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Artificial Intelligence in the Covid-19 Pandemic

Artificial intelligence (AI) was originally designed to solve simple problems but has since evolved into something with much greater potential to transform society. Since its inception, it has become far less expensive to develop and much more efficient at solving problems. In recent years, AI has produced great benefits for the healthcare field.[1] However, with this rapid development, concerns have been raised about the ethics and application of AI.[2] With the onset of the Covid-19 Pandemic, new challenges in healthcare present an opportunity for AI application. This report will review current uses of AI in response to the coronavirus, its potential benefits, and drawbacks.

AI in Healthcare

Implications for pandemics

AI can help detect pandemics before they start by identifying early warning signs, predicting, and detecting outbreaks. It can help quickly mitigate outbreaks by monitoring and analyzing disease spread, helping determine effective treatments, and completing pathogen analysis.[3] By analyzing big data satellite imaging, such as seeing places where cars were crowded, can help determine localized outbreaks.[4] AI reduces the human-hours, and thus cost, required to analyze drug discoveries and perform clinical trials by preforming these tasks itself. For example, the AI system BenevolentAI was used to search medical information about drugs that may work to reduce the symptoms of and treat COVID-19. That AI search led to the discovery that the drug baricitinib can have antiviral effects.[5]

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[1] Sathian Dananjayan and Gerard Marshall Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," *International Journal of Health Planning Management* 35, no. 5 (May 2020): 1260, https://doi.org.10.1002/hpm.2987.

[2] Carmel Shachar, Sara Gerke, and Eli Y. Adashi, "AI Surveillance during Pandemics: Ethical Implementation Imperatives," *The Hastings Report* 50, no. 3, (Summer 2020): 18-21.

[3] Dananjayan and Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," 1260.

[4] Agam Bansal et al., "Utility of Artificial Intelligence Amidst the COVID 19 Pandemic: A Review," *Journal of Medical Systems 44,* no. 9 (August 2020): 2, https://doi.org/10.1007/s10916-020-01617-3.

[5] Christina M. Williams et al., "Artificial Intelligence and a Pandemic: An Analysis of the Potential Uses and Drawbacks," *Journal of Medical Systems* 45 (January 2021): 25-26, https://doi.org/10.1007/s10916-021-01705-y.

AI can also help monitor the news, social media, and healthcare reports in multiple languages across the world to assess the possibility of pandemics and the risk of spread. It can also determine the priority of information it finds and relay this information to the appropriate people.[6]

Susceptible-Exposed-Infectious-Recovered (SEIR) modeling can help predict locations and extent of disease spread, cases under-reported, effectiveness of interventions, and how accurate testing methods are.[7] Models used to predict outbreak and spread of the Zika virus in Americans resulted in 85% accuracy, with even higher accuracy when using backward propagation neural network (BPNN) modeling.[8]

Mirador, a data visualization tool, was used to create an application called "Ebola CARE" (Computational Assignment of Risk Estimates) that determined a patient's outcome when infected and diagnosed with Ebola. clinical and laboratory parameters were used to determine a patient's prognosis, a tool that can be used as well to determine a COVID-19 patient's prognosis.[9]

Risks of AI in healthcare

Given that not all AI systems are flawless, there are bound to be errors and these errors can be detrimental to the patient.[10] With an increased reliance on these systems, small errors can become widespread. Professor of Health Law, W. Price, warns

> If AI systems become widespread, an underlying problem in one AI system might result in injuries to thousands of patients rather than the limited number of patients injured by any single providers error.[11]

Further, AI systems learn from data input, therefore, ensuring information is complete and accurate is crucial, yet a difficult task. Price points out "[d]ata are typically fragmented across many different systems."[12] It becomes hard to collect coherent sets of data from insurance claims, fitness trackers, or even pharmacy records.[13] Also "patients typically see different providers and switch insurance companies, leading to data split in multiple systems."[14] With fragmented sets of data comes an increased risk of error which could negatively impact the patient.[15]

