Artificial Intelligence: Introduction and Scope in Healthcare Sector

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Abstract: ***Artificial intelligence (AI) increasingly complex algorithms currently influence not only our livesbut also our civilization than all other. The areas of AI application are diverse and the possibilities areExtensive than other: in particular, because of improvements in computer hardware, most of theAI algorithms already surpass the capacities of human experts today. As AI capacity improves,its field of application will grow further and further. In concrete terms, it is likely that the relevantalgorithms will start optimizing themselves to an ever greater level —might be evenreaching superhuman levels of intelligence. This kind of progress is likely to presentus with historically unprecedented ethical challenges. The increasing application of Artificial Intelligence (AI) in health and medicine has attracted a great deal of research interest in recent years. This study aims to provide a global and historical picture of research concerning AI in field of health and medicine. A total of 27,451 papers that were published between 1977 and 2018 (84.6% were dated 2008–2018) were retrieved from the Web of Science platform. The descriptive analysis of data examined the publication volume, and authors and countries collaboration. A global network of authors' keywords and content analysis of related scientific literature highlighted use of major techniques, including Robotic network, Artificial intelligence, Natural language process, and their most frequent applications in Clinical Prediction and Treatment of patients. The number of cancer-related publications was the highest in number, followed by Heart Diseases and Stroke, Vision impairment, Alzheimer's, and Depression. Moreover, the shortage in the research of AI application to some high burden diseases suggests future directions in AI in core research. This study offers a first and comprehensive picture of the global efforts directed towards this increasingly important and prolific field of research and suggests the development of global and national protocols and regulations on the justification and adaptation of medical field.***

Keywords: Artificial intelligence, Robotic network, Alzheimer's, and Depression

1. Introduction

In the 21st century artificial intelligence (AI) has become an important area of ressearch in virtually all fields: engineering, science, education, medicine, business, account- ing, finance, marketing, economics, stock market and law, among other. The field of AI has grown enormously to the extent that tracking proliferation of studies becomes a difficult task. Apart from the application of AI to the fields mentioned above, studies have been segregated into many areas with each of these springing up as individual fields of knowledge. Within the medical literature, scholars have written extensively on the benefits of AI applications, highlighting the technology's potential to improve diagnostic and therapeutic accuracy and the overall clinical treatment process [10,11]. With its sophisticated algorithms and deep learning capacity, AI applications have assisted doctors and medical professionals in general in the domains of health information systems, geocoding health data, epidemic and syndromic surveillance, predictive modeling and decision support, and medical imaging [4,5,12,13]. In particular instances, an AI system can provide health professionals with constant, possibly real-time updates of medical information from various sources including journals, textbooks, clinical practices, and patients to inform proper patient care [14] and enable appropriate inferences for health risk alert and health outcome prediction [15].

As AI is rapidly transforming the medical landscape, scholarship on the topic has also mounted substantially in recent years, presenting the need for a comprehensive review of the research patterns as well as trends of AI in medicine (AIM). In their thorough review article on Nature Biomedical Engineering, Yu, Beam, and Kohane [4] survey the literature on AIM, explain the advanced techniques and their applications, and point out the breakthroughs and challenges for the field. The paper, though among the most recent attempts to draw out clinical integration of medical AI at various stages, has yet to dig into the entirety of the literature on AIM over a certain period of time. Thus, in order to identify research gaps and facilitate the clear, on-point translation of knowledge that would better inform policy development, this study presents the use of scientometric analysis in exploring research trends in the subject of AI in health and medicine. Scientometrics uses databases of published literature to objectively assess the impact of research knowledge on health issues and provide substantial empirical evidence. It shows the way of changing concerned research topics in national and international context with the increasing number of published articles over time, and reflects the visual collaborations of researcher networks within different topics [16–18]. Scientometric methods are particularly useful in the evaluation of global scientific production and development trends, such as in the cases of health systems research [19], administrative healthcare database [20], or diabetes research in Middle East countries from 1992 to 2012 [21], to name a few. Through an extensive review of the scholarship on AIM, this paper aims to present a better understanding of publications and research trends, and suggests potential directions toward solving this ongoing challenge. Specifically, we reviewed the global growth of research production in medical AI and analyzed patterns of research areas and trends in this field.

