COMMENTARY
McGill Journal of Medicine

Artificial Intelligence – the EHR savior?

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Publication Date
August 6, 2020

MJM 2020 (18) 14

McGill Journal of Medicine

www.mjmmed.com

SUMMARY

Electronic health records have limited humanistic aspects of medicine while further increasing redundancy and are often perceived as counterproductive. Artificial intelligence has the potential to address the gaps by creating a practice of evidence-based, personalized, and cost-effective medicine. It will augment efforts to make electronic health records more streamlined, accessible, and, ironically, less computerized.

KEYWORDS
electronic health record; artificial intelligence; humanities

Section I: The Problem

Since its origins, medicine has always been regarded as a patient-centered enterprise. The ethical basis of the Hippocratic Oath values humanism such that the patient's interest has always been put first. (1) But, do these principles hold in the digital age of medicine? The humanistic practice of medicine requires the physician to have two things: adequate time and prime focus afforded to the patient. (2) Unfortunately, the fashion in which medicine is delivered today, in a "distraction-filled environment", makes it difficult to provide either of these. (2) Meaningful interactions with patients have become limited, and as a result, the humanistic element of medicine has diminished.

The Electronic Health record (EHR), a "lauded innovation", arrived with both opportunity and limitations. Looking at its implications from a humanism-focused lens, the EHR does more harm than good. Although widely thought to be transformative of the paper record, the EHR is a greater distraction than note taking because it diverts the attention away from the patient inevitably reducing quality of care. (3) As many physicians argue, the framework compels one to give the "computer complete attention, the kind of attention (physicians) reserved for a patient." (4) Numerous patients have also complained that doctors "seems more interested in looking at the computer screen than (them)". (5) Research has shown that one-third of the time used during a patient visit is spent navigating and inputting data into the EHR. (6) More alarming, the distraction of the EHR presents a barrier to the indispensable personal connection that dictates a functional patient-physician relationship. (2) The rapid changes in digitizing medicine have led to a focus on refining methods for billing, administration, and regulatory issues yet have excluded the core value of capturing the patient's narrative. (3) The healthcare field as a whole has unknowingly shifted the focus towards "clinical productivity." (7)

The design and implementation of EHRs nationwide has been inconsistent and ineffective resulting in many technical and usability flaws. Because of the increased system complexity, the user interface has been compromised and made even more confusing. (8) A staggering 92% of nurses in the US are dissatisfied with the use of technology, a concern mainly stemming from the convoluted interface of the EHR. (9) Another study showed the increased probability of system failures and maintenance harms patients in events of technical difficulties, such as muddling patients' allergies or medications between numerous medical records. (10) Additional errors arise from the redundancy of data, prompting clinicians to cut and paste data from previous, potentially outdated, encounters contributing to malpractice and hurting the necessary integrity of the EHR. (11) As a result of irrelevant information, some clinicians assert that "EHRs are cluttered making it difficult to locate and comprehend important details" of the patient. (8)

Not only does the structure of the EHR make finding information difficult, but also has a grave impact on clinical reasoning skills and decision-making abilities of both current and future physicians. Certain characteristics of the record eliminate the need to interact directly with the patient which encourages "superficial clinical thinking" in a virtual environment where medical reasoning is limited. (3) Research has shown that medical students now use a flawed method of information acquisition where questions are asked as they appear on the computer screen. (12) Making matters worse, the physician cannot effectively demonstrate their thought process as they are inclined to pick the "best option in a drop-down list" instead of typing, and are distracted by many irrelevant fields or prompts. (12) Altogether, the development of vital reasoning and communication skills are disrupted as medical students become accustomed to the inflexible and redundant data entry methods. (3) In addition to impeding the doctor's development of good judgement, EHRs themselves have poor usability and employ linear decision making - linear in the sense that it is difficult for EHRs to produce helpful recommendations in novel situations and emulate the "flexible and fluid ways in which healthcare is provided in real life." (13) The non-intuitive clinical decision support systems, unable to handle all possibilities, present uniform recommendations or redundant alerts which remind the physician of a recommended treat-

ment or warn of a possible medical risk associated with a treatment. (14) Clinical decision practice, in its current state, is founded on preliminary decision support rules, major design flaws and misuse of systems conflicting with developer expectations. (14) Additionally, the physician may not understand which clinical factors or relevant premises have been taken into consideration by the computer and these systems are perceived to be interruptive.(8)

