Artificial Intelligence for Clinical Decision Support

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There is abundant research being conducted on the use of artificial intelligence (AI) to improve diagnosis in dermatology. Recently, convolutional neural networks trained using large image libraries have achieved parity with dermatologists in discriminating between benign and malignant lesions.[1] There are expectations that these systems, as they improve and are implemented in mobile electronic devices, will revolutionize diagnosis. Substantially less attention has been given to the use of AI to guide management options following a diagnosis. There are several reasons this area lends itself to the application of AI.

In 2015, the National Library of Medicine indexed more than 800,000 articles.[2] Medical literature is growing at an overwhelming pace that makes it challenging for health care professionals to read, retain, and appropriately implement the latest research into their care. One survey found that physicians spend no more than 4 hours per week reading medical journals, and for the majority of articles, only the abstracts are read.[3] Conversely, AI networks today are able to interpret millions of pages of data within seconds. It is worth investigating how AI can be used to improve treatment and management decisions made by physicians.

Cognitive computing is a modern approach to AI that incorporates natural language processing, machine learning, and other techniques to answer questions. One cognitive computing system developed by IBM research in 2007, Watson, can interpret a user's query using natural language processing and then generate hypotheses. It searches data sources extensively to find and score evidence for each candidate hypothesis.[4] This information is synthesized to provide a simple output: ranked answers with associated confidence scores. Machine learning is used to improve the answers with feedback, training, and repetition.[4,5]

Watson Oncology, an ongoing collaboration between IBM and Memorial Sloan Kettering Cancer Center, is an application of cognitive computing to medicine. At Memorial Sloan Kettering, Watson has been trained by expert clinicians to provide an individualized, evidence-based list of therapeutic options for oncologists and patients to discuss. Furthermore, Watson is capable of taking patient preferences into consideration.[4]

In the near future, there also may be a role that cognitive computing could play in aiding dermatologists. Dermatologists manage a multitude of conditions requiring systemic therapies such as chemotherapeutics, biologics, and immunosuppressant medications. Frequently, the patient population has a complicated medical history with multiple comorbidities. Although current electronic health record (EHR) systems are able to assist physicians with structured numerical data such as vitals and laboratory results, cognitive computing systems could interpret the natural language of journal articles, textbooks, and published guidelines, as well as the narrative components of EHR notes. Outcomes from similar patients also could be used as inputs. With enough data, cognitive computing systems may be able to identify associations and epidemiologic trends that would not otherwise be noticed. As described by Miotto et al,[6] one system, "deep patient," was able to accurately predict the development of schizophrenia, diabetes mellitus, and various cancers based on EHR data. Patient genetic information also could one day be used to generate new insights into pharmacogenomics.

The benefit of a cognitive computing decision support system is that ineffective treatments and adverse reactions could be minimized, which may improve outcomes and reduce costs. Artificial intelligence also could help to decrease work burden so that physicians can spend more

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time with their patients, resulting in improved patient satisfaction and overall increased access to the specialty.

As with other clinical decision support systems, a number of challenges exist with the integration of cognitive computing into real care. One obstacle unique to machine learning algorithms is the black box problem. For instance, the skin lesion–identifying neural network cannot be questioned to determine which factors it used to arrive at its diagnosis. This shortcoming can lead to dangerous situations, such as the one reported by Caruana et al.[7] A predictive model classified patients with pneumonia and a history of asthma as having a lower mortality risk than those with pneumonia alone because the model was unable to recognize the confounder that asthmatic patients were preemptively admitted to the intensive care unit and treated more aggressively, which is another reason that AI recommendations must always be evaluated by a physician.[7] Physician and patient input also will be integral to incorporate contextual and qualitative information that may not be accessible to computers.[8]

As cognitive computing decision support systems are primarily used in oncology, they will need to be adjusted to optimize them for dermatologic conditions. It also will be up to health care providers to benchmark the performance of these systems.

Current clinical decision support systems that do not use AI have struggled to improve major patient outcomes such as mortality. These systems have been hobbled by poor usability and human-computer integration. Clinicians find their alerts and warnings to be a nuisance. The adoption of cognitive computing systems has the potential to give clinicians an intelligent partner. Their natural language processing, ability to comprehend questions, and easily understandable output give them an inherent ease of use that simplifies interactions with clinicians. Rather than replacing physicians, these systems will free clinicians to spend more of their time on the components of care that only a human can provide.

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