1.1 Where does the human intelligence differ from AI?

Artificial intelligence refers to the potential of computer controlled machines/robots towards performing tasks that that almost or similar to human beings. In this case, Artificial intelligence is used to develop various robots that have human intellectual characteristics, behaviors, learning from past experience, have abilities to sense, and abilities to making predications and determine meaning of certain situation [29]. Robotic technology is largely trending in the current life which has gained popularity in various sectors such as industries, hospitals, schools, military, music, gaming, quantum science and many others [28]. Artificial Intelligence is an efficient means that make computers and software control robotic thinking with expert systems that significantly illustrate the intelligent behavior, learning and effectively advice users. In general, AI is basically known as the ability or potential of robotics to decide, solve problems and reason [30]. There are various innovations of Artificial Intelligence, for example robotic cars which dont require a driver to control or supervise them. In addition, artificially intelligent technology (robots) involves smart machines that process a large amount of data that a human being cant be in position to perform. By so robotics are assuming repetitive duties that require creativity and knowledge base. Furthermore, Artificial Intelligence (AI) is the combination of various technologies that give chance to robotics to understand, learn, perceive or complete human activities on their own [2]. In this case, Artificial Intelligence programs (robots) are built for a specific purpose such as learning, acting and understating whereas humans intelligence is basically concerned with various abilities of multitasking.

In general, an Artificial Intelligence tool is majorly concerned with emphasizing robotics which portrays human behaviors. But however, Artificial Intelligence may fail out at some points due to differences in human brain and computers. In brief, Artificial Intelligence has the potential to mimic human character or behaviors [31]. Furthermore, Artificial intelligence is currently partially developed without advanced abilities to learn on their own but instead given commands to act on. This will be the ultimate future of artificial intelligence, where the AI machines will be recognized the human behavior and emotions and will train their kernel as per it [32].

1.2 AI applications in health and medicine:

For example, “machine learning”, “artificial intelligence”, “support vector machines” were used to support the diagnose and/or treatment of “Parkinson’s disease”, “Alzheimer’s disease” or used in “neuroimaging”. “Robotics” was utilized mainly for assisting laparoscopy of “oropharyngeal cancer” or “cervical cancer” or “surgery”. “Natural language processing” was applied for collecting “health records” information contributing to “big data” system.

It is quite remarkable thatthe keyword “ethics” is nowhere to be seen in the figure, suggesting that there is a lack of attention toward AI ethics in health and medicine. Additionally, in our dataset, when searching “ethics” on both keyword field and abstracts there are only 204 papers (0.7%) related to ethics. The first paper was published in 1994 “Ethical considerations in the management of individuals with severe neuromuscular disorders”. The application of AI has brought many benefits to the healthcare system and improve medicine. However, the use of AI technology unethically may be dangerous to patients and physicians. Thus, we need an ethical standard to apply to all the actors not only in healthcare services, but also in health-related fields [29]. Table 3 provides the number of publications of most common AI tools and types of clinical application using AI (diagnosis/prediction or treatment) for each of the top 25 diseases in terms of the burden of disease measured in DALYs [30]. Robotics is transforming health care with its diverse applications, such as early detection, training future doctors, or treatment. The highest number of papers were about robotic surgery. Machine learning was the second most popular AI type in which one would use for large and complex data analysis fields, such as genetics [31]. AI clinicians are higher than medical clinicians [32], however, in our dataset, the number of papers using AI for prediction of disease or its consequences was higher than that of treatment. The burdens of disease shift from infectious diseases to noncommunicational diseases (NCDs) [33], thus the research on AI application for heart disease, stroke, or respiratory disease were higher than for other diseases. The increasing burden due to cancer has attracted scientific concern, with the highest total number of papers in AI tools (Robotic, Machine leaning, or Artificial neural network) and in treatment and diagnosis. Robotics received the highest concern due to its broad application in medicine and health care, from serving as a nurse to supporting in surgery [34].

1.3 Artificial Intelligence in Pharmaceutical Industry

Artificial intelligence is finding its applications in all aspects of life and industry: like smart assistants found in the latest smartphones, and in smart factories to enhance their efficiency. Likewise, the pharmaceutical industry is finding the new and innovative ways to use this powerful technology to solve some of the biggest problems faced by pharmaceutical industry today.

