

**Review Article**

**A REVIEW ON THE IMPACT OF THE COVID-19 PANDEMIC ON THE HEALTH CARE SECTOR**

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**ABSTRACT**

The global crisis of the present era, the COVID-19 pandemic, has changed given new normal ways in many of the sectors. The present review highlights the impact, problems, and challenges faced by major areas of the health care sector due to pandemics and also addresses some of the aspects of upcoming approaches. The healthcare sector is the one sector that is on-demand since this COVID-19 pandemic raised. During the initial period, there was disruption of various services provided by the health care sector due to supply chain management issues and reduction in demand by consumers, quarantine, and lockdown period. The healthcare workers also confronted a huge challenge due to the increased number of cases and shortage of amenities and safety measures. This significantly affected even COVID-19 patients and the general public suffering from other diseases. To fight this issue, research and development (RandD) in pharmaceutical industries with great efforts to explore molecules and save many lives. Gradually innovative ways to strengthen and combat pandemics started emerging. Numeral ways and rules were adopted to prevent, diagnose and cure the disease. Artificial intelligence technology has emerged as one of the boons to address many of the unresolved or time-consuming mysteries. All the divisions of health care sectors have started working more efficiently with adopted new strategies to face future challenges.

**Keywords:** COVID-19, Health care sector, Pharmaceutical industries, Telehealth, Artificial intelligence

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**INTRODUCTION**

The pandemic of SARS-Cov, which took birth in China, has turned to grapple of historic proportions. As quoted by George Bernard Shaw "History repeats itself" [1], and each crisis leaves behind permanent structural changes [2], but the man seems to be incapable to learn from history.

On December 31<sup>st</sup>, 2019, the World Health Organization (WHO) has informed the cases of pneumonia of unknown causes in Wuhan City, China [3]. The batch of people first infected had shared their exposure in the Huanan seafood wholesale market, where not only farm animals and seafood but also small carnivore animals like bats and snakes were also sold [4]. By 7<sup>th</sup> January 2020, Betacoronavirus which was previously unknown, was reported as a causative agent for this novel [5] infection by the Chinese authorities, and it was named as "SARS-CoV-2" by the International Committee of Taxonomy of Viruses [6] isolated from Human airway epithelial cells [7]. Patients infected were observed with common symptoms like fever, cough, headache, throat pain, tastelessness, fatigue followed by difficulty in breathing. Some patients were also found to have sepsis, septic shock, pulmonary edema, severe pneumonia, and acute respiratory distress syndrome [8]. This deadly virus infects the respiratory, gastrointestinal, hepatic, and central nervous system tracts of humans as well as cattle, birds, bats [6], and other wild animals. This novel virus possesses a ball-like structure and along with some other cell surface proteins. It also possesses a spike-like structure on the surface which is made up of glycoprotein gives coronaviruses their name [9]. It is the crown-like structure that binds to host cells. The researchers found that SARS-CoV-2 glycoproteins which are like spikes bind to receptors on the human cell surface called Angiotensin-converting enzyme 2 (ACE2) and its binding capacity was found to be 10 to 20 times more likely than the SARS virus of 2002 [10]. Though there are few structural and sequence similarities between the SARS 2002 and SARS-CoV-2 the unique difference of SARS-CoV-2 is that it cannot bind against three different antibodies [11], enabling the interhuman transmission, implementing high impact in public health [6].

