Artificial Intelligence in Global Health

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In January 2019, the International Telecommunication Union (ITU) and World Health Organization (WHO) held their third workshop on Artificial Intelligence for Health (AI4H). The workshops were linked to the ITU-T Focus Group on "Artificial Intelligence for Health," or FG-AI4H, one of seven focus groups the ITU has formed to develop standards and best practice guidance about the relationship between artificial intelligence (AI) innovation and the achievement of the UN Sustainable Development Goals. These focus groups provide a "neutral platform" to engage government, academia, business, and nongovernmental organizations in building "a common understanding of the capabilities of emerging AI technologies and consequent needs for technical standardization and policy guidance."[1] In the field of health, AI is currently being used to help improve the diagnostics, treatment, and speed of healthcare delivery. When data is fed into the relevant machine-learning software, AI can predict specific health risks, such as heart disease or suicidal tendencies, among particular groups. For a physician or humanitarian worker, AI can potentially improve the prioritization and distribution of healthcare.

In this essay I examine one example of AI's potential contributions and limitations in global health: the prediction, treatment, and containment of a global influenza outbreak. The potential advantages are clear. AI has the potential to aid global influenza surveillance platforms by improving the capacity of organizations to look for novel influenza outbreak strains in the right places, to identify populations most likely to spread influenza (and ensure that vaccination programs reach these populations), and to produce real-time information about the disease's spread by monitoring social media communications to track outbreak events. But there are also very real limitations to what AI can do, and

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as such it is crucial that AI not be used as an excuse not to invest in strengthening health systems and other traditional components of global healthcare. For example, though AI has the potential to identify the locations and populations at risk of spreading influenza, it cannot protect these locations and individuals from discriminatory and retaliatory practices. Nor can it ensure that providing early warning signs of an outbreak will translate into action. AI may be able to improve our understanding of who should receive a vaccine and how to most effectively provide for large-scale vaccine delivery, but there will always be blind spots in the data that it cannot fill. Finally, AI could be used to justify discrete rather than universal investment in influenza preparedness in low- and middle-income countries, leaving a vast number of people vulnerable to such diseases.

I outline these contributions and limitations in detail and then conclude with some preliminary suggestions on how to ensure the provision of an inclusive and accessible AI in the global health sphere. Before doing so, however, let us look at how AI is already being used in the area of global public health.

AI in Global Public Health

The FG-AI4H defines AI in the field of global public health as a machine-learning tool that can "improve medical diagnostics and treatment decision processes based on digital data."[2] The development of AI has been associated with a number of technological applications intended to universalize healthcare delivery. For example, AI can potentially "find" people who are not receiving treatment and then use improved telecommunications or remote diagnostic imagery to, for example, deliver treatment to those who are homebound with disabilities or who reside in remote locations.[3] AI can also open up opportunities to identify who is most vulnerable to exclusion from advanced medical research and treatment due to intersectional inequalities (that is, some combination of income, race, sexuality, education, and disability, among other factors). Additionally, AI can help predict who is at greatest risk of particular adverse health outcomes and thus facilitate the efficient use of scarce resources. For example, tuberculosis (TB) is the leading cause of death from infectious disease in the world, and the WHO estimates that every year 3.6 million people with TB are not getting adequate care because existing health systems fail to identify them.[4] Effective use of machine learning

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could identify the patterns of risk for the disease and improve the coverage of testing and treatment.

During an international public health emergency, the potential for AI is clearly evident in three areas. If we take the example of a novel influenza outbreak, the focus of our discussion in the next section, AI could help predict the spread, improve the targeted treatment, and contain the international spread of influenza. In terms of prediction, AI can be used to forecast infectious disease outbreaks using crowdsourced information as well as to create risk maps that visualize the probability that a disease outbreak might occur at a given location.[5] In terms of treatment, AI can enable rapid virus strain detection as well as optimized vaccine production, distribution, and delivery to the most affected and high-risk areas. Finally, to contain the international spread of the disease, AI can provide information that will guide governments and international organizations in the areas of risk communication (communicating outbreak news to the public) and population surveillance.

However, the unregulated use of AI could also result in serious harms. As the WHO reported in 2017, the ethical, legal, and social challenges for big data and AI in health include issues of privacy and consent, challenges of governance, and the dangers of flawed data.[6]

In response to such challenges, some countries have started adopting their own independent codes of conduct and regulations concerning the use of health technologies. Nonetheless, many humanitarian and international organizations, including the United Nations, are still navigating how to incorporate AI into their work in areas such as predicting migration and humanitarian crises.[7] In such situations there is clearly a role for AI to play in predicting healthcare needs and managing the maximization of healthcare delivery where resources are strained. At the same time, however, overreliance could be dangerous. In particular, as the WHO warns, not all data is created (or gathered) equally. Political instability, discrimination, fear, corruption, and overregulation can affect the quality of the data that AI relies on to make decisions about distribution and care. Furthermore, because we lack norms concerning the use and application of AI, there are (as yet) no rules to guide the global health sector, which could result in the abuse or invasion of privacy, among other things. In the humanitarian field, for example, practitioners rely on international human rights law to guide practice. Mark Latonero argues that decisions concerning the use of AI should be guided *not* by whether AI can do the task but by whether its use would

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improve the human rights of affected individuals.[8] Global health would do well to follow suit.

