

Artificial Intelligence
Managing a Pandemic
By Neal Woollen

Introductory Comments:

First of all, I want to make sure you understand that I am not an expert in the field of Artificial Intelligence. It is my job to develop capabilities, tools, and strategies for mitigating chemical, biological, radiological, and nuclear threats. Like you, I am very interested in how Artificial Intelligence can be leveraged and my presentation will reflect an assessment of current literature on the subject as it relates to recent infectious disease outbreaks and pandemics.

Maturity of Artificial Intelligence for Pandemic Mitigation:

Several article titles make it sound as if Artificial Intelligence is ready to solve all of our problems during a pandemic. The title of the article reflected on this slide accurately reflects what most authors get around to saying in their articles, that are based more on promise than current proven capability. Artificial Intelligence did sound the first alarm for the current SARS-COV-2 pandemic, with human teams independently identifying concern the same day, and HealthMap discovered the outbreak of a “mystery hemorrhagic fever” nine days before the World Health Organization declared an Ebola epidemic in 2014 in West Africa. In both cases, significant action was not taken until humans assessed the reports and elevated the level of concern. The authors of this article published in the MIT Technology Review caution that hype is currently elevated in comparison to reality and that may be counterproductive. In the past, Artificial Intelligence has overpromised and disappointed with outcomes, resulting in loss of funding.

Value of Artificial Intelligence:

There is broad agreement that Artificial Intelligence and Machine Learning are here to stay and that they can be of great value. AI/ML offers speed, efficiency, and consistency for tasks that humans can also perform. They also possess capabilities that go beyond human capacity. While humans possess superior performance traits in the areas of empathy, critical/creative thinking, and the ability to extrapolate, AI and ML may enhance decision-making and remove biased thinking, especially in resource constrained geographic regions or during emergent situations.

Examples of AI Application:

Artificial Intelligence promises to accelerate research, especially in areas where months or years of human effort would be required to explore data trends and identify candidate new drugs or vaccines. This slide also shows current capabilities being explored to address needs during detection, prevention, response, and recovery of the current pandemic.

The next slide demonstrates potential utilization during various phases of an influenza pandemic for early detection of the outbreak, predicting the spread of the outbreak, host/vector identification, preventive strategy development and vaccine development, early case definition and tracking, prognosis prediction, management, and drug development. Predictive models have been developed for determining host range in bats for the Ebola virus and for determining the geographic epicenter for Ebola outbreaks.

Outbreak Detection:

As was previously mentioned, at least two AI systems identified concerning cases of pneumonia in Wuhan, China, and generated bulletins to their subscriber lists. HealthMap is one of those systems and it generated a one-line email bulletin on 30 December, one hour prior to interaction between medical colleagues that generated similar concern. This system originally rated urgency as a 3 on a scale of 5. The interaction between colleagues elevated the level of concern and resulted in the posting of a more detailed report to PROMED with approximately 85,000 subscribers. This combination of events demonstrates both the utility of Artificial Intelligence and how reports may be ignored until human assessment confirms and elevates the level of concern. One author compared AI generated alarms to that of car alarms that are often ignored.

Drug Discovery:

AI use for drug discovery has been described as being in the early stages of development for proof-of-concept and feasibility studies, but the pandemic is accelerating exploration of its utility. It is considered of value to accelerate discovery of new drugs and to enable identification of compounds that can be repurposed. New drug development has historically been high risk research with 9 of 10 candidates failing to make it to market with an average cost for a successful candidate of \$2.6 billion. An example of where AI has been used to accelerate new drug development was during the West Africa Ebola outbreak where AI was used to screen almost 7,000 molecules for their potential use as small molecule inhibitors for viral entry and fusion. All of these molecules had already been evaluated in phase 2 or later clinical trials to minimize the risk of failure for selected candidates.

Image Diagnostics:

Image diagnostics is a potential use for AI that has received mixed reviews. Some see great utility for its use and tout the success rate of the study shown on this slide, but others question if it can effectively differentiate agent specific etiology from non-specific viral pattern pneumonia. Unfortunately, this article did not discuss performance on COVID-19 negative cases, so we are left to assume it did not have a significant false positive rate. I have not reviewed the original article published on the data from the study. The director of this study suggested a conservative approach to using the AI model as a second opinion tool.

Other Uses:

Smartphone app use for contact tracing highlights two potential constraints for use of Artificial Intelligence: people's trust, acceptance, and use of the technology and privacy concerns. Population screening tools have also shown utility and are being employed in some countries for identification of people with fevers in mass transit areas. Drones and robots are not impacted by viruses that affect humans and can provide services in high-risk areas. However, they can also become fomites for transmission and effective strategies for their safe use must be developed.

Artificial Intelligence in Society:

Several day-to-day functions in our society are driven or facilitated by Artificial Intelligence. The current pandemic has highlighted the socioeconomic and geopolitical impacts a pandemic can produce. Sudden changes in patterns that systems were trained on were confounded by public reaction, changes in patterns, and the second and third order impacts of the pandemic. These changes had profound impact on logistics, transportation, supply chain, purchasing, and third-party seller systems. This outcome highlights the need for continuous training on new data and developing situations that is currently limited by human effort. It also emphasizes the need for self-supervised learning capability in future AI systems. In addition, it emphasizes that we need to understand limitations and vulnerabilities of systems that we employ.

Challenges for Artificial Intelligence Systems:

Almost every article that I reviewed in preparation for this presentation highlighted the need and the significance for quality data, and lots of it, to optimize the use of Artificial Intelligence. This can be challenging for healthcare environments due to the nature of health record management. We also experience challenges with geopolitical situations that constrain sharing of information across countries, and privacy laws and policies can create local, regional, and national hurdles. Trust is paramount to successful employment of AI systems. Will they be used once they are developed? Trust in the system can be enhanced by the availability and input of the right amount, the right type, and accurate data. Trust can also be enhanced by Artificial Intelligence that provides solutions appropriate to local and regional conditions. People will not embrace AI driven solutions that are being forced on them when they do not see the applicability. Artificial Intelligence as an industry is expected to grow with 58 million jobs projected by 2022. Currently, we have an estimated 300,000 people qualified to fill those positions. Meeting the demands of the industry will be a significant challenge.

The Future of Artificial Intelligence:

In spite of concerns mentioned in this presentation, it is believed that Artificial Intelligence will play a significant role in the mitigation of infectious disease threats in the future and is currently proving its value. The current and recent pandemics have stimulated significant effort over the past two decades, convening subject matter experts to find new solutions to age old problems through greater application of Artificial Intelligence. Some predict that AI will never measure up to expectations, while others predict that AI, within the next decade, will transform how we look at patterns in data and how research is conducted and applied to human health.