Reverse transcription-polymerase chain reaction (RT-PCR) is the confirmatory and final test for individuals for diagnosis and confirmation of COVID-19. This test is done by taking swabs from the nasal and oral tracts of the suspects, and extracting the viral RNA in a printer-like machine, and amplifying it to detect SARS-CoV-2. The rapid antibody test is one more test to detect COVID-19 positive patients that checks the level of antibodies developed against a certain infection. ELISA is another antibody test approved for serological surveys to detect the infection in the containment zones or population exposed to COVID-19 patients. The drawback of the above two tests is they may detect antibodies produced against some other infection and show that the sample is positive for COVID-19 [12]. Although the deadly virus was isolated from a throat swab, consequently, specimens of blood and stool [13] could also use to detect it. But document on virus shedding patterns was not understood [6], which would help to collect the optimum specimen. In contrast to SARS-CoV or Middle East respiratory syndrome MERS-CoV, this novel SARS-nCoV-2 grows better in primary human airway epithelial cells than *in vitro* standard tissue-culture cells techniques. By early March 2020, the World Health Organization claimed COVID-19 infection to be "PANDEMIC". By then, it was spread over 200 countries and territories across the globe. In the first week of June, more than 1.4 billion confirmed cases were detected worldwide. As of 1:00 pm on 4<sup>th</sup> August 2020 number of confirmed virus cases in India is 1,858,689 with a death rate of 39,002 [14]. In this current emergent situation when drugs or vaccines are still under clinical trials, experts in India have begun with treatment as per the guidelines given by the Ministry of Health and Family Welfare Directorate General of Health Services. As per the above-stated protocol patients with mild complication/condition are administered antipyretic, and are also advised to take adequate nutrition and hydration. Hydroxychloroquine tablet an old antimalarial drug also administered to patients with moderate symptoms, those having high-risk features for severe disease [15]. Hydroxychloroquine is proved to be safer than chloroquine with fewer drug-drug interactions [16, 17]. On May 1, 2020 drug Remdesivir gained emergency use authorization (EUA), from FDA

[18] and was repurposed to treat severe, hospitalized COVID-19 patients with oxygen supplementation therapy [19]. Another treatment that proved effective is to choose individuals from the previous pandemic with a significant reduction in the relative risk of mortality, and get convalescent plasma or antibody and use against severe acute respiratory infections [20]. Most importantly, the current guidelines in *The Lancet* emphasize that systematic corticosteroids should not be given routinely for the treatment of COVID-19 [21] that can result in delayed clearance of viral RNA (from the previous report of SARS-CoV and MERS-CoV) and other complications such as psychosis [22]. Even though there is no specific drug/vaccine developed for fighting against COVID-19, preparing a route map of people who have come across the COVID-19 patients, collection of their appropriate specimen for testing is a priority for clinical management and outbreak control [6]. Apart from this, restricting the movement of COVID-19 patients either by admitting them in the hospitals or by properly making the arrangements for their quarantine and treating them until they get back to normal health is one more important aspect. This discusses the issues about the healthcare sector and assumes that artificial intelligence and telehealth play a key role in future perspectives. The review article was compiled utilizing search engines include Pubmed, Scopus, Science Direct, Google scholar, etc. The articles related to the review were compiled from the last 10 y from 2010 to 2020.

#### COVID-19 impact on hospital and medical services

India is one of the worst-hit countries [23] with shooting up coronavirus pandemic cases day by day. This pandemic is pushing the limits of the healthcare systems [24] and hospital administrators are forced to start preparing for worst-case scenarios now [25]. The novel COVID-19 pandemic has multiply affected the health care sector. In the initial response, there was a serious shortage of healthcare facilities, equipment, pharmaceuticals, and skilled personnel [26] in hospitals but in contrast, demand for medical masks, hand sanitizers, and gloves has significantly increased [27]. Loss of life because of an inadequate inventory of drugs or ventilators would be tragic [27]. Suspension of most surgical procedures focus on reducing excess inpatient capacity, postponement of non-COVID-19 health-related issues is walking a precarious line [28], OPD (outpatient department) counters remained closed for too long, which sparked fears of an impending economic crisis and recession in hospital [27]. Cancer patients who are already immunocompromised facing a high risk because of the need for chemotherapy, they weigh the risks of delaying treatment [29]. But when compared with patients suffering from other types of cancer, lung cancer patients did not have a higher probability of severe complications [30]. Hospitals have a responsibility to minimize foreseeable risks to their patients in consideration to that, both doctors and nurses are in a dilemma in making decisions on patients suffering from paranoid delusions [31, 32].

