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REVIEW

Barriers to vaccination for coronavirus disease 2019 (COVID-19) control: experience from the United States

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ABSTRACT

To date, the United States (U.S.) has been the most heavily impacted country by the coronavirus disease 2019 (COVID-19). By November 30, 2020, when this paper was written, 13.5 million cases were reported in the U.S. with over 268 000 deaths. Historically, vaccines have been one of the most effective and efficient technical tools for controlling a communicable disease. While the development of these vaccines has certainly been a challenge, it could be more challenging to achieve robust vaccine uptake because of many barriers. In this review, we focused on two types of barriers documented from long-term experience in the U.S.: structural and attitudinal. Structural barriers are systemic issues that impact one's ability to access a service, and they include time, transportation, cost, and clinic or outlet location; while attitudinal barriers are beliefs or perceptions that impact the willingness of at-risk individuals to seek out and/or accept a service. In the context of vaccination they include beliefs about the communicable disease, beliefs about vaccines, fear, and trust in healthcare and governmental agencies. Of the attitudinal barriers, public trust is a barrier that is of particular importance. In addition to affecting reception of vaccines, it may exacerbate disparities and reduce the likelihood of success of a vaccination program. Recommendations are made to overcome attitudinal barriers to help improve the effectiveness of vaccination programs for COVID-19 control in the U.S., such as building public support through bipartisan endorsements and leveraging social media platforms to promote vaccination.

1. Introduction

The pandemic of coronavirus disease 2019 (COVID-19) is a respiratory infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, previously provisionally named 2019 novel coronavirus or 2019-nCoV). After cases of pneumonia of unknown etiology (unknown cause) detected in Wuhan City of China in December 2019, COVID-19 was detected in almost all countries in the world during a short period. In January 2020, the first travel-related COVID-19 cases were found in the United States (U.S.), with community spread confirmed in late February.¹ Recent studies have indicated an earlier introduction with lower levels of community spread occurring in January.¹ By November 30, a total of 13.5 million persons in the U.S. were confirmed COVID-19 cases with over 268 000 of deaths due to the infection.²

To curb the pandemic, initial control measures in the U.S. relied on widespread closures of public and commercial spaces through Stay at Home, Shelter in Place, or “lockdown” orders to enforce social distancing guidelines to help slow the spread of the virus. These restrictions in the U.S. varied states by states and were largely relaxed throughout the summer and fall months, although some places

are reintroducing stricter measures as cases are once again spiking. While interventions to encourage social distancing and masking have been effective, these interventions have not been without economic and psychological impacts. Furthermore, there is a widespread fatigue, resistance to taking preventative actions or enacting preventative policies, and a strong desire for life to return to a pre-pandemic normal.

An effective vaccine represents the best COVID-19 control option for a country to return to normalcy. However, as public health practice indicate that to control an epidemic like COVID-19, adequate number of people must be vaccinated. In December 2020, two vaccines were granted an emergency use authorization (EUA) by the U.S. Food and Drug Administration for use.³⁻⁴ To control the COVID-19 pandemic with the vaccination program, public health administrators and practitioners must consider all barriers that may prevent people from accessing and receiving the approved vaccines.

Experience from infectious disease control in the U.S. and the world has identified a large array of barriers that can interfere with vaccine uptake, resulting failure in disease control. The barriers can be broadly divided into two categories: structural and attitudinal. In this review, we summarize these two types of barriers.

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Table 1
Common structural barriers to vaccination.

Barrier	Description
Cost	Price of the vaccine or medical visit to receive the vaccine that is incurred by the individual ⁵⁻⁶
Convenience	The time someone has to take to get vaccinated, easy of physical access, and geographic and functional proximity to vaccines ⁷⁻¹²
Supply chain issues	Disruptions to or constraints on the production, distribution, and delivery of vaccines ¹³⁻¹⁴

2. Structural barriers

Structural barriers are systemic issues that may limit the ability of individual persons to access a vaccine service. These types of barriers could be addressed by making changes to the structure and funding mechanisms of the healthcare system and industries that supply the healthcare system. Table 1 summarizes common structural barriers to a vaccination program.

