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Perspective

COVID-19 pandemic and artificial intelligence possibilities: A healthcare perspective

R.M. Gupta ^a, Mahima Lall ^{b,*}

^a MG (Med), HQ Western Command, C/o 56 APO, India

^b Professor, Department of Microbiology, Armed Forces Medical College, Pune, India

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Introduction

What are the skills and competencies we will need in the post-COVID era? The world economic forum ranks innovation, active learning, and complex problem solving as the top 3 skills which will be useful by 2025. The post-COVID era shall continue to tickle our minds in seeking new solutions to newer problems.

A random observation by BlueDot, an artificial intelligence (AI) platform, was the first alert to the world of an outbreak when it registered clustering of an unusual respiratory pneumonia-like disease in December 2019 and January 2020 in China.^{1–3} It had spotted the beginnings of what would be known as the Coronavirus Disease 2019 (COVID-19) caused by a novel coronavirus. This was nine days before the World Health Organization (WHO) released its official statement alerting the world to a new threat, the severe acute respiratory

syndrome virus (SARS-CoV-2). Its role in spotting the beginnings of the SARS-CoV-2 pandemic is an example of the possibilities of AI in health care and the possibility of pandemic proofing the world in the future. How can we be prepared for similar eventualities in the future? Developing disease surveillance AI-based platforms which can actively monitor and track rising number of cases of a disease would be needed for predicting pandemics.⁴ Such platforms would perform real-time surveillance of population demographics. They would be required to screen data including an individual's medical history, professional details and socioeconomic parameters across regions and ethnicities in large subsets of population. This would provide the link between the disease and its possible origins. This will enable us to find the first site where patients are in contact with a positive case. This would require transparency and open data-sharing policies globally.

AI is intelligent thought and action using computers. It performs tasks requiring thinking, learning, problem-solving, and decision-making. Machine learning (ML) gives computers the capability to learn without being explicitly programmed. Based on using the data, it lets the computer or the machine to adapt and learn. The computer uses the data set to generate a model or logic, and this output is ML. Predicting trends of diseases locally and globally by AI-based solutions could give a lead time to pandemic proof and prepare. Throughout history, outbreaks of infectious diseases have resulted in pandemics that have ravaged across continents, giving rise to lasting economic, political, and social changes. It has been during these times that new ways of prevention, immunization, and treatment have been evolved. Today as we face the pandemic by the novel Coronavirus, there is again a need for developing innovative solutions. Contextual thinking and historical

* Corresponding author.

E-mail address: drmahimalall@gmail.com (M. Lall).

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lessons from the Spanish flu helped us adopt measures such as social distancing and using face masks.

The need of the hour is mathematical models that can track the spread of novel pathogens and automation of these tracking tools for online real-time decision-making. By developing, compiling, and analysing data of the infected people, including patient details, their community movement, and public health data, we would be able to predict disease behavior.⁵ Integrating these data with AI, ML forecasts can be carried out of where and when the disease is likely to spread. Prior notification to these regions may be given in time to make necessary arrangements. Today AI is capable of imitating human intelligence, performing tasks that require thinking and learning, solving problems, and decision-making. In today's era of personalized and precision medicine, data referred to as recreational data are becoming more and more relevant in health care. Multiple sources of data in the form of online communications, social media, and web-based articles may be extremely useful in analysing the growth of infection within a community. Internet of things includes a network of all devices and gadgets being used in our daily life which can monitor and collect vital information. Smartphone applications and wearable devices generate continuous data that can be useful for COVID-19. Contact tracing using smartphone data can help identify people who may have come in contact with a COVID-positive case. Identifying these individuals may limit the spread of COVID-19 by breaking the chain of transmission. But automated contact tracing also carries serious privacy risks which need to be safeguarded.