In the two sections below, I first detail the three advantages that AI will offer in the event of an influenza outbreak: prediction, treatment, and containment. I then examine AI's three main limitations in this area: the increasing divide between AI haves and AI have-nots; the dangers of poor data and data biases; and the potential for AI to be used to justify human rights abuses, particularly for containment purposes.

Advantages of AI in the Event of an Influenza Outbreak

In 1918, as World War I still raged, an influenza virus of avian origin began to spread across the globe, eventually killing over fifty million people in less than three years.[9] The so-called Spanish flu was particularly lethal because there was no medical intervention that could stop its progress, no antibiotics to treat secondary infection, and certainly no vaccine. Today there is fear that a similar outbreak is not only likely but inevitable, and that despite the advances in our treatment repertoire, the world might be as vulnerable today as it was a century ago.[10] This is where AI enters, offering new potential to stave off the worst effects of such an outbreak.

First, AI can play a role in prediction. The use of technology to monitor the volume of influenza cases is improving thanks to "flu tracker" apps, whereby users report their flu symptoms into crowdsourced platforms to improve the global surveillance of influenza.[11] These platforms are growing in popularity, and some sites now contain over a decade's worth of data. With these large datasets, analysts can begin to chart and predict the onset of the flu in a given city, the seasonal variation, the longevity of illness, and even the strain of the virus (in cases where patients use self-swabbing kits).

In addition to individuals self-reporting their flu symptoms, AI researchers continue to test the reliability of algorithms in forecasting seasonal trends in influenza outbreaks—notably by tracking social media applications, such as Twitter, and major search engines, such as Google, using keywords such as "flu," "antivirals," and "vaccine."[12] A study of ten countries, for example, found that surveillance of influenza infection–related tweets is a reliable "nowcasting" (real-time forecasting) method that identifies week-by-week seasonal influenza infections and can assist with prediction of strains on public health systems and vaccination supplies.[13]

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Second, beyond prediction, AI could help identify optimal treatment plans more rapidly once an outbreak is detected.[14] AI will be able to detect patterns in the vast quantities of data about the affected populations. During an influenza outbreak there will be thousands, possibly millions, of people with different virus strains, as well as populations with existing diseases. Those infected will include children, pregnant women, minority ethnic groups, and indigenous groups—populations that sometimes experience a higher risk of morbidity as a result of respiratory infection. Some populations will receive private treatment, and some will go through the public system. With so many variables, there will be a need to collect data and analyze patterns to understand where the risks of complications are highest from infection, the international spread of the disease, and information gaps, as well as to understand who is best responding to which vaccine or which treatment. During a global influenza outbreak, maximizing data coverage in order to improve treatment decisions would help improve and quicken decision-making and potentially make the process more transparent.

The WHO's Global Influenza Surveillance and Response System continually receives and tests virus samples, but the majority of countries that share influenza strains are high-income countries.[15] This is for two reasons. First, until very recently influenza surveillance, detection, and vaccination were not a priority in low- and middle-income countries due to competing infectious disease surveillance and vaccination priorities for governments.[16] Second, distributing and collecting the swabbing kits is a high-resource exercise that is difficult to undertake in low-resource settings, especially in tropical climates where peak seasonal influenza does not mimic the predictable patterns of temperate climates.[17] Since a number of low- and middle-income countries have little or no data on preexisting seasonal influenza surveillance, in the event that an outbreak of influenza occurs, there will be a need to have a treatment plan that can predict populations most at risk of complications and most at risk of spreading the disease.[18] For these countries, AI may be the only way of finding timely answers to these questions.

Finally, AI has the potential to assist with containment logistics during a global influenza outbreak. Influenza circulates in different seasons in the northern and southern hemispheres, and health institutions therefore make different vaccines for different strains available accordingly. Thus, few countries have the necessary vaccines to protect their populations from a flu that arrives from a different hemisphere. Given global air travel, influenza strains can of course move quickly between hemispheres. Until now, these outbreaks have been limited because the

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strains themselves have not been highly contagious, have not been novel (meaning the population already had some immunity to different strains), or may not have been particularly infectious during the time an infected person was traveling. However, when luck runs out and a new virus strain is efficiently spread to large sectors of the population, containment will become vital.

