HIGH SCHOOL EDITION
Journal of Student Research
Volume 12 Issue 4 (2023)

Recommendations for United States Pandemic Prevention After COVID-19

Albert Zhang[1], Reto Asmis[2#] and Avi-Yona Israel[3#]

[1]Biotechnology High School
[2]Wake Forest University School of Medicine
[3]American University School of Public Affairs
[#]Advisor

ABSTRACT

Severe acute respiratory system coronavirus 2 (SARS-CoV-2) is a novel coronavirus that was responsible for the 2020 pandemic. As of June 2023, it has resulted in over 700 million confirmed cases and almost 7 million deaths globally (WHO, 2023). The United States suffered the most during the early pandemic, surpassing 1 million cases and 100,000 deaths by June 2020 (CDC, 2023). Several factors affected the US's response to the SARs-CoV2 outbreak, including social forces, public health legislation, and the healthcare system. These all altered the rate at which COVID spread among Americans, as well as its lethality. This review examines the effects various factors had on the US government's COVID-19 response, and how they either positively or negatively affected the spread of SARS-CoV2. This is a multidisciplinary review focused on not only the mechanisms of the virus, but also on political and social factors. Based on the successes and shortcomings of the United States COVID-19 response, this paper suggests recommendations that will help the United States respond more effectively to the next pandemic similar to the novel coronavirus outbreak.

Introduction

The SARS-CoV2 is a novel coronavirus that caused the recent COVID-19 pandemic. Ever since the virus surfaced in 2019 in Wuhan, China, it has experienced rapid spread around the world. By late June 2020, the COVID-19 pandemic had reached 10 million confirmed cases and 590,000 deaths worldwide (WHO, 2023). The United States was particularly harshly affected by the pandemic, surpassing China with the most confirmed cases in the world in late March of 2020 (Alexander et al., 2021). The US still leads the world in the number of confirmed cases and deaths today (WHO, 2023).

SARS-CoV2 is a member of the beta-coronavirus group (Chams et al., 2020). Earlier members of the family include severe acute respiratory syndrome coronavirus (SARS-CoV), which originated in 2002 in Foshan, China, and the Middle East respiratory syndrome coronavirus (MERS-CoV), which originated in Jordan in 2012 (CDC, 2020). SARS-CoV2 is defined by a lower case fatality rate than its predecessors, but it is also far more infectious. The three variants of the coronavirus share a zoonotic origin. The origin of SARS-CoV2 in particular has been associated with bats in southern China; this has been supported by base sequencing of viral genetic material from SARS-CoV2 and viruses present on the bats (Guo et al., 2020).

SARS-CoV2 is spread through respiratory droplets, such as coughing or sneezing. It is also an airborne virus, and as such accumulates in confined spaces. Once the virus infiltrates the body, it infects respiratory cells through the cell receptors Angiotensin-converting enzyme 2 and transmembrane protease, serine 2 (Bohn et al., 2020). Once inside the cell, the viral RNA is copied and then transcribed by the host cell's bound ribosomes. The newly made viral components self-assemble and then are expelled from the cell through vesicles (CDC, 2023).

The primary cause of the symptoms of COVID-19 is the human body's inflammatory response to the virus. Symptoms of COVID-19 include cough, fever, difficulty breathing, shortness of breath, headache, loss of taste or smell, muscle ache, sore throat, sneezing, congestion or runny nose, fatigue, and nausea or vomiting. Long-COVID may occur in some individuals after initial recovery from COVID-19. It is defined by the persistence of symptoms of the disease. Long-COVID primarily affects the respiratory system (Raveendran et al., 2021). Causes of long-COVID are still unknown.

Many factors, such as public policy, disease tracking, and vaccination, defined the United States' response to the COVID-19 outbreak, for better and for worse. The early US response was ineffective and slow; this is surprising, as global evaluations ranked the US as one of the countries highest in pandemic preparedness prior to the 2020 pandemic.

This article discusses and reflects on the various components of the US COVID-19 pandemic response and uses them to create recommendations to facilitate a more effective response to the next global pandemic. Both statistical and holistic data has been analyzed in the formation of these recommendations. They consist of enforcing and clarifying regulations, putting more focus into the development and distribution of disease testing early on, researching potential mRNA vaccines, improving contact tracing, and faster action on the part of the government.

Enforcing and Clarifying Public Regulations Limiting Pathogen Transmission

In the United States, the use of regulations to help control the spread of COVID-19 was often ineffective. One area for improvement is mask mandates. There is strong support that the use of masks has led to slower infection rates compared to an absence of mask usage. Studies have shown that mandates have been conducive to lowering the number of new COVID-19 in both urban areas and smaller counties, including an analysis on the spread of COVID-19 in different counties in Kansas with varying mask policies (Islam et al., 2021).