#### Challenges and problems faced by healthcare workers

Health workers (HWs) are at the forefront of the COVID-19 outbreak response and responsible for daily patient care and are directly exposed to hazards that put them at high risk of infection [33]. This new reality in the healthcare sector comes with a lack of adequate personnel and resources. Physicians and nurses are asked to work for an extended period of a day or two [26]. Patients in ICU need to be shifted to other units to cater to the need for increased cases of COVID-19. Later on, as the number of cases started increasing the Indian Council of Medical Research (ICMR) approved 176 government and 78 private hospitals [34] to undertake coronavirus testing [35]. However, after the introduction of testing kiosks and even drive-through testing recently, shortage of testing kits and handling gear and high-test cost have been some of the problems faced by private hospitals after scaling up of coronavirus testing [20]. Healthcare workers approaching the patients are instructed to wrap themselves with a PPE (personal protective equipment) kit hence the availability of the gowns must be monitored by the store and inventory control. It is reported that currently half of the healthcare workforce (that includes nurses, lab workers, and housekeeping) are self-reporting the fear of work, inadequate facilities, and mental depression altogether has forced them to

resign. In the year 2020 World Health Organization (WHO) identified that there is a shortage of 9 million nurses and midwives around the world [36]. Fields R the researchers surveyed the healthcare workers to know their opinion on hospital management whether the management indulges in the betterment of hospital running by implementing novel technology and surveys report says that healthcare professionals felt they had insufficient access to novel technology, inadequate training may leave employees frustrated and confused, the lack of time with patients may be exacerbated by an overload of administrative tasks or non-clinical assignments, too few staff resulting in high work pressure all this would result in poor handling of the pandemic situation in some hospitals [37].

#### COVID-19 impact on pharmaceutical industries

This unprecedented time has brought a negative impact on the pharmaceutical industry for a short while of time. Wherein some pharma industries remained closed for a certain period as workers test positive for COVID-19 [38]. But to prevent this last long special COVID-19 HR team was appointed in pharma industries to monitor the spread of infection among the employees working within the plants. This team includes the panel of doctors to provide virtual guidance to employees on health issues, conduct a periodic medical checkup, including a thermal checkup/scanning at the entry point for all employees, and also prepared a protocol for staff working at plants [39]. Unfortunately, Indian pharmaceutical industries faced other problems too. Some industries in India rely heavily on China for API, starting and intermediate materials for the manufacture of generic drugs. At this pandemic period, some generic drugs played a crucial role to fight against COVID-19. To name few Indian pharma industries manufacturing these generic drugs to include IPCA LABS, Zydus Cadila, Mangalam drugs and organics, Wallace Pharma. With a canceled or reduced frequency of cargo flights and erratic supply chain rendering it impossible for these Indian pharma companies to purchase the product from China [38]. This resulted in slow production, less availability, and higher costs for the drugs like vitamins, penicillin, and also the cost of paracetamol hiked up from Rs 250-300 kg to 400-450 kg [40]. Indian pharma industries can sell drugs in the US market only after undergoing inspection and get approval from US FDA. With the ban on international travel, inspection becomes out of topic, rendering it impossible for Indian drug companies to sell in the US and other overseas markets [38].

#### Challenges and problems faced by pharmaceutical industries

The challenges faced by the pharma sector are hoped to be temporary. In the present critical situation, pharmaceutical companies across the globe are striving very hard to fulfill the huge demand for much-needed medicines, vaccines, and medical devices. In the global healthcare infrastructure, the Indian pharma sector is considered as an important component and an instrument in saving millions of lives every year, engaging in manufacturing almost 60 percent of the vaccines used globally and certainly almost 50 percent of the US's generic drug requirements. It's a matter of pride [41] that India belongs to the third-largest pharma sector of the world [42]. Medicine choice for COVID-19 often works on a trial and error basis [43], which is currently under investigation and yet to be fully approved by the FDA that includes hydroxychloroquine, lopinavir, and ritonavir, tocilizumab, and sarilumab [44]. Chloroquine tablets manufactured by Bayers Pharmaceutical are considered as a drug for emergency use by the emergency use authorization US government for treating COVID-19 patients. Even though Bayer's had a great hit in revenue during the pandemic time, the repurposing of Chloroquine made them balance in their business. While Bayer's would sell 3 million of worth drugs to the public, Novartis is engaged in giving back the population 130 million doses of Hydroxychloroquine tablets to aid the global pandemic [45]. This drug is known to have similar benefits as Chloroquine with greater tolerability [46]. An unexpected jump in sales was observed with Pfizer's company in manufacturing the Pevnar 13 vaccine, which could be used in treating pneumonia in the course of the COVID-19 pandemic. Pharmaceutical Company AbbVie is engaged in a joint venture with health authorities and several institutions involved in clinical studies and research of antiviral