Containment requires a combination of responses that include communicating risk to affected populations about how to avoid infection and what to do in the event of illness, as well as an effective treatment strategy. AI can assist with public health information campaigns by helping to identify the most trusted sources of communication for different populations, which can in turn help maximize the reach of an information campaign during an emergency. This would improve the capability of predictive, longitudinal modelling of influenza outbreak risk and vulnerability.[19]

Interestingly, AI is already influencing donor and humanitarian action to address the risk of influenza outbreaks. Knowledge that more data will improve prediction, treatment, and containment strategies during an influenza outbreak appears to be influencing investments. The drive for improved data collection has led to diversified vaccination investments in influenza programs and, arguably, benefits for previously neglected populations. For example, Joseph Bresee and colleagues note that "the scarcity of adequate data on severe disease among pregnant women during seasonal epidemics was one reason cited by the Global Alliance for Vaccines and Immunizations for their decision against opening an investment window to fund low-income countries to vaccinate pregnant women as part of their most recent vaccine investment strategy."[20]

In short, the potential contribution of AI to help predict, treat, and contain disease in response to a global influenza outbreak is clear. However, there are potential unintended consequences that arise from AI practices that could place particular populations in harm's way and make them vulnerable to human rights abuses.

Limitations of AI in the Event of an Influenza Outbreak

The potential advantages that AI could deliver in the event of an influenza outbreak are conditional on states and international organizations overcoming healthcare, technological, and structural inequalities that pose a particular challenge for pandemic preparedness and treatment in the midst of an outbreak. Here I will explore further the three gaps mentioned earlier that AI cannot address

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without concerted political cooperation: (1) the increasing divide between AI haves and AI have-nots; (2) the dangers of poor data and data biases; and (3) the potential for AI to be used to justify human rights abuses, particularly for containment purposes.

All of AI's limitations will likely serve to exacerbate existing disparities in global health. The only certainty when it comes to an influenza outbreak is that one will occur in this century and that low- to middle-income countries will be particularly vulnerable. Countries and global health donor programs are responding to this challenge in a number of ways. In 2006 the WHO adopted the Global Action Plan (GAP) for Influenza Vaccines to promote the uptake of seasonal influenza vaccination in high-, middle-, and low-income countries.[21] Despite the closure of GAP in 2016, efforts are still underway to improve data collection about virus strains in low- and middle-income countries. The WHO is leading the creation of working groups to develop vaccines that cover populations at risk of seasonal influenza in low- and middle-income countries, so as to build capacity during a global influenza outbreak.[22] Today, the Global Vaccine Action Plan (adopted by the World Health Assembly in 2012) promotes the development of regional seasonal influenza vaccination industries.[23] In addition to the production and supply chains in North America, Europe, and Australia, the plan advises the creation of production and supply centers in South America (already established), Africa, the Middle East, and North and Southeast Asia.[24]

That AI is used to fill the significant gaps that remain between low-, middle-, and high-income countries in the event of an influenza outbreak gives rise to questions about inequity and power within the health technology sector. For instance, one state may use its technological superiority to deny another state equal access to the benefit of health technologies.[25] During an outbreak states may utilize extraordinary emergency measures to "nationalize" data, stockpile vaccines and antiviral medications, and reform their legislation on quarantine and ports of entry. All of these actions create negative externalities for less wealthy, less capable states. Overall, present inequalities will permit, in the name of health security, practices that challenge the conventional and ethical boundaries of development and regulation in order to protect national security.[26] In such cases, the solution is not investment in AI but investment in seasonal influenza vaccines and vaccine production hubs in low- and middle-income countries.[27]

Beyond issues of power and inequity, a second limitation of AI involves data biases. For example, improving efforts to provide particular at-risk groups, such

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as pregnant mothers, children under five, and the elderly, with seasonal influenza vaccination coverage will mean collecting more and better data on who is being vaccinated, where they go for vaccination, and when they seek vaccination.[28] However, a system predicated on using data from at-risk groups accessing seasonal influenza coverage to establish user behavior and inform best practice on public health information and communication campaigns assumes that sufficient data can be collected. It assumes, for example, that at-risk populations will appear for their vaccination in the event of an emergency. In practice, this is often not the case. Furthermore, each outbreak is different, as are the affected populations' responses, meaning that data might be patchier than assumed.

Moreover, in an emergency situation where AI is used to identify optimal treatment plans, assumptions about human behavior may become inconsistent with actual practice, particularly if those assumptions rest on implicit cultural bias in the algorithms or data collection.[29] Put another way, "machine learning could propagate discrimination because it learns from social data which is itself often biased."[30] There is a real risk, for example, that on utilitarian grounds AI might legitimize the quarantine or containment of the high-risk populations most in need of vaccination in order to prevent the spread of an outbreak—something that would, of course, be a gross violation of human rights.