However, many Americans disregarded mask mandates, which greatly hastened the spread of the COVID-19. Adherence to mask policy was inconsistent in some areas of the United States; a multi-state study on mask policy reported that a third of the sample did not follow masking policies, while roughly 20% did not carry a mask at all (Ruiz et al., 2023). This underperformance in the face of a mandate may have stemmed from a lack of enforcement of mask policy. During the COVID-19 pandemic, local law enforcement was often hesitant to enforce mask regulations through legal repercussions (Jacobs et al., 2020). Many sheriffs and police chiefs attributed the lack of enforcement to limited resources, while others cited moral and legal conflicts.

However, other countries such as As such, it is recommended that in the case of a future pandemic, state and local governments should encourage authorities to take action to actively enforce mask mandates. More resources should be allocated to help enforce regulations; for instance, manpower could be increased by outsourcing some of the workload to public civil workers.

Another shortcoming of policy implementation in limiting the infection spread regards the institution of lockdowns and limiting of social gatherings. On March 16, 2020, President Trump issued a national lockdown to attempt to limit mass gatherings and close public places; however, participation in the lockdown was voluntary, not required. As such, there was no unified response to substantially control COVID-19 transmission (Alexander et al., 2021). As such, future lockdowns should be enforced through disincentives, such as fines for lack of adherence, and active imposition of community moral responsibility. Moral responsibility would involve extensive communication to remind individuals of their responsibility to help keep their community safe, pressuring them to adhere to pandemic regulations. Moral responsibility would be imposed primarily through social media, the press, school education, and communicative media. In other words, communication will be key to effective policy.

Continue Refining RNA Vaccines

The next pandemic is very likely to be caused by a novel spillover virus, similar to how SARS-CoV2 was responsible for the COVID-19 pandemic. As such, quickly finding a vaccine for the new virus will be a task of utmost importance. Fortunately, the recent pandemic has brought to light RNA vaccines as a valuable tool in the fight against disease outbreaks in the future. Although there were several clinical trials for vaccine candidates of MERS-CoV, SARS-CoV, and SARS-CoV2, the mRNA vaccines mRNA-1273 by Moderna and BNT162b by Pfizer were the first vaccines to be licensed for use in several countries (Park et al., 2021). Through the successful implementation of mRNA vaccines for SARS-CoV2, mRNA vaccines have proven to be advantageous over other vaccines due to their versatility and capability for rapid development (Park et al., 2021).

Several challenges were faced in the initial development of the mRNA vaccine for SARS-CoV2. The primary problem was rapid mRNA degradation; mRNA is naturally highly unstable, typically degrading in vivo after roughly 10-15 minutes (Park et al., 2021); as such, the viral RNA would degrade before it could make a host cell synthesize viral proteins. In addition, the mRNA activates the innate immune system, as the system is designed to attack foreign objects in the body including viruses. The innate immune system targets the RNA and hinders the production of viral proteins, preventing the activation of the adaptive immune response. However, the major roadblocks regarding mRNA vaccines were overcome during the development of COVID-19 vaccines. Optimizations to the vaccine design, such as 5' mRNA capping and modification of the 3' polyA tail, have significantly improved the RNA stability. Additionally, nucleoside modification prevents antigen recognition by the innate immune system's Toll-like receptors. These techniques used in the COVID-19 mRNA vaccines can also be applied to mRNA vaccines that are developed in the future. RNA vaccines are versatile and can be rapidly developed; since their design issues have already been addressed, they may possibly become a gold standard for vaccines in the future.

Improving Contact Tracing

Contact tracing is one bastion against the early spread of epidemic diseases. Contract tracing has already proven to be effective in slowing the transmission of COVID-19 through prompt quarantining of close contacts of COVID patients (Juneau, 2023). However, within the US contact tracing was often inconsistent or even lacking. This was due to a lack of human resources during the COVID-19 pandemic. When cases surged in 2020, the number of contact tracers in the US was far below the count recommended by public health experts at the start of the pandemic (Simmons-Duffin, 2020). Contact tracers were increasing in number during this time, but at a very slow pace. With many regions lacking in contact tracing workforce, efforts to contain the spread of the virus have been less effective. The COVID pandemic has also seen an increase in the use of digital contact tracing apps, but this did not have a significant impact on the overall scene.

As such, we propose that for future pandemics, the manpower for contact tracing should be improved through taking more decisive action earlier to train contact tracers. Authorities can facilitate this by encouraging the education of civil workers, such as teachers, on contact tracing procedures, which outsources the work to far more adults. In addition, the use of digital contact tracing apps should be encouraged. Currently, it has shown to marginally improve contact tracing efforts, but its effectiveness is hindered by a lack of public use and acceptance (Simmons-Duffin, 2020). Encouraging more people to utilize digital contact tracing technology would address one of its main flaws, increasing its benefit in slowing disease transmission.

