Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
All for one and one for all: Why a pandemic preparedness league of nations?

Sukhen Dey\textsuperscript{a}, Qiang Cheng\textsuperscript{b}, Joseph Tan\textsuperscript{c,}\textsuperscript{*}

\textsuperscript{a}Founder, Deyta.com, United States  
\textsuperscript{b}Associate Professor, Institute of Biomedical Informatics & Dept of CS, University of Kentucky, United States  
\textsuperscript{c}Professor, eHealth Innovation & Informatics, McMaster University, Canada

\textbf{ABSTRACT}

In light of today’s COVID-19 crisis, it is argued that new ways to collaborate among all nations for pandemic preparedness may be the next big thing. A workable solution for pandemic preparedness requires leaders of all nations to be on the same page (all for one), aiming at a swift turnaround of the crisis in tandem that can only benefit everyone on a global scale (one for all). After all, a public health crisis of this magnitude involves all humankind, demanding not only the most sensible and intelligent adoption of progressive policies and innovative technology, but an effective balancing of emergency supply chain management (SCM) reserve of personal protective equipment (PPE), professional workers and/or other urgently needed resources (e.g., ICU beds) to save lives. Above all, accurate sharing of information and massive-scale testings vis-à-vis targeted isolations must be sustained. Notably, such a framework may not just be limited to influenza. Here, the authors elaborate on several key strategies and aim to provide grounds for scientific innovations and clearer policy thinking across international boundaries to combat a global public health pandemic via a league of nations conceived as IPPO: Intercontinental Pandemic Preparedness Organization.

© 2020 Fellowship of Postgraduate Medicine. Published by Elsevier Ltd. All rights reserved.

\textbf{Introduction}

The novel coronavirus SARS-CoV-2 coined by the World Health Organization (WHO) as COVID-19 is now declared to be pandemic, affecting 210 countries and territories (and 2 international conveyances) with over 2,026,958 confirmed infected cases worldwide, 129,100 deaths, and 494,418 recoveries as of April 15th, 2020, 15:27 GMT [6]. Statistically, this rate simply predicates an exponential increase in the confirmed cases, vis-à-vis March 20th 2020 figure of 269,000 infected cases. Without taking into consideration the infection multiplier factor, and assuming no effective antidotes are out and distributed at this time, we can expect more than six million confirmed cases to surface on our planet by the later part of May 2020 with the death rate and other derogatory impacts to increase proportionately.

Such an outbreak is already having a sweeping effect on every region of the globe. Indeed, our world has yet to experience the velocity of such a virus infection and mortality rate, resulting in massive shortage of resources, job loss, and/or disruption as well as mounting and drastic economic impact on a global scale. The sad part is, at this very moment, COVID-19 spread continues to be highly contagious with various stages of devastation and progressively in steep-curve full calamity among several countries including Spain, Italy, Iran and the USA, following China. The “aftermath” is unknown and, may indeed, take months, if not years, to recuperate to some form of normality. Moreover, the loss of lives will be non-reversible. Its economic devastation, we doubt, can be normalized by the lower- or the upper-income regions of the world, in a moderately short timeframe. Nor do we know the nature and magnitude of mental health issues arising from self-isolation, social distancing, the uncertainties, loneliness and anxiety, as well as loss of loved ones as a result of the various levels of governmental sanctions and political restrictions on physical mobility due to zonal, state, or provincial quarantines.

The good news is that humankind has always managed to come out victoriously from calamities and disasters with scientific innovations often coming to the rescue. A growing list of past severe diseases are now treatable, with ease. As well, an average person today can expect to have a longer lifespan than a few decades earlier. There is, thus, no question that the current crisis will eventually pass. How soon, we believe, is dependent upon the notion of “All for One and One for All.” The rationale is simply systems science where the whole is more than the sum of its parts as it is not
possible nor even wise for individual nations, regardless of how affluent and advanced they happen to be, to handle the COVID-19 by themselves in isolation, let alone the aftermath. Nonetheless, within a single precinct, the ability to implement the right policy thinking at a timely manner will also significantly impact on the number of anticipated deaths.

