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Title

Supporting Diagnosis With Next-Generation Artificial Intelligence—Reply

Permalink

<https://escholarship.org/uc/item/7nj548sh>

Journal

JAMA: The Journal of the American Medical Association, 327(14)

ISSN

0098-7484

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Publication Date

2022-04-12

DOI

10.1001/jama.2022.2306

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Peer reviewed

VIEWPOINT

DIAGNOSTIC EXCELLENCE

Next-Generation Artificial Intelligence for Diagnosis
From Predicting Diagnostic Labels to “Wayfinding”

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Improving the diagnostic process is a quality and safety priority.¹ With the digitization of health records and rapid expansion of health data, the cognitive demand on the diagnostician has increased. The use of artificial intelligence (AI) to assist human cognition has the potential to reduce this demand and associated diagnostic errors. However, current AI tools have not realized this potential, due in part to the long-standing focus of these tools on predicting final diagnostic labels instead of helping clinicians navigate the dynamic refinement process of diagnosis. This Viewpoint highlights the importance of shifting the role of diagnostic AI from predicting labels to “wayfinding” (interpreting context and providing cues that guide the diagnostician).

Starting With the End

There are many examples of AI solutions for well-characterized, stand-alone diagnostic questions. AI-enabled image analysis can predict diabetic retinopathy or whether a chest radiograph shows a pneumothorax.^{2,3} Differential diagnosis generators⁴ process data on signs and symptoms to create a prioritized list of diagnoses. These AI tools aim to predict a label that represents the end point of the diagnostic process.

In doing so, these tools overlook the upstream work of navigating the decision nodes along the diagnostic pathway, and therefore are unlikely to garner the trust of clinicians.⁵ The critical challenges clinicians encounter when making a diagnosis are synthesizing complex patient data and determining the best next steps. A new generation of AI is needed that considers the dynamism of the diagnostic process and answers the questions of where are the clinician and patient on the diagnostic pathway and what should be done next.

Diagnosis as a Wayfinding Process

Wayfinding is the process of determining a current position and navigating a route between an origin and a destination. The basic elements of wayfinding are orientation (what is the current location?), path selection (which way to go?), route monitoring (is this the right track?), and destination recognition (is this the end point?).⁶ Wayfinding also refers to the environmental cues that orient people and help them choose a path within complex spaces such as airports and hospitals (eg, hallway curvature and color that subconsciously guide a person to their final destination). Effective wayfinding reduces cognitive load in navigating a complex journey. It operates in the background, with the individual unaware of why or how.

From the clinician's perspective, the diagnostic journey begins with assessment of the patient's signs

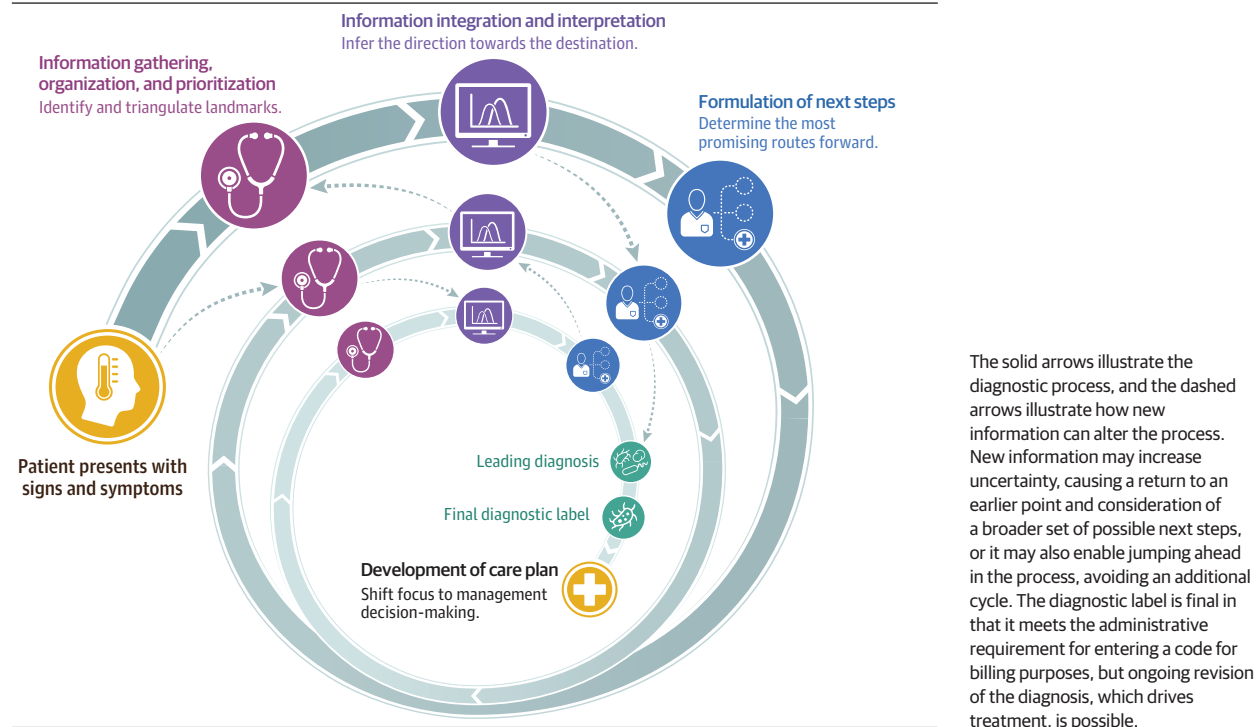
and symptoms, which in turn triggers information gathering (eg, asking questions or reviewing the medical record). As the clinician integrates and interprets accumulating data, next steps are planned, often with a general direction or potential destinations (diagnostic hypotheses) in mind. As next steps are pursued, new information is generated (eg, test result or physical examination), which prompts another round of the data acquisition-integration cycle. As cycles repeat, uncertainty is reduced, and the destination becomes clearer. The diagnostic journey ends when the clinician and patient have reduced uncertainty sufficiently to shift their focus to management decisions. Conceptualizing diagnosis as a dynamic refinement process (**Figure**) moves the emphasis from the destination (diagnostic label) to the journey, including information-intensive activities in the electronic health record.

