Artificial Intelligence in COVID-19 Pandemic

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The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which caused coronavirus diseases (COVID-19) in late 2019 in China created a devastating economical loss and loss of human lives.11 variants have been identified with minimum to maximum severity of infection and surges in cases. Bacterial co-infection/secondary infection is identified during viral respiratory infection, which is a vital reason for morbidity and mortality. The occurrence of secondary infections is an additional burden to the healthcare system; therefore, the quick diagnosis of both COVID-19 and secondary infections will reduce work pressure on healthcare workers. Therefore, well-established support from Artificial Intelligence (AI) could reduce the stress in healthcare and even help in creating novel products to defend against the coronavirus. AI is one of the rapidly growing fields with numerous applications for the healthcare sector.

Keywords: artificial intelligence ; COVID-19 ; nanofiber mask ; machine learning

1. AI in Utility Services

The recent research used a machine learning model, namely the Pandemic Electricity Consumption Scenario (PECS) model, for the prediction of energy usage in India. This model was used to effectively analyze and measure the impact of the pandemic on electricity consumption based on weather, econometrics, and social distancing in seven major states in India. The machine learning model predicted a 15 to 33% drop in consumption from March to May in 2020 during the complete lockdown period, and a 6 to 13% drop from June to August 2020 during the unlocked period, returning to normal in September 2020. The analysis also showed a drop in CO2 emissions of between 7 and 5% compared to previous years. This prediction can be used in future energy policy decisions [1]. A similar study was conducted in China using a comparative regressive and neural network model to identify the impact of the pandemic on electricity and petroleum demand. The model showed a downtrend in the demand for fuel consumption [2].

2. AI for Researchers

The search engines for the extraction of COVID-19-oriented publications from servers are more important for researchers. A powerful language model, BERT, is used by Google for extracting data [3]. A CORD-19 search and COVID-19 research explorer information retrieval (IR) system were analyzed for the study. CORD-19 was subjected to a language processing service, in Amazon Comprehend Medical (ACM), which is a natural language processing (NLP) service for extracting clinical data from unstructured text [3].

3. ML in Oil and Gas

The machine learning model of the pandemic oil demand analysis (PODA) predicted gasoline consumption in the USA. Since the oil price went negative due to the pandemic, the predictions were made based on public travel, their trip activities, and fuel usage. Later on, in October 2020, the prices gradually recovered, so this model predicts the demand for oil and its impact for a shorter duration [4].

4. AI-Based Decision-Making in the Hospital

Recent digital technologies were implemented in cardiology-based devices to collect and observe data. Machine learning (ML) was used to study large datasets from hospitals for clinical practice, and this was further used to identify complex heart problems and treatment strategies for COVID-19 patients [5]. There are various ML algorithms used to screen the structured data in hospitals, such as ensemble, support vector machine (SVM), hierarchical clustering, and topological data analysis, and for unstructured data, convolutional neural network (CNN), deep neural network (DNN), AdaBoost, and long short-time memory (LSTM). A DL model was proposed to identify which patient may receive more of a benefit from surgery in treating epilepsy [6]. AI assists in providing a strategic execution picture in operating theater surgeries by lowering risk and ensuring surgical success [7]. Cardiothoracic surgery, a fine example of AI-supported cognitive augmentation, requires a combination of a doctor team, highly advanced equipment, and special care [7].