Our recommendation, amid this global crisis, is to initiate a Global Pandemic Safeguard Agency, with a conceived name of IPPO: Intercontinental Pandemic Preparedness Organization to share workable solutions and higher level policy measures while each region or country is implementing their specific policies to control the spread in a timely manner.

A strategic global pandemic management organization

While several highly respected coalitions among members from a majority of nations, such as the United Nations, Intergovernmental Economic Organisation (OECD), and WHO exist, there is however not a global arrangement endowed with a systematic infrastructure to oversee readily available but necessary medical supplies in reserve, cooperative technology, and adequate funding when dealing with an unknown pandemic such as the COVID-19 crisis. Apparently, the 7.8 billion citizens of the world are not prepared to deal with another pandemic given what we are witnessing minute-by-minute on the devastating effects of COVID-19. This may be the god-sent wakeup call for humankind to start planning for an effective global coalition such as IPPO with a league of nations, notwithstanding the current efforts by individual countries to implement best-practice, epidemiological model-driven policies to flatten the curve of COVID-19 contagion.

As of today, April 15th, 2020, we have yet no remedy for a confirmed COVID-19 case, although speculations abound. Nevertheless, while the survival rates are relatively high, any healthcare system will soon cripple itself as the infection spreads without properly targeting quarantines, having the needed supplies while awaiting an effective cure. Aside from massively increasing the number of COVID-19 tests and contact tracing, the only working strategy at this stage has been to plank the curve via social distancing and regulated quarantines or mandated lockdown for slowing down the spread of the virus. Many nations are applying these tactics to cities, municipalities, states, or even the entire country. While these strategies have proven to be somewhat useful, as we have learned from nations such as China and South Korea, there is now the possibility of a second (or even a third) wave where returning residents from affected countries continue to revive the spread as experienced in countries and special administrative regions such as Hong Kong, Singapore and even China.

China administered the lockdown for the affected Hubei province, where the epicenter for COVID-19 outbreak, Wuhan, is located. Despite the success of Taiwan in leading the world as being one of the most-prepared and well-equipped, their efforts to get involve is being brushed aside by WHO [27]. In Germany and South Korea, the nationwide lockdown and contact tracing were well managed and disciplined, perhaps due to their size, education, sense of nationalism, and national healthcare policies. An American teacher stationed in South Korea writes, "Nationwide testing, transparent and frequent government updates, free healthcare for all affected an overall sense of community responsibility has prevented me from feeling like my world has turned upside down" [15].

To date, the successes of Taiwan, Germany and South Korea have not, however, appeared to be successfully replicated to other countries, and maybe it might not even happen soon if it ever does.

Virtual staffing platform

One of the key challenges we face today is the shortage of medical staff, especially doctors and nurses, to care for COVID-19 patients. Such a shortage will not only distress the COVID-19 patients but will also stymie the regular flow of typical patients who may need an equal or higher level of care, such as a stroke or cardiovascular patient. In the US, recently retired doctors and nurses are generously giving their time. Other possibilities include having graduating medical students and foreign-certified practicing physicians who were unable to practice after they have migrated to now help out in this national emergency [24]. Under this complex situation, a virtual medical staffing platform can be of great utility.

A virtual care outfit provides a simple e-health solution. "Virtual Care Providers can be accessed with just the touch of a smart screen...access to health records, answers to many questions, and the option to schedule video calls with a patient's provider. By moving these simple tasks to a virtual platform, front-line nurses can provide the best hands-on patient care uninterrupted...[giving] your patients peace of mind and exceptional care..." [2].