drugs lopinavir and ritonavir. The company concluded lopinavir and ritonavir as investigational drugs for COVID-19 treatment in various countries [47]. Bill gates while commenting on the strength of the Indian Pharmaceutical industries, highlighted the contribution of Bharat Biotech in developing a vaccine that could immunize the whole world to fight against pandemics [48]. COVAXIN an inactivated vaccine manufactured and marketed by Bharat biotech jointly with ICMR-National institute of virology, received DCGI approval is now under Phase II clinical trials [49]. Remdesevir antiviral drug from Gilead's Pharmaceuticals showed a promising result in animal studies and is considered as top-ranked drug to help battle the coronavirus crisis. This marked increase in the financial status of the pharmaceutical company has raised the question of whether this pandemic outbreak has come in beneficial to them? [45]. The above statement can be justified based on the sales lift in Novartis pharmaceutical of 400 million and other companies like Eli-Lilly, Sanofi Pharmaceuticals having a profit of 280 million during the COVID time.

### Future prospects

#### Protecting patients and health care workers

Strategic planning in the healthcare sector has been opened. Many health care facilities need to improve and upgrade their infrastructure that could help in streamlining and make their facilities more conducive to the health and safety of patients, staff, and health care professionals. Based on their own experience and inputs received from experts, hospital administration would emphasize employing effective measures for the future management of this kind of pandemic. Eli Perencevich, doctor and epidemiologist at the University of IOWA quoted that "Ninety-nine percent of alcohol hand rub is placed at the entrance could help in the maintenance of hygiene among patients and healthcare workers of hospital. There's some evidence that higher air humidity can reduce the viability and airborne transmission of certain kinds of viruses, including coronaviruses so hospitals can plan to bump up their ventilation rates air in from outside says Kevin Van Den. Handrail in hospitals is installed on staircases to serve as support for those climbing steps, especially, the sick, the elderly person, visitors, etc. But these handrails are silent vehicles for transmitting pathogenic bacteria. Transmission of pathogens from toilet lock handles to office lock handles was also been identified by Amala, Smart Enoch in his studies. Therefore, to prevent these potential pathogens, adequate sanitary surveillance should be ensured through the provision of soap and water for hand-washing for visitors, healthcare workers, and subsequent application of disinfectant where necessary [50]. Hospitals in the future must be planned with independent rooms for hospitalized patients to reduce hospital-acquired infections. In 2010, Sweden's Skane University Hospital an infectious-disease building could give an idea for constructing a hospital wherein outpatient or suspected Corona patients can give entry to several private isolation rooms can bypass the communal waiting areas, on the upper floors the inpatient rooms, have doors that open onto balconies that wrap around the circular building. Patients can be admitted to rooms via the outdoor pathways. The doctor from Swedish hospital Torsten Holmdahl, says resolving the entrance of COVID patients to the hospital in emergency condition is done by giving separate entrances and waiting areas. Scientists have also found the virus in stool samples and toilet bowls so flushing an uncovered toilet can spray aerosolized droplets of water and waste around the room [51]. Toner and Waldhorn suggested his opinion as a preventive measure that Physicians, nurses, respiratory therapists, pharmacists, environmental services staff, supply chain managers, will require a multidisciplinary effort and needed expertise in their field [25] to prepare effectively and respond to crises [52]. On expert information read from an article published in the American Journal of Infection Control, there was a 30 percent reduction of antibiotic prescriptions and prescriptions related to common respiratory infection in a group that used hand sanitizers [53]. Hospitals and healthcare professionals have been recognized as vital not only to the safety and well-being of their local communities but also to the security and economic health of the nation. To ensure the safety of the patients' outpatient departments (OPD) and in-patients, services should be resumed to treat all non-COVID-related cases. To make it