5. Telemonitoring during COVID-19

The value of telemonitoring should be taken into account in the care and monitoring of patients in hospitals, and even in outlying areas nowadays. Various portable devices, such as a blood pressure cuff, glucometer, pulse oximeter, ECG + stethoscope, activity trackers, wearables, thermometer, etc., are now used by patients even at home. Aysha Shabbir et al. (2022) proposed an improved model for remotely monitoring a patient's condition and to make decisions based on that condition using ML and DL models. In this process, the remote monitoring station's patient monitoring device sends signals about higher and lower thresholds via the Internet using Cloud computing and IoT servers, which are relayed to a healthcare specialist. Later, primary/secondary care requirements are decided by specialists based on severity. This was framed by a pattern of sensing, transmission of data, interaction with the patient, and situational response [8]. In Italy, 23.2% of the population is 65 years of age or older, making it difficult to treat them during the COVID-19 pandemic. Therefore, they proposed a connected-care solution in the context of digital health, where the citizen or patient was kept in a high-priority center and supported with various integrated organizational measures. Further, in this recent organizational model, patient clinical information was shared with different healthcare workers involved in the treatment process. For this purpose, various healthcare models were combined to support patients with chronic illnesses. A remote/home healthcare Resilia app, a simple mobile phone application, was introduced by Italy healthcare, and guides users to identify nursing care, doctors, and other healthcare professionals for a quick response [9]. The northwest Tuscany region of Italy consists of local health units that have introduced territorial telemonitoring of chronic patients (Tel.Te.C.): telemedicine mobile applications since 2017. Both the patient and the healthcare professional receive a home monitoring kit and a professional monitoring kit, from which vital parameters such as temperature, heart rate, oxygen saturation, blood pressure, and weight can be measured; any parameter that is out of range raises an alarm for immediate action. Under compulsion, this platform has been used by 40 general physicians and 180 patients since March 2020. Patients with different stages of illnesses have been enrolled in this application, which has resulted in positive feedback from patients and doctors with reduced hospitalization and no mortality [10].

6. Electrospun nanofiber mask by nanotechnology

Another major breakthrough in controlling the airborne transmission of SARS-CoV-2 is through the advanced electrospun nanofibrous air filters adopted masks. Electrospun nanofibers are not a new material to the medical field, these fibers are used in various medical applications for the past two decades, Abutaleb et al., (2021) have described various biodegradable nanofiber materials from natural resources for medical applications [134]. Nanotechnology is highly reliable in developing effective, scalable and cheaper air filters for mask and respirators. Electrospun technique have the capacity to produce a lesser pore size to several micrometers, when compared to commercial filters ES fibers capture smaller airborne particles [134,135]. In this study, a coronavirus aerosol test against ES mask was carried out. A polypropylene fabric was subjected to electrospun with polyvinylidene fluoride $PVDF_{20}$ and $PVDF_{30}$. This layer was soaked in to a polyelectrolyte poly(ethylenimine) (PEI) and poly(vinylphosphonic acid) (PVPA) which is positively or negatively charged to enhance the electrostatic attraction for virus removal. The diameter of this PVDF nanofiber is found to be 0.2 – 1.3µm, but other commercial face mask and neck gaiter in this study showed fiber diameter of 5.7 ± 2.8 and 12.0 ± 1.0µm. Usually fibers with larger diameter and pore size are less effective in airborne particle filter, but lesser in diameter and pore size are highly effective in filtration of aerosol. This is achieved by increasing the ES spinning time, which exhibit highest removal of corona virus aerosol up to 99.9% for $PVDF_{30}$ and 99.1% for $PVDF_{20}$ Figure 6 [136]. The reuse of facemask is an important question in this pandemic, a study carried out to identify melt-blown filter used in N95 face mask and nanofiber filter face mask reusability test with 75% ethanol treatment. It shows, there is a loss of filtering efficiency in N95 mask after ethanol treatment, but nanofiber filter mask shows promising results of filtering capacity up to 97 -99% irrespective of cleaning method [137]. The economically cheaper materials like ES fabrics are highly recommended for mask production in this pandemic time. This ES air filters are more competitive against other commercial filters in market and portable ES apparatus can be much helpful in rapid preparation of ES masks at home and for minor populations [134].

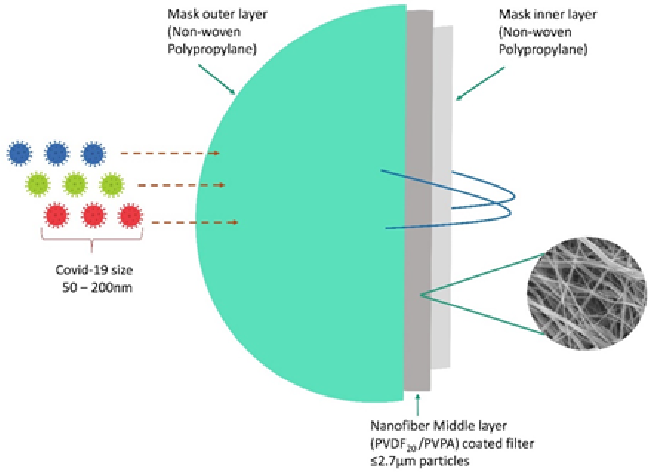

Figure 1. Illustration of a nanofiber mask with 3 layers of protection against micro-aerosol droplets with corona virus.

