

Demystifying Artificial Intelligence in Medicine

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ABSTRACT

The advent of artificial intelligence (AI) is revolutionising a variety of industries, and its impact on medicine is already apparent. AI is currently advancing the fields of clinical and diagnostic medicine, and its broader application to improve delivery of care is a source of excitement. However, the promise of AI in medicine is accompanied by concerns regarding proper use of data, privacy and ownership considerations, and uncertainty regarding the role of a physician in an AI-reliant world. This piece aims to discuss various advances of AI in medicine, their potential benefits, and associated challenges.

RÉSUMÉ

L'arrivée de l'intelligence artificielle (IA) a révolutionné toute une série d'industries et son impact sur la médecine est déjà apparent. L'IA fait actuellement progresser les domaines de la médecine clinique et diagnostique, et son application plus large afin d'améliorer la prestation des soins suscite notre enthousiasme. Cependant, les promesses de l'IA en médecine s'accompagnent de préoccupations concernant l'utilisation correcte des données, les considérations relatives à la vie privée et l'incertitude quant au rôle du médecin dans un monde dépendant de l'IA. Cet article a pour but de discuter des différentes avancées de l'IA en médecine, de leurs avantages potentiels et des défis qui y sont associés.

1. WHAT IS AI IN MEDICINE?

Artificial intelligence (AI) is a branch of computer science that focuses on building machines capable of independently performing tasks typically associated with human cognition, such as “learning” and “problem-solving” (1). AI relies on tools that can identify patterns in data, and it encompasses various subdisciplines, including robotics and machine learning (1).

In the context of medicine, AI can be classified into

physical and virtual branches (2). The physical branch is concerned with robotics, such as surgical navigation systems, or machines used to assist with patient mobility and rehabilitation (3). The virtual branch, which is the major focus of this analysis, is powered through machine learning (ML). In short, ML consists of mathematical algorithms that improve through self-iteration with minimal human intervention (1). These algorithms power the pivotal advances in speech and image recognition, the latter

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particularly important in diagnostic imaging and laboratory medicine.

2. AI'S ADVANTAGE IN MEDICINE

2.1 Clinical Medicine

When given enough data for it to fine-tune itself, AI can be applied to life-saving strategies. For example, the early detection of atrial fibrillation was one of the first applications of AI in medicine. The REHEARSE-AF study showed that a smartphone-based ECG monitoring system was better at identifying atrial fibrillation incidence in patients at risk of stroke than routine care (4). Another study using AI to interpret pulmonary function tests showed that AI's interpretation was comparable in its accuracy to that of pulmonologists (5). In clinical nephrology, AI was shown to be useful in predicting the decline of glomerular filtration rate in patients with polycystic kidney disease, and for establishing risk of progressive IgA nephropathy (6,7). In the realm of neurology, the FDA approved, in 2018, a wearable device that can detect generalised epileptic seizures (8). The device connects to a mobile application that can alert relatives or physicians when seizures occur and can provide clinical information and patient localisation (9). In these examples, AI predictions can alert physicians and prompt early interventions to decrease the morbidity associated with atrial fibrillation, respiratory compromise, kidney disease, and seizures. The algorithms provide timely information to physicians; however, the judgment on how to act is ultimately the physician's responsibility.

2.2 Diagnostic Medicine

One of the most practical applications of AI is within specialties that rely heavily on pattern recognition, since AI can learn from vast amounts of data in a fraction of the time it would take a human. In 2019, a systematic review found that deep-learning AI algorithms had equivalent sensitivity and specificity to radiologists (10). Another study demonstrated that an AI algorithm was capable of ruling out cancer in pathology specimens with high sensitivity using computational histopathology (11). Using AI-powered computational decision support systems like this in clinical practice could allow specialists to focus on at-risk specimens and images, freeing up time for patient care or discussions with a patient's primary care provider. The overarching implications of AI use in diagnostic imaging are vast. An AI system paired with telehealth tools

connecting it to a specialist could potentially be used to service populations with scarce human expertise. Such a screening software could also help stratify patients in primary care. Family doctors could use the AI results to reassure patients identified as low-risk while allowing for lower referral waiting times for those identified as high-risk (12).



