AI in Medicine and Medical Education: Critical Issues and Potential Solutions

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AI in Medicine and Medical Education: Critical Issues and Potential Solutions

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1

Objectives and disclosures

- After this talk, you will to be able to
  - Define the major types of AI and their applications, successes, and limitations in biomedicine
  - Discuss the evidence base for AI, its limitations, and how to improve it
  - Describe the issues and challenges for AI in medical education
- Disclosures
  - Funding from Voice AI Bridge2AI 1OT2OD032720 and other NIH grants

2

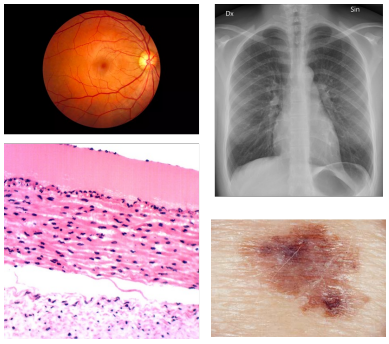
Artificial intelligence (AI)

- AI – "information systems and algorithms capable of performing tasks associated with human intelligence" (Rajpurkar, 2022)
- Some classify AI into two broad categories (Khare, 2023)
  - Predictive AI – use of data and algorithms to predict some output (e.g., diagnosis, treatment recommendation, prognosis, etc.)
  - Generative AI – generates new output based on prompts (e.g., text, images, etc.)
- A large part of modern success of AI due to machine learning (ML) – "computer programs that learn without being explicitly programmed" (McCarthy, 1990, attributed to Samuel, 1959; Shah, 2023)
  - Most success with deep learning, based on many-layered neural networks

3

Predictive AI in medicine

- "Predictive AI" driven by advances in ML, increasing availability of data, and more powerful computers and networks (Topol, 2019; Rajpurkar, 2022)
  - Deep learning in imaging breakthroughs by Hinton (2006)
- Most success in image interpretation (Rajpurkar, 2023); examples include
  - Radiology – chest x-rays for diagnosis of pneumonia and tuberculosis
  - Ophthalmology – retinal images for diagnosis of diabetic retinopathy
  - Dermatology – skin lesions for diagnosis of cancer
  - Pathology – breast cancer slides to predict metastasis



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Predictive AI not limited to imaging

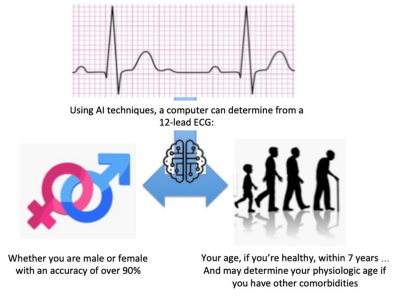
- Adverse events in hospitalizations from electronic health record (EHR) data (Rajkomar, 2018)
- Protein folding from amino acid sequences (Jumper, 2021)
- Model based on past ICD-10 codes and lab results to predict future diagnoses in office visits (Mukherjee, 2023)
- Semantic reconstruction of continuous language from fMRI brain recordings (Tang, 2023)
- Map chemicals to odors perceived by humans (Lee, 2023)
- Predict Alzheimer's Disease from EHR data up to 7 years before diagnosis (Tang, 2024)
- Voice as a biomarker in Parkinson's Disease, Alzheimer's Disease, cognitive impairment, COVID-19, and others (Idrisoglu, 2023; Bensoussan, 2024)

- The list goes on and on, especially with addition of generative AI…

5

Also success in "seeing" where humans cannot (Topol, 2022)

- Retinal images
  - Age, biological sex, and cardiovascular risk determination from retinal images (Poplin, 2018)
  - Race (Coyner, 2023)
- Electrocardiograms (ECGs)
  - Age and biological sex determination (Attia, 2019)
  - Chronic kidney disease (Holmstrom, 2023)
- Chest x-rays
  - Race (Gichoya, 2022)
  - Cardiac function and valvular heart diseases (Ueda, 2023)
  - Diabetes (Pyrros, 2023)
  - Correlation with chronological age in healthy cohorts and, for various chronic diseases, difference between estimated age and chronological age (Mitsuyama, 2023)
  - Cardiac risk as accurately as common models, e.g., atherosclerotic cardiovascular disease (ASCVD) (Weiss, 2024)



