Chapter

Potential Therapeutics Pathways in Solving the Challenges of the COVID-19 Pandemic

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Abstract

Millions of lives throughout the globe are under threat due to the COVID-19 pandemic. COVID-19 causes severe respiratory tract infections. In most countries COVID-19 Infections and deaths continue to soar despite the various measures put in place by the World Health Organization. These measures include limited mobility through lock down and banning international travelers. Furthermore, social distancing, wearing masks, frequent hand washing with soap and sanitizing were undertaken to slow down the rate of the virus spread. Only few countries like South Korea have been able to contain the virus to date. Our only hope is in biotechnology which have been used to develop diagnostic kits and more recently approved vaccines: vaccines by Pfizer-BioNTech and Moderna; AstraZeneca and Oxford University vaccine; Sputnik V vaccine; Sinopharm and the Beijing Institute of Biological Products vaccine. However, the vaccines are yet to reach the majority of the world population. Hence, there is need for concerted effort among governments and non-governmental organizations in all nations to develop the necessary infrastructures to step up vaccine production, and procurement as well as vaccination programmes. There is need for continued effort in biotechnology, to develop COVID-19 therapeutic drugs.

Keywords: COVID-19, social distancing, pandemic, diagnostic kits, prevention, biotechnology, vaccines

1. Introduction

The outbreak of the novel COVID-19 (SARS-CoV-2) which the World Health Organization declared a pandemic in March 2020 was first detected in Wuhan, China [1]. It has endangered millions of lives, especially individuals with chronic conditions such as high blood pressure and diabetes [2]. COVID-19 causes severe respiratory tract infections. This chapter focuses on the current status of coronavirus cases and deaths worldwide, and the underway efforts to develop a vaccine or a therapeutic drug to the pandemic.

2. The current status of coronavirus cases and deaths

On the 12th of December 2020, the World Health Organization (WHO) reports that there were 69 808 588 confirmed cases and 1 588 854 deaths worldwide [3]. From **Figure 1**. America and Europe had the highest number of confirmed daily

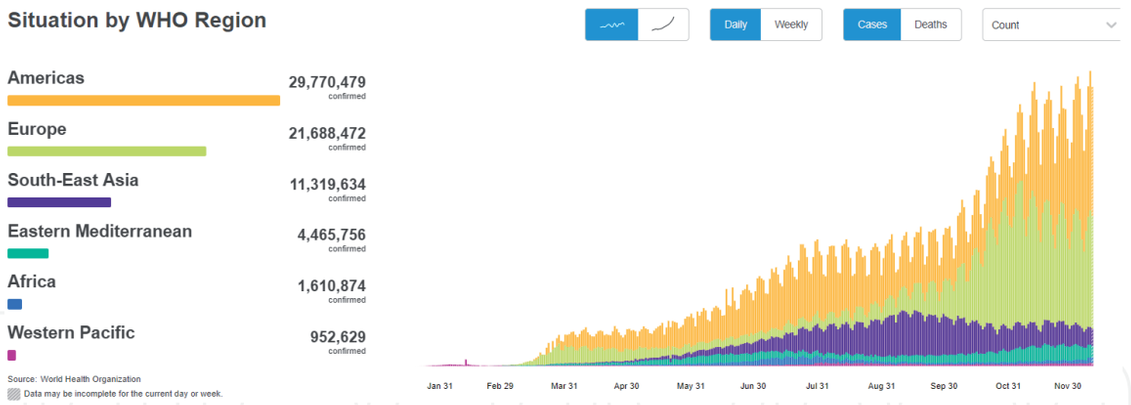

Figure 1.
Number of COVID-19 daily confirmed cases by WHO region from 31 January 2020 up to 30 November 2020 (WHO, 2020).