In the U.S., many of these barriers are being addressed by Operation Warp Speed (OWS), including effort from President Trump Administration to support the development vaccines against COVID-19, roll out for use once available.¹⁵ As a part of this effort, OWS has worked with major pharmacies, both stand alone and those within other businesses, across the U.S. to make the vaccine widely available to the general public.¹⁶ Additionally, the vaccine will be provided at no cost to individuals.¹⁶

Measures taken by OWS enhance the availability of vaccines by removing the structural barriers of time commitment, geographic proximity, and cost for many Americans. These measures have been used in the past to increase influenza vaccine uptake.¹⁷⁻¹⁸ Workplace vaccination programs, both for healthcare and essential non-healthcare workers, are effective for increasing vaccine uptake and could be utilized to increase COVID-19 vaccine uptake among people who have to leave their homes for work.⁸ OWS has also laid out their plans for distributing the vaccine and developing systems to monitor supply and demand, so that shortages do not occur where the vaccine is needed.¹⁵ Despite these plans, news reports indicate that the expected initial supply of COVID-19 vaccines is going to fall short of what was originally expected.¹⁹

The U.S. government agencies have ample experiences in supporting fast-paced vaccine development and distribution program to control the influenza pandemic. Although, the current outbreak of COVID-19 in the U.S. is more urgent and more challenge than influenza to control; these experiences will bode political will and funding for addressing the structural barriers. However, only focusing on these structural barriers and making vaccines widely available does not guarantee their uptake, as seen yearly with seasonal influenza vaccinations.²⁰

3. Attitudinal barriers

Different from structural barriers, attitudinal barriers are beliefs or perceptions that may reduce one’s willingness to seek out or accept a vaccine service. Addressing these barriers involves working with individuals and communities to build partnerships, listening to concerns and allaying fears, combatting misinformation, providing education to allow people to make fully informed decisions, and building trust. Table 2 summarizes common attitudinal barriers.

Drawing from experiences with other vaccine-preventable diseases is helpful but not necessary, as we are already seeing the impacts of these barriers on intent to receive a COVID-19 vaccine once it becomes available.^{1,27-31} A survey recently conducted by the Pew Research Center found that 39% of U.S. adults did not intend to get vaccinated against COVID-19.³² While it is reassuring that this proportion has decreased over time, it is greatly concerning that of these individuals, 53% would

Table 2
Common attitudinal barriers to vaccination.

Barrier	Description
Complacency about the disease being prevented	Low perceived risk of contracting or severity of the disease being prevented ^{6,21-22}
Perceived risks of vaccines	Beliefs that vaccines are harmful (i.e., cause the disease they claim to prevent or cause other conditions) ^{6,21-22}
Lack of trust	Mistrust towards vaccines, regulatory agencies that monitor vaccine development and distribution, healthcare workers who deliver vaccines, and companies who develop and produce vaccines ^{21,23-24}
Misinformation	False information that is produced and distributed to create fear and uncertainty around vaccines ²⁵
Misconceptions	Lack of knowledge about vaccines and recommendations to get vaccinated ^{5-6,21-22,26}

not change their minds with more information about the vaccines.³² If someone does not think the disease being prevented is serious or a big hoax, then they are unlikely to get a vaccine protecting them from that disease. If someone thinks that vaccines are dangerous and they are likely a plot to make money, they will be highly likely to skip the vaccination. If someone thinks that government agencies and medical communities involved in recommending and distributing a vaccine are not trustworthy, they are unlikely to listen to recommendations and get vaccinated.

These beliefs can be reinforced or introduced by the wealth of conspiracy theories about COVID-19, its origins, and the measures taken or not taken to control its spread and vaccines in general. In one study, conspiracy theories about COVID-19 were endorsed by a third of the study participants.²⁷ These beliefs are not without impact as these individuals were less likely to get a vaccine even if it is free and widely available.²⁷⁻²⁸ Unfortunately, these beliefs appear to be stable across time.²⁸ Correcting the errors present in conspiracy theories is important to help prevent propagation but addressing the underlying mistrust towards the medical community and governmental agencies is going to be key to overcoming this type of barrier.

