Artificial intelligence and global health

Jay Vietas

Emerging Technologies Branch, Division of Science Integration, the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Washington DC, United States

Introduction

Artificial intelligence (AI) has the potential to have profound impacts on improvements in global health. Where data are available and of sufficient quality, algorithms can be applied to improve the forecasting of disease outbreaks, assist in identifying pathogens, recommend treatments to address and control outbreaks, and place clinical decision-making tools in the hands of healthcare providers to ensure treatment is optimized and personalized. Many of these tools are in early development, but improvements in predictive tools, such as those to predict malaria disease burden will revolutionize the public health profession and optimize the healthcare response [1]. While there is significant promise for improvements in global health due to the use of AI, the development, implementation, and maintenance of these tools will be critical to ensure the anticipated results are realized.

Disease outbreaks

Instead of waiting for cases to arrive at a local clinic, predictive models can be applied to determine where and when potential disease outbreaks may occur. Since John Snow identified the water at the Broad Street pump as the source of cholera, epidemiologists have been developing relationships between human health outcomes and activities which result in disease [2]. AI builds on these relationships and is able to connect multiple variables in space and time to anticipate where and when disease may occur. Before the

COVID-19 pandemic, a significant amount of effort went into forecasting the early and precise detection of influenza outbreaks by developing artificial intelligent tools from a variety of data sources including from the Centers for Disease Control and Prevention [3], data curated from social media [4], and more complicated systems attempting to combine various data sets [5]. COVID-19 provided ample opportunity to use AI to improve methods of tracking and forecasting the spread of disease [6], including data collected from wastewater [7], the use of mobile phone surveys [8], as well as the exploration of the use of wireless systems and drones [9]. Future use cases of AI will be able to recognize patterns to forecast and monitor disease outbreaks, optimize treatment plans once identified, and assist in the optimization of the use of healthcare supplies and personnel to contain the outbreak [10].

Hazard identification

AI has the capacity to automate and standardize techniques using machine learning and computer vision, which are trained programs able to recognize objects or items from images. These tools, previously reserved for the expertise and training of a limited number of personnel, can now be used in the field and in the laboratory with minimal amounts of training to identify potential hazards or disease vectors. The technology associated with cameras on mobile phones has improved enough to employ AI tools for a wide variety of applications. Additionally, due to the increasing ubiquity of phones with this technology, the use of these tools can occur in ever increasing locations. Photographs and smart phone applications can be used to identify hazardous versus nonhazardous snakes [11], plants [12], and insects [13−15]. Furthermore, this technology typically collects the location of these photographs, too. For entomologists, the combination of tick and mosquito identification with location, especially when combined with molecular techniques, can improve the understanding of relationships between environmental factors and disease spread.

More elaborate AI systems can also be used to protect the public. Computer systems linked to air monitoring sensors can be used to automate pollution warnings [16] and assist first responders to effectively access life-saving information through the use of machine learning [17]. Similar technology is promising for the diagnosis of dental caries using a smartphone and would be useful, particularly in low-income countries, for identifying the most at-risk populations in order to optimize treatment [18].

Clinical decision support systems

AI has the capacity to improve clinical decision-making. Tools have been created to assist surgeons in predicting the need for total knee arthroplasty [19], to guide physicians in breast cancer treatment options [20], and to predict diabetes by noninvasive methods [21]. AI also has the potential to predict the child-birthing location of maternal health program enrollees, and to improve outcomes by distributing support to those not delivering at a healthcare

facility [22]. The challenge of relying on these systems is to ensure appropriate use of these tools to minimize misuse or overdiagnosis [23]. Currently clinical decision support tools which provide guidance appear to be the most effective, such as those which assist in prescribing medications [24].

Challenges related to the use of artificial intelligence in global health

To harness the power and promise of AI in global health, adequate investment must be made in communication, computer systems, and supporting personnel to collect, curate, and manage the data necessary to enable benefits and minimize harm from the use of AI-related tools. In developed countries, this has either occurred or is underway. Developing countries run the risk of widening the digital divide if this does not occur [25]. Furthermore, data, models, and forecasts alone do not improve population health. These measures must be paired with appropriately developed policies, logistics, and research efforts to truly make a difference. Training of personnel to understand how these systems work must be accomplished in a manner to develop trust; and the systems themselves must be designed with the user in mind while ensuring data confidentiality and privacy. Finally, the systems must consider the uncertainty of the results, which should include an examination of bias. A review of bias should include the type and representative nature of the data collected, the development and implementation of the algorithm, and the need to continuously examine and validate outcomes to ensure the system is functioning as desired. This will be particularly important for underrepresented populations in the data, and careless use of these tools has the potential to increase health inequities, particularly for those who are already marginalized.