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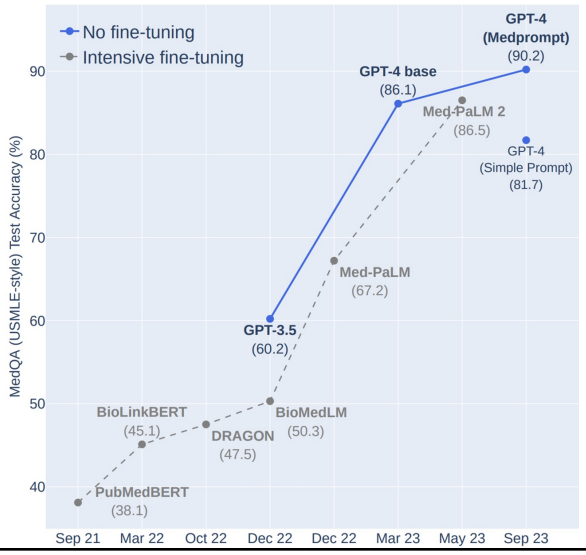
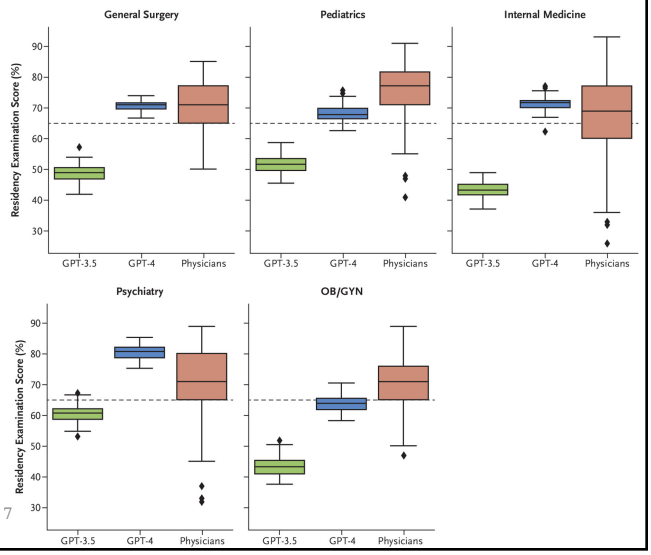
Success of generative AI – board exams (Kung, 2023; Nori, 2023; Katz, 2024; and more)





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7

Success of LLMs (cont.)

- Solving clinical cases – comparable to but not better than expert humans (Levine, 2023; Kanjee, 2023; Rao, 2023; Benoit, 2023; Chen, 2023; Levkovich, 2023)
- In simulated (text-based) objective structured clinical exam (OSCE) format, Google's Articulate Medical Intelligence Explorer (AMIE) outperformed primary care physicians in text-based dialogue in history-taking, diagnostic accuracy, management reasoning, communication skills, and empathy (Tu, 2024)
- For 20 clinical cases, GPT-4 performed comparable to attending physicians and residents in diagnostic accuracy, correct clinical reasoning, and cannot-miss diagnosis inclusion (Cabral, 2024)

8

Results of LLMs (cont.)

- Communicating with patients
  - Answering questions in public forums (Sarraju, 2023; Ayers, 2023)
  - Writing letters with comparable or better empathy (Ali, 2023, Ayers, 2023)
  - Generating surgical consent forms better than surgeons (Decker, 2023)
- Closing the loop with predictive AI
  - Classifying CXR findings based on previous images and reports (Xu, 2023)
  - Generating CXR reports from new images in ED from prior images and reports (Huang, 2023)
  - Predicting cardiovascular risk comparable to Framingham models (Han, 2023)
  - Designing and validating easily synthesizable and structurally novel antibiotics (Swanson, 2024)

But there are some downsides to generative AI

- Dictionary.com 2023 word of year: hallucinate
  - https://content.dictionary.com/word-of-the-year-2023/
- Fabrication and errors in the bibliographic citations – asked to produce short literature reviews on 42 multidisciplinary topics (Walters, 2023)
  - 55% of GPT-3.5 citations and 18% of GPT-4 citations fabricated
  - 43% of real (non-fabricated) GPT-3.5 citations and 24% of real GPT-4 citations include substantive errors
- 8 clinical questions asked of 4 LLMs recapitulated "harmful, race-based medicine" (Omiye, 2023)

Downsides to generative AI (cont.)