3. AI IN MEDICINE TODAY: CHALLENGES & CONCERNS

3.1 Caveats in Data Usage

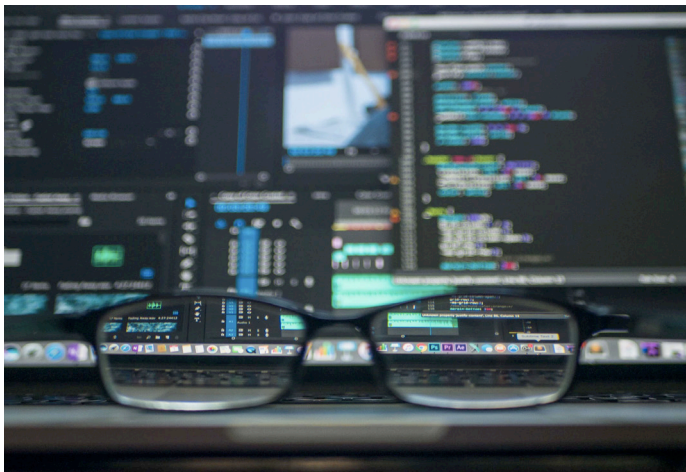
AI is only as good as its input data. As such, healthcare providers should be aware of the scope of the data used to produce a certain predictor or diagnostic software. For example, predictions generated via AI may have limited applicability to patient populations historically underrepresented in clinical trials, such as women and minorities (13). If the algorithm is fed data that does not include these cohorts, then the predictions rendered may not be accurate for these patients. ML algorithms are powerful tools, but if the data fed to them does not correspond to the patients it is intended for, or if the data comes from research of low-quality evidence, a healthcare provider must be able to critically examine its recommendations.

Another source of concern is the “black-box” problem associated with AI. ML algorithms self-iterate and self-improve, and thus the methodology behind an output is unclear. Some advocate for increased transparency and model simplicity at the expense of predictive power (14). Others contest that, when our knowledge of causal systems is incomplete, the ability to explain why an intervention benefits a patient can be less important than the ability to provide such benefits (14). In many areas of medicine,

clinicians often make decisions based on experience and empirical evidence without having an exact understanding as to why certain interventions work (14). Whether it be non-representative data sources or unclear algorithm methodologies, healthcare providers must be aware of the caveats in using AI. Otherwise, they risk becoming complacent, which negatively impacts decisions and care. Providers should understand the basics of the methodology behind AI in order to be able to critically examine its results and synergistically work with them.

3.2 Data Ownership & Security

While the issue of data ownership and protection is not new, it is a fundamental concern with AI, particularly with the advent of ongoing monitoring via medical devices and wearable sensors (9). Attitudes towards data ownership range from proponents of a common ownership between patients and healthcare systems to full ownership by either party (9, 15).



Adding to the concern of data ownership is that of data security. Regardless of who owns patient data, there is always a risk of security breaches or targeted malware attacks. These may result in improper use of information, from distribution of private data to impacts on clinical decision-making by healthcare providers unaware of the data's compromise. Who would be held liable in this case? The answer, as shown by recent scandals involving tech giants like Facebook and Google, are incredibly complex and evolving every day (16). Addressing these concerns will require multidisciplinary efforts involving, among others, public discourse, policy, technology, and regulatory affairs. Legislation will be paramount in order to have all parties involved adhere to common ground rules regarding data safety.

3.3 Can physicians be replaced by AI?

It is important to acknowledge the fear that adoption of AI in medicine will lead to job losses. Historically, technological disruptions have resulted in redundancy of certain professions (e.g. automation in factories or, more recently, taxi vs. Uber drivers) (17). Inevitably, some provider responsibilities will be delegated to AI. However, medicine is more than algorithmic testing and diagnosing. A physician deals with patients as whole individuals within unique sociocultural and economic contexts, and a physician is thus unlikely to ever be fully replaced by a machine. As Hugh Harvey eloquently said, "The biggest impact of AI in medicine won't come from making machines do human-like tasks, but from removing machine-like tasks from humans." (18). The histopathology software described above exemplifies such an instance. In the end, physicians will provide complementary roles to prediction, namely judgment and action.

4. SUMMARY & CONCLUSION

Advances in AI are revolutionising industries around the world, and effect of AI on the way we practise medicine will be no different. AI research in areas such as clinical and diagnostic medicine are already showcasing the power of ML algorithms, and implementation of AI into clinical practice is a promising area of development. As technological advances power the development of modern solutions to improve healthcare, significant concerns arise regarding the proper and safe use of data together with ownership and privacy considerations. Further, a paradigm shift in clinical practice is associated with fears of AI replacing healthcare practitioners. However, the future of AI in medicine points more towards synergy rather than takeover.

Widespread adoption of AI into clinical practice will not solely be shaped by scientific progress, but also by legislation of regulatory and health policies. Much like how risks and benefits are weighed for anything in medicine, the same must hold true for the use of AI. The promise this technology holds, when used adequately within substantiated frameworks, will be worth the substantial effort needed to integrate it into practice.

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