Last but not least, EHRs add increased responsibility and redundancy to a physician's already busy schedule, making the use of the EHR counterproductive. The EHR has been held responsible for physician burnout because of the increased documentation of nonclinical data. (19) Furthermore, the unsystematic purposes aggravate physician mental health and increases frustration. (15) Similarly, the rising pressure of capturing accurate and structured data adds to the negative impact of EHRs on the physician's wellbeing. For example, workflow incompatibility is an added concern to a poorly designed EHR infrastructure. (8) EHR data varies widely across entities such that "building an insightful, granular database is next to impossible." (43) Many physicians are dissatisfied by the fact that exchanging records is a demanding process, and are thereby forced to fall back on the conventional method of faxing medical documents. (16) When a simple task such as generating a referral or prescription becomes tedious, addressing the issue is of essence as the "care of patients also requires attention to the care of clinicians." (17) The irony of electronic records in improving the practice of medicine now becomes evident as they "break care" for both patient and physician. (18) Overall, the present-day dilapidated EHR system is "enough to make old Hippocrates roll over in his grave!" for the many reasons discussed above. (2) Having discussed the complications of the EHR, in the next section we will present what is believed to be the needs of the clinical community and detail essential considerations in restricting the use of technology in medicine.

Section II: What is Needed?

Although the EHR systems have streamlined the ways healthcare is delivered, they have given rise to unanticipated usability issues. Research from Stanford Medical School reports 9 out of 10 physicians want the EHR to be more responsive, intuitive and have an improved interface. (19) Furthermore, 38% of physicians hoped for highly accurate voice recording technology that acts as a scribe during patient visits, while six out of ten physicians (59%) think EHRs need a complete overhaul. The scribe profession may help lower the burden for the need of data entry, but they prove to be expensive in the long run. (20) David Blumenthal, M.D., M.P.P., president of The Commonwealth Fund, envisions natural language processing and artificial intelligence as a long-term solution to the tribulation. It may not be enough to redesign the EHR with an improved interface. Indeed, novel functionalities to minimize EHR-associated errors and a "fundamental redesign" is needed. (8,15) As a result of this change, clinicians will have greater control of the system's customization aligning well with their needs, flexibility and realistic prospect.

The improvement of the one-dimensional decision-making capabilities endemic to the EHR must also be addressed. There is a need for using clinical data to build more predictive models and a more efficient Clinical Decision Support System (CDSS). (21) The utilization of big data and large databases are therefore encouraged. Improved support and ease of use of such systems make clinicians' lives better and allow them to focus on patient-centered communication and participate in confident decision making. (22) With the advent of artificial intelligence, machine learning and "big data", the EHR can be wisely used for increased adaptability in improving diagnostics, personalizing care and discovering disease associations. (23) Only when we step outside of "paper-chart thinking"–EHRs as simply a replacement for paper charts–can these systems allow the natural recording of a physician's thinking focused on a patient's unique story and experience. (4) Several studies have hinted that EHRs should support data analysis/mining with "intelligent stimulus" and "goal-oriented function-

ality" to allow a holistic view of patient data. (15) Consequently, these systems should also employ the idea of machine learning where the computer learns from its mistakes and tailors itself to the physician it assists.