Improving Testing Kit Distribution and Development

Development of testing within the US was slow, as it was hindered by defective tests and slow enlistment of labs for research (Alexander et al., 2021). In February 2020, many of the test kits produced by the CDC were discovered to be contaminated and give inaccurate readings (Kenen, 2020). The first COVID fully functional test in the United States was authorized in 2020 on March 8th, after the outbreak was well underway in the country (CDC, 2023). However, the test kit's accuracy was still a concern, as false readings remained an issue.

The arduous process of creating a new test kit for COVID-19 could have been easily avoided. The first ever tests for public use were created as early as January; in fact, by the end of February the World Health Organization (WHO) was supplying test kits to almost 60 countries (Kenen, 2020). However, the United States refused to use the WHO tests. This was one of the key failures in the Trump Administration's response to the COVID-19 pandemic. The lack of adequate testing during the initial outbreak in the US made it harder to monitor new cases and infection spread, contributing to the rapid spread of COVID-19 and the resulting high death count in 2020.

This contrasted starkly with Germany's effective development and use of testing early on. Germany was the first country to create a diagnostic test for COVID-19 through rPCR amplification, merely weeks after the genome of the virus was published on January 11 (Tan et al., 2020). This test was soon implemented in February, showing fast approval by the government. By April 7, 2020, Germany had carried out a total of 1.3 million tests, far exceeding the number of tested conducted in other COVID-19 hotspots in the European Union (Tan et al., 2020).

As such, for future pandemics testing kits developed by foreign nations must be used without hesitation if there is no viable replacement. In addition, domestically developed diagnostic tests should be approved with greater urgency, and more resources should be allocated to test kit development. Having access to fast, reliable testing earlier allowed both symptomatic and asymptomatic individuals who were exposed to the virus to quickly test for the disease. This would play a major role in disease control.

Improving Federal Government Response Speed

The early response to COVID-19 was comparatively slow within the US, hindering control of the virus and allowing it to spread faster early on. This contrasted starkly with other countries such as Germany. Germany had remarkable success in managing the early outbreak, with the reported death rate in early April 2020 being considerably lower than other European countries at only 1.5% (Tan et al., 2020). This was partly due to good coordination between the national and local governments. In addition, Germany's Chancellor Merkel displayed excellent communication with the public regarding pandemic safety (Frieden, 2021). As a result, the country was able to mount a strong, unified response to fight the COVID-19 epidemic. However, in the United States the bulk of the decision-making and management fell out from the federal government to state governments, and sometimes even from state to municipal governments. This inconsistency prevented a cohesive national response to the pandemic (Tan et al., 2020), as there were several policy differences between counties and states.

One significant reason for this difference in response between the two countries lies in the nature of the leaders of the two countries. Chancellor Merkel had a scientific background and adopted a more technocratic approach towards the pandemic, while Trump's course of action stemmed more from his ideological and political motivation (Forster et al., 2021). As such, Merkel relied more on science-based facts to make decisions regarding the COVID-19 pandemic, while Trump often ignored the advice of experts regarding the pandemic. An analysis showed that leaders who relied more on scientific evidence were quicker to take action and react during the early COVID-19 pandemic (Forster et al., 2021). This would give the people more time to mount an effective response before the outbreak spreads further.

As such, for future pandemics governments on federal and state levels should more closely observe the responses of other countries and states. From this, they can learn from the shortcomings and successes of others, leading

to a more effective pandemic response. In addition, the United States President and other major national leaders should take a larger role in communicating with citizens for clarity and to inform the public.

Conclusion

In conclusion, for the next pandemic, the United States government should actively enforce mandates and policies, through legal and moral incentives. In addition, contact tracer training should be more widespread, with ordinary civil workers also being given training in contact tracing. Before the next pandemic, governments must continue to research and refine RNA vaccines so that they can promptly be used to create vaccines for the new spillover virus. Lastly, the US federal government must maintain an open-minded and prompt approach, seeking guidance from other countries that are performing well in outbreak control.

Acknowledgements

I would like to that Dr. Reto Asmis for his guidance and scientific knowledge, both of which contributed greatly to the creation of this paper. I also thank Avi-Yona Israel for her help in editing and proofreading this paper.

