trachomatis</i> urethral infection have <i>no evident signs or symptoms of urethritis</i> Such patients generally have <i>pyuria</i> ..., a <i>positive leukocyte esterase test</i> , ...
Question	A 57-year-old man presents to his primary care physician with a 2-month history of <i>right upper and lower extremity weakness</i> . He noticed the weakness when he started falling far more frequently while running errands. Since then, he has had <i>increasing difficulty</i> with walking and lifting objects. His past medical history is significant only for well-controlled hypertension, but he says that some members of their <i>family have had musculoskeletal problems</i> . His right upper extremity shows <i>forearm atrophy</i> and <i>depressed reflexes</i> while their right lower extremity is <i>hypertonic with a positive Babinski sign</i> . Which of the following is most likely associated with the cause of this patient’s symptoms?
Options	A: HLA-B8 haplotype, B: HLA-DR2 haplotype, C: Mutation in SOD1 , D: Mutation in SMN1, E: Viral infection
Evidence	1. The manifestations of ALS ... <i>insidiously developing asymmetric weakness</i> , usually first evident distally in one of the limbs. 2. ... <i>hyperactivity of the muscle-stretch reflexes (tendon jerks)</i> and, often, <i>spastic resistance to passive movements</i> ... 3. <i>Familial ALS (FALS)</i> ... clinically indistinguishable from sporadic ALS... Genetic studies have identified mutations in multiple genes, including cytosolic enzyme <i>SOD1</i> ...

Board exams – USMLE “arms race” and more



Other board and in-training exams

Systematic review found 16 LLMs on 198 medical exams conducted in 28 countries across 15 languages (Zong, 2024)

Concerns for MedQA dataset

- Time to bench USMLE benchmark? (Raji, 2025)
- Changing correct answer to “none of the above” resulted in up to halving of scores (Bedi, 2025)