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[6] Dananjayan and Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," 1260.
[7] Agam Bansal et al., "Utility of Artificial Intelligence Amidst the COVID 19 Pandemic," 3.
[8] Agam Bansal et al., "Utility of Artificial Intelligence Amidst the COVID 19 Pandemic," 3.
[9] Agam Bansal et al., "Utility of Artificial Intelligence Amidst the COVID 19 Pandemic," 4.
[10] W. Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care," a report from The Brookings Institution's Artificial Intelligence and Emerging Technology (AIET) Initiative , May 6, 2020, accessed May 11, 2021, https://www.brookings.edu/research/risks-and-remedies-for-artificial-intelligence-in-health-care/.
[11] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[12] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[13] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[14] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[15] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."

Privacy concerns are another issue that arise with the use of AI. Given that AI developers need access to large amounts of personal data, some patients may be concerned about who has access to their data.[16] This apprehension is valid as lawsuits have already transpired due to information sharing between healthcare systems and AI developers.[17] Further, the accuracy of these systems (they can do things like predict illness such as Parkinson's before most health experts)[18] means such information could also be used by insurance companies to the detriment of the patient.[19]

Finally, there is the issue of career loss looking at any AI system. As AI gets better it will inevitably be able to replace professional workers due to the economic benefits as well as the accuracy benefits. In the case of healthcare, Price posits those certain specialties, such as radiology, are likely to see an immense shift.[20] This is bad news not only for those who may lose their jobs to AI at some point. It could also lead to a lack of human knowledge, and with this the fears we may lose the ability to catch errors made by the system.[21]

COVID-19 Pandemic and Use of AI in Healthcare

BlueDot, a company that has been using machine learning since 2013 to detect and track outbreaks, was one of the first to detect the COVID-19 and the risk of the spread.[22] Its AI algorithm was able to analyze the outbreak and spread of COVID-19 through "news reports, airline ticketing, and animal disease outbreaks," and "accurately predicted which areas of the world would be the most prone to COVID-19 outbreaks." BlueDot also accurately predicted the spread of the 2009 H1N1 virus outbreak, the 2014 spread of the Ebola virus in West Africa, and the 2016 Zika virus outbreak in Florida.[23]

Metabiota, an AI company, accurately predicted which Asian countries would be at risk of COVID-19 multiple days before the first cases showed up through an analysis of flight patterns and data.[24]

The AI start-up Nference utilized deep neural networks and clinical notes from tens of thousands of confirmed COVID-19 patients to identify any telltale symptoms of the virus. Nference found anosmia, or lack of smell, to be a potential indicator of COVID-19 positivity.[25]

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[16] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[17] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[18] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[19] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[20] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[21] Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[22] Dananjayan and Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," 1260; "Outbreak Risk Software."
[23] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[24] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[25] Tyler Wagner et al., "Augmented curation of clinical notes from a massive EHR system reveal symptoms of impending COVID-19 diagnosis," *eLife* 9, (2020)

Boston Children's Hospital's AI system HealthMap was the first to notify the world about COVID-19 on December 30, 2020, before the World Health Organization (WHO) released their first report on the virus.[26]

In China, a new AI algorithm has been developed to analyze blood samples of COVID-19 patients to predict survival rates, which is 90% effective.[27] This algorithm gives medical professionals information on which patients need the most intensive care and could be used for triage during pandemics. This technique was developed after blood samples of patients were retroactively scanned for the most discriminate biological markers to determine patient survival probability, helping hospitals prioritize care and resources.[28]

In France, a tech startup called Clevy.io is utilizing AI to assist answering COVID-19 questions and directing users to appropriate resources. The AI chatbot can respond, much like a human would, to a wide variety of COVID-19 queries, drawing on real time information from the World Health Organization and French government. Three cities in France are utilizing the company's platform to efficiently distribute verified information. In doing so, Clevy.io reduces the strain on human operators.[29]

