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Is it Time for Artificial Intelligence to Invade Personal Privacy, for Pandemic Control?

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Introduction

Artificial intelligence (AI), specifically machine-learning, provides techniques to uncover complex associations that would normally not be resolved from simple computer algorithms/equations. In medicine, the introduction of AI systems have allowed for an unprecedented analysis of clinical presentations – systems are now able to systematically weigh pieces of information to reach logical conclusions, mimicking a clinician's thought process [1]. In fact, AI systems have evolved to the point where in some clinical settings, their diagnostic accuracy surpasses those of clinicians: AI has been able to out-perform dermatologists in assessing suspicious skin lesions, and more effective at identifying pulmonary tuberculosis on chest radiographs than radiologists [2-3]. AI systems have even been given the responsibility of triaging severity of patient symptoms; the National Health Services in the United Kingdom recently employed AI to tend to medical questions from a population of 1.2 million residents, and assess the urgency of medical conditions to subsequently advise of appropriate action (i.e. advising rest, or recommending for immediate emergency room consult) [4].

There has been an increased interest in the use of artificial intelligence (AI) in public health, specifically to assist with health promotion and health protection. For example, personalized and targeted health advice can be provided to different members of the population based on personal health profiles, as identified through electronic medical records. AI can also be used to rapidly analyze data and anticipate subsequent data modulation with respect to disease surveillance and health protection; for example, AI can utilize GPS data from cellular phones to predict areas at risk of outbreak, based on the temporal exposure of a region to the origin/person harbouring an outbreak [5]. AI may not only allow for personalized public health but may allow for expedited assessments of complex public health scenarios.

The Problem

Influenza is an acute illness that infects the respiratory tract. It typically presents in patients as headache, myalgia, sore throat, non-productive cough, sneezing and nasal discharge [6]. Each year, influenza re-appears as either a local outbreak or widespread epidemic In the United States, influenza is responsible for over 200,000 hospitalizations and over 30,000 deaths, annually [7]. Current public health practice focuses on preventative vaccines/antiviral agents and controlling outbreak, through tracking & implementing control mechanisms [8].

It is difficult to produce an effective prophylactic vaccine. The influenza vaccine is annually developed months before flu season, based on predictions of virus strains that are likely to dominate over the upcoming flu season. However, the influenza virus mutates rapidly and may mutate such that the vaccine is no longer effective, when it is deployed [8].

Tracking influenza is also difficult due to the slow diagnosis of influenza. The diagnosis is often delayed, due to both low suspicion and limited use of specific diagnostic tests. Furthermore, the overlapping clinical features of influenza and other respiratory pathogens makes it difficult for clinicians to rapidly identify influenza from clinical investigations without diagnostic tests [7]. A slow diagnosis, coupled with an incubation period of 2 to 5 days, allows for an infected individual to carry on about their regular daily activities, hence exposing those around them to influenza and allowing for an outbreak to happen [6].

Both slow diagnosis and poor predictive ability make it difficult for current public health strategies to efficiently and effectively prevent and control the outbreak.

The Solution

Developing A Better Vaccine

Artificial intelligence can be utilized to combat influenza, through both vaccine development and outbreak tracking/forecasting.

A virologist at St Jude Children's Research Hospital in Memphis, United States, retrospectively studied the 2009 swine flu outbreak and observed that AI can help predict flu mutations [8]. He postulated that AI could be incorporated into vaccine development, as it can help predict which flu strains will be active during a specific season. In early 2019, researchers in South Australia trained AI to create a flu vaccine, all on its own [9]. Early trials showed that the developed vaccine was effective, and the vaccine is currently being administered via a 12-month clinical trial.

The end goal would be for AI to accurately predict the flu strain that will present during the flu season, so that an effective vaccine can be produced in anticipation of the mutations.

Improving Outbreak Tracking Using Electronic Medical Records

Computers process information at a much faster pace than humans and can simultaneously analyze many databases to identify and track outbreaks. Considering that today's hospital records are virtually all electronic and also the use of cross-hospital record systems (i.e. administrative databases such as those maintained by the Institute for Clinical Evaluative Sciences in Ontario, Canada), AI can easily access electronic medical records and track influenza cases across hospitals.