- Equally compelling disinformation – humans cannot distinguish between true and false tweets generated by GPT-3 and written by real Twitter users (Spitale, 2023)
- Automated GPT detectors have mixed results (Sadasivan, 2023; Odri, 2023; Desaire, 2023; Tang, 2024)
  - More likely to classify non-native English writing as AI-generated (Liang, 2023)
  - Humans not able to discern AI writing either (Dell'Acqua, 2023)

11

And some downsides to AI in general

- After clinical models deployed, performance may decline due to actual real-world use (Vaid, 2023; Palmer, 2023)
- Implementing diabetic retinopathy screening in rural Thailand and India found (Widner, 2023)
  - Challenges related to equipment operation, workflows, and image quality
  - Need for training and attention to human factors
- ML algorithms, especially generative AI, have large carbon footprints, although details sometimes not known due to lack of company transparency (Kirkpatrick, 2023)
  - One estimate is that electricity consumption of AI request is 10-fold more than Google search (de Vries, 2023)

12

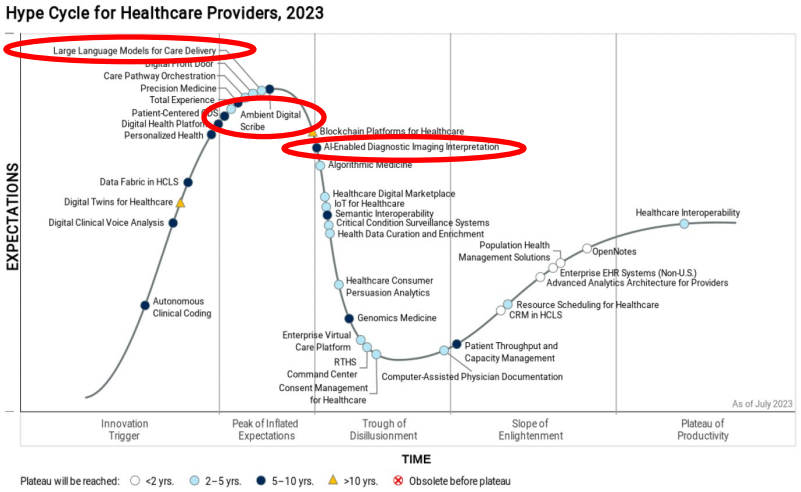
Downsides to AI in general (cont.)

- Variable impacts on different levels of radiologists, leading to automation bias and detrimental effects of incorrect AI (Dratsch, 2023; Yu, 2024)
- Concerns about reproducibility (Ball, 2023)
  - Data bias (especially from EHR – Lewis, 2023; Chin, 2023)
  - Data leakage (Kapoor, 2023)
  - Data drift/shift (Finlayson, 2021; Li, 2024)

Will AI help or hinder healthcare?

- Real-world use still modest
  - As of Sept 2023, only 21% of medical groups using AI applications in practice (MGMA, 2023)
  - EHR usability, patient communications, and billing outrank AI as top tech priorities among medical groups (MGMA, 2023)
  - AI tools used by only 38% of physicians (AMA, 2023)
- "AI won't replace radiologists, but radiologists who use AI will replace radiologists who don't," (Langlotz, 2019)
  - (Plug in your health profession)

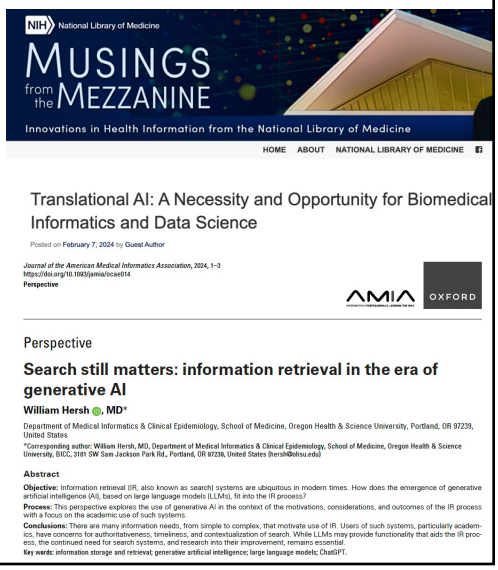
AI is at peak of inflated expectations (Meyer, 2023)



Gartner

What do we need for AI applications to get to plateau of productivity?

