

**ESSAY**  
**On**  
**AI-BASED COVID SURVEILLANCE**

**Submitted by**

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## ***Problem Statement***

It is widely known Artificial intelligence is ability of machine to predict the result based on the data entered. India is a high population country and hence it is not possible to check everyone for the SARS-CoV-2 virus which is the cause of the corona virus outbreak.

So how can we integrate AI tools to help identify virus transmission chains and monitor broader economic impacts to halt the outbreak of COVID-19 pandemic?

# ***INTRODUCTION***

Given the pace of globalization, future pandemics are likely to follow novel coronavirus disease 2019 (COVID-19), although their frequency is uncertain. Half a year into the pandemic, it was estimated that 59–92% of COVID-19 deaths in the World could have been avoided if the pandemic had been managed differently and mortality rates were similar to those in countries with moderate rates of COVID-19 deaths, such as Norway or Canada. Despite a significantly lower mortality rate compared with severe acute respiratory syndrome (SARS), caused by a related coronavirus (SARS-CoV) with a case fatality rate of 11%, COVID-19 has resulted in exponentially more harm. The virus spread rapidly and widely around the world, in a way SARS-CoV did not, from asymptomatic and mild cases resulting in undetected spread and leading to a higher number of deaths overall. If pandemics are to be managed effectively, policymakers, clinicians, and other stakeholders need access to data and recommendations in near real time, including models to weigh the relative risks and benefits of various interventions. Notably, there have been numerous conflicting projection models for COVID-19, but few were accurate for this novel pathogen.

Artificial intelligence (AI) represents a valuable tool that could be widely used to inform clinical and public health decision-making to effectively manage the impacts of a pandemic. The objective of this scoping review was to identify the key use cases for involving AI for pandemic preparedness and response from the peer-reviewed, preprint, and grey literature. The data synthesis had two parts: an in-depth review of studies that leveraged machine learning (ML) techniques and a limited review of studies that applied traditional modeling approaches. ML applications from the in-depth review were categorized into use cases related to public health and clinical practice, and narratively synthesized. One hundred eighty-three articles met the inclusion criteria for the in-depth review. Six key use cases were identified: forecasting infectious disease dynamics and effects of interventions; surveillance and outbreak detection; real-time monitoring of adherence to public health recommendations; real-time detection of influenza-like illness; triage and timely diagnosis of infections; and prognosis of illness and response to treatment. Data sources and types of ML that were useful varied by use case. The search identified 1167 articles that reported on traditional modeling approaches, which highlighted additional areas where ML could be leveraged for improving the accuracy of estimations or projections. Important ML-based solutions have been developed in response to pandemics, and particularly for COVID-19 but few were optimized for practical application early in the pandemic. These findings can support policymakers, clinicians, and other stakeholders in prioritizing research and development to support operationalization of AI for future pandemics.

## ***Methods***

To locate research on AI-based disease surveillance amid COVID-19, we will search databases including PubMed, IEEE Explore, ACM Digital Library, and Science Direct to identify all potential records. Titles, abstracts, and full-text articles were screened against eligibility criteria developed a priori. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses procedures was adopted as the reporting framework.

This scoping review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).

## ***Search Strategies***

Five databases (PubMed [NCBI], Embase [Elsevier], Web of Science [Clarivate], IEEE Xplore [IEEE], and the ACM Guide to Computing Literature [ACM]) were searched without date limits on May 4, 2020, to identify relevant peer-reviewed literature. Two main concepts of AI and pandemics were mapped to the most relevant controlled vocabulary using Medical Subject Headings (MeSH), and free-text terms were included. Although the search strategy captured the published literature on all pandemics, additional MeSH terms and keywords were added to focus on the COVID-19 pandemic and the most recent past pandemic of influenza A subtype H1N1 in 2009. The search also captured relevant literature about the SARS global outbreak caused by SARS-CoV in 2003. Two preprint servers (medRxiv and bioRxiv) were searched from January 1 to May 27, 2020, to locate relevant research that had not yet been published. The main concepts of AI and COVID-19 were captured using free text terms. Reference lists of included structured reviews were hand searched to identify further relevant studies. In addition, a structured Google search was conducted to locate grey literature describing the application of AI for the management of COVID-19. Reputable trade and commercial publications were also reviewed to identify emerging and proprietary AI solutions.