AI can subsequently analyze medical records from many hospitals simultaneously, similar to how public health officials can analyze hospital records, but can do it more efficiently and therefore detect and track an outbreak earlier and more effectively [10].

Improving Outbreak Tracking/Forecasting Using Personal Data

In today's social media culture, the first signs of illness an individual experiences are commonly circulated online, whether it is via a Twitter tweet, a Facebook status, a Snapchat story, or an Instagram post. Even for those individuals who may not maintain a social media presence, they may search their symptoms on Google or WebMD. An individual's online activity may therefore be an earlier indicator of influenza symptoms than electronic medical records.

AI may be able to analyze millions of individual browsing data and social media preferences, allowing for earlier identification of influenza symptoms. If AI has access to location data from people's phones, AI could even identify all the individuals that an infected person had come in contact with, and therefore forecast who may contract influenza symptoms.

By using personal data, AI can identify and anticipate the spread of influenza faster than simply using electronic medical records.

Infrastructure Considerations for Implementation of AI

The three aforementioned foci of AI require the establishment of AI infrastructure for vaccine development in the laboratory and AI infrastructure setup to analyze electronic medical records and personal data. The former would likely need to be on-site, while the latter can be located elsewhere as long as it can have access to information for analysis.

AI infrastructure for vaccine development may be an individualistic or joint venture by both public and private sectors. As this is a matter of public health, the public sector has an obligation to be involved in infrastructure development. For private sectors, namely pharmaceutical companies, helping to establish infrastructure may allow them exclusive access to vaccine development, thereby enabling them to earn revenue from vaccine sales following the costs associated with infrastructure development.

Expenditure for AI infrastructure to analyze electronic medical records and personal data may be solely of interest to public sectors, as it may be difficult and even unethical for a private corporation to sell relevant data they may uncover.

While there are no costs yet associated to AI systems for public health, the cost figures for AI in healthcare are already multiplying at an exponential rate; the annual increase in spending on AI in healthcare in the United States is 50% and is projected to snowball to $36 billion by 2025, compared to $2 billion in 2018 [11]. It would be logical to foresee the costs of AI for public health being enormous and increasing over time, and burdensome.

Furthermore, as the first influenza vaccine developed by AI is only in early clinical testing, there does not exist any cost-effectiveness studies yet, to assess whether the additional costs from AI infrastructure is worth the additional effectiveness.

Nevertheless, implementation of such an infrastructure will enable vertical equity, where those who have different needs will be treated differently; in this situation, those regions which have been exposed and experiencing an influenza outbreak will be identified by AI and therefore can have more public health resources funnelled to control the outbreak.

Concern of Breach of Privacy

The use of AI to analyze electronic medical records is, in itself, a concern of privacy. Through this, medical records are being exposed to more systems, which makes it potentially more vulnerable to security breaches, as a product of data being shared across more systems.

Additionally, AI is not directly involved in the patient's care. It thereby cannot access medical records by the same mechanism as physicians and nurses; there will need to be some additional consent mechanism to allow for medical records to be regularly monitored and utilized in outbreak tracking and forecasting. New mechanisms will need to be investigated and put into place to collect consent and ensure that privacy is maintained.

But, an even greater concern of privacy comes with respect to AI analyzing personal online activity and utilizing phone location data. The level of data gathering from individual's personal lives, to the extent of gathering browser searching data... is a level of surveillance that mirrors that of Big Brother in Orwell's dystopian novel *1984*. It may be difficult to obtain consent from each person in a population for such an invasive data monitoring program, not to mention the potential public outcry/protest from such invasion to privacy.

A potential mechanism to obtain permission from the country's population would be to pass a law through legislative bodies enabling such data collection or executing a referendum that could approve such monitoring.

Conclusion

AI could be used in public health for model prediction and developing more effective flu vaccines, as well as identifying and tracking influenza outbreaks. These ideas could also be implemented today to help combat the COVID-19 pandemic. However, such systems would require expensive infrastructure and infringes on privacy.

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