REVIEW ARTICLE

Artificial Intelligence and Healthcare: A Qualitative Review of Recent Advances and Predictions for the Future

Yaw Ansong Jnr

Author's affiliation: Research Assistant, Dept. of Biomedical Engineering, University of New Haven, West Haven CT
Correspondence: Yaw Ansong Jnr, Email: yanso2@unh.newhaven.edu, Mob. No. +1-203-343-8629

ABSTRACT

Artificial Intelligence (AI) describes computers that mimic human cognitive functions. This review assesses the potential impact of AI on different areas of healthcare such as nursing care, pathology, radiology, surgery, and blood diagnostics. It also addresses ethical concerns and concludes that individual narrow AI improvements have the potential to form a giant unit that can eventually surpass human health professionals in the performance of key tasks.

Keywords: Artificial Intelligence, Healthcare, Machine Learning, Robotics

INTRODUCTION

Artificial Intelligence (AI) describes computers that mimic human cognitive functions.[1] AI is typically sorted into two groups: Narrow and Strong AI. Narrow AI (sometimes referred to as weak AI) is basically AI trained to perform a singular task whilst strong AI unlike Narrow AI handles a variety of tasks.[2] In the past, Amazon's Alexa and Apple's Siri would pass for sci-fi. Today, not only are they real, they actually form an integral part of our everyday lives and could eventually be discredited, as demonstrated in the AI effect: onlookers eventually discount the behavior of an AI program by arguing that it's not real intelligence.[3] Pundits made us believe that the impending disruption of the job market by Artificial Intelligence (AI) would only affect repetitive, low skilled jobs.[4] We mostly visualized factory workers and farmers as the two groups most at risk of disruption; however current trends prove that even the most highly sophisticated players such as lawyers and doctors are at risk of being disrupted by AI and robots.[5] Most people envisioning this take over imagine a sci-fi-like robotic figure acting like a human; yet the encroachment of robots into the realm of healthcare will begin as a rather benign narrow AI phenomenon, with robots trained to do specific tasks very well. This review analyses current progress in the field of medical AI and makes predictions for the future.

METHODOLOGY

This paper summarizes the most recent health research in AI and healthcare across various branches of healthcare. It discusses current achievements, challenges, and predictions. Journals were selected based on keywords relating to Artificial Intelligence, deep learning, and robotics. This is not a systematic review and articles were selected based on the subjective experience of the author as a medical practitioner, biomedical engineer and an AI developer. The focus of this review is to provide evidence of current achievements and predictions for the future so as to ensure that health workers, particularly those in leadership positions are made aware of how the quickly advancing field of AI will transform healthcare, thus preparing them for the future.

FINDINGS

Cancer Diagnostics and Medical Imaging

Pathology deals with the cause, pathogenesis, morphologic changes, and the clinical manifestations of diseases.[6] Whilst the medical diagnostics pipeline is a multidisciplinary one, Pathologists and radiologists play a key role in the diagnosis of cancer and other diseases. This has traditionally relied on their ability to observe tissue images under the microscope so as to detect abnormal patterns and thus predict if that individual is diseased or not (e.g. a benign versus malignant cancer). With the advances made in image recognition and computing power, several AI algorithms have been trained recently to detect abnormal patterns that enable the identification and diagnosis of cancer. For example, radiologists showed a signifi-

cantly improved cancer detection rate (two-sided p-value = 0.030, confidence interval = 95%) whencmAssist™, an AI-based computer-aided detection algorithm was used, with a 7.2% increase in the area-under-the-curve of the receiver operating characteristic (ROC) curve with two-sided p-value < 0.01 for the reader group. Early cancer detection rate also significantly improved with the use of the cmAssist™ system.[7] Furthermore, several heavily funded firms are already building image recognition algorithms for cancer detection, and in most cases, these algorithms have outperformed their human counterparts. For example, Google recently built a deep learning system that outperformed human doctors in lung cancer detection. (8) Think about it, would you rather work with the diagnosis made by a highly skilled human (who has flaws, can get fatigued, etc) and who has at most been exposed to say a few thousand images to detect patterns, versus an algorithm that has been exposed to millions of images?

From the viewpoint of an algorithm, the work of radiologists is no different from pathologists, in that it involves pattern recognition. Radiologists use medical images to diagnose and treat diseases within the body. They have thus traditionally relied on radiological methods such as X-Ray, CT Scans, etc. Simple as this may seem (for example detecting broken bones); some radiological patterns may take years to master; for instance, diagnosing certain types of bleeds or cancers on a CT Scan takes years of practice. With the advent of AI, however, the algorithms can be trained much better and more efficiently to detect abnormalities in radiological films and images; therefore this field is also at risk of being disrupted. It is thus very likely that several tasks performed by radiologists and pathologists could be improved and in some instances entirely replaced by AI algorithms.

Surgical Practice

19 years ago, the Da Vinci Surgical System was born. The system was cleared by the FDA and has been used to perform over 200,000 surgical procedures including vasectomies and prostatectomies, and yet it was typically used in minimally invasive procedures, controlled by a surgeon from a console.[9] Current computing power far supersedes that which was available at the dawn of the millennium, and with the advancements made in robotics and artificial intelligence, AI is increasingly assisting surgeons to perform surgeries more efficiently. In China, a robotic surgeon was able to completely carry out the world's first autonomous dental surgery without any human help.[10] As far back as 2016, The Smart Tissue Autonomous Robot (STAR) successfully performed a complete in vivo, autonomous robotic anastomosis of porcine intestine.(14) Considering these developments, it is therefore very likely that robots will in the near future be increasingly important in the surgical process; eventually taking over surgical tasks traditionally performed by surgeons.