A third limitation has to do with the securitization of data and global health priorities. As suggested above, data biases heighten the risk that government data collection can become an extended tool of social control in environments where surveillance, response, containment, and risk communication are already politicized.[31] Beyond unintended biases, AI technology for forecasting an outbreak may also serve leaders who wish to manipulate or misinterpret data to control populations for their own means. The more influenza is discussed as a security threat, for example, the higher the risk that human rights–based approaches to treating infected populations will be subsumed by the perceived greater priority of protecting the state, resulting in states using AI's forecasting and tracking capabilities to justify mistreatment of high-risk/underprivileged populations.[32] Neither AI nor the practitioners who use it are equipped to forecast how this capacity to predict risk will affect particular populations in societies that do not respect human rights norms.

In sum, there are important limits to what AI can achieve. Some have to do with the nature of the technology itself; others do not. For example, in the event of a global influenza outbreak, trade routes may be significantly disrupted and

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countries may choose to stockpile vaccinations. No matter how good the data is, this problem can only be overcome by an effort to enhance political cooperation and research networks. Clearly, there needs to be diversification in the production and supply of vaccines in order to mitigate the consequence of these events.[33] The creation of an expanded influenza production industry, with regional vaccination production chains and supply hubs, will be necessary to meet the global need in the event of an outbreak. Effort in generating political will and international cooperation among states is essential to ensure the equal distribution of health technology. Thankfully, technological innovation other than AI is a constant in the field of biosecurity. The methods of vaccination delivery, the time it takes to create a new vaccine, the methods of transportation for cold chain vaccines, and diagnostics in the field are all rapidly improving. Access to these technologies via healthcare systems for the most at-risk populations, however, is not keeping up.

Conclusion

In areas such as vaccine development, radiology, and cancer treatment, access to big data could enable the development of advanced treatments and proactive public health systems that provide early risk assessment and intervention. In relation to communicable diseases, AI is already and will continue improving the forecasting of the risk of international outbreaks. In the specific area of influenza preparedness and response, there is immense potential for AI to forecast, optimize treatment, and assist containment in an international emergency, when both political actors and resources will be under intense pressure. However, there is also a risk that AI could legitimize political control over forecasting systems; compound the denial of treatment to certain populations; and physically prevent minority populations from treatment, the right to migration, and even the right to be safe from arbitrary detention. These are, after all, political decisions. At its best, AI technology has the potential to be a very useful tool during a public health emergency such as a novel influenza outbreak, but, as I and others have argued, any such use must be underpinned by the human right to health, coupled with a social, ethical, and legal framework.[34]

The FG-AI4H's "Terms of Reference" document referred to in the notes of this essay[35] suggests that what is presently missing is a best practices international framework to ensure that the methods, practices, and platforms for AI are safe,

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reliable, appropriate, and inclusive. A benchmark is being encouraged by the FG-AI4H, including the World Health Organization, to protect the confidentiality and nonexploitation of data, which is essential to protect participating individuals, researchers, and industries.[36] States should strongly support adherence to such a benchmark. Without efforts to ensure that inclusion and accessibility are addressed at the point of data collection, AI systems will remain limited in their capacity to shape positive outcomes.[37] There is both an ethical need and practical concern in adopting an international framework that benchmarks AI best practice in the scientific, technological, and human rights realms to "ensure the highest integrity, quality, fairness, and confidentiality of this data set."[38] It is also important to remember that AI cannot solve all resource and distribution problems. Political agency will continue to be essential in championing universal healthcare packages, the right to migration, and the right to healthcare for minority populations.

NOTES

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Abstract: Artificial intelligence (AI) is reaching into every aspect of global health. In this essay, I examine one example of AI's potential contributions and limitations in global health: the prediction, treatment, and containment of a global influenza outbreak. The potential advantages are clear. AI can aid global influenza surveillance platforms by improving the capacity of organizations to look for novel influenza outbreak strains in the right places, to identify populations most likely to spread influenza, and to produce real-time information about the disease's spread by monitoring social media communications to track outbreak events. There are also very real limitations to what AI can do, and it is crucial that AI not be used as an excuse not to invest in strengthening health systems and other traditional components of global healthcare. AI may also be able to improve our understanding of who should receive a vaccine and what is most effective for large-scale vaccine delivery, but there will always be blind spots that the data cannot fill. Investment in healthcare, with attention to the danger of minimal access to care for minority groups that are at risk and in fragile situations, remains the best chance to prepare communities for outbreak detection, surveillance, and containment.

Keywords: algorithm, gender, human rights, influenza, intersectionality, minority groups, pandemic, social media, surveillance, artificial intelligence

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