Under the Microscope: Artificial Intelligence in Healthcare

Authors: Darcy Richards, EMJ, London, UK

Citation: Microbiol Infect Dis AMJ. 2023;1[1]:14-16. DOI/10.33590/microbiolinfectdisamj/10307187. https://doi.org/10.33590/microbiolinfectdisamj/10307187.

ARTIFICIAL INTELLIGENCE (AI) was a theme embedded throughout the program of IDWeek 2023, which was held in Boston, Massachusetts, USA, between the 11th–15th October. The opening session saw Isaac Kohane, Harvard Medical School, Boston, Massachusetts, USA, deliver a fascinating presentation spotlighting the rapid progression of AI algorithms in healthcare, the potential pitfalls associated with its use, and its future implications in clinical practice.

INTRODUCTION

AI in healthcare is emerging and continually evolving, with seemingly infinite potential, including improving screening and diagnosis, identifying novel therapeutic targets, and streamlining workflows. However, whilst these possibilities are exciting and encouraging, implementation and rollout of AI in healthcare will not be straightforward. During his presentation, Kohane explored the rapidly progressing field, and gave insight into its impact on healthcare.

THE RAPID EVOLUTION OF ARTIFICIAL INTELLIGENCE

Kohane discussed the pace of change in AI, highlighting that what was considered state-of-the-art in 2021, is now considered 'old-school' AI.

Spotlighting an example of 'old-school' AI used in 2021, Kohane reflected on his personal experience with the evolution of AI. He compared AI used as part of work performed with an undiagnosed disease network, comprising 12 clinical sites in the USA, to more recent work utilizing GPT-4 in 2022. The work in 2021 involved genome sequencing from patients with undiagnosed diseases, and then utilizing AI algorithms to determine which identified mutations were most likely to be responsible for the patient phenotype, followed by evaluation from a corresponding clinical expert to put everything together, and determine the diagnosis.

Comparatively in 2022, Kohane discussed the use of GPT-4 to diagnose a rare disease. He detailed a case and highlighted that, after being fed information pertaining to five genes that displayed severe loss of function on whole-exome sequencing, the GPT-4 algorithm was able to identify and give expert level insights into a rare disease diagnosis. The algorithm was able to rationalize the likelihood of these genes contributing to the patient phenotype, and its selection was confirmed using CRISPR technology.

In the space of just 2 years, AI technology has matured, and it is anticipated this trajectory of evolution will continue over the coming years.

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PITFALLS AND IMPLICATIONS

Whilst AI undoubtedly has the potential to effect significant benefits to healthcare systems, professionals, and patients, it is not without its challenges. Kohane explained that temporal and financial investment is required to train AI models, and that even when trained, they can make mistakes and require regular updates, which can be costly. Challenges with globalization were also noted as a concern.

Kohane also explored the issue surrounding AI software quality, emphasizing that the U.S. Food & Drug Administration (FDA) evaluates AI as a medical device using a standard trial framework with a specified outcome, conditions, and population. However, Kohane stressed that this type of evaluation only works well for a narrow spectrum task, and works less well for larger, general purpose, generative AI models. This creates a challenge, as these large generative models exist in the public domain, and lend themselves to self-diagnosis. This, in turn, could result in misdiagnosis and perpetuation or deterioration of health conditions.

A potential solution to overcome this is the use of reinforcement learning, but again, this has its limitations. Reinforcement learning works well when the material being learned is deterministic and fully observed, the action space is discrete, there is access to a perfect simulator, the episode is short, the evaluation is clear and fast, and there is a large dataset. Human physiology and medicine, drug response, surgery, and disease course, however, do not follow these rules. Kohane did comment that an area in medicine that does fulfill these criteria is reimbursement and billing, and suggested that AI in this space could be transformative.

Alongside implications for the business of healthcare, Kohane explored the potential AI may have in bridging gaps in physician shortages. For example, in the USA, there were fewer applicants than there were slots available to pediatric infectious disease posts. Physician shortages pose a significant problem for the future, and are not limited to the USA. This problem gives rise to the discussion exploring whether combining the knowledge and skills of other healthcare professionals, such as nurse practitioners

and physician assistants, with AI, can result in performance close to, or better than, that of the average physician. Kohane discussed evidence from a study showing that usage of AI to report on echocardiograms leads to less inter-observer variance than that seen with standard cardiologist reporting. This AI technology could therefore reduce the need for echocardiogram technicians to consult cardiologists, and therefore reduce physician workload.

An important caveat to consider with the implementation of AI models in healthcare is the need for quality and accurate data. Alongside this, there are challenges regarding data ownership, and the ever-changing nature of medicine and medical practice. This means that different institutions will require devices that need to be customized to different populations and different medical practices, and require continual updates, which will pose a challenge for FDA approval.

POTENTIAL IMPACT FOR INFECTIOUS DISEASES PRACTICE

Kohane displayed a video example, where he utilized an AI algorithm to review a Centers for Disease Control and Prevention (CDC) document. The algorithm relayed the information and potential analyses that could be performed from the data. He displayed how he was able to ask the algorithm a series of questions, which culminated in the algorithm's ability to provide visual representation in the form of a video displaying antibiotic resistance distribution across the USA over time. Following this demonstration, Kohane stated: "This should give you courage to go into data, and you have the world's best programmer at your fingertips to do your analyses."

CONCLUSION

In the concluding remarks of the presentation, Kohane explained that the change in AI is happening at a much faster rate than its regulation and education on the subject matter, noting that there is a gap in medical education, and the inclusion of AI into medical training is needed. He also highlighted the need for implementation of appropriate computational resources, as this will be crucial in training AI models in healthcare settings. Kohane further stressed that for public health and practice, it is important that experts in quantitative data analysis perform the analyses of the data, to limit the dangers of non-quantitative data exploration. Kohane ended by urging the audience to start exploring AI algorithms to be able to keep pace with this rapidly advancing field.

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