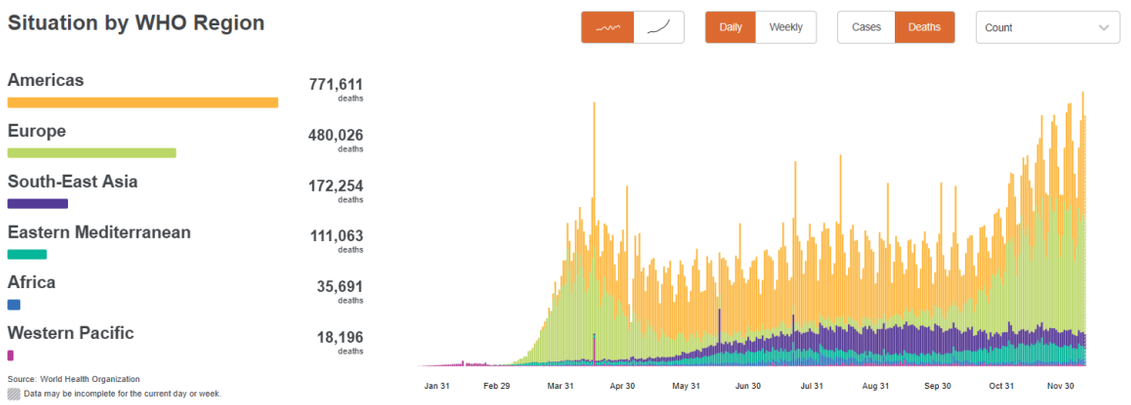

Figure 2.
Number of COVID-19 daily confirmed deaths by WHO region from 31 January 2020 up to 30 November 2020 (WHO, 2020).

COVID-19 cases of 29 770 479 and 21 688 472 respectively on the 30th of November 2020. The least numbers of daily confirmed cases are recorded in Africa (1 610 874) and the Western Pacific (952 629).

From **Figure 2**. America and Europe recorded the highest numbers of deaths by the 30th of November 2020 while Africa and the Western Pacific recorded the least numbers of deaths.

3. An overview of the successes and failures to contain the virus

The COVID-19 pandemic has affected the health, economy, and social mobility of people in countries around the world. Limited mobility through a lockdown and banning international travelers and social distancing, wearing face masks, and health officials and agencies undertook frequent hand washing with soap to slow down the rate of infection. These measures delay the spread of viral infections, reduce the acute pressure on hospital beds, frontline medical personnel, and resources [4]. The measures, thus, prevent the collapse of the national healthcare systems.

Countries like South Korea and Singapore were able to contain the virus due to the rapid and extensive tests carried out accompanied by preventive measures, including early school closures [5]. Furthermore, interviews were conducted by the South Korean government followed by cellphone contact tracing to track down the contacts of new coronavirus patients and ordered those contacts to self-isolate [6]. However, the United States of America's failure to contain COVID-19 is attributed to the slow

rate of testing during the first onset of the pandemic due to the shortage of testing kits [7]. A huge proportion of the population in the USA has chronic conditions [8]. Hence, they easily succumb to the virus. Measures such as lockdown are important to slow down the rate of transmission. However, there is a need to develop a vaccine or a drug that can treat the coronavirus. It is hoped that Biotechnology companies will come with a suitable vaccine or therapeutic drug to ease the pressure of the pandemic.

4. Opportunities in the biotechnology industry

Biotechnology research is essential in the development of key interventions such as vaccines and drugs to fight off the pandemic [9]. The new pandemic opened up opportunities for medical specialists and biological researchers to look for different ways of managing and containing the spread of the virus using biotechnology. Rosales-Mendoza, Comas-García and Korban (2020, p.283) assert that the onset of Covid-19 opened up opportunities for researchers:

> *Under these unusual circumstances, academic researchers can work on pending manuscripts, analyze data, conduct experiments left behind on the back burner, and more importantly pursue new ideas for discovery: developing vaccines and monoclonal antibodies and screening antiviral compounds, such as secondary metabolites and peptides; thereby, actively participating in finding solutions to ongoing real-time global human and economic crises.*

More research groups in academia and in private industry are now offering free webinars to share and demonstrate new technologies or experimental protocols [9]. Young researchers will have valuable new opportunities to acquire and develop new skills and ideas to make the best out of this situation.

Efforts were made to develop diagnostic assays, prophylactic vaccines and therapeutics using biotechnology to combat the Covid-19 pandemic. Significant efforts have been made by biotechnology companies and organizations to develop new types of diagnostic kits, ventilators and therapeutic regimens or antivirals [1]. Several centres were made available for clinical trials.