more convenient, morning and evening shifts in consulting doctors can be planned to avoid overcrowding of people or even a prior appointment system can also be taken into consideration. Healthcare staff involved in treating COVID-19 suspected patients should be provided with PPEs, rotation duty, and periodic offs must be planned to remove the mental stress felt by the staff. On completion of his shift duty, all the staff must be provided with the facilities to quarantine in hospital by management to avoid the infection to carry over to their families.

#### Optimizing telehealth system for recovery from COVID-19

Almost overnight this pandemic has made healthcare sectors start switching towards immediate and universal secure telehealth. It is now considered a lifesaving tool that saves time and money. In the management of COVID-19 patients, telemedicine has included an additional informational page, for guidance about the prevention and treatment, training, communication, to assist the remote consulting for the community residents and medical staff. This enabled to conduct of preliminary screenings through remote consultation, which avoided the risk of cross-infection in the hospitals. Additionally, helped the medical staff to communicate with their colleagues, listen to lectures and apply for consultations [54]. This enabled care providers of smaller health care facilities situated in the rural areas to connect with specialists in large hospitals over a video calling and update them on the latest treatment and even demonstration can also be made on certain therapeutic aspects, including surgery [55]. With this regard, the Indian Space Research Organization (ISRO) began a pilot project linking Apollo Hospital in Chennai with Apollo Rural Hospital at Aragonda Village in Andhra Pradesh [56]. It not only benefits the rural people but people in urban areas, especially [55] at the time of a pandemic outbreak, people under quarantine were instructed on quarantine processes at home, applications for personal protection, and seeking medical attention. Song X with his own experience in the telehealth platform suggests that with this innovation, the health care sector has got great benefits and also become capable of sharing the necessary information and support healthcare providers. Telehealth is scaling up in this era, because of achieving high-quality outcomes regardless of geography at lower costs, also a burden on traveling can be reduced [55]. Centers for Disease Control and Prevention (CDC) in 2002, developed Crisis Emergency and Risk Communication training module, which is also called a communication model "to communicate information that public wants or needs to know to reduce the incidence of illness and death" in an emergency. Wherein the communication is done by "spokesperson" from public health officials or hospital physicians from the top official level in front of television [57]. Finally, COVID-19 lockdown 2.0 in India, long-pending telemedicine guidelines were issued by the ministry of health and family welfare (MoHFW), in collaboration with NITI Aayog and the Board of Governors (BOG) medical Council of India (MCI), these resulted in a surge teleconsultations program [58].

#### Application of artificial intelligence in tackling COVID-19

"Infectious disease surveillance, in particular, the timely detection and early warning of disease outbreaks are indeed a function of strength and capacity of the health system. The new booming artificial Intelligence (AI) has proven as a very good weapon to fight back [59] and analyze many issues. In the present situation, Artificial Intelligence (AI) has played a major role, starting from the outbreak of the virus, virus mutation to its forecast, and is useful in controlling this infection in real-time [60, 61]. It has helped the hospitals to prepare a strategic plan regarding the requirements. Biosensors have helped very efficiently for detecting viral pathogens in the air, water, soil surfaces, human and animal tissues and also detect symptoms even before people realize they're infected [62]. In the future, this seems to become an important technology to fight against other epidemics and pandemics as well [63]. While the world waits for a vaccine for COVID-19, Artificial intelligence (AI) accelerates the process by reasoning across all available biomedical data and information in a systematic search for existing approved medicines [64, 65]. White House and a coalition of leading research groups in response to the pandemic have started free COVID-19