- Translational AI (Hersh, 2024)
  - Show us the evidence
  - How do we learn about it
- Education of clinical workforce and others (Hersh, 2023)
- Search still matters (Hersh, 2024)
  - In many circumstances, who said what is more important than providing a generated answer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Translational AI: A Necessity and Opportunity for Biomedical Informatics and Data Science

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Perspective

AMIA OXFORD

Perspective

Search still matters: information retrieval in the era of generative AI

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Abstract

Objective: Information retrieval (IR, also known as search) systems are ubiquitous in modern times. How does the emergence of generative artificial intelligence (AI), based on large language models (LLMs), fit into the IR process?

Process: This perspective explores the use of generative AI in the context of the motivations, considerations, and outcomes of the IR process with a focus on the academic use of such systems.

Conclusions: There are many information needs, from simple to complex, that motivate use of IR. Users of such systems, particularly academics, have concerns for authoritativeness, timeliness, and contextualization of search. While LLMs may provide functionality that aids the IR process, the continued need for search systems, and research into their improvement, remains essential.

Key words: information storage and retrieval; generative artificial intelligence; large language models; ChatGPT.

How do we "show the evidence?"

- From evidence-based medicine (EBM), best evidence for any clinical intervention is from randomized controlled trials (RCTs) or systematic reviews of RCTs
- Although not as easy to carry out as RCTs of drugs or devices (and placebos), AI must demonstrate benefit for patient outcomes and/or healthcare delivery improvement
  - Additional issues for RCTs of AI (Liu, 2020)
- As with drugs and devices, we need to move from "basic science" to "clinical science"
- Not everything can be studied in an RCT and RCTs cannot be done for every last clinical question (Greenhalgh, 2022)

17

What is the evidence so far?

- Many, many papers published about models and simulated use (basic science), including systematic reviews of those papers
- Very few RCTs demonstrating value from real-world use (clinical science) – systematic reviews of RCTs show (Zhou, 2021; Plana, 2022; Han, 2023)
  - Much smaller numbers of RCTs – about 100, depending on how we count
  - 65-82% of RCT showed positive outcomes
  - Many RCTs showed aspects of "risk of bias"

18

Perspective from some specific examples

- Computer-aided detection (CADe) of polyps in colonoscopy
  - One of earliest and most widely-studied applications of AI
  - Recent systematic review shows polyps missed by colonoscopists are discovered, but mostly small and clinically inconsequential (Hassan, 2023)
  - RCT of CADe found no increased detection of advanced neoplasias (Mangas-Sanjuan, 2023)
- 30-day hospital readmissions
  - After implementation of CMS penalty, proliferation of highly accurate predictive models published in mid-2010s
  - Recent RCT showed use of high-quality model and implementation of program around it did not reduce readmissions (Donzé, 2023)

Perspective from examples (cont.)

- RCT to assess whether use of previously validated hospital-acquired venous thromboembolism (HA-VTE) prognostic model, together with pediatric hematologist review, could reduce pediatric inpatient rates of HA-VTE (Walker, 2023)
  - No difference for intervention group randomized to use model
  - Reluctance to use model by primary physicians – used only 26% of time
  - For children in intervention arm, model mostly not used, AI's "Cassandra problem" (Wilson, 2023)?
- Pragmatic trial of predictive algorithm and practice facilitators in outpatient practices did not reduce hospitalization rate in chronic kidney disease over 1 year compared with usual care (Vazquez, 2024)

How do we get to "translational AI?"

- In pediatric critical care ML research, "the literature demonstrates incomplete reporting, absence of external validation, and infrequent clinical implementation" (Heneghan, 2023)
- Singh, X/Twitter, Feb 8 2024: "Researched models aren't implemented. Implemented models aren't researched."
- Postmarket surveillance, e.g., algorithmovigilance (Embi, 2021)
- Responsible use (Dorr, 2023) and code of conduct (Adams, NAM, 2024) for AI
- Building the evidence base (Hersh, 2024)

21

Also critical is education of clinicians and informaticians

- AI should build on competencies in clinical informatics (Hersh, 2014; Hersh 2020; Hersh, 2023)
- Others note
  - Clinicians must be prepared to practice in a world of AI (James, 2022)
  - Medical schools face dual challenges of needing to teach about AI in practice but also adapt to its use by learners and faculty (Cooper, 2023)
  - Impact in many fields beyond medicine, including
    - Computer science (Denny, 2024)
    - Data science (Hong, 2024)
    - Law (Choi, 2023)
  - How to deal with "homework apocalypse" (Mollick, 2023)