Future directions

Employed properly, AI can improve health systems and health outcomes across the global health landscape. Research, investment, and training will be necessary for programmers, implementers, public health and healthcare workers, and support personnel to ensure that appropriate systems and infrastructure are built to deliver equitable and effective global health outcomes. Finally, the systems must ensure humans are in control of decision-making and that the policies and standards associated with these tools are adequate to fairly safeguard human health.

Disclaimer

The findings and conclusions in this report are those of the author and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

References

[1] Brown BJ, Manescu P, Przybylski AA, Caccioli F, Oyinloye G, Elmi M, et al. Data-driven malaria prevalence prediction in large densely populated urban holoendemic sub-saharan west africa. Sci Rep 2020;10(1).

[2] Tulchinsky TH. John snow, cholera, the broad street pump; waterborne diseases then and now. Case Stud Public Health 2018;77—99.

[3] Aldhyani THH, Joshi MR, AlMaaytah SA, Alqarni AA, Alsharif N. Using sequence mining to predict complex systems: a case study in influenza epidemics. Complexity 2021;2021:9929013.

[4] Wang F, Wang H, Xu K, Raymond R, Chon J, Fuller S, et al. Regional level influenza study with geo-tagged twitter data. J Med Syst 2016;40(8):189.

[5] Santillana M, Nguyen AT, Dredze M, Paul MJ, Nsoesie EO, Brownstein JS. Combining search, social media, and traditional data sources to improve influenza surveillance. PLoS Comput Biol 2015;11:10.

[6] Atek S, Pesaresi C, Eugeni M, De Vito C, Cardinale V, Mecella M, et al. A geospatial artificial intelligence and satellite-based earth observation cognitive system in response to covid-19. Acta Astronaut 2022; 197:323—35.

[7] Mahmoudi T, Naghdi T, Morales-Narváez E, Golmohammadi H. Toward smart diagnosis of pandemic infectious diseases using wastewater-based epidemiology. TrAC Trends Analyt Chem 2022;153:116635.

[8] Srinivasa Rao ASR, Vazquez JA. Identification of covid-19 can be quicker through artificial intelligence framework using a mobile phone-based survey when cities and towns are under quarantine. Infect Control Hosp Epidemiol 2020;41:826—30.

[9] Alsarhan A, Almalkawi I, Kilani Y. A new covid-19 tracing approach using machine learning and drones enabled wireless network. Int J Interact Mobile Technol 2021;15:111—26.

[10] Davies SE. Artificial intelligence in global health. Ethics Int Affairs 2019;33(2):181—92.

[11] Bolon I, Picek L, Durso AM, Alcoba G, Chappuis F, Ruiz de Castaneda R. An artificial intelligence model to identify snakes from across the world: opportunities and challenges for global health and herpetology. PLoS Negl Trop Dis 2022;16(8):e0010647.

[12] Otter J, Mayer S, Tomaszewski CA. Swipe right: a comparison of accuracy of plant identification apps for toxic plants. J Med Toxicol 2021;17(1):42—7.

[13] Høye TT, Ärje J, Bjerge K, Hansen OLP, Iosifidis A, Leese F, et al. Deep learning and computer vision will transform entomology. Proc Natl Acad Sci U S A 2021;118(2):e2002545117.

[14] Ong S-Q, Nair G, Yusof UK, Ahmad H. Community-based mosquito surveillance: An automatic mosquito-on-human-skin recognition system with a deep learning algorithm. Pest Manag Sci 2022; 78(10):4092—104.

[15] Luo C-Y, Pearson P, Xu G, Rich SM. A computer vision-based approach for tick identification using deep learning models. Insects 2022;13(2):116.

[16] Guo Q, Ren M, Wu S, Sun Y, Wang J, Wang Q, et al. Applications of artificial intelligence in the field of air pollution: a bibliometric analysis. Front Public Health 2022;10.

