Place of Artificial Intelligence in Healthcare: Highlights

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Introduction

Artificial Intelligence (AI) is seriously impacting healthcare. We believe that human physicians will not be replaced by machines in the foreseeable future, but AI can definitely assist physicians to make better evidence based clinical decisions or even replace to a great extent human judgment in certain functional areas of healthcare, including: radiology, cardiology, neurology and many surgical specialties including ophthalmology, urology and even plastic surgery.

The increasing generation and availability of healthcare data and rapid development of big data analytic methods has facilitated and made possible the recent successful application of AI in healthcare.

Clinical Data

AI can use sophisticated algorithms to "learn" features from a large volume of healthcare data, and then use the obtained insights to assist clinical practice. It can also be equipped with learning and self-correcting abilities toimprove its accuracy based on feedback. An AI system can assist physicians by providing up-to-date medical information from journals, textbooks and clinical practices to provide proper patient care. In addition, an AI system can help to reduce diagnostic and therapeutic errors that are inevitable in the human clinical practice. Moreover, an AI system extracts useful information from a large patient population to assist making real-time inferences for health risk alert and health outcome prediction.

All the AI devices mainly fall into two major categories. The first category includes machine learning (ML) techniques that analyze structured data such as imaging, genetic and electrophysiological (EP) data. In the medical applications, the ML procedures attempt to cluster patients' traits, or infer the probability of the disease outcomes. The second category includes natural language processing (NLP) methods that extract information from unstructured data such as clinical notes/medical journals to supplement and enrich structured medical data. The NLP procedures target at turning texts to machine-readable structured data, which can then be analyzed by ML techniques.

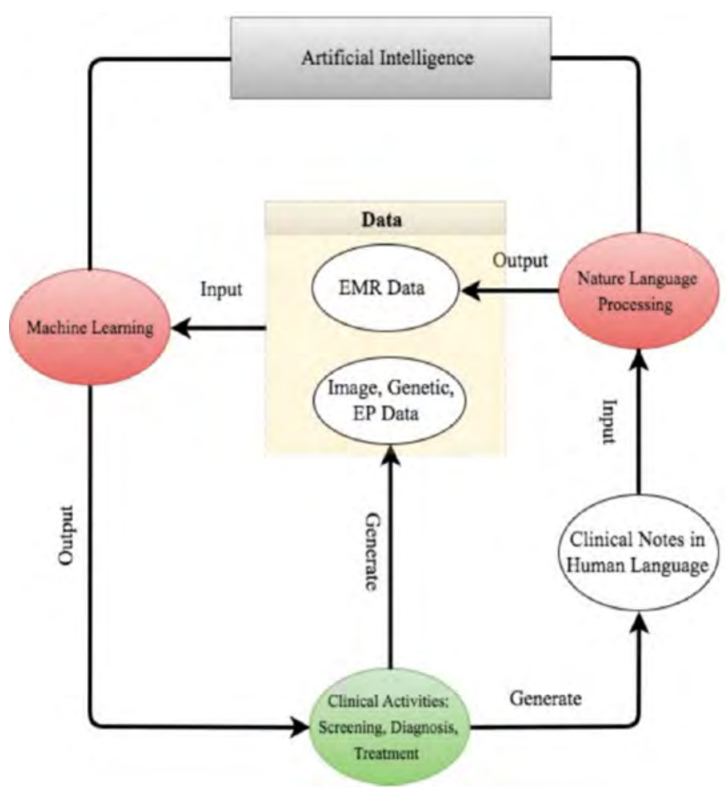

Figure 1. The road map from clinical data generation to natural language processing data enrichment, to machine learning data analysis, to clinical decision making. EMR, electronic medical record; EP, electrophysiological.

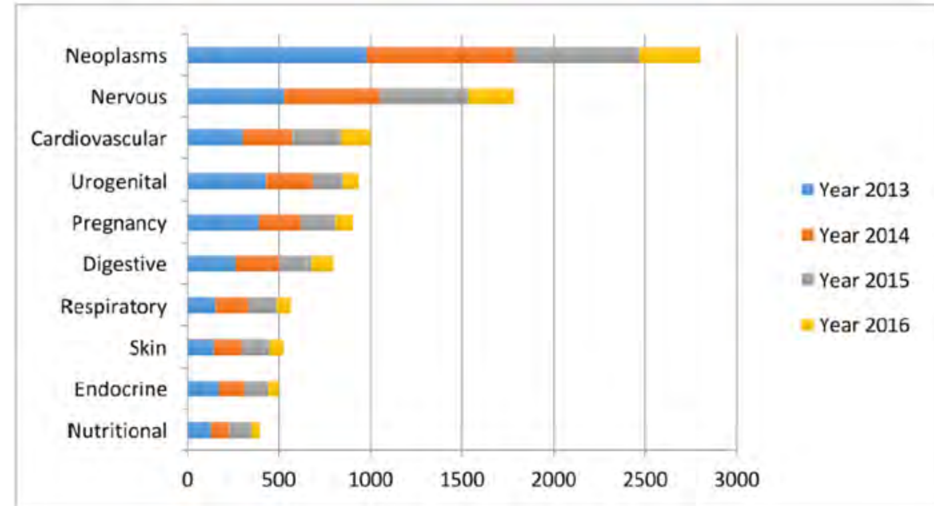

Figure 2. The 10 leadingdisease types considered in the artificial intelligence (AI) literature. The first vocabularies in the disease names are displayed. The comparison is obtained through searching the disease types in the AI literature on PubMed.

For better presentation, the flow chart in figure 1 describes the road map from clinical data generation, through NLP data enrichment and ML data analysis, to clinical decision making. We comment that the road map starts and ends with clinical activities. As powerful as AI techniques can be, they have to be motivated by clinical problems and be applied to assist clinical practice in the end.

A successful AI system must possess the ML component for handling structured data (images, EP data, genetic data) and the NLP component for mining unstructured texts. The sophisticated algorithms then need to be trained through healthcare data before the system can assist physicians with disease diagnosis and treatment suggestions.

Conclusion

Although the AI technologies are attracting substantial attentions in medical research, the real-life implementation is still facing obstacles. The first hurdle comes from the regulations. Current regulations lack clear standards to assess the safety and efficacy of AI systems. To overcome the difficulty, the US FDA made the first attempt toprovide guidance for assessing AI systems. The first guidance classifies AI systems to be the "general wellness products", which are loosely regulated as long as the devices intend are for only general wellness and present low risk tousers. The second guidance justifies the use of real-world evidence to access the performance of AI systems. Lastly, the guidance clarifies the rules for the adaptive design inclinical trials, which would be widely used in assessing theoperating characteristics of AI systems. Not long after the disclosure of these guidances, Arterys' medical imaging platform became the first FDA-approved deep learning clinical platform that can help cardiologists to diagnose cardiac diseases.

The second hurdle is data exchange. In order to work well, AI systems need to be trained (continuously) by data from clinical studies. However, once an AI system gets deployed after initial training with historical data, continuation of the data supply becomes a crucial issue for further development and improvement of the system. Current healthcare environment does not provide incentives for sharing data on the system. Nevertheless, a healthcare revolution is under way to stimulate data sharing in the USA. The reform starts with changing the health service payment scheme. Many payers, mostly insurance companies, have shifted from rewarding the physicians by shifting the treatment volume to the treatment outcome. Furthermore, the payers also reimburse for a medication or a treatment procedure by its efficiency. Under this new environment, all the parties in the healthcare system, the physicians, the pharmaceutical companies and the patients, have greater incentives to compile and exchange information.

Future articles will tackle AI in various systemic diseases as well as the ethical implications involved.