Reducing Cognitive Load to Optimize Performance

Although clinicians have been hesitant to relinquish decision-making to prediction tools, they have used technologic guidance for key cognitive tasks along the pathway (eg, computer interpretation of electrocardiograms). AI tools that support the dynamic diagnostic refinement process should help the clinician understand where they are on the diagnostic pathway and help them select the paths most likely to reduce uncertainty. The clinician still analyzes data and makes decisions, with AI serving to lower the cognitive load.

For example, AI could be designed around the evaluation of a patient who presents to a primary care clinician with progressive shortness of breath. To support information gathering, an AI tool, recognizing the context of dyspnea in an adult patient, could engage in an automatic chart search for data that are pertinent to the most common and most morbid conditions (eg, recent echocardiograms or cardiac catheterization reports), as well as for other risk factors (eg, recent course of steroids or remote history of venous thromboembolism) that could change the clinician's thinking. A more sophisticated AI tool could engage in real-time natural language processing of the clinical interview and suggest questions that could be relevant for determining an accurate diagnosis (eg, occupational exposures). As the clinician integrates information, AI could detect patterns in patient data from digital monitoring devices (such as sleep quality or walking distance) and suggest additional questions (eg, screening for sleep apnea) or testing (eg, ankle-brachial index measurement). These AI tools could help the clinician by interpreting the context and placing cues and guidance along the diagnostic pathway.

Figure. The Dynamic Diagnostic Refinement Process



The Way Forward

To develop wayfinding AI tools, new types of data assets need to be generated. Alongside traditional patient-centric (clinical) information, new clinician-centric data are needed that capture clinicians' actions during the diagnostic process⁷ (eg, what data clinicians typically review when evaluating a patient with low back pain) and the contextual factors that surround the clinician and patient during this process (eg, team structure, patient volume). Given the breadth of diagnostic scenarios, initial data sets should focus on characterizing the information processing and decision nodes in the diagnostic process for common symptoms.

Observing the digital footprints of clinicians' current wayfinding activities will reveal where AI could optimize information navigation and decision-making. Doing so may enable discovery of more efficient and accurate diagnostic pathways. For instance,

an AI algorithm may prioritize a lung nodule excision instead of the traditional intermediary steps of laboratory tests, additional imaging, or observation periods. This may appear illogical or anomalous, but the AI system, unconstrained by standard practices that make sense to clinicians, may uncover the safety and efficiency of alternative approaches that inform wayfinding guidance.

Conclusions

Diagnostic AI has not realized its potential to improve diagnostic performance because it has not focused on supporting the diagnostic journey. Knowing the direction of the pathway in a complex environment is important, but the essential decision is determining the next step. A shift to wayfinding AI could help achieve the synergy of human intelligence and AI to achieve diagnostic excellence.

ARTICLE INFORMATION

Published Online: December 9, 2021.
doi:10.1001/jama.2021.22396

Conflict of Interest Disclosures: Dr Chen reports receipt of grants from the National Institutes of Health (NIH)/National Library of Medicine (R56LM013365), the Stanford Artificial Intelligence in Medicine and Imaging-Human-Centered Artificial Intelligence Partnership Grant, Stanford Aging and Ethnogeriatrics Research Center (under NIH/National Institute on Aging grant P30AG059307), and the Stanford Clinical Excellence Research Center. Dr Dhaliwal reports board of directors membership with the Society to Improve Diagnosis in Medicine. No other disclosures were reported.

Funding/Support: Funding for this article was provided by the Gordon and Betty Moore Foundation (Drs Adler-Milstein and Chen).

Role of the Funder/Sponsor: The Gordon and Betty Moore Foundation encouraged submission of this article and provided feedback on the first draft but had no other role in the preparation or approval of the manuscript.

Additional Contributions: We would like to thank Steven Lin, MD, Paul Tang, MD, MS, Noemi Elhadad, PhD, and Krzysztof Geras, PhD, for their uncompensated contributions to this article.

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