6. AI-Based Law in Various Countries

Various countries understand the importance of AI-based technology and their applications in the health sector and are moving forward to bring AI under national law. A proper legal channel is suggested by different counties to justify its safety and reliability in the healthcare and clinical sectors. Similarly, the FDA approved 350 AI- and ML-based equipment for use in the healthcare in the United States of America until 2021 [11]. Similarly, various countries implemented AI/ML laws in the area of data protection, AI robotics, decision support software, diagnosis and predicting patient conditions, COVID-19 tracking apps, etc. (see **Table 1**).

Table 1. Laws and regulations implemented based on AI healthcare in various countries past and present regarding the pandemic.

Country	Law/Regulation	Purpose of This Law	Date Effective
USA	**No Vaccine Passports Act [12]**	**Relaxing the restrictions of forcing vaccine certificate**	**4 August 2021**
The Netherlands (Red Cross)	**510 Data Responsibility Policy [13]**	**Data protection**	**12 November 2018**
United Kingdom	**Contact-tracing app (General Data Protection Regulation (UK GDPR) and Data Protection Act (DPA) 2018) [14]**	**Data protection and digital COVID tracking app**	**May 2020**
European Union	**General Data Protection Regulation [15]**	**Data protection of public and health records**	**27 April 2016**
European Union	**Medical Devices Regulations 2017/745 (MDR) [16]**	**Protection of patients from medical device, protection of produced data using this device**	**5 April 2017**
European Union	**The 2017/746 In Vitro Diagnostic Medical Devices Regulation (IVDR) [17]**	**Protection of patient health and users, quality and safety of in vitro medical devices**	**25 January 2022**
European Union	**Regulation of the European Parliament and of the council laying down harmonized rules on AI (Artificial Intelligence ACT) and amending certain union legislative acts [18]**	**Facilitate and creating innovation in AI, creating trusted AI applications**	**21 April 2021**
European Union	**Civil Law Rules on Robotics [19]**	**Implementation of AI robotics**	**16 February 2017**
Singapore	**Personal Data Protection Act 2012 [20]**	**Data protection**	**31 December 2021**
Australia	**Therapeutic Goods (Medical Devices) Regulations 2002 [21]**	**Clinical decision support software**	**25 February 2021**

Country	Law/Regulation	Purpose of This Law	Date Effective
China	**Notice of the State Council Issuing the New Generation of Artificial Intelligence Development Plan. State Council Document. No. 35. 2017** [22]	**Healthcare and management**	**8 July 2017**
Kingdom of Saudi Arabia	**Guidance on Software as a Medical Device/SFDA MDS-G23** [23]	**AI- and BigData-based medical software to diagnose and predict patient conditions**	**27 April 2021**
Russia	**Development of AI in healthcare up to 2030, approved on 10 October 2019, No. 490** [24]	**Software as medical device in healthcare**	**10 October 2019**
South Korea	**Medical Devices Act No. 15945, 11 December 2018** [25]	**Software as medical device in healthcare**	**11 December 2008**
Singapore	**Standalone Medical Mobile Applications (SaMD) and Qualification of Clinical Decision Support Software (CDSS)** [26]	**Clinical decision support software**	**19 July 2021**
China	**Cybersecurity Law of the People's Republic of China** [27]	**To preserve cyberspace sovereignty and national security**	**7 November 2016**
Malaysia	**Medical Device Act 737-2012** [28]	**Medical device, software regulation in healthcare**	**30 January 2012**
Emirate of Abu Dhabi	**Artificial Intelligence (AI) in the Healthcare Sector of the Emirate of Abu Dhabi, Policy/AI/0.9, Version 0.9** [29]	**Health system monitors, analysis, and public health observation**	**30 April 2018**
Canada	**Digital Charter Implementation Act, 2022 (Bill C-27)** [30]	**Protection of personal information, data, and health records, along with any serious direct cause to patients by AI**	**16 June 2022**
Brazil	**LGPD–General Personal Data Protection Law (Federal Law no. 13,709/2018)** [31]	**AI regulation in health sector of Brazil**	**14 August 2018**
Brazil	**Brazilian Artificial Intelligence Bill (Bill No. 21/2020)** [32]	**Development and applying of AI in various sectors of Brazil**	**29 September 2021**

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