## ***Screening and data abstraction***

Articles were screened in two stages using Covidence (Australia), a web-based review management tool. Articles were first screened for relevance based on the information provided in the title and abstract and then evaluated for inclusion based on the full text. Articles were screened by one reviewer at each stage. For articles that described the use of ML, the following criteria were abstracted into standardized forms: citation information; relevant use cases; respiratory pandemic (or SARS); population under study (i.e., region); purpose of the models (e.g., surveillance or prediction); type of ML models; outcomes of interest (e.g., infections or deaths); and data sources. Given the volume of relevant peer-reviewed and preprint literature reporting on traditional modeling approaches, data abstraction was not completed for studies included in the limited review.

## ***Inclusion and exclusion criteria***

This scoping review had two parts: an in-depth review focused on the use of ‘complex’ ML for preparedness or response to viral respiratory pandemics as well as the SARS global outbreak, and a limited review describing the use of traditional modeling approaches. ‘Complex’ ML (hereafter referred to as ML) included neural networks, tree-based algorithms, support vector machines, and natural language processing. Traditional approaches included compartmental, simulation, statistical, and time series models. The Glossary provides a detailed listing of complex and traditional models (Box 1). Although categorization could be considered somewhat arbitrary, models were categorized as complex if they were generally less explainable, required increased computing power, or could more effectively manage irregularly sampled or high-dimensional data. Various publications have summarized these methods and offer insights about strengths and weaknesses. All study designs were considered for inclusion. Articles were excluded if they did not report on original research or describe a structured review of the literature, did not focus on human populations, or were not published in the English language. Studies reporting on public opinion, vaccine uptake or adverse events, molecular docking, genomic sequencing, or applications in robotics were also excluded. Detailed inclusion and exclusion criteria are provided in Supplementary Table. The Google search focused on grey literature describing the application of proprietary AI solutions by governments or industry for COVID-19 response, and other emerging applications not yet captured by the peer-reviewed and preprint literature. The same exclusion criteria were applied.

## ***In-depth review of studies that applied AI techniques***

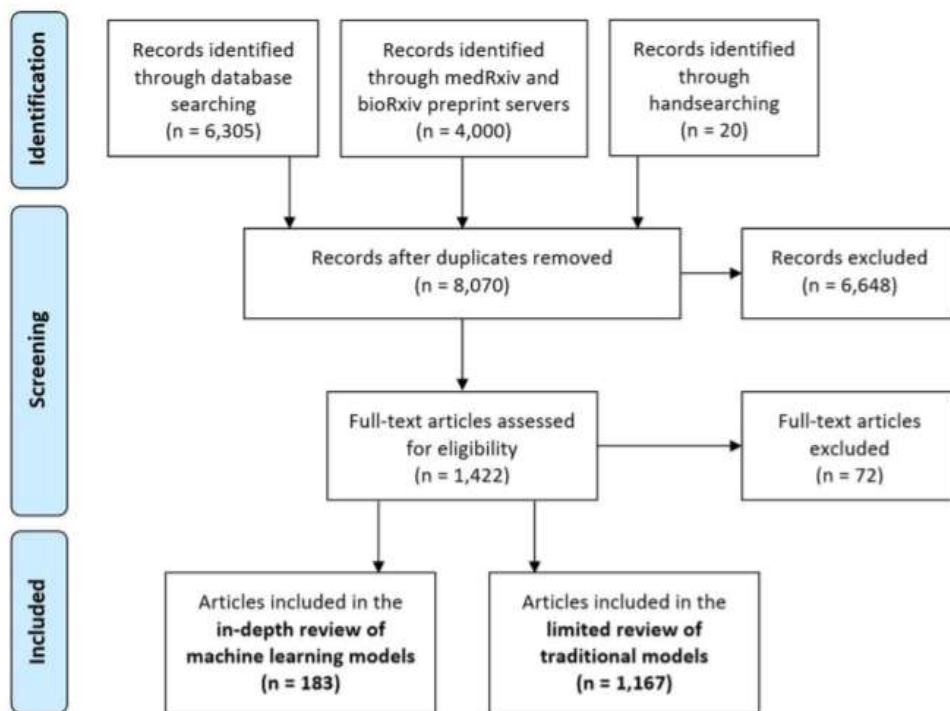
The characteristics of studies that reported on the use of AI were summarized. Examples from the peer-reviewed, preprint, and grey literature were categorized into a framework of use cases related to public health and clinical practice. Each use case was narratively synthesized. Commonly used data sources and ML techniques were summarized in tabular form. Emerging use cases were identified as opportunities for future work.

