DOI: 10.1002/ima.22466

EDITORIAL

WILEY

The COVID-19 pandemic: What can bioengineers, computer scientists and big data specialists bring to the table

COVID-19, the infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has put to the test many sectors such as health, education, socioeconomic development, transport, trade and finance. Millions of people have been infected, hundreds of thousands have died, and the toll continues to soar. The international scientific community has found itself in a race against time to contain the spread of the disease, with an urgent need to devise fast screening and triage systems for early detection and isolation of affected patients. With advanced health-care technologies and prior experiences with many epidemics in the past, people were confident that the scientific community will lead them out of this crisis. However, what has become apparent is a sense of panic and amateurism of some health-care authorities, and a lack of agreement among scientists and experts with sometimes conflicting recommendations from trusted research institutions. This will not be the last pandemic; the international scientific community must learn valuable lessons from it to be able to combat future disease outbreaks that could be more infectious and lethal than COVID-19.

Over the past few months, we heard the voice of many key players in the global fight against this pandemic, including health professionals, crisis counselors, epidemiologists, medical scientists and immunologists. In this editorial, we aim to cast light on the crucial contribution of other players, working behind the scenes, including bioengineers, computer scientists and big data specialists. Their contribution is shaping the way the international community is going to stop this outbreak. This concerns promoting innovative solutions to the following four areas that are of paramount importance to current global interventions: (a) develop portable imaging systems that are fast and accurate for diagnostic and prognostic purposes, (b) create bespoke databases with robust and secure data-sharing protocols of patient-level COVID-19 metadata, (c) devise AI-powered tools that can process complex data and can make accurate and useful individualized data-driven predictions and (d) derive accurate models about the spread of pandemics, with the ultimate aim to generate useful forecasts about the effects of interventions.

1 | DEVELOP PORTABLE IMAGING SYSTEMS

Many health-care providers are now able to bring sophisticated portable imaging equipment (eg, portable X-ray and ultrasound systems) to the patient with high quality, speed and flexibility. During the last decade, the most popular applications for portable radiographic systems have concerned sports medicine, emergency, obstetrics, nursing homes and small clinics in remote locations. There is a huge surge of interest in such portable systems in the current crisis, not only because of the convenience and flexibility they bring to health professionals, but crucially to minimize movement of people which is a key dimension in monitoring and controlling the spread of a disease. These systems can enable on-the-spot diagnoses, triage emergency patients, eliminate long wait times, dramatically shorten the time from evaluation to treatment, bring advanced imaging protocols to secluded areas and reduce costs of patient transportation as many of these miniaturized systems are easily transportable within an ambulance. Bioengineers and imaging researchers should work together to develop and promote the use of such portable systems that can be a game changer during pandemics. Developing rapid screening technology to potentially enable mass screening of people where they live, and ultimately identifying carriers before they become infectious, is central to any fight against a viral pandemic that is spreading at exponential rates.

2 | CREATE BESPOKE DATABASES

Sharing knowledge and talent is of vital importance to tackle a pandemic. By making their data public, scientists enable other researchers to replicate scientific findings and to perform their own analyses and explore a wider range of questions. The COVID-19 pandemic has accelerated the rate at which new research and data from all over the world are shared, in order to inform international responses to the pandemic and to speed up the development of diagnostic tools, drug treatments and vaccines. Researchers should make sure to share patient-level COVID-19 metadata, properly anonymized and deidentified, in addition to details

about data collection protocols. Versatile and secure data sharing protocols should be put in place to efficiently handle complex data, including demographic data, genomic data, microscopy data, clinical data, epidemiological data and imaging data. The more data researchers can access, the more quickly they can understand the behavior of the pandemic spread, identify biomarkers and develop therapies. Strengthening international collaboration and creating scientific data sharing platforms is central to understanding and combatting viral outbreaks, and such international initiatives should be supported by policy makers and funding bodies. Some initiatives can be mentioned here: GISAID (Global Initiative on Sharing All Influenza Data; https://www.gisaid.org/) and COVID-19 Data Portal (https://www.covid19dataportal.org/).

3 | DEVISE VERSATILE AI-POWERED TOOLS

Artificial intelligence (AI) is reinventing modern health care through machines that can process, learn, predict and act. Many AI-enabled imaging systems are now equipped with advanced analytics for faster and more accurate image processing (ie, AI radiologists). Thanks to the high availability of large-scale annotated image data sets, great success has been achieved for image recognition and classification. AI can process unstructured complex medical data to predict and diagnose disease more efficiently at a faster rate and with high accuracy at the individual patient level, which is a significant advantage when dealing with a disease like COVID-19 with a clinical presentation that overlaps with that of many respiratory viral illnesses. Some very encouraging recent initiatives included the use of deep learning algorithms to diagnose, triage and monitor coronavirus cases from a chest scan, with the attractive possibility to give immediate alerts if a patient needs support. AI-powered tools have the potential to alleviate the growing burden on health professionals, who must review and prioritize a rising number of cases each day. These AI-powered tools can be made available as cloud-accessible systems to assist clinicians even in remote areas or in regions where there is a shortage of expertise. Such tools can help clinicians take a more comprehensive approach for disease management and to develop real-time forecasts. For instance, AI-powered chatbot streamlines the review of a patient's symptoms, and then recommends either a virtual check-in or a visit of a healthcare professional for screening with portable imaging systems. With the ability to track exposed people—thanks to the proliferation of consumer wearables and smart devices—AI-powered systems can provide timely feedback on how to stay healthy and safe during pandemics.

4 | DERIVE USEFUL MODELS OF PANDEMICS

To assess the scale of a spread of a pandemic and to evaluate the effectiveness of interventions, it is vital to understand the transmission dynamics of the disease in diverse populations and areas. Modeling pandemics can provide valuable information to inform decision makers and crisis counselors, including for instance the possibility to generate accurate forecasts about the likelihood of outbreaks from newly diagnosed cases in other areas. These models can be handy for assessing the effects of population demographics on the spread of the disease (eg, social and environmental determinants), the effects of preventive measures (eg, confinement and social distancing) and differences among groups. They can assist decision makers to plan and predict what works better for a given group/population and can estimate the different observable and latent factors that can explain the spread of a virus through a population. One attractive feature is the ability to compare different explanations (ie, model comparison), based on prior knowledge and empirical data, that can tell decision makers and health professionals about the most likely scenarios that may unravel given a particular parametrization of the problem, and in evaluating competing models of population-wide intervention strategies. Big data specialists and modeling experts should design useful and realistic mathematical models that can take advantage of the recent sophistication in analytics and the wider availability of big data.

There is no question that the way to tackle the current pandemic is to be guided by science and research. This pandemic has also revealed to the general public how scientific knowledge is intertwined with politics, and hence all scientists must stand up for quality information and independent evidence. This crisis has also shed the light on the pivotal role of many physicists, microbiologists, immunologists and other scientists. It is time for bioengineers, computer scientists and data specialists to reconnect with the general public and to reaffirm their invaluable contributions to the fight against the COVID-19 pandemic.

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