[17] Do V, Huyen A, Joubert FJ, Gabriel M, Yun K, Lu T, et al. Virtual assistant for first responders using natural language understanding and optical character recognition. In: 12101, proceedings of SPIE—the International Society for Optical Engineering; 2022.

[18] Thanh MT, Van Toan N, Ngoc VT, Tra NT, Giap CN, Nguyen DM. Deep learning application in dental caries detection using intraoral photos taken by smartphones. Appl Sci 2022;12:11.

[19] Lee LS, Chan PK, Wen C, Fung WC, Cheung A, Chan VWK, et al. Artificial intelligence in diagnosis of knee osteoarthritis and prediction of arthroplasty outcomes: a review. Arthroplasty 2022;4(1):16.

[20] Torkey H, Atlam M, El-Fishawy N, Salem H. A novel deep autoencoder based survival analysis approach for microarray dataset. PeerJ Comput Sci 2021;7:e492.

[21] Spänig S, Emberger-Klein A, Sowa JP, Canbay A, Menrad K, Heider D. The virtual doctor: An interactive clinical-decision-support system based on deep learning for non-invasive prediction of diabetes. Artif Intell Med 2019;100.

[22] Fredriksson A, Fulcher IR, Russell AL, Li T, Tsai Y-T, Seif SS, et al. Machine learning for maternal health: Predicting delivery location in a community health worker program in zanzibar. Front Digital Health 2022;4.

[23] Vogt H, Green S, Ekstrøm CT, Brodersen J. How precision medicine and screening with big data could increase overdiagnosis. BMJ 2019;366:5270.

[24] Shahmoradi L, Safdari R, Ahmadi H, Zahmatkeshan M. Clinical decision support systems-based interventions to improve medication outcomes: a systematic literature review on features and effects. Med J Islam Repub Iran 2021;35:27.

[25] Chatterjee J, Nina D. Developing countries are being left behind in the ai race—and that's a problem for all of us. 2022; <https://theconversation.com/developing-countries-are-being-left-behind-in-the-ai-race-and-thats-a-problem-for-all-of-us-180218>.
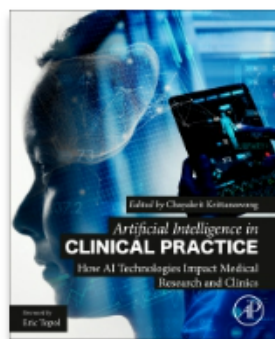
Artificial Intelligence in Clinical Practice

How AI Technologies Impact Medical Research and Clinics

1st Edition - September 13, 2023

Editor: Chayakrit Krittanawong

Paperback ISBN: 9780443156885 • eBook ISBN: 9780443156892

Description —

Artificial Intelligence in Clinical Practice: How AI Technologies Impact Medical Research and Clinics compiles current research on Artificial Intelligence within medical subspecialties, helping practitioners with diagnosis, clinical decision-making, disease prediction, prevention, and the facilitation of precision medicine. The book defines the basic concepts of big data and AI in medicine and highlights current applications, challenges, ethical issues, and biases. Each chapter discusses AI applied to a specific medical subspecialty, including primary care, preventive medicine, general internal medicine, radiology, pathology, infectious disease, gastroenterology, cardiology, hematology, oncology, dermatology, ophthalmology, mental health, neurology, pulmonary, critical care, rheumatology, surgery, and OB-GYN.

This is a valuable resource for clinicians, students, researchers and members of medical and biomedical fields who are interested in learning more about artificial intelligence technologies and their applications in medicine.

ARTIFICIAL INTELLIGENCE IN CLINICAL PRACTICE

ARTIFICIAL INTELLIGENCE IN CLINICAL PRACTICE

How AI Technologies Impact Medical Research and Clinics

Edited by

CHAYAKRIT KRITTANAWONG
*Cardiology Division, NYU Langone Health and NYU School of Medicine,
New York, NY, United States*

ELSEVIER

ACADEMIC PRESS

An imprint of Elsevier

For Information on all Academic Press publications
visit our website at https://www.elsevier.com/books-and-journals

Working together
to grow libraries in
developing countries

www.elsevier.com • www.bookaid.org