Section III: The Solution – Artificial Intelligence

Artificial Intelligence (AI) has the potential to create a way of practicing evidence-based, personalized and cost-effective medicine. Since humanism is becoming increasingly important in a changing healthcare landscape, artificial intelligence (AI) is a possible solution to the various shortfalls of the EHR we have so far discussed. But what is AI? AI is the term used to describe the use of computers and technology to simulate intelligent behavior and critical thinking comparable to a human being. (24) The broad benefits of AI such as efficiency, monitoring and reasoning may help tame the growing disconnect between the physician and patient by providing increased patient-physician face time. As Dr. Eric Topol, cardiologist and director of the Scripps Research Translational Institute in California, said "The greatest gift that AI can give us is to go back to the future, to get us to the humanity in medicine, which is presence." (25) Professors at the University of Stanford have argued that AI is an overlooked opportunity that can "help clinicians deliver better and more humanistic care." (26) But how exactly can AI be used to refocus our attention on the patient-doctor relationship? Here we present four ways which can make this possible.

First is increasing physician-patient engagement by assisting the doctor in capturing patient data more efficiently. As an alternate to dictation, most hospitals now have scribes to help physicians document the visit while the physician interacts with the patient. Indeed, medical dictation has been the standard method to take the verbal notes of a physician and convert them into written notes. However, as we mentioned above, there are several problems with scribing and dictation, namely being expensive and inaccurate. Compared to these traditional methods, AI has its advantages in easing the healthcare documentation burden. For example, AI will help with automatic charting through speech recognition during a patient visit. This would be valuable and could free clinicians to return to facing the patient rather than spending almost twice as much time on computer. (27) Capturing clinical notes with natural language processing allows clinicians to focus on their patients rather than keyboards and screens. While AI is being applied in EHR systems principally to improve data discovery and extraction and personalize treatment recommendations, it has great potential to make EHRs more user friendly and easy to understand. This is a basic objective, as EHRs are confounded and difficult to utilize and are frequently referred to as adding to clinician burnout. (28)

Because of this, several companies are working on digital scribes, machine-learning algorithms that can take a conversation between a doctor and a patient, parse the content and use it to fill in the applicable data in the patient's EHR. (29) This may seem far-fetched but Kara, a 2017 iOS application, uses machine learning, voice recognition and language processing to capture conversations between patients and physicians and turn them into notes, diagnoses and orders in the EHR. Past renditions of the application required prompts from the doctor—much like Apple's Siri—however the present form can be placed in "ambient mode," in which it essentially tunes in to the whole conservation and afterward chooses the important data filling in as a smart, proficient colleague. Since AI would have access to health data sets similar to current technologies, it would need to adhere to the same regulations.

Second is the use of machine learning to facilitate the physician's task in a more personalized and flexible manner. Machine learning is a subset of AI where the computer systems can learn from data, identify patterns and make decisions with minimal human intervention. Machine learning can be supervised or unsupervised. Supervised learning starts with the goal of predicting a known output or target while unsupervised learning tries to find naturally occurring patterns or groupings within the data. (42) The key distinction between traditional approaches and machine learning is that in machine learning, a model learns from examples rather than being programmed with rules. (30) In ap-

plications where predictive accuracy is critically important, the ability of a model to find patterns across millions of features and examples is what enables superhuman performance. This is particularly helpful in making clinical decisions since the algorithms can help expose relevant information in a patient's chart for a clinician without multiple clicks or arduous searching. Data entry of forms and text fields can be improved with the use of machine-learning techniques such as predictive typing, voice dictation, and automatic summarization. Automation of chart documentation also makes it easier to prevent improper payments by authorizing payments based on information already recorded in the patient's chart. (40) An AI could search through the large amount of EHR data to find the most important information for the situation. Furthermore, AI systems learn to recognize key terms and pull out data from clinical notes and other patient data. (31) For example, Amazon Web Services recently launched a service where AI pulls out and indexes data from clinical notes. (32) The capability of AIs can also produce material beyond the rote medical and family or environmental history, "digested in a vivid useable form with graphics and animation equivalent to what is readily available in other spheres of the digital world." (26) This can help clinicians get a more accurate picture of their patient's health, help diagnose and, treat more accurately, and better set up appointments.