Shortages of Test kits prompted Local companies such as CapeBio Technologies in South Africa to develop Covid-19 test kits that were more efficient than the imported kits [1]. To speed up the production of reagents and test kits for Covid-19, the organizations such Department of Science and Innovation, the South African Medical Research Council and the Technology Innovation Agency funded companies, organizations and researchers for Covid-19 projects. The University of the Witwatersrand collaborated with the University of Oxford and started the Ox1Cov-19 vaccine trial in South Africa in June 2020 [1]. Human Research Ethics Committee had to approve the vaccine to ensure the safety of participants. The Covid-19 pandemic has demonstrated that some developing countries such as South Africa have the biotechnological expertise needed to address their health challenges.

5. The role of plants in biotechnology

Plants can play an essential role in producing diagnostic reagents to identify infected and recovered individuals, vaccines to combat infection, and antivirals to treat symptoms [4]. Plants have been used as a platform for the production of plant-derived proteins as diagnostic reagents for more than 30 years [10]. Assays for the detection of the virus can either detect the virus genomic RNA or virus

proteins. The RNA based assay lacks a universal positive control, which would allow standardization across different testing laboratories. Scientists are using biotechnology to develop a diagnostic control reagent for COVID-19 based on virus-like particles (VLPs) derived from Cowpea mosaic virus [11]. Thus, plant biotechnology is playing an important role in the development of diagnostic reagents. In addition, the plant is also being used to produce vaccines and antivirals that are being tested using mice. According to Capell et al., antiviral drugs interfere with the viral replication cycle and slow down the infection [4]. The slowed infection gives the immune system more time to respond to the virus.

6. Current efforts and successes in finding a lasting solution to the coronavirus pandemic

Healthcare professional researchers are trying different types of drugs existing in the market [2]. Such drugs have proven effective in the treatment of other respiratory illnesses. They are hopeful that some of the drugs may also be effective against COVID-19.

Lockdowns due to the COVID 19 pandemic can only be implemented for a reasonably short period as they disrupt industrial production, the global supply chain as well as international trade [2]. Hence, there is need to develop thereupetic drugs and vaccines through biotechnology.

As a result, the demand for the vaccine, drugs and other medical products is rising exponentially as the new COVID-19 cases rise throughout the world. The biotechnology industry, such as pharmaceutical companies and research organizations across the world have the challenge to develop vaccines and drug therapies to combat the spread of COVID-19 [2]. Different organizations are working together in tracking the pandemic, providing advice on essential interventions, distributing vital medical supplies to the needy [12].

Vaccines save millions of lives by boosting the immune system to produce the necessary antibodies that recognize and fight off the pathogens they target [12]. If the body is exposed to the pathogens later, the immune system immediately destroys them, preventing illness. Vaccines consist of small amounts of weakened harmless versions of the pathogen that cause the disease.

Several companies including non-governmental entities and the World Health Organization are working tirelessly to identify the vaccines and treatment drugs to prevent the spread of COVID-19 [1, 12, 13]. WHO is working in collaboration with different partners, with more than 50 COVID-19 vaccine in trials to speed up the pandemic response. A safe vaccine will first be distributed to people who are most at risk while the public health actions continue to suppress transmission and reduce mortality. The people who are at risk include health workers, older age groups and people with underlying medical conditions. It has not been established how long the vaccines will last in terms of protection. Therefore, all measures being taken now to reduce the transmission should continue.

The National Institute of Allergy and Infectious Diseases and the Coalition for Epidemic Preparedness Innovations – developed a vaccine using mRNA biotechnology with hopes to begin human tests of their product in April 2020 [14]. The Regional Centre for Biotechnology (RCB), a top research institute in Faridabad, India, is actively contributing to the global research efforts to combat the COVID-19 pandemic. RCB is conducting research activities such as potential inhibitors, markers and transmission reduction through the virucidal coating [14]. The virucidal coating will help destroy or deactivate the virus on different surfaces like glass, plastic and textiles, including cotton, nylon, and polyester that can potentially

hinder the viral transmission [14]. Several companies have begun the development of vaccines and antiviral therapies.

The work previously done on medical countermeasures (MCMs) against other coronaviruses, including SARS, are being tested against the novel COVID-19. Various other antiviral drugs and biologics are being investigated, and several have entered clinical trials to test for efficacy and safety against COVID-19.