4. Trust as the salient attitudinal barrier and driver of disparities

From the literature on seasonal influenza vaccinations, trust in agencies involved with vaccine development and distribution and their perceived competence significantly influences vaccine uptake. Furthermore, institutional mistrust is often not equally spread across subpopulation groups in a country. Differential institutional mistrust has also been found for COVID-19 in the U.S. Qualitative and quantitative studies have indicated that African Americans are more likely than others to mistrust the agencies involved in vaccine development and distribution, that may affect COVID-19 vaccine uptake.^{23-24,33}

Racial disparity in institutional mistrust is rather complex and politically sensitive. The legacy of abuses and ongoing discrimination against African Americans by the medical community and U.S. government helps to undermine their credibility. Understanding the disparity is beyond the scope of this study. However, be aware of this issue is key to protect all individuals in the U.S. regardless of skin color. Several studies have already reported that African Americans are less likely to report an intention to get a vaccination against COVID-19.^{30-31,34} We cannot ignore the issue in our vaccination program to promote equal health for all.

Issues around trust and the impacts of race on trust can help explain disparities in influenza vaccine uptake beyond structural barriers to accessing these vaccines, and it is very likely that they will also affect COVID-19 vaccine uptake. Greater belief in conspiracy theories around influenza vaccines among African Americans is another concerning parallel between influenza vaccination and the likely situation with COVID-

19 vaccines, as African Americans are more likely to endorse believing in conspiracy theories. New data from a survey conducted by Pew indicated that African Americans were less likely to intend to get the vaccine than Whites, Hispanics, or Asians.³²

Both historical and current data provide solid evidence, supporting the need for extra efforts to enhance equal vaccine update take across all racial groups in the U.S. Fortunately OWS acknowledged the barriers posed by mistrust and misinformation and the importance of building trust. Rebuilding trust will be a key to the success of any vaccination programs in the U.S. to achieve equal protection of all Americans from COVID-19 infection and to effectively control the epidemic.

5. Discussion and implications

Having an effective and widely available vaccine will be the best tool at our disposal for infectious disease control. Findings of this review suggest that programs to deliver vaccine must consider both structural and attitudinal barriers to ensure adequate number of persons being vaccinated. Further, all vaccines must be distributed fairly to achieve equal protection and to reduce disparities in infectious disease control. While the logistics of distributing a two-dose vaccine are challenging, they can be addressed with enough resources. Although it is a systematic issue in the U.S. around who can and cannot access healthcare, it can be easier to address than the attitudinal barriers. For example, with adequate funding, equipment can be purchased for transporting and storing vaccines; but it is rather difficult if not impossible to change people's minds. It can be especially difficult building trust, especially after the trust was undermined. Based on our review of the literature, the following recommendations can be considered to help rebuild trust for vaccination.

First, despite disparities in trust in national and international health agencies across populations in the U.S., endorsements from these organizations will increase the willingness of individuals to receive a vaccine.²⁹ The U.S. Centers for Disease Control and Prevention (CDC) has been promoting the seasonal flu vaccine to encourage uptake.³⁵ Since granting the EUAs to Pfizer and Moderna, the U.S. CDC has updated their website to promote these vaccines and provide educational materials on the vaccines and EUAs to both providers and recipients of the vaccine.³⁶ The Advisory Committee on Immunization Practices has made recommendations for who should be prioritized for receiving the vaccines, but these are not binding. There are many concerns about this, so more open dialogue on how the recommendations are determined may help improve trust in the process.³⁷

Second, since the first two vaccine candidates were approved by an emergency use authorization, it will be important for the public to understand what this means. Studies indicate that people would be less willing to get vaccinated if the vaccine was approved under an emergency use authorization.²⁹ This is especially concerning as experiences from earlier in the pandemic with this mechanism may undermine confidence in the system.³⁸ Therefore, it will be important to combat misconceptions about this process and be clear about the standards for approval. As mentioned above, the U.S. CDC's website provides educational materials on EUAs, but further proactive promotion of this information may help people feel more comfortable with the approval mechanism.