Two different AI systems have been designed to analyze patients' computerized tomography (CT) scans and X-ray scans of their chest to quickly detect pneumonia from COVID-19 and provide relief to frontline radiologists. Researchers found that radiologists' severity scores and those of the AI were in agreement, and the AI improved efficiency and shortened computational time while retaining quality of diagnosis.[30] These systems improve early diagnosis and can help determine who needs the most treatment.[31] COVID-Net, which can diagnose COVID-19 from chest radiography images, replaces a time-consuming manual analysis of chest radiography images through a "conventional reverse transcriptase-polymerase chain reaction (RT-PCR)" technique. COVID-Net significantly shortens the number of images that radiologists must look at and the time spent looking at scans.[32]

China also developed AI service robots to provide entertainment and food and medicines to patients in hospitals in Wuhan, China.[33]

Another AI program, Artificial Neural Networks (ANN), was used to help find and target six potential vaccine target proteins through scanning the entire viral proteome to predict

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[26] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[27] Dananjayan and Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," 1260.
[28] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[29] Swami Sivasubramanian, "How AI and machine learning are helping to fight COVID-19" *World Economic Forum,* May 8, 2020, https://www.weforum.org/agenda/2020/05/how-ai-and-machine-learning-are-helping-to-fight-covid-19/.
[30] Jocelyn Zhu et al., "Deep transfer learning artificial intelligence accurately stages COVID-19 lung disease severity on portable chest radiographs," *PloS ONE 15,* no. 7, (July 2020): 8, https://doi.org/10.1371/journal.pone.0236621.
[31] Dananjayan and Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," 1260.
[32] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[33] Dananjayan and Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," 1260.

antigenic regions in the viral membrane protein of SARS-CoV, vital to quickly and inexpensively produce vaccines.[34]

AI and Mental Health

A growing public health concern is mental health and suicide prevention. About 800,000 people per year die from suicide, globally, a number that increased due to the pandemic.[35] Machine learning approaches are being used to improve suicide care and better predict the risk that individuals face from self-harm. Machine learning (ML) is an algorithm that is a subset of AI that can

> detect patterns from huge complex datasets to become more precise and accurate as they interact with training data, allowing humans to gain unprecedented insights into early detection of diseases, drug discovery, diagnostics, healthcare processes, treatment variability, and patient outcomes.[36]

The main goal of ML in this situation is to "develop modalities that simulate aspects of human intelligence such as planning, reasoning, pattern recognition and problem-solving" through ML that recognizes patterns or features through an algorithm.[37] This method can be used to determine risk, predict suicide outbreaks, and identify at-risk populations, as well as help develop technologies that can monitor suicide risk in real time and help individuals in crisis.[38] ML has been used to assess social media and develop "social media-based suicide interventions and therapeutic conversation agents," which can be of particular use with youth.[39] It is important to note that this technology is best used in conjunction with clinical expertise, and not as an isolated diagnosis.[40]

Mental health has been of particular concern during the pandemic, especially among frontline healthcare workers. Healthcare workers have experienced elevated anxiety, depression, posttraumatic stress disorder and suicidal behavior due to the stress of the COVID-19 pandemic, particularly those working with ill or quarantined patients and experience chronic fatigue and overworking.[41] This can be exacerbated by personality or pre-existing mental health issues, such as "low overall stress resilience and have other vulnerability factors, such as the general propensity to psychological distress and low self-control."[42] AI systems can help predict