The key here is the technology creating a virtual assistive framework, to release front-end caregivers to take care of patients who urgently need the hands-on consultation. This type of telemedicine setup, we presume, can be deployed within and even across national boundaries. It can also be supervised by reputed international experts with many younger and less experienced practicing clinicians being engaged with patients simultaneously, thereby relieving the shortage.

Even so, there are international regulations, patient privacy factors, and other localized healthcare legalities. For preserving mass-scale lives and also to ease the burden of calamities from the aftermath, the details of how the experts can best work with the less-than-experts can all be negotiated for saving lives with effectiveness and efficiencies. The high-level stature of a league of nations can weigh the pros and cons of the crisis and create a cooperative agreement on privacy, credentialing, training, certification, and policymaking on a “reserve force” deployment protocol, in coordination with the legal framework of the organizational charter.

A global telehealth infrastructure

IPPO will oversee a global telehealth setting, including the selection criteria for competing vendors and cooperative partnership agreements. As early as 1910, the use of the telephone to reduce unnecessary physician visits and a tele-stethoscope was in operation [3]. With the hyper-growth and advancements in mobile, satellite, and wireless technology, telemedicine has matured and is now being fueled by the COVID-19 pandemic. In 2017, remote patient monitoring (RPM), being the most prevalent e-health technology to have been implemented, occupied a 63% of total telehealth market share [1]. There are major players in the global market, and the global telemedicine market size has been valued at $24.9B in 2016 and is expected to reach $113.1B by 2025 [20].

Today there are telemedicine applications for many chronic conditions, mental health, as well as emergency treatments. If not already, progress in e-technology will soon allow a secured and matured telemedicine setup for assistive medical consultation throughout the world. Telemedicine has gone through a remarkable evolution in the last decade, and is becoming an increasingly important part of the American healthcare infrastructure [4], enabling care professionals to check, diagnose, and treat patients at a distance via telecommunications technology. With the COVID-19 pandemic, a spike in mental health crises all over the planet will soon emerge and teleconsultation will also provide an excellent
modality to offer urgently needed services and credibly prescribe medicine within localized guidelines in this regard.

While it may not be possible to institute a global telehealth framework for a pandemic overnight, with careful consideration, we know that it is possible and greatly beneficial to implement telemedicine services by networking existing telemedical infrastructures in order to save lives and provide mental health care while moderating the anticipated spike in behavioral health and emotional upheaval of would-be patients as an integral outcome of COVID-19 [19]. Given that a mental health patient can be a threat to himself and others, the existence of IPPO will be an effective mechanism to share proven solutions, to implement large-scale policy thinking, and to manage and oversee a telehealth setting to be fully operational on a global scale during a pandemic.

A standby emergency medical supply chain ecosystem

Supply chain management (SCM) is the active and systematic flow of goods and services, and it includes all processes that transform raw materials into final products. With the use of technology, optimization models, and business intelligence, SCM systems attempt to centrally control and synchronize the production, shipment, and distribution of goods and services to avoid over storage or shortage [14].

One of the unfortunate and severe crises we are facing during COVID-19 is the shortage of medical and personal protective equipment (PPE) supplies, including ventilators, N95 respirators, surgical gowns, gloves and masks, to name a few. The lack of such medical supplies is the primary cause of complications during the COVID-19 treatment process as well as the high risk of exposing healthy medical professionals to the virus. In the US, many states will soon run into an extraordinary shortage of ventilators and other necessary self-protection gears within weeks, if large-scale productions are not already in full-scale operation. Unfortunately, the current SCM may be too dependent on the countries that previously mass-produce and supply these items and if these countries would also need the items urgently, such supply chain would ultimately be cut off for self-preservation among the supplying countries. Moreover, a country’s highest level of government can always impose the “emergency clause” whereby all production of such PPE and other needed equipment will no longer be available for export to other countries.