1. Find, search, and apply knowledge-based information to patient care and other clinical tasks
2. Effectively read from, and write to, the electronic health record (EHR) for patient care and other clinical activities
3. Use and guide implementation of clinical decision support (CDS)
4. Provide care using population health management approaches
5. Protect patient privacy and security
6. Use information technology to improve patient safety
7. Engage in quality measurement selection and improvement
8. Use health information exchange (HIE) to identify and access patient information across clinical settings
9. Engage patients to improve their health and care delivery though personal health records and patient portals
10. Maintain professionalism in use of information technology tools, including social media
11. Provide clinical care via telemedicine and refer patients as indicated
12. Apply personalized/precision medicine
13. Participate in practice-based clinical and translational research
14. Use and critique artificial intelligence (AI) applications in clinical care

22

Need competencies for use of AI-based tools by healthcare professionals (Russell, 2023)

Domain	Competency
Basic knowledge of AI	Explain what AI is and describe its healthcare applications
Social and ethical implications of AI	Explain how social, economic, and political systems influence AI-based tools and how these relationships impact justice, equity, and ethics
AI-enhanced clinical encounters	Carry out AI-enhanced clinical encounters that integrate diverse sources of information in creating patient-centered care plans
Evidence-based evaluation of AI-based tools	Evaluate the quality, accuracy, safety, contextual appropriateness, and biases of AI-based tools and their underlying datasets in providing care to patients and populations
Workflow analysis for AI-based tools	Analyze and adapt to changes in teams, roles, responsibilities, and workflows resulting from implementation of AI-based tools
Practice-based learning and improvement regarding AI-based tools	Participate in continuing professional development and practice-based improvement activities related to use of AI tools in healthcare

Educators need to assign and innovate with AI (Mollick, 2024)

Assigning (Mollick, 2023)

- Can use as
  - Mentor
  - Tutor
  - Coach
  - Teammate
  - Student
  - Simulator
  - Tool
- Risks include
  - Confabulation
  - Bias – from training content
  - Privacy – policies not always clear
  - Instructional – student over-reliance

Innovating (Mollick, 2024)

- One Useful Thing
  - https://www.oneusefulthing.org/

CATEGORY	PROMPT	PEDAGOGICAL PRINCIPLES
SIMULATION	Role-playing with AI feedback	Practicing and applying knowledge
SIMULATION	Goal-playing with AI feedback	Practicing applying frameworks in new situations
CRITIQUE	Critique a scenario	Structuring knowledge. Critical thinking and protégé effect
TEACH	Teach the AI	Teaching others is a powerful learning technique
CO-CREATE	Co-create a case	Break the illusion of explanatory depth. Structuring knowledge. Retrieval
MENTOR AND COACH	Reflection coach	Reflection is critical to learning
MENTOR AND COACH	Integration agent	Creating connections and interleaving concepts
TUTOR	Tutor	Tutoring is an effective technique for improving learning

Need policy for generative AI: mine for introductory course

https://dmice.ohsu.edu/hersh/introcourse-generativeAI-policy.html

OHSU *Introduction to Biomedical & Health Informatics* Course Policy for Use of ChatGPT and Generative AI

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This page reflects course policy for the Oregon Health & Science University (OHSU) course that I teach called **Introduction to Biomedical & Health Informatics**. I teach versions of this course in several OHSU programs, including:

- Biomedical Informatics Graduate program - BMI 510/610 - Introduction to Biomedical & Health Informatics
- AMIA 10x10 ("ten by ten") course - OHSU-AMIA 10x10 course
- MD curriculum course, MINF 705B/709A

ChatGPT and generative AI systems based on large language models (LLMs) can be a useful tool for learning all kinds of topics, including in biomedical and health informatics. These tools should not, however, be used to substitute one's own knowledge. Students can "converse" with ChatGPT or generative AI systems to get ideas for answers to questions, but the final responses to discussion forums, quiz and test questions, and the term paper, should reflect their own thinking, judgment, and language.