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[34] Agam Bansal et al., "Utility of Artificial Intelligence Amidst the COVID 19 Pandemic," 3.
[35] Trehani M. Fonseka, Venkat Bhat, and Sidney H. Kennedy, "The utility of artificial intelligence in suicide risk prevention and the management of suicidal behaviors," *Australian & New Zealand Journal of Psychiatry* 53, no. 10 (October 2019): 954-964, https://doi.org/10.1177/0004867419864428.
[36] Dananjayan and Raj, "Artificial Intelligence during a pandemic: The COVID-19 example," 1260.
[37] Fonseka, Bhat, and Kennedy, "The utility of artificial intelligence in suicide risk prevention," 955.
[38] Fonseka, Bhat, and Kennedy, "The utility of artificial intelligence in suicide risk prevention," 955.
[39] Fonseka, Bhat, and Kennedy, "The utility of artificial intelligence in suicide risk prevention," 960.
[40] Fonseka, Bhat, and Kennedy, "The utility of artificial intelligence in suicide risk prevention," 961.
[41] Krešimir Ćosić et al., "Artificial intelligence in prediction of mental health disorders induced by the COVID-19 pandemic among health care workers," *Croation Medical Journal* 61, no. 3 (2020): 279: https://doi.org/10.3325/cmj.2020.61.279.
[42] Ćosić et al., "Artificial intelligence in prediction of mental health disorders," 279.

and assess mental health disorders through algorithms identifying patterns in data sets including

> various psychometric scales or mood rating scales, brain imaging data, genomics, blood biomarkers, data based on novel monitoring systems (e.g., smartphones), data scraped from social media platforms, speech and language data, facial data, dynamics of the coulometric system, attention assessment based on eye-gaze data, as well as various features based on the analysis of peripheral physiological signals, e.g., respiratory sinus arrhythmia, startle reactivity, etc.[43]

Using this data, AI systems can detect early warnings of mental health conditions. It is more reliable than using only self-report predictor variables because it uses neuro-physiological features such as speed features and biomarkers. While the literature focuses on healthcare workers, it can be extended to anyone experiencing high stress levels due to the COVID-19 pandemic.[44]

AI Healthcare in Vermont

A new Vermont startup, Biocogniv, utilizes data from electronic health records to make predictive suggestions to health care providers.[45] In response to COVID-19, Biocogniv trained its AI to analyze bloodwork from both positive and negative COVID-19 patients to identify patterns. The machine learning software could then predict, from bloodwork, when someone was quite unlikely to have Covid-19 or if the result was inconclusive.[46] Training and testing of accuracy conducted by scientists of the company concluded the machine learning software demonstrated "high rule-out accuracy for COVID-19 status, and might inform selective use of [polymerase chain reaction (PCR)]-based testing.[47]

Issues with the use of AI

There are ethical issues that arise with the use of AI. The algorithms may be difficult to understand as many AIs now develop their own algorithms through learning and mimicry, making them both smarter and harder to understand.[48]

One issue is that data must be openly shared and widespread, because "a predictive model is only as good as the data it is based on"; poor communication between national governments or international institutions can lead to poor predictive modeling.[49] During the 2013-2016 Ebola

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[43] Ćosić et al., "Artificial intelligence in prediction of mental health disorders," 280.
[44] Ćosić et al., "Artificial intelligence in prediction of mental health disorders," 285.
[45] Biocogniv, "About Us," accessed April 14th, 2020, https://www.biocogniv.com/company/about-us
[46] Colin Flanders, "Vermont Tech Company Develops AI Software That Can Detect Covid Status," *Seven Days,* December 7th, 2020, https://www.sevendaysvt.com/OffMessage/archives/2020/12/07/vermont-tech-company-develops-ai-software-that-can-detect-covid-status.
[47] Plante et al., "Developmental and External Validation of a Machine Learning Tool to Rule out Covid-19 Among Adults in the Emergency Department Using Routine Blood Test: A Large, Multi-Center, Real World Study," *Journal of Medical Internet Research* 22, no 12 (December 2020): DOI: 10.2196/24048
[48] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[49] Agam Bansal et al., "Utility of Artificial Intelligence Amidst the COVID 19 Pandemic," 3.

virus outbreak, clearer communication between the World Health Organization and national governments would've provided better data to model the virus's spread.[50]