## ***Limited review of studies that used traditional modeling approaches***

The number of peer-reviewed articles and preprints that described traditional modeling approaches was reported to highlight the large volume of literature compared with manuscripts describing the application of ML. The objectives of these models and data sources were summarized in tabular form to identify additional areas where ML could be leveraged to provide more accurate estimations or projections.

# RESULTS

From 8070 unique peer-reviewed and preprint records, 183 reported on the use of ML and met the inclusion criteria for the in-depth review. A modified Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram is provided in Fig 1. The review of the grey literature identified one additional use case not captured by the peer-reviewed or preprint literature and provided supporting examples for other use cases. Overall, the in-depth review identified six key use cases where ML was used for pandemic preparedness and response, as well as emerging areas beyond management of infectious disease, such as impacts of a pandemic on mental health or chronic conditions.



**Fig 1** Study selection flow diagram.

# ***CONCLUSION***

Important AI-based solutions have been developed in response to pandemics and particularly for COVID-19 but few were optimized for practical clinical or public health application early in the pandemic. These findings can support policymakers, clinicians, and other stakeholders in prioritizing operationalization of AI for future pandemics.

Adopting a three-pronged approach based on testing, isolation and contact tracing is warranted to combat COVID-19. It is necessary to exploit the available knowledge base to develop effective chemotherapeutic agents against COVID-19, taking cues from lessons learnt in the past during other such outbreaks.

As there is no silver bullet available to cure the disease, we need to hasten progress on all fronts ranging from surveillance and monitoring to prevention and treatment. As this is the third outbreak of a coronavirus in recent times and many coronaviruses are circulating in animal reservoirs, we must focus on deciphering the molecular mechanism of SARS-CoV-2 and other coronaviruses and increasing our preparedness by capacity building for preventing future outbreaks.

As the current scenario warrants the need for immediate delivery of solutions, response to this outbreak was hugely augmented by various digital technologies and AI. AI was found to be on par with and even more accurate than human experts in COVID-19 diagnosis and drug discovery. We need bigger datasets for training AI models and a legal framework and ethical considerations for sharing data before AI takes the forefront in diagnosis and other areas. Several bottlenecks in harnessing AI to its full potential in the current scenario are availability and sharing of clinical and epidemiological data, computational resources, scalability, privacy and ethical concerns.

Healthcare organizations are in an urgent need for decision-making technologies to handle this virus and help them in getting proper suggestions in real-time to avoid its spread. AI works in a proficient way to mimic like human intelligence. It may also play a vital role in understanding and suggesting the development of a vaccine for COVID-19. This result-driven technology is used for proper screening, analyzing, prediction and tracking of current patients and likely future patients. The significant applications are applied to tracks data of confirmed, recovered and death cases.

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