The current drug discovery process is too lengthy and very expensiveIt takes up to 15 years to translate a drug discovery idea from its inception to a market ready product. The cost for this process exceeds 1 billion dollar per drug. What usually makes drug discovery more time-consuming and inefficient is the lack of understanding of the biological complexities of disease, and AI could help to identify true causal genes and pathways for complex diseases. By having a more comprehensive understanding of the biological basis of disease through AI, the R&D process will be more streamlined and scientistswill be in a better position to develop therapies, without much trial and error. Additionally, it is hoped that AI will also help to eliminate the element of “luck” that is observed in whether a drug is successful in clinical trials by accurately identifying the subset of patients who will benefit. Further reducing the failure and may save the industries billions of dollars

AI uses modern supercomputers and machine learning systems to predict how molecules will behave and how likely they are to make a useful drug, thereby saving time and money on unnecessary tests. By integrating AI with human-driven workflows, organizations will begin to function with more precision and decision-making. Implementing AI solutions may also provide speed for cost reduction, while maintaining regulatory compliance.

As a practical example Benevolent BioCompany, is doing research on Amyotrophic Lateral Sclerosis (ALS). They developed company's Judgment Correlation System **(JACS)** – which is able to review billions of sentences and paragraphs from millions of scientific research papers and abstracts.

Using computer algorithms, AI can teach machines how to relate raw complex data through the detection of patterns. This makes AI and its subsets to relate the mountainous genotypic and phenotypic data being collected worldwide in public and private databases, in hospitals and doctors' offices, in academic research journals and in individual wearable health monitoring devices. JACS then begins to link direct relationships between the data and regulates the data into 'known facts'. These known facts are curated, and unrealized connections made, to generate a large number of possible hypotheses using criteria set by the scientist

An expert team of researchers then assess the validity of these hypotheses and arrives at a prioritized list of hypotheses which are considered to be worth exploring. Further interrogation by the scientists carve this down to few hypotheses that we then test in the lab – and some potential new mechanisms for disease modification are identified.

The technology will also help in terms of the industry's selection of patients for clinical trials and help companies to identify issues with compounds much earlier when it comes to efficacy and safety. It can be used to build a strong, sustainable pipeline of new medicines.

Though no AI-driven drug has acquired regulatory approval yet, AI will soon be necessary to compete in the industry. In the next ten years AI will be universally integrated into pharmaR&D operations.

1.4 Top Pharmaceutical Companies current projectsusing AI in drug discovery:

- **Astra Zeneca:** discover therapeutic targets for neurological diseasessuch as Parkinson's.
- **BASF**: Combines artificial intelligence and genomics to discover natural peptides with health benefits.
- **Boehringer Ingelheim**: Cloud computing and novel computational methods to transform the drug design process
- **Genetech**: Find And Validate Potential Cancer Drug Targets by analyzing data from sources such as electronic medical records and next generation sequencing
- **GSK**: use AI for the design of novel small-molecule drugs with Cloud Pharmaceuticals.
- **Jansen:** Predicting dementia and neurodegenerative diseases from voice samples obtained through Janssen clinical trials.
- **Lilly**: AI-powered technology to enable on-demand drug discovery operations.
- **Merck:**Generating novel small molecule drug leads for an unnamed cardiovascular disease target.
- **Nestle**: Use AI to discover therapeutic peptides in foods.
- **Novo Nordisk**: Therapeutics to use its AI-based drug discovery technology to find new treatments for type 2 diabetes.
- **Pfizer and IBM**: Accelerate Drug Discovery In Immuno-Oncology
- **Sanofi:** Finding Bi-Specific Small Molecule Drugs For Metabolic Diseases
- **Santen:**Find New Drug Candidates for Glaucoma.
- **Takeda**: Identifying candidates for oncology, gastroenterology, and central nervous system disorders

2. Discussion

The growth of scientific literature in the field of AI has increased rapidly, particularly in the past 10 years, thanks to the exponential growth of computing power and data storage capacity [2,25,26]. This growth is attributed to the prolific output of research at leading institutions located in the United States, Europe, and China. These three players are also the biggest contributors to overall AI research worldwide [2]. At the national level, this study points out that among the top 10 researchers, the number of citations per paper of Asian researchers is significantly lower than that of their North American peers. This can be explained by the late-coming of China to the field. In-depth research should look into factors driving the differences in research output and citation impacts between the two regions. Our research was the first study showing the number of papers with AI applications in healthcare and medicine with the global burden of disease measured by DALYs. The number of papers related to disease with high rank in burden of disease shows there is shifting focus from infectious diseases to NCDs. The volume of publications mentioned about AI application in cancer was the highest, although the rank of cancer was 12th in the list (Table 3). The special concern that the scientific community spent for the second leading cause of death disease can be explained by (1) the uncertainty in early diagnosis and treatment outcomes; (2) the severity of late treatment, (3) the variety in types of cancers. Using AI in treatment will increase the level of accuracy, which may cause evolution of cancer treatment. The absence of the word "ethics" in the research subjects, the keywords, and the text mining of the abstracts (Figure 5 and Figure S2 Supplementary) suggests the promotion of evidence-informed policy making, health system strengthening, and a renewed focus to ensure that AI should be developed and used in the transparent and accountable way, which is consistent with public interest. This suggests a need for research on AI-related policy. The effect of AI might be reduced where data are not available, difficult to collect, or transfer digitally.