By the 18th of November 2020, Pfizer and BioNTech conclude phase 3 study of the covid-19 vaccine candidate. Their vaccine, BNT162b2, has proved to be 95% effective against COVID-19 beginning 28 days after the first dose. The vaccine has met the following conditions:

- Efficacy was consistent across age, gender, race and ethnicity demographics; observed efficacy in adults over 65 years of age was over 94%

- Safety data milestone required by the U.S. Food and Drug Administration (FDA) for Emergency Use Authorization (EUA) has been achieved

- Data demonstrate vaccine was well tolerated across all populations with over 43,000 participants enrolled; no serious safety concerns observed; the only Grade 3 adverse event greater than 2% in frequency was fatigue at 3.8% and headache at 2.0% [15].

The following plans are under way:

- Companies plan to submit within days to the FDA for EUA and share data with other regulatory agencies around the globe

- The companies expect to produce globally up to 50 million vaccine doses in 2020 and up to 1.3 billion doses by the end of 2021

- Pfizer is confident in its vast experience, expertise and existing cold-chain infrastructure to distribute the vaccine around the world [15].

The vaccines by Pfizer-BioNTech and Moderna are nucleic acid/genetic vaccines [16]. Nucleic acid/genetic vaccines use synthetic virus genes to initiate the immune response. The genetic material causes the body's cells to produce the antigen, which in turn stimulates the production of antibodies [16, 17]. Although the immune response is long-lasting, the genetic instructions are short-lived. Nucleic acid vaccine technology allows the creation of vaccines and prompt manufacture of thousands of doses once the viral genetic sequence is known [18].

Similarly, viral vector-based vaccines provide the body cells with genetic instructions [19]. They use a harmless virus to transport the instructions [19]. The body's cells produce the antigen, which triggers antibody production. The Covid-19 vaccine Sputnik and the vaccine made by AstraZeneca and Oxford University use this biotechnology [16].

The third type of vaccines is called Inactivated vaccines. Inactivated vaccines contain viruses with destroyed genetic material, but they can still stimulate the immune system to produce antibodies [20]. The vaccine by Sinopharm and the Beijing Institute of Biological Products use this biotechnology [16].

Finally, the Protein-based vaccines use either fragment of or the entire virus protein, which triggers an immune response. Coronavirus vaccines produced by Novavax, Sanofi and Bektop, use this biotechnology although they are currently not yet approved [16].

Once a vaccine has been produced, it is critical to identify the dose that best balances safety and efficacy. Age is also another important factor that should be considered since the immune functions decline with age leading to poor vaccine responses. Currently, it has not been proved whether older adults would need high doses of Covid-19 vaccine as is the case with influenza vaccines [21]. After passing all the trial phases, each vaccine must be licensed and then production must be increased to meet the global demands. It is critical to ensure that vaccines are affordable and accessible to both low income and middle-income countries for immunization programmes can be implemented.

Efforts are being made to use monoclonal antibodies in the treatment of COVID-19. Currently, cocktail REGN-CoV 2 and Lilly's LY-CoV555 which target the viral spike glycoprotein (S-protein) are under trial for the treatment of the coronavirus [22]. Eleven other monoclonal antibodies that target the S-protein are under trial [22]. Monoclonal antibodies are vital especially for the elderly who may not respond well to the vaccine.

Although there is no cure for COVID-19, patients have been found to benefit from the use of remdesivir [23]. However, the solidarity trials done in October 2020 indicated that the remdesivir and other drugs (hydroxychloroquine, lopinavir and interferon) had little or no effect on mortality and duration of hospital stay for patients in hospital[Who 2020]. The use of corticosteroids has been found to be effective against severe COVID-19 [24].

7. Conclusion

Biotechnology has raised hope to the world through the production of several vaccines. However, until there is an efficacious vaccine and an effective treatment drug that is accessible to everyone, we should keep in mind that SARS-CoV-2 or coronavirus is likely to remain a seasonal pathogen. The current measures that are in place to prevent the spread of infection should be maintained because it will take a long time for the vaccine to be accessible to all nations. The efforts that are being made to come up with more vaccines and therapeutic drugs should continue to be supported. The governments and the private sector should collaborate in providing the necessary funding to companies and researchers who are working tirelessly to develop new vaccines and treatment drugs.

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Conflict of interest

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