References

Alexander, M., Unruh, L., Koval, A., & Belanger, W. (2021). United States Response to the COVID-19 Pandemic, January-November 2020. *Health Economics, Policy and Law*, *17*(1), 1–29. https://doi.org/10.1017/s1744133121000116

Bohn, Mary Kathryn, et al. "Pathophysiology of COVID-19: Mechanisms Underlying Disease Severity and Progression." *Physiology*, vol. 35, no. 5, American Physiological Society, Sept. 2020, pp. 288–301. https://doi.org/10.1152/physiol.00019.2020.

Centers for Disease Control and Prevention. (2022, August 16). *CDC Museum COVID-19 Timeline*. Centers for Disease Control and Prevention; CDC. https://www.cdc.gov/museum/timeline/covid19.html

Chams, N., Chams, S., Badran, R., Shams, A., Araji, A., Raad, M., Mukhopadhyay, S., Stroberg, E., Duval, E. J., Barton, L. M., & Hajj Hussein, I. (2020). COVID-19: A Multidisciplinary Review. *Frontiers in Public Health*, *8*. https://doi.org/10.3389/fpubh.2020.00383

Coronavirus Disease (COVID-19) – World Health Organization. 23 June 2023, www.who.int/emergencies/diseases/novel-coronavirus-2019.

Forster, Timon, and Mirko Heinzel. "Reacting, Fast and Slow: How World Leaders Shaped Government Responses to the COVID-19 Pandemic." *Journal of European Public Policy*, vol. 28, no. 8, Routledge, June 2021, pp. 1299–320. https://doi.org/10.1080/13501763.2021.1942157.

Frieden, Tom. "Which Countries Have Responded Best to Covid-19?" *WSJ*, 1 Jan. 2021, www.wsj.com/articles/which-countries-have-responded-best-to-covid-19-11609516800.

Guo, Yanrong, et al. "The Origin, Transmission and Clinical Therapies on Coronavirus Disease 2019 (COVID-19) Outbreak – an Update on the Status." *Military Medical Research*, vol. 7, no. 1, Springer Science+Business Media, Mar. 2020, https://doi.org/10.1186/s40779-020-00240-0.

Human Coronavirus Types | CDC. www.cdc.gov/coronavirus/types.html.

Islam, Hadie, et al. "Evaluating the Effectiveness of Countywide Mask Mandates at Reducing SARS-CoV-2 Infection in the United States." *Journal of Osteopathic Medicine*, vol. 122, no. 4, De Gruyter, Jan. 2022, pp. 211–15. https://doi.org/10.1515/jom-2021-0214.

Jacobs, Philip, and Arvi Ohinmaa. "The Enforcement of Statewide Mask Wearing Mandates to Prevent COVID-19 in the US: An Overview." *F1000Research*, vol. 9, Faculty of 1000, Sept. 2020, p. 1100. https://doi.org/10.12688/f1000research.25907.1.

Juneau, Carl-Etienne, et al. "Effective Contact Tracing for COVID-19: A Systematic Review." *Global Epidemiology*, vol. 5, Elsevier BV, Dec. 2023, p. 100103. https://doi.org/10.1016/j.gloepi.2023.100103.

Kenen, Joanne. "How Testing Failures Allowed Coronavirus to Sweep the U.S." *POLITICO*, 6 Mar. 2020, www.politico.com/news/2020/03/06/coronavirus-testing-failure-123166.

Park, Jung-Woo, et al. "mRNA Vaccines for COVID-19: What, Why and How." *International Journal of Biological Sciences*, vol. 17, no. 6, Ivyspring International Publisher, Jan. 2021, pp. 1446–60. https://doi.org/10.7150/ijbs.59233.

Raveendran, A. V., et al. "Long COVID: An Overview." *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, vol. 15, no. 3, Elsevier BV, May 2021, pp. 869–75. https://doi.org/10.1016/j.dsx.2021.04.007.

Ruiz, Monica S., et al. "Maintaining Adherence to COVID-19 Preventive Practices and Policies: A Systematic Observational Study of Masking and Distancing in the District of Columbia and Other US States (Preprint)." *JMIR Publications*, June 2022, https://doi.org/10.2196/40138.

Simmons-Duffin, Selena. "COVID-19 Contact Tracing Workforce Barely 'Inching up' as Cases Surge." *NPR*, 14 Oct. 2020, www.npr.org/sections/health-shots/2020/10/14/923468159/covid-19-contact-tracing-workforce-barely-inching-up-as-cases-surge.

Tan, Yongtian Tina, and Aaron S. Kesselheim. "Implementing U.S. Covid-19 Testing: Regulatory and Infrastructural Challenges." *Journal of Law Medicine & Ethics*, vol. 48, no. 3, SAGE Publishing, Jan. 2020, pp. 608–12. https://doi.org/10.1177/1073110520958889.

WHO. (2023, May 18). *WHO COVID-19 dashboard*. World Health Organization. https://covid19.who.int/