There is a debate in AI use around implicit bias. Some experts think that AI can reduce implicit bias in decision making, but others believe, and some studies show, that implicit bias is carried over from the programmer and data it learns from.[51] AI is "only as useful as the information it trains from." If physicians have implicit bias, this will be passed on to the technology and will not solve any bias issues. For example, a study conducted by Eric Fleegler, MD, found that "Black Children received opioids for severe pain at miserly adjusted odds ratio of 0.2 compared to white children."[52] If this data was collected and put in an AI system, it is likely that the Bias would persist within the AI.[53] AI can also exacerbate issues of bias because of misinformation or lack of information, such as when the data used in AI programs is taken from existing health records so the program only has access to information about individuals who can access healthcare.[54]

A persistent issue with AI is that data stored in AI models may be stolen, deleted, or changed, raising privacy and security concerns. Information that is stolen may be spread and have long-lasting effects for patients who have lost their privacy, such as a raise in insurance premiums.[55]

Data collected through apps and wearables and utilized in AI also poses surveillance concerns. The Health Insurance Portability and Accountability Act, frequently referred to as HIPPA, outlines how personally identifying health information is to be maintained by professionals. As the Health Law Policy Director at Harvard Law says that "cell phone geolocation data do not fall under HIPPA but are sensitive data."[56]

As the Vaccine becomes widely available and the economy normalizes the demand for labor will be driven up. This will likely lead to an increased use of AI-backed hiring technology which has been criticized for bias in the past. For example, Amazon made a resume assessing AI which discriminated against Women candidates.[57] Another one of Amazons AI systems used facial recognition to compare congressmembers faces to that of mugshots.[58] This system had a significantly higher rate of false matches with congress members of color than that of white members.[59] In both cases we see that human bias in some way typically finds its way into AI

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[50] Agam Bansal et al., "Utility of Artificial Intelligence Amidst the COVID 19 Pandemic," 3.
[51] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[52] Fleeger et al., "Pain and Prejudice," *The Journal of the American Medical Association, Pediatrics* 169, no. 11 (November 2015): 991-993, DOI:10.1001/jamapediatrics.2015.2284.
[53]Nicholson Price II, "Risks and Remedies for Artificial Intelligence in Health Care."
[54] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[55] Williams et al., "Artificial Intelligence and a Pandemic," 25.
[56] Carmel Shachar, Sara Gerke, and Eli Y Adashi, "AI Surveillance during Pandemics: Ethical Implementation Imperatives" *Hastings Center Report* 50, no. 3 (Summer 2020): 18-21
[57]Jeffrey Dastin, "Amazon Scraps Secret AI Recruiting Tool That Showed Bias against Women," Reuters, October 10, 2018, https://www.reuters.com/article/us-amazon-com-jobs-automation-insight/amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idUSKCN1MK08G.
[58] Jeffrey Dastin, "Amazon Scraps Secret AI Recruiting Tool That Showed Bias against Women,"
[59] Rachel Goodman, "Why Amazon's Automated Hiring Tool Discriminated Against Women,"

systems. Therefore, if companies rely on these AI hiring systems post COVID, we may see increased issues with equal employment opportunities.

Conclusion

The pandemic has presented a unique occasion for the application of AI to assist humans in the management of viruses and their subsequent outcomes. During the pandemic, machine learning programs have increased the capacity with which healthcare professionals are able to quickly make discoveries about the virus. These potentially lifesaving advances are weighed against the negative potential for AI biases and the utilization of sensitive personal data. As the Vermont Artificial Intelligence Task Force has concluded, "The ethical use and development of artificial intelligence can help to solve our greatest problems and improve quality of life while respecting the liberties and values Vermonters hold dear."[60]

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[60] Artificial Intelligence Task Force, "Artificial Intelligence: Final Report," accessed April 28th, 2021, https://legislature.vermont.gov/assets/Legislative-Reports/Artificial-Intelligence-Task-Force-Final-Report-1.15.2020.pdf.