According to the New York Times, “The White House was set to announce a deal with Ventec Life Systems, a Washington State-based ventilator maker, and GM on March 25th...We are fortunate that the auto manufacturer has the expertise and infrastructure to mass-produce ventilators.” [5] noted that “The US has about 160,000 ventilators, according to a 2018 analysis from the Johns Hopkins Center for Health Security, a number that experts have warned will not suffice if social distancing measures and other attempts to flatten the curve of the disease do not work quickly enough.”

Dr. Steven Choi, the chief quality officer for the Yale School of Medicine and the Yale-New Haven Health System, said that diseases like COVID-19 will put unusual pressure on ventilator resources. “People need to understand, though, that a typical adult patient normally stays in the ICU only for three to four days. What we’re seeing in Covid-19 patients in Asia, Italy and the US is that when patients do end up being ill enough to be admitted to the ICU, they need to be intubated and remain on a ventilator for two to three weeks, which increases the demands for ICU beds and ventilators dramatically.” [16]. There is a strong possibility that the supply will be severely scarce, by May 2020, if production and supplies are not at a near equilibrium. Undoubtedly, for future pandemics, a large-scale standby reserve must be there if humankind is to survive.

IPPO, as conceived, will contract with competing vendors from around the globe to create a stockpile of such needed medical supply surplus, which will come handy during such global-scale disasters. What specific equipment and apparatus will be needed is hard to predict. But there are standard supplies such as the mask, self-protection devices, and even an upper respiratory complication normalizer such as a ventilator, or other innovations that can be pre-determined by healthcare professionals.

Artificial Intelligence (AI) and COVID-19

Artificial Intelligence (AI) is visible in every sector of our present-day society.

“AI, robotics and other forms of smart automation have the potential to bring great economic benefits, contributing up to $15 trillion to global GDP by 2030 according to PwC analysis.” [21].

Keeping our focus on COVID-19, AI and automation are playing at least two major roles.

Robotics

The world is facing a dire shortage of healthcare workforce during COVID-AI 19. In most regions, the situation has gone from bad to worse. Furthermore, the deficit is re-calling for retired health workers such as nurses and doctors to help out. Many of these unsung “heroes-on-the-floor” are overworked, frustrated, and becoming fearful that they would be inflicting themselves and their loved-ones given that they may be frequently become unprotected and exposed. We cannot afford to lose a single professional to the virus, while that remains a frequently reported event [30].

COVID-19 is motivating us to develop robotic systems that can be rapidly deployed with remote access by experts and essential service providers without the need to travel to front lines [31]. Originating from AI and automation, the technology, and the algorithms to perform frontline tasks, such as giving a flu shot, will be, if not already, available. Just as with Zoom meetings, one can appreciate the role of robotics more clearly during a pandemic crisis than ever.

AI algorithms for cure and diagnosis

As yet, we are waiting for an effective haven-sent vaccine against the COVID-19 virus; meanwhile, there are promising laboratory research studies, clinical trials, and biomedical experiments taking place throughout the globe. A new drug or vaccine to control and kill the virus will be liken to winning a humanitarian jackpot towards preventing the present and near future calamities from COVID-19.

AI is crucial in the race to find a vaccine. AI procedures such as machine learning and deep learning can help demystify viral protein structures and probably create an agent that will induce the body to produce defensive white-blood cells and antigens. An Al tool, the artificial neural networks (ANN), is typically deployed on various large-scale samples of structured and unstructured data organized from the affected cells to predict the best possible route to kill the virus. Based on numerous successes of past AI technologies, we believe AI will be, if not already is, a principal deputy in this battlefield [11].

Another noteworthy AI initiative that has been developed by Wang & Wong at the University of Waterloo and the AI firm DarwinAI in Canada, COVID-Net was trained to identify signs of COVID-19 in chest x-rays using 5,941 images taken from 2,839 patients with various lung conditions, including bacterial infections, non-COVID-19 viral infections, and COVID-19 [9,29]. The data set is
being provided alongside the tool so that researchers—or anyone who wants to tinker—can explore and tweak it." [13].

