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Leveraging Artificial Intelligence and Machine Learning in Predicting and Managing Pandemics: Lessons Learnt and Future Implications in the Healthcare Sector

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Abstract **Original Research Article**

Artificial intelligence (AI) is a game changer in the healthcare, educational, and other sectors. The use of AI in the healthcare sector has shown that AI and machine learning should be promoted in the improvement of service provision, including in predicting and managing pandemics. This study assessed the roles of AI in predicting and managing pandemics with lessons learnt from the COVID-19 pandemic. A narrative review was conducted from December 2023 to January 2024 on the role of AI and machine learning in predicting and managing pandemics. A literature search was done using PubMed and Google Scholar. This study found that AI is useful in the healthcare sector and can be used to predict and manage pandemics. Additionally, AI can be used in disease modelling and improve public health service provision. There is a need to promote and strengthen the use of AI and machine learning in the healthcare sector.

Keywords: Artificial Intelligence, COVID-19, Healthcare, Machine Learning, Pandemics.

INTRODUCTION

Pandemics can disrupt various activities and increase morbidity and mortality worldwide [1–3]. For instance, the coronavirus disease 2019 (COVID-19) pandemic emerged as a global health problem that disrupted activities in the education sector, health sector, commerce and economic sector, and led to increased morbidity and deaths across countries [4–12]. Predicting and managing pandemics has been challenging and affects many countries worldwide. However, these challenges are being addressed by the use of artificial intelligence (AI) and machine learning [13]. Intriguingly, AI and machine learning can be used to understand the experiences and lessons learnt from previous pandemics [14]. Hence, this may help provide mitigation measures in case of similar pandemics in the future [15].

Artificial intelligence (AI) has emerged as a game changer in addressing many public health problems globally [16–20]. Consequently, AI has a significant role in predicting and managing pandemics including the COVID-19 pandemic [21–25]. Additionally, AI has the potential to predict the severity of disease including COVID-19 [26]. This paper focuses on some of the ways that AI and machine learning can be used to predict and manage pandemics and these may include early detection and warning, monitoring, and response.

This paper highlights the usefulness of AI and machine learning in the healthcare sector to predict and manage pandemics. Additionally, it discusses the usefulness of AI and machine learning in drug and vaccine discovery, allocation of resources, contact tracing, monitoring adherence to recommended disease preventive measures, and distribution of vaccines and other resources during pandemics.

MATERIALS AND METHODS

This narrative review was conducted from December 2023 to January 2024. The literature search was done using PubMed and Google Scholar. This study included all publications on AI AND Machine learning in healthcare done up to January 2024. To search for all the relevant publications, we used key terms ‘artificial intelligence’, ‘machine learning’, ‘infectious diseases’, ‘pandemics’, ‘COVID-19’, ‘healthcare’, ‘predicting’, ‘management’, and Boolean operators (AND/OR). We

included publications that were done in the English language. We excluded all publications that we had not done in the English language as we did not have translators. The two authors ensured that all the selected publications met the inclusion criteria. Consequently, any discordances were normalized by the principal author (SM).

Roles of AI and Machine Learning in Healthcare, Predicting and Managing Pandemics

Artificial intelligence (AI) and machine learning can be utilized in early warning systems to predict disease outbreaks [27, 28]. AI algorithms can analyze vast amounts of data from various sources, including social media, news reports, healthcare data, and environmental data, to identify early signals of potential outbreaks. By monitoring for unusual patterns of symptoms, disease clusters, or related keywords in online discussions, AI can provide early warning of emerging health threats [29, 30]. Additionally, AI is very critical in disease modeling [30–35]. AI can be used to create sophisticated disease models that simulate the spread of infectious diseases [36–39]. These models consider various factors like population density, travel patterns, healthcare infrastructure, and more to predict how diseases may spread. These predictions can inform public health responses and resource allocation [20–42].

Drug discovery for new infectious agents is critical in managing infections caused by such pathogens [43–50]. AI-driven drug discovery platforms can accelerate the identification of potential treatments and vaccines [27-52]. Machine learning models can analyze vast datasets to identify existing drugs with potential efficacy against a new pathogen like viruses or bacteria, significantly reducing the time and cost and speeding up drug development [53–55]. Further, AI can analyze the genetic sequences of viruses and identify potential mutations or variations that might impact transmission, severity, or vaccine effectiveness [56]. Pathogen genomic analysis is very critical in understanding the best efficacious treatment for a particular microbe [57]. This information can guide public health measures and vaccine development [57–64]. The era of technology has caused AI to be used to monitor and analyze reports of adverse events related to vaccines or treatments, helping to quickly identify and respond to potential safety concerns [65–67].

AI can assist in optimizing the allocation of healthcare resources during pandemics [41–70]. Predictive analytics can help healthcare systems anticipate surges in cases, allocate hospital beds, ventilators, and medical staff efficiently, and ensure that critical resources are available where and when they are needed most [41-72]. AI can optimize the distribution of vaccines by identifying the most effective distribution routes, considering factors like temperature sensitivity and population density [73, 74]. Interestingly, AI can also predict demand and prevent vaccine wastage by distributing the quantity of vaccines required in a specific area [75].

AI-powered contact tracing apps can help identify and notify individuals who may have been exposed to the virus or other pathogens [28-69]. These apps use Bluetooth technology and machine learning algorithms to track and trace potential contacts more effectively than manual methods [13]. By doing so, AI can improve contact tracing and diagnosis of diseases during outbreaks. Intriguingly, AI can be used to analyze data from surveillance cameras and drones to monitor public compliance with pandemic-related measures, such as mask-wearing, social distancing, and treatment [76–81]. This information can help authorities to monitor public compliance with recommended preventive measures and enforce public health guidelines. AI-driven sentiment analysis of social media and news can gauge public sentiment and help authorities understand public perceptions and concerns about a disease or intervention [82–85]. Therefore, this information can be used to tailor public health messaging and responses.

This study noted that AI should be used in conjunction with traditional epidemiological methods and with the guidance of experts. Further, ethical considerations, privacy concerns, and data security are also critical when implementing AI-driven pandemic prediction and management solutions. Furthermore, AI can be a valuable tool in our global efforts to prevent, detect, and respond to pandemics, but it is not a standalone solution. Finally, collaboration between experts in various fields, governments, and technology companies is essential for effective pandemic management. In this regard, governments should employ experts in Machine Learning and integrate AI in their healthcare sector.

CONCLUSION

This review found that AI is very beneficial in the healthcare sector and other sectors and can be used to predict and manage pandemics. Additionally, AI is very critical in infectious disease diagnosis and modelling thereby contributing positively to the management of infections. Therefore, there is a need for global healthcare sectors to leverage machine learning for the betterment of service provision.

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