Third, AI can help drive down the expanding costs of healthcare by having financial implications in multiple areas. For example, AI will enable clinicians to make better, more sophisticated decisions since a more complex and robust system might list the likelihood of a side effect with drug option A versus drug option B and provide a cost comparison. (29) AI applications can be utilized to reduce unnecessary testing, decrease the disparities, discrepancies and reduce hospital admissions and length of stay. (33) With the integration of AI, clinicians could use a virtual assistant to make phone calls, place prescription orders, take notes, and better navigate the EHR system allowing staff to perform their tasks faster and more efficiently. (31) AI applications in medical workflow management are estimated to save $18 billion per year for the healthcare industry by 2026. (41) Further, costly errors in clinical documentation are reduced since AI streamlines the tedious clinical documentation process and can automatically generate accurate and complete reports.

Lastly, AI can increase insights from unstructured data by providing more precise, pertinent data and highly intuitive systems. Currently, customizing EHRs to make them easier for clinicians is largely a manual process, and the systems' rigidity is a real obstacle to improvement. AI, and machine learning specifically, could help EHRs continuously adapt to users' preferences, improving both clinical outcomes and clinicians' quality of life. (28) Machine learning and predictive analytics models also furnish healthcare providers with analytics on patient satisfaction or help foresee patient risk. (34) The potential to create a graphical synthesis of patient data using a combination of natural language processing and AI technology is exciting because AI systems perform a rapid and thorough search of single or multiple patient electronic medical records, the Internet, textbooks, and journals for data. (33) It is worth mentioning that AI would help differentiate between the importance "to know what sort of patient has a disease than what sort of a disease a patient has" –the former attainable by the power of AI. (26) Further, this technology could also be utilized to cross correlate data from a patient's family history, find patients similar to that patient, and evaluate ultimate diagnoses and treatment responses. Overall, the benefits of AI are numerous and by streamlining the healthcare field, humanism might be restored.

Section IV: Considerations and the Future of AI in Medicine

The wide applicability of machine learning will require a sophisticated structure of regulatory oversight, legal frameworks, and local practices to ensure the safe development, use, and monitoring of systems. (35) Critically, clinicians who use machine-learning systems need to understand their limitations, including instances in which a model is not designed to be generalized to a different particular scenario. (36) Another major challenge involves concerns about patient data privacy breaches.

This is especially true for AI, as hospitals will most likely rely on third-party providers of AI software to provide highly integrated EMR solutions. (33) Crucially, since AI's predictive prowess comes from sifting large data sets, we must be careful to use representative data sets of society which are not biased by sex, race, ethnicity, socioeconomic status, age, ability, and geography. (37) Not only will an unrepresentative sample build a bad model, it will raise a moral question in the absence of equal representation whose disastrous effects are already evident in inequitable criminal justice sentencing, unfair hiring practices, and many other injustices. (38)

Lastly, the use of AI raises specific medicolegal concerns–who should be blamed if the system provides an incorrect diagnosis. Is it the "authors of the software, the technology provider, the hospital who provided the technology, the doctor or all of the above"? For widespread adoption to take place, AI frameworks must be endorsed by regulators, integrated with EHR systems, standardized to a sufficient degree that similar products work in a similar fashion, taught to clinicians and updated over time. (39) It is becoming progressively evident that AI frameworks won't fully replace clinicians, but rather will augment their efforts to care for patients and enlarge their endeavors to focus on patients. (39) As a result, clinicians will be able draw on remarkable human aptitudes like empathy, social intelligence and patient-level connections that machines cannot replicate. Patients not only must be placed at the focal point of care, but also at the center of health technology. All in all, we must empower clinicians to help us navigate through the technological jungle and re-establish humanism in the age of digital health.

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