Imagine extending such applications to accelerate COVID-19 testing, enhance data-driven contact tracing, and targeted quarantines. Most importantly, this type of open source initiative can further lead us to discuss AI models and the need for an intercontinental clinical dataset platform for all patients affected by COVID-19, which can be shared worldwide to ensure future isolation of returning residents will not be cause for a second or third wave of the pandemic - an essential paradigm for future pandemic preparedness initiative.

Global AI patient dataset repository

COVID-Net uses Convolutional Neural Networks (CNNs) on chest X-rays to detect COVID-19 infections. It reports an encouraging positive predictive value of 88.9%. Simply put, a CNN algorithm mimics the way how human eyes extract and process visual information to recognize attributes of interest and/or differentiate one group of images from others. For example, the discriminating attributes might be a particular shape of shadow found in the X-rays of COVID-19 infected patients, compared to non-infected ones. Typically, a large-scale data set is required to train the AI algorithms, such as CNN, to reach high accuracy.

COVID-Net is a good step towards open-source databases to fight against the invisible public enemy. Also, the CDC has made publicly available some demographics, infection trends, frequencies, growth rates, geo-maps, and travel histories. To date, however, only limited clinically meaningful datasets are available about the infected, recovered, and deceased patients, as of April 14th, 2020. For researchers to make significant progress in understanding and to develop effective vaccines, we need a repository of clinical data on as many COVID-19 cases as possible. It would be difficult or even impossible to gain better insights into the nature, velocity, and detection of antibodies against a virus like the COVID-19 without such clinical datasets.

AI tools are good at predicting the fate of patients; for example, which patients will develop severe or even fatal symptoms. But such prediction relies on detailed data of the patients, such as pre-existing conditions, lung and heart conditions, chronic illnesses, smoking or alcoholic life-traits, active health status, medications, treatment, and lab data. Currently, the repository of clinical data is elusive and collaborative efforts are needed to set up an intercontinental platform to fill this gap. The platform needs to be online at anytime, accepting and providing data in real-time, open to independent researchers, institutions, and biomedical trials, with proper and authorized credentials. The sharable, de-identified patient records from across the globe, in our opinion, would expedite the process of finding an antidote.

Put simply, we need to establish a platform championed by IPPO (and under its custody) for such records to combat the current crisis, a platform that will serve as an essential infrastructure for future pandemics.

Virtual agents

AI can be of great use in the form of virtual agents.

Specifically, AI is creating assistive virtual agents, such as chatbots. "The virtual assistant can answer questions about the coronavirus and use a series of questions built on data from the Centers for Disease Control and Prevention (CDC) and other reputable sources to perform a preliminary screening for symptoms. Depending on what the answers are, the AI (application) can then suggest the next best steps for further testing and treatment. The chatbot can be added to any healthcare provider’s website... for free." [22].

We can depict several other use scenarios for a virtual assistant when support centers and helplines are overloaded. These virtual agents can be localized for a geographical location for a provider such as a hospital and/or nursing home during a crisis. Chatbots can be designed to provide institutional directives, updated by the minutes, to a specific group of clinicians or front-liners as an agent via two-way communication capabilities.

AI and COVID-19 testing policy

The use of AI models is promising for current and future health crises. There is a constant flow of AI-driven clues to find a cure for the COVID-19 virus [17]. We need more AI experts and expect a spike in demand for AI analysts and developers in all social sectors, including public health. An AI workforce cannot be produced overnight. The US education ecosystem does not seem to have placed adequate emphasis on, and funding for, this need thus far.

Above all, the capacity for accelerating COVID-19 testing is critical in a pandemic. Here, the rationale lies in isolating those who are infected from those who are not to stop the spread. The need to explore possibilities for AI applications to enhance such testings cannot be overly emphasized.