Another implication is the factors contributing to research output in medical AI. Empirical data suggest influential authors, as measured by the total number of citations and the number of citations per paper, are often those who either lead a field and stay productive throughout his or her career, or invents a method applicable in a variety of research areas. This pattern has been observed in other studies, such that senior and productive authors will drive the productivity of their collaborators [28]. In terms of policy implications, this study puts forth three suggestions. First, recent approaches that are rising in popularity include the use of AI to collect health data and information, in support of treating cancer (Table 3). This means applications of AI in medicine will be increasingly useful in aiding diagnosis and clinical treatment. Second, developing countries should look to investment in research in medical AI. Particularly China and India, which are emerging as top players in the field.Third, rapidly development of AI might create new challenges to established frameworks. Fourth, future AI techniques and development trends will focus on machine learning based on data obtained from the latest diagnostic modalities, including multi-omics (e.g., genomics, metabolomics) [35] and state-of-the-art imaging methods to predict treatment responses [36,37], especially in areas where there is a lack of objective diagnostic methods, e.g., psychiatric disorders [38]. Finally, to accelerate application and expansion of AI in health and medicine, it is critical to develop global and national protocols and regulations to frequently review and justify the validity of AIM products in clinical and practical environments.

An important challenge in applying AI for health and medicine is the lack of large clinical datasets for training AI models. This is especially true for datasets with labels, which require doctors/medical expert annotation and therefore are very costly and time-consuming to collect [39–41]. In general, AI techniques that are applicable to situations with limited amounts of labeled training data are of great interest for many applications [42], in addition to health and medicine. This is an important fundamental problem with active AI research and several promising AI directions: First, more sophisticated data augmentation techniques have recently been proposed to enrich the training datasets to better characterize data distribution. These techniques include feature space data augmentation [42,43] and data synthesis using complex deep neural networks models,notably generative adversarial networks (GAN) [44–47]. Second, there are substantial interests to improve semisupervised learning: learning methods that typically use a small amount of labeled data and unlabeled data [48]. Third, self-supervised learning [49,50] has attracted a lot of attention. Self-supervised learning methods automatically identify and extract supervisory signals without using any labeled data. Self-supervised learned models represent strong baselines that can be used in different applications with limited labeled data, including many medical and health applications.

Regarding the weaknesses and limitations of this study, the restriction on searchable peer-reviewed research publication and the exclusion of other documents may impact the thoroughness of the results and analysis. In addition, as only English articles and reviews were included in this study, the non-English papers were not counted. That made the number of Western countries' publications, especially English-speaking ones, more than that of Asia or Africa. Nonetheless, a bibliometric analysis of a large volume of publications and a summary of keywords is a helpful proxy for the overall content of these papers. Further studies may benefit from investigating how different AI techniques are being used to resolve specific medical tasks or exploring the impacts of methodological versus more application-oriented AI studies.

Given the limitations and current scope of the study, both academics and practitioners are aware that the AI developments—despite the field's vibrant growth—will further evolve in line with rising uncertainties and complexities in the coming years. It is hard to tell if one specific technique will prevail, but the surging trend is inexorable, to the extent that entrepreneurial attempts and policymaking changes will have to adapt. This study provides a contextual outline which may become useful for creating a more enabling environment, in which both AI developers and health researchers will work. It is anticipated that more in-depth reviews and theoretical surveys will be conducted, and early "maps" will more likely help at this early stage of development, let alone the fact that therecent debates on ethical issues of AI in the industries in general, and in the medical realm, in particular, will be less fruitful without a more updated understanding of macro views.