This policy is derived from the overall OHSU policy for academic integrity, including the use of AI. The OHSU Biomedical Informatics Graduate Program is developing a general policy for use of generative AI in courses, but in the meantime, I am adopting the following guidelines for course activities:

- **Discussion forums** - the purpose of the discussion forums is for students to discuss issues that elaborate on unit course materials. Individual forum postings are not graded, although a component of the course grade is based on participation in the forums, comparable to what used to be participation in live classrooms. While students can "converse" with generative AI to get ideas for responses to forum questions, what is actually posted in the forum by students should represent their own ideas and thought processes.
- **Homework self-assessment** - students can ask generative AI about topics mentioned in the multiple-choice questions but are expected to answer the questions based on their own knowledge of materials covered in the lectures.
- **Term paper/project** - students can ask generative AI for help in brainstorming about their term paper. Generative AI systems do not write long papers, and their output tends to focus on generalities and may be prone to confabulation, especially in generating references. The 10-15 page term paper should have a focus on a specific topic, and delve into it with coherent discussion and ample references, including recent ones, as outlined in the course syllabus.
- **Final exam** - students must not access generative AI during the final exam.

If you are a student and have a question on whether use of generative AI is appropriate, please reach out directly to me (email is best for initial contact).

As a guiding principle, we expect and require that all work submitted be the student's own, original work. When considering using such a generative AI tool, students should ask themselves: Will the tool's output be something I will be turning in directly? In general, students may use such tools as a source of information, but not to produce output that they intend to turn in or as a replacement for a traditional cited reference.

Most ethical and conduct policies in our informatics educational programs, and in the work we subsequently do as professionals, are enforced through an **honor code**. We recognize we cannot police all inappropriate use of AI or other activities. We hope that students will find ways to use LLMs to enhance their learning but not substitute for or become dependent on it.

Last update: January 8, 2024

Search still matters (Hersh, 2024)

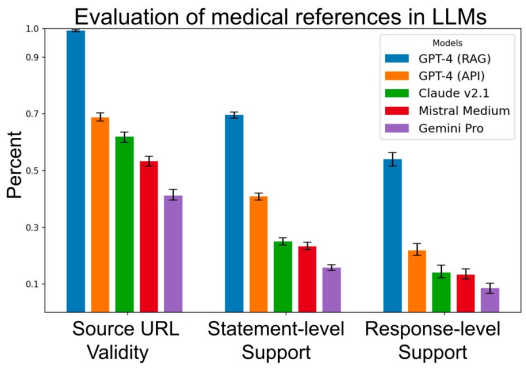
- Generative AI systems such as ChatGPT are cool and fun but
  - For some tasks that many of us do, need more than answers, e.g.,
    - Clinical – patient-care questions
    - Research – methods and insights
    - Teaching – synthesizing knowledge for our students
  - Where the information comes from is as important what it says
- Information retrieval (IR) systems "do not inform user about a subject; indicate the existence (or nonexistence) and whereabouts of documents related to an information request" (Lancaster, 1979)

Other concerns for search

- Concerns for search and LLMs (Shah, 2023)
  - Opacity and hallucinations
    - LLMs don't know when they don't know
  - Stealing content and Web site traffic
    - LLMs learn from other people's content and may divert traffic from their Web sites
  - Taking away learning and serendipity
    - Search is exploring and we may learn new unrelated things
- LLMs "contaminating" scientific literature and peer review
  - Scientific literature – estimates range from
    - 1% generally (Gray, 2024)
    - 6% for Nature portfolio and 17.5% in computer science (Liang, 2024)
  - Peer review
    - Usage in AI conference peer reviews estimated to be 6.5-16.9% (Liang, 2024)

Search in the era of generative AI

- Another adage of EBM?
  - Gen AI for background questions
  - Search and critical appraisal for foreground questions
- Retrieval-augmented generation (RAG) for improving Gen AI but do we need "generation-augmented retrieval" for LLMs to aid search?
  - Evidence modest so far, e.g., using ChatGPT for generating Boolean queries did not improve search results (Wang, 2023)
  - Best LLM with RAG (GPT-4 in CoPilot) achieved about 70% statement-level support and <50% for others (Wu, 2024)



Conclusions

- AI will profoundly impact the practice and education of all health professions
- Translational AI is a necessity and opportunity for clinicians, researchers and others
- Healthcare, informatics, and educational professionals must be competent with AI as much as any other tool in clinical practice
- Generative AI systems must provide attribution for their assertions

29

Questions?

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30