The role of the overseer agency might be to evaluate, fund, and monitor the progress of pandemic-specific applications and testing technologies from around the planet continuously, thereby ensuring that any spaces being open for public activities would be safe and secure.

Concluding remarks on pandemic education

Our final remarks might not be directly related to IPPO, but education-related issues that surface as essential social ingredients to combat a pandemic as vigorous as COVID-19.

Education and literacy

The word “Pandemic” seems to have roots in the Greek term “pan” meaning “all,” and “demos” meaning “people.” Today, the word “Pandemic” has a specific standing as an epidemic that spreads over a wide geographic area and carries the potential to affect a large proportion of people. We are not sure if there is a specific term for COVID-19 to refer to a disaster beyond a wide geographic area encompassing beyond the planet Earth. Scientifically speaking, the characteristics of COVID-19 correlates to all people, all age groups, and all socio-economic sectors, whether rich or poor. Thus, clustering a particular region or a demographic segment with a classification logic, thus far, remains inconclusive. Furthermore, there is no global clinical data repository for the infected cases and the deceased patients, for researchers to design and test detection modeling.

Herein lies the rationale for why the IPPO is an effective mechanism and necessary framework for all nations to move the agenda towards fighting against COVID-19, as system science dictates a solution for the entire system (world), not just a single system component or element (country). In other words, everyone can and may be affected by COVID-19 and not caring for any individual in anyone country confined to this Earth would still be a problem. Imagine that an individual in a neighbouring country is infected with COVID-19, but is asymptomatic so that s/he may not be isolated. Someone travelling from the neighbour’s country who happens to be near this individual will likely transport the virus to their own country, eventually causing great harm and calamities. This is exactly how so many countries are now in the same boat, where travellers from COVID-19 epicenters have brought the virus with them to their very own surrounding. In the context of
COVID-19, we are, indeed, our “brother’s keepers” as any individual infected with COVID-19 has the likelihood of impacting on the health and well-being of all concerned.

At this moment, the widely implemented strategy that seems to be somewhat useful is social distancing and a lockdown of an entire region or even a nation, on time. It is, however, unknown if the virus will resume spreading after removing the social distancing, and at what duration? Indeed, nations such as Singapore (and special regions such as Hong Kong) are experiencing a second wave of COVID-19 spread. While many factors such as the quarantine duration remains uncertain, the key is “population compliance and discipline", during a lockdown. Hopefully, that will buy us some time to figure things out.

Finally, social distancing and compliance come from literacy and education, which remains to be an uneven curve around the world. Literacy will accommodate compliances and discipline. We can only offer some practical recommendations while COVID-19 is still at an experimental and emotionally draining stage.

- **Education**: The world of education needs to incorporate a component on a possible pandemic, at an early stage of the education continuum. The majority of the world population appears to have limited knowledge of a health-related, infectious epidemic and its widespread impact. With COVID-19, many are being educated, and subsequently, having an appreciation of the seriousness of the issues and the impact of an pandemic.

- **The Business of Educational Continuity**: With virtual learning technology and continuous advancements, all post-secondary institutions need to establish a standby cloud-based “academic continuity” paradigm. Most schools and colleges are closed, and not all institutions around the globe have an instantly deployable online learning infrastructure. Many courses, especially in post-secondary education, are not designed for virtual continuity with substitute teachers in case the assigned instructor(s) may no longer be available. The sudden pause will delay graduation, and it might be a year or two before a student completes the degree. The Department of Education notified all post-secondary institutions “The Department is providing broad approval to institutions to use online technologies to accommodate students on a temporary basis, without going through the regular approval process of the Department in the event that an institution is otherwise required to seek Departmental approval for the use or expansion of distance learning programs” [10]. A standardized online education platform, as we know, cannot be established overnight.