3. Conclusion

AI has been applied for a wide range of purposes, especially in in the field of healthcare. With the rapid development of technology, AI has the opportunity to help raise important health problems to light but might be restricted by the unavailability of health data, and/or by the inability of AI to have some human characteristics, such as compassion. The use of AI raises some ethical and social issues, which might be overcome via data policy. A key challenge for governments is that AI development should be conducted in a way that is easy to approach and aligned with the public interest.

References

[1] Nuffield Council on Bioethics. Bioethics Briefing Notes: Artificial Intelligence (AI) in Healthcare and Research. Available online: http://nuffieldbioethics.org/wpcontent/uploads/Artificial-Intelligence-AIin-healthcare-and-research.pdf (accessed on 21 December 2018).
[2] Elsevier. Artificial Intelligence: How Knowledge Is Created, Transferred, and Used; Elsevier Artificial Intelligence Program: Amsterdam, The Netherlands, 2018.
[3] Frankish, K.; Ramsey,W.M. (Eds.) Introduction. In The Cambridge Handbook of Artificial Intelligence; Cambridge University Press: Cambridge, UK, 2014; pp. 1–14.
[4] Yu, K.-H.; Beam, A.L.; Kohane, I.S. Artificial intelligence in healthcare. Nat. Biomed. Eng. **2018**, 2, 719–731.
[5] Hamet, P.; Tremblay, J. Artificial intelligence in medicine. Metabolism **2017**, 69, S36–S40. [CrossRef] [PubMed]
[6] Trivikram, C.; Samarpitha, S.; Madhavi, K.; Moses, D. Evaluation of hybrid face and voice recognition systems for biometric identification in areas requiring high security. I-Manag. J. Pattern Recognit. **2017**, 4, 9–16.
[7] J. Shabbir and T. Anwer, "A Survey of Deep Learning Techniques for Mobile Robot Applications," ArXiv e-prints, Mar. 2018. [2] U. Neisser, G. Boodoo, T. J. Bouchard Jr, A. W. Boykin, N. Brody, S. J. Ceci, D. F. Halpern, J. C. Loehlin, R. Perloff, R. J. Sternberg et al.,

"Intelligence: Knowns and unknowns." American psychologist, vol. 51, no. 2, p. 77, 1996.

[8] R. Feuerstein, The Dynamic Assessment of Cognitive Modifiability: The Learning Propensity Assessment Device : Theory, Instruments and Techniques. ICELP Press, 2002. [Online]. Available: https://books.google.com.pk/books?id=-3vsAAAAMAAJ

[9] M. Milford, C. Shen, S. Lowry, N. Suenderhauf, S. Shirazi, G. Lin, F. Liu, E. Pepperell, C. Lerma, B. Upcroft et al., "Sequence searching with deep-learnt depth for condition-and view point in variant route-based place recognition," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops, 2015, pp. 18–25.

[10] K. Fragkiadaki, S. Levine, P. Felsen, and J. Malik, "Recurrent network models for human dynamics," in Computer Vision (ICCV), 2015 IEEE International Conference on. IEEE, 2015, pp. 4346–4354.

[11] S. Niekum, S. Osentoski, G. Konidaris, S. Chitta, B. Marthi, and A. G. Barto, "Learning grounded finite-state representations from unstructured demonstrations," The International Journal of Robotics Research, vol. 34, no. 2, pp. 131–157, 2015.

[12] CB Insights Research. Healthcare remains the hottest AI category for deals. 2017. https://www.cbinsights.com/research/artificial-intelligence-healthcare-startupsinvestors/ (accessed 15 Jan 2018).

[13] Chen JH, Asch SM. Machine learning and prediction in medicine — beyond the peak of inflated expectations. N Eng J Med 2017; **376(26):** 2507–2509.

[14] Burgess M. The NHS is trialling an AI chatbotto answer your medical questions. Wired 2017: **5 Jan:** http://www.wired.co.uk/article/babylonnhs-chatbot-app (accessed 15 Jan 2018).

[15] Esteva A, Kuprel B, Novoa RA, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature 2017; **542(7639):** 115–118.

[16] LakhaniP, Sundaram B. Deep learning at chest radiography: automated classification of pulmonary tuberculosis by using convolutional neural networks. Radiology 2017; **284(2):** 574–582.

[17] Oppenheim M. Stephen Hawking: artificialintelligence could be the greatest disaster in human history. Independent 2016; **20 Oct:**http://www.independent.co.uk/news/people/stephen-hawking-artificial-intelligencediaster- human-history-leverhulme-centrecambridge-a7371106.html (accessed 15 Jan 2017).

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