Blood diagnosis

Blood is the biobank of the body. Numerous diseases are diagnosed with blood samples. Traditionally, diseases like malaria and sickle cell have been diagnosed using a wide range of blood tests; from antigen tests to microscopic analysis. As AI improves, these patterns can be automatically detected by AI and will make medical diagnosis not just cheaper and more efficient but also easier to use; eventually eclipsing numerous blood tests. For instance, Katherine Torres and her colleagues developed an automated machine-learning algorithm for malaria detection. The diagnostic performance of their algorithm was on par with routine microscopy.[11]It is therefore predicted that such improvements, in addition to improvements in genomics, deep learning, and big data will lead to earlier disease detection. This can also provide an avenue for better diagnosis, improved public health systems, and personalized medicine.

Robotic Nurses

Whereas in the past, concepts like Robotic nurses were relegated to Disney movies like Big Hero 6, today they seem more plausible than ever. In Japan, due to an aging elderly population, the government invested heavily in healthcare robots.[12] In China, a team of roboticist developed a companion for elderly patients.[13] Robots are therefore already replacing humans in the performance of tasks such as lifting patients and caring for elderly patients. With the improvement in human robot interactions, and robotic hardware technologies, it is very likely that nurses and numerous repetitive care-taking tasks will be improved or in some instances completely replaced by robots.

Ethical considerations

Whereas it is very tempting to be excited over the recent advancements made in AI and robotics, it is important to consider the ethical perspectives as well. One of the greatest potential pitfalls associated with the use of AI in healthcare has to do with data and privacy concerns. Researchers, developers and companies that use AI must therefore ensure that data used for training their algorithms are ethically sourced. It is also very possible for AI predictions to be biased if the data used is not representative enough of the general population. For example, a diagnostic algorithm built with data from a particular racial group could give a biased response when data from other racial groups are inputted into the system. It is therefore critical that regulatory agencies ensure that AI based healthcare protocols amongst other things are not biased. There is also the question of

legal liability. If a robot surgeon makes an error for example, who would be liable? The hospital? The doctor? Perhaps the manufacturing company? These and other issues need to deeply considered by health professionals, particularly leaders in the field as AI transcends into every area of our healthcare system.

CONCLUSION

Whilst recent advances in AI are not enough to ensure that robots completely take over the role of a fully trained medical practitioner, it is very likely that eventually, these individual advances could come together to form a giant unit. With the improvement of human robot interactions, coupled with the improvements in reinforcement and unsupervised learning, it is very likely that AI could ultimately surpass health professionals in most areas; eventually out performing them in key roles and serving as a personalized data trove of patients.

Acknowledgement

Special thanks to Kagya Amoako for supporting and motivating me in my research career.

REFERENCES

1. Russell Stuart, Norvig Peter. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall, New Jersey, 2009.
2. Ben Goertzel. Artificial General Intelligence: Concept, State of the Art, and Future Prospects. JAGI 2014; 5: 1-48
3. Haenlein Michael, Kaplan Andreas. A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence. Sagepub 2019.
4. Hope Reese. 50% of low skilled jobs will be replaced by AI and automation, report claims. Available Online: https://www.techrepublic.com/article/50-of-low-skilled-jobs-will-be-replaced-by-ai-and-automation-report-claims/
5. Tim Wilson. No longer science fiction, AI and robotics are transforming healthcare. Available Online: https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html
6. Robbins Stanley. Robbins and Cotran pathologic basis of disease. Saunders/Elsevier, Philadelphia, 2010.
7. Watanabe AT et al. Improved Cancer Detection Using Artificial Intelligence: a Retrospective Evaluation of Missed Cancers on Mammography. J Digit Imaging 2019; 32(4): 625-637
8. Ana Sandoiu. Artificial intelligence better than humans at spotting lung cancer. Available Online: https://www. medicalnewstoday.com/articles/325223.php
9. Barnaby J. Feder. Prepping Robots to Perform Surgery. Available Online: https://www.nytimes.com/2008/05/04/business/04moll.html
10. Alice Yan. Chinese robot dentist is first to fit implants in patient's mouth without any human involvement. Available Online: https://www.scmp.com/news/china/article/2112197/chinese-robot-dentist-first-fit-implants-patients-mouth-without-any-human
11. Katherine Torres, et al. Automated microscopy for routine malaria diagnosis: a field comparison on Giemsa-stained blood films in Peru. Malar J 2018; 17: 339.
12. Mori K, Scearce C. Robot nation: robots and the declining Japanese population. ProQuest Discovery Guides, 2010
13. Tao Y et al. A behavioral adaptation method for an elderly companion robot. ICSR 2010 Proceedings of the Second International Conference on Social Robotics. Berlin: Springer-Verlag, Singapore, 2010.
14. Panesar Sandip. Artificial Intelligence and the Future of Surgical Robotics. Annals of Surgery 2019; 270 (2): 223-226.