Machine learning and its role in COVID-19 diagnosis

The 21st century witnessed pandemics of infectious diseases such as the Ebola, SARS, Middle East respiratory syndrome, and Zika virus. An early diagnosis is critical to the prevention, control, and management of any pandemic. WHO's Global Influenza Surveillance and Response System has been monitoring the evolution of influenza viruses in both northern and southern hemispheres. This database serves as a global alert system for emerging viruses with a potential to cause pandemics, and this applies to the current SARS-CoV-2 pandemic. Rapid diagnosis of COVID-positive cases is based on nucleic acid tests such as the reverse transcriptase real-time polymerase chain reaction (RT-PCR) which is regarded as the gold standard test for diagnosis.⁶ The assay sensitivity is variable, and false-negative results are a frequent problem.⁷ These are due to various factors including human errors, mutations in the genetic sequence of the virus, long turnaround time, and short supply of reagents and testing kits. Low sensitivities of RT-PCR and an initial negative result may cause a delay in detecting patients with COVID-19. As the pandemic evolves and variants of SARS-CoV-2 emerge, it becomes a necessity to rapidly screen positive cases to prevent further spread. Neural networks (NN), random forests (RF), gradient boosting trees, logistic regression, and support vector machines

(SVM) are useful ML approaches to predict the threat of COVID-19.

Machine learning and its role in radiological diagnosis of COVID-19

Machine learning techniques are being used to diagnose COVID-19 from images such as radiographs and computed tomography (CT) scans of the lungs thus overcoming the limitations of molecular tests such as RT-PCR. Image analysis and pattern recognition are being used for classifying pneumonias. Trained NN correctly identified pneumonia infiltrates (>90% sensitivity and 100% specificity). This has implications especially during a pandemic, when resources are scarce and time is premium.⁸ This is expected to reduce demand on physicians and decrease the time of confirmation of diagnosis. Hence, a combined approach of both Nucleic Acid Testing (NAT) and clinico-radiological features is being used to arrive at a confirmed diagnosis. It is now suggested that CT scan is a sensitive modality with which to detect COVID-19 pneumonia, even in asymptomatic individuals, and could be considered as a screening tool, together with RT-PCR, for testing in suspected individuals. Different types of pneumonia can be resolved using ML-based CT Image Analytics Solution, which can be helpful to monitor the patients with COVID-19.

Algorithms based on blood biomarkers for predicting survival and length of hospital stay of COVID patients

Screening out susceptible patients using algorithms that can assess the severity of the infection and predict survival is among the available techniques of ML, SVM, and RF Networks which seem to be most promising, when it comes to being tools for data regression and classification. A tool based on RF algorithm was developed based on detection of 11 blood biomarkers from clinical samples. The biomarkers studied were atrial natriuretic peptide, C-reactive protein, myoglobin, D-dimer, procalcitonin, creatine kinase myocardial band, and cardiac troponin. The COVID-19 Severity Score combines multiplex biomarker measurements and risk factors in a statistical learning algorithm to predict mortality.⁹ After multiple verifications and testing, this algorithm has emerged as a precise tool for diagnosing COVID-19.

Machine learning for early detection of sepsis in COVID-19

The fundamental capability of ML is deriving predictive models without any prior knowledge or defined mechanisms. Complex patterns are generated from large amounts of data. Using the combination of such predictive models aids clinical diagnosis. Sepsis complicates about ten percent of patients with COVID-19. Early detection and identification of patients at risk for sepsis can lead to a more aggressive treatment given early thus improving the chances of survival. It can also help hospitals triage patients as well as prioritize their intensive-

care resources. An ML system to analyze images of patients' white blood cells for signs of an activated immune response against sepsis may be useful.¹⁰

Treatment options with repurposed drugs for COVID-19

Machine learning can rapidly screen potential drugs for SARS-CoV-2 by identifying candidate molecules, thus helping in developing newer treatment modalities. Three-dimensional modeling may be used for studying the spatial structure of drug molecules, identifying the drug molecule-virus interaction most relevant for viral inhibition. Apart from newer drug development, repurposed drugs may be tested as potential therapeutic agents. These ML techniques help in going through electronic records of drug directories to shortlist potential drugs which may have some benefit in COVID-19.¹¹

Artificial intelligence and its role in vaccine development

Analysis of the SARS-CoV-2 genome sequences along with bioinformatics has accelerated the development of vaccines for this novel virus.^{12,13} The next challenge where AI has made an impact is in the distribution of the vaccine doses globally. The biomanufacturing capacity would require to be scaled up. Data may be used for predictive modeling and help the decision-makers by providing vital information for planning cost-effective global distribution and access to vaccines.

The story of the COVID-19 pandemic can easily top the charts of movie makers. It is heart-wrenching, inspiring, amazing, and unbelievable at the same time. Yet the heroic efforts by the scientific community and governments alike and the rollout of a vaccine in record time could even be a bigger hit. The "jury is still out."

Disclosure of competing interest

The authors have none to declare.

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