- **The potential of AI in Education**: AI has been changing the world, including education. AI is changing the way we work, the way we learn, and the way we live [23]. A special report by The Chronicle of Higher Education suggests, “Colleges should offer all students, regardless of the field of study, opportunities to learn about AI" [28]. As we noted earlier, the potential of AI in pandemic preparedness is limitless. We strongly recommend an exposure to AI methods and models to the students, researchers, and public health officials to have an appreciation for the new world of technology and automation. We need to incorporate AI in Public Health Informatics and in the overall curriculum. For example, AI literacy as a required component of the STEM education in the K12 sector as well as in the higher education STEM areas should be mandated in the US. Many nations are in the process of incorporating AI on all floors of the education system [26].

- **AI in China**: China has taken a major initiative to educate the college population in AI. AI is the fastest growing discipline in China’s universities, with 180 new approved majors, up from 35 the year before. The ramping up of approvals comes as China attempts to attract more talent to drive what has been referred to as the fourth industrial revolution [25].

- **AI in Europe**: AI is a significant initiative in the education of European Union (EU). The EU has adopted a Digital Education Action Plan, which includes 11 actions to support the technology use and development of digital competences in education. From the secondary to the post-secondary science curriculum, AI appears to be a required component [12]. In comparison, the US education continuum seems to have made some progress but still lags. AI in the US remains a playground for the giant tech sector. Unfortunately, the US Tech Giants appear to have a limited role in combating COVID-19 with strategic innovations, thus far, although there is some news emerging on how Google and Apple are collaborating on virtually enhancing the contact tracing efforts.

Experts believe that the world is already starting to face a sizable recession, amid COVID-19 pandemic [8]. "There’s little doubt we’re heading for a global recession or already in one, but these economists say it’s more like the next Great Depression.” [18]. At the least, the possibility of a prolonged recession appears to be sure for heavy-hit nations. The world is getting more biologically, chemically, and socially complex, along with an all-time high migration rate [7]. Will there be another pandemic? It is not a question of if but when. The world certainly needs a better combat strategy and ecosystem for the next one.

We suspect the process for a majority of nations to participate in a conceived IPPO will be both lengthy and complicated. When it comes to another COVID-19, however, we do not appear to have another choice.

**Author Statements**

**Funding**

None.

**Competing interests**

None declared.

**Ethical approval**

Not required.

**References**

[1] Research and Markets. (2019, 11). Retrieved from Global Telehealth Market by Technology, Application and Region (2018-2023): https://www.prnewswire.com/news-releases/global-telehealth-market-by-technology-application-and-region-2018-2023-300965588.html.

[2] Banynamed. (2020, March). Retrieved from AURA Virtual Care Solutions: https://banynamed.com/teleprofessionals/.

[3] Birthe Dinesen ea. Personalized Telehealth in the future: a global research agenda. J Med Internet Res. 2016;18(3).

[4] Chron. (2020). Retrieved from What is Telemedicine?: https://chroniclehealth.com/telemedicine/what-is-telemedicine/.

[5] Chuck, E. (2020, March). NBCNEWS. Retrieved from What is a ventilator? The ‘critical resource’ that is in short supply: https://www.nbcnews.com/health/health-news/what-ventilator-critical-resource-currently-short-supply-n1168641.

[6] CNA. (2020, April 15th). Retrieved from COVID-19 Outbreak Worldometers: https://www.worldometers.info/coronavirus/?utm_campaign=homeAdvegas17.

[7] Connor, P. (2016, 12). Pew Research Center. Retrieved from International migration: Key findings from the US, Europe and the world: https://www.pewresearch.org/fact-tank/2016/12/15/international-migration-key-finds-from-the-us-europe-and-the-world/.

[8] Crutsinger, M. (2020, March 27th). IMF. Retrieved from IMF head says global economy now in recession: https://abcnews.go.com/US/wireStory/imf-head-global-economy-now-recession-69843184.

[9] DarwinAI. (2020, March 25th). DarwinAI, University of Waterloo Develop Neural Network for COVID-19 Detection. Retrieved from https://www.darwinai.com.