open Research Dataset Challenge(AI's COVID-19), which contains around 200,000 resources and 93,000 full-text articles on SARS-CoV-2 and related matter [65]. These resources are provided to the global research community to apply Artificial intelligence and extract relevant medical information from resources and guide the practitioners for effective treatment. Artificial intelligence also has a promising role starting from the prevention of disease-to predict the probable sites of infection, the influx of the virus, the need for beds, and necessary information/guidance for healthcare professionals during this crisis [60]. BlueDot is a Canadian start-up and Amazon web services (AWS) customer that uses AI machine learning algorithms to detect disease outbreaks, and first to raise the alarm about an outbreak of a respiratory illness in Wuhan, China [6]. *In silico* methods by using AI have designed six new molecules that could limit COVID-19 pneumonia's ability to virally replicate in cells [67]. A neural network is a kind of machine learning method that can extract the visual features of this disease and this would help in proper monitoring and treatment of the affected individuals [69]. Benevolent AI and imperial college London used algorithms to find the potential drug targets, which are found to be more promising because software pointed to the enzyme adaptor-associated protein kinase (AAK1) as possible to target for the disease [67]. For instance, experts from the pharmaceutical industries often seek help through artificial Intelligence to understand the depth of health crises in society.

## CONCLUSION

Novel COVID-19 pandemic has affected almost all the sectors very badly perhaps pharmaceuticals and health care sector are also a major hit at the initial lockdown period. Currently, the detection of the corona infection is been carried out by taking the swabs from nasal and oral tracts of the suspects however, since the presence of the virus is also reported from the stool samples of the patients hence alternatively examining fecal samples of the suspects for the confirmation of the virus can be thought of. The usage of face masks, hand gloves, and hand sanitizers has greatly increased by health workers and also by the general public. Although there was a shortage of ventilators and PPE kits supply initially but gradually, it is adequately supplied now. Doctors and nurses and allied health workers are forced to work many extra hours to treat the over the rush of COVID 19 patients which are causing them stress and exposing them to great health risk in this situation some governments came forward to announce the life insurance policy to corona warriors which are a welcome move, in addition, hospital management should also think to compensate the health care professionals involved in treating the corona patients with good incentives or other benefits. During this COVID 19 pandemic telemedicine was experimented very well by most of the doctors to reach out to their patients and to provide consultation, so this in future can be of major help in case of any such outbreaks. Artificial intelligence is much to offer future as in this biosensor were initially helped to find the pandemic in future, they can be adopted great way to detect the outbreaks. This pandemic also made to think about constructing the wards in the hospitals in a special way to offer not only a better for the such rapid spreading infected patients but also to avoid the other outpatients and other admitted in-patients with other complications from such isolation wards. As symptomatic treatment was offered for the patients initially such as Hydroxychloroquine, Lopinavir, Ritonavir, Tocilizumab, and Sarilumab. Thus, pharmaceutical companies were asked to manufacture these drugs in bulk quantity to cater to the world's needs and in the first quarter of this year, it was seen that there was a great surge in the manufacture and distribution of these drugs especially hydroxychloroquine by renowned pharmacy companies worldwide. India and China played a major role in supplying these drugs to many countries around the world. As this pandemic hit the world's economy very badly, after the lockdown of more than two months slowly many countries started to unlock the movement of transport, public and other processes to normalize and help the common public to lead their normal life. As the process of unlocking began the number of COVID 19 cases is also increasing drastically as sometimes it is hard to follow strictly the guidelines suggested by the health authorities. This situation necessitates the strong immunization of the people such as vaccines or interferons which

can effectively save the life of patients against such infections. Inactivated COVID 19 vaccines are tried in laboratory animals and also in humans on a small scale by some pharmaceutical companies but still, it will take time to complete the clinical trials and to get final approval by authorities to reach the people, till then it is advised to work by maintaining social distancing, protecting oneself with mask, by employing hand sanitization and avoid overcrowding. Certainly, new potential therapeutic regimens will emerge out with the researches going on across the globe with the rapid phase against this rapidly spreading COVID 19 virus. Let us be optimistic and work safely to save ourselves and serve the community.

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Nil

## RESPONSE TO COMMENTS

Corrections on font size, changing the referencing style are done accurately.

## AUTHORS CONTRIBUTIONS

All author has equally contributed by giving ideas in writing this review.

## CONFLICTS OF INTERESTS

All the authors have hereby declared that they have no conflict of interest.

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