Debate & Analysis

Artificial intelligence in medicine:

current trends and future possibilities

Artificial intelligence (AI) research within medicine is growing rapidly. In 2016, healthcare AI projects attracted more investment than AI projects within any other sector of the global economy.[1] However, among the excitement, there is equal scepticism, with some urging caution at inflated expectations.[2] This article takes a close look at current trends in medical AI and the future possibilities for general practice.

WHAT IS MEDICAL ARTIFICIAL INTELLIGENCE?

Informing clinical decision making through insights from past data is the essence of evidence-based medicine. Traditionally, statistical methods have approached this task by characterising patterns within data as mathematical equations, for example, linear regression suggests a 'line of best fit'. Through 'machine learning' (ML), AI provides techniques that uncover complex associations which cannot easily be reduced to an equation. For example, neural networks represent data through vast numbers of interconnected neurones in a similar fashion to the human brain. This allows ML systems to approach complex problem solving just as a clinician might — by carefully weighing evidence to reach reasoned conclusions. However, unlike a single clinician, these systems can simultaneously observe and rapidly process an almost limitless number of inputs. For example, an AI-driven smartphone app now capably handles the task of triaging 1.2 million people in North London to Accident & Emergency (A&E).[3] Furthermore, these systems are able to learn from each incremental case and can be exposed, within minutes, to more cases than a clinician could see in many lifetimes. This is why an AI-driven application is able to out-perform dermatologists at correctly classifying suspicious skin lesions[4] or why AI is being trusted with tasks where experts often disagree, such as identifying pulmonary tuberculosis on chest radiographs.[5] Although AI is a broad field, this article focuses exclusively on ML techniques because of their ubiquitous usage in important clinical applications.

WHAT ARE THE CURRENT TRENDS IN MEDICAL AI?

Aside from simply demonstrating superior efficacy, new technologies entering the medical field must also integrate with current practices, gain appropriate regulatory approval, and, perhaps most importantly, inspire medical staff and patients to invest in a new paradigm. These challenges have led to a number of emerging trends in AI research and adoption.

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AI excels at well-defined tasks

Research has focused on tasks where AI is able to effectively demonstrate its performance in relation to a human doctor. Generally, these tasks have clearly defined inputs and a binary output that is easily validated. In classifying suspicious skin lesions, the input is a digital photograph and the output is a simple binary classification: benign or malignant. Under these conditions, researchers simply had to demonstrate that AI had superior sensitivity and specificity than dermatologists when classifying previously unseen photographs of biopsy-validated lesions.[4]

AI is supporting doctors, not replacing them

Machines lack human qualities such as empathy and compassion, and therefore patients must perceive that consultations are being led by human doctors. Furthermore, patients cannot be expected to immediately trust AI; a technology shrouded by mistrust.[6] Therefore, AI commonly handles tasks that are essential, but limited enough in their scope so as to leave the primary responsibility of patient management with a human doctor. There is an ongoing clinical trial using AI to calculate target zones for head and neck radiotherapy more accurately and far more quickly than a human being. An interventional radiologist is still ultimately responsible for delivering the therapy but AI has a significant background role in protecting the patient from harmful radiation.[7]

AI supports poorly resourced services

A single AI system is able to support a large population and therefore it is ideally suited to situations where human expertise is a scarce resource. In many TB-prevalent countries there is a lack of radiological expertise at remote centres.[8] Using AI, radiographs uploaded from these centres could be interpreted by a single central system; a recent study shows that AI correctly diagnoses pulmonary TB with a sensitivity of 95% and specificity of 100%.[5] Furthermore, under-resourced tasks where patients are experiencing unsatisfactory waiting times are also attractive to AI in the form of triage systems.[3]

AI is a very picky eater

Developing ML models requires well-structured training data about a phenomenon that remains relatively stable over time. A departure from this results in 'over-fitting', where AI gives undue importance to spurious correlations within past data. In 2008, Google tried to predict the seasonal prevalence of influenza using only

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the search terms entered into its search engine. Because people's searching habits change dramatically with every passing year, the model was so poorly predictive of the future that it was quickly discontinued.[9] Additionally, data that are anonymised and digitised at source are also preferable, as this aids in research and development.

FUTURE POSSIBILITIES IN GENERAL PRACTICE

AI will extract important information from a patient's electronic footprint. At first this will save time and improve efficiency, but following adequate testing it will also directly guide patient management. Take the example of a consultation with a patient with type 2 diabetes; currently a clinician spends significant time reading outpatient letters, checking blood tests, and finding clinical guidelines from a number of disconnected systems. In contrast, AI could automatically prepare the most important risks and actions given the patient's clinical record. It could also automatically convert recorded dialogue of the consultation into a summary letter for the clinician to approve or amend. Both of these applications would save considerable time and could be implemented very quickly because they assist clinicians rather than replacing them.

As these systems become better validated, they will be given more responsibility. For the patient with type 2 diabetes, the threshold of statin commencement could be determined by AI on an individualised basis given nuisances of the patient's history rather than a rigidly defined 'one-size-fits-all' algorithm. The research required for this 'personalised' medicine would only be possible through AI intelligently summarising enormous quantities of medical information. Furthermore, because AI is able to simultaneously monitor millions of inputs, it will have a significant role in preventative medicine. AI could proactively suggest consultations when it determines that the patient's risk of developing a particular diabetic complication warrants intervention. In contrast, it would be impractical to task a human being with the responsibility of closely monitoring every test result and appointment of every diabetic patient in a practice in real time.

AI-based systems will also bring specialist diagnostic expertise into primary care. If an image of a skin lesion is sufficient to capably diagnose its aetiology, images could be captured at a GP practice and sent to a specialist dermatology AI system for instant analysis. Patients identified as low risk would receive instant reassurance while high-risk patients would experience lower referral waiting times because clinics would only be receiving selected cases. This concept is not limited to skin lesions, AI has shown potential in interpreting many different types of image data including retinal scans,[10] radiographs,[5] and ultrasound.[11] Many of these images can be captured with relatively inexpensive and widely available equipment.

Future AI research should be directed towards carefully selected tasks that broadly align with the trends outlined in this article. Integrating these systems into clinical practice necessitates building a mutually beneficial relationship between AI and clinicians, where AI offers clinicians greater efficiency or cost-effectiveness and clinicians offer AI the essential clinical exposure it needs to learn complex clinical case management. Throughout the process it will be critical to ensure that AI does not obscure the human face of medicine because the biggest impediment to AI's widespread adoption will be the public's hesitation to embrace an increasingly controversial technology.[12]

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