Third, social media has been a way for misinformation to spread quickly and a platform for the anti-vaccine movement.³⁹ The good news is that social media can also be used to promote vaccination. In a study of American and Canadian adults, only 4% said they would not get a vaccine if it were promoted within their social media networks.⁴⁰ Enlisting social media influencers and celebrities to promote vaccination may also help uptake.⁴¹ It should be noted that this should be used with a degree of caution. When testing was scarce for average Americans, celebrities were criticized for seemingly being preferentially treated in getting access to tests.⁴² Efforts should ensure that this image is not repeated with the vaccine. One option may be to encourage individuals

who get the vaccine to share this on their social media platforms along with their experiences. Recommendations for the types of communications that should be used or considered have been made by others and should be used in conjunction with these recommendations.⁴³⁻⁴⁵

Fourth, it has been a politically contentious year in the United States, with some politicians sowing distrust among their supporters. Many of these same politicians have also undermined the risk and severity of COVID-19 and questioned the competence and motivations of people and organizations trying to bring the pandemic under control.⁴⁶⁻⁴⁸ This same partisan rhetoric has already spilled over into the debate over vaccines.⁴⁹ Moving forward, it will be important to garner widespread political support for the vaccine from both of the major political parties at the local, state, and national level. Several governors, from both red and blue states, the three living former presidents, and the President-elect have come out in support of the vaccine, so hopefully this trend continues.⁵⁰⁻⁵² Cautions around using politicians to promote the vaccine are similar to the caution needed around leveraging celebrities and influencers to promote the vaccine. When prominent politicians received the COVID-19 vaccine early on, they were criticized for getting the vaccine while being perceived as denying aid to other Americans.⁵³

Fifth, it is going to be important to build relationships with community leaders to promote the vaccine among groups who have been historically marginalized and maligned, as many others have previously stated.⁴³ This is not going to be easy. In the past, governmental organizations and researchers have gone into these communities with claims they were there to help and then abused that trust.⁵⁴ In addition to building true, mutually beneficial partnerships, it is going to be important that the language around this issue not take on a tone that blames the victims of past and ongoing abuses.

This review focuses on the situation in the U.S. Some of these recommendations may be applicable to other countries, while some may not. For example, the approval mechanisms differ between countries, so discussions around education on granting approval for use in an emergency setting may or may not apply. Leveraging social media, national organizations charged with improving the nation's health, and politicians could apply to many countries, although the details may differ greatly across settings and the necessary messaging will change based on the context.

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Competing interests

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References

1. CDC COVID-19 Response Team, Jordan MA, Rudman SL, et al. CDC COVID-19 Response Team Evidence for limited early spread of COVID-19 within the United States, January-February 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69(22):680-684. doi:10.15585/mmwr.mm6922e1.

2. COVID-19 United States cases by County. Johns Hopkins Coronavirus Resource Center website. <https://coronavirus.jhu.edu/us-map>. Accessed October 4, 2020.
3. FDA Takes Key Action in Fight Against COVID-19 by Issuing Emergency Use Authorization for First COVID-19 Vaccine. U.S. Food & Drug Administration website. <https://www.fda.gov/news-events/press-announcements/fda-takes-key-action-fight-against-covid-19-issuing-emergency-use-authorization-first-covid-19>. Accessed December 22, 2020.
4. FDA Takes Additional Action in Fight Against COVID-19 by Issuing Emergency Use Authorization for second COVID-19 Vaccine. U.S. Food & Drug Administration website. <https://www.fda.gov/news-events/press-announcements/fda-takes-additional-action-fight-against-covid-19-issuing-emergency-use-authorization-second-covid>. Accessed December 24, 2020.
5. Chen G, Kazmi M, Chen D, Phillips J. Identifying associations between influenza vaccination status and access, beliefs, and sociodemographic factors among the uninsured population in Suffolk County, NY. *J Community Health*. 2020;45(6):1236-1241. doi:10.1007/s10900-020-00873-1.
6. Schmid P, Rauber D, Betsch C, Lidolt G, Denker ML. Barriers of influenza vaccination intention and behavior – A systematic review of influenza vaccine hesitancy, 2005–2016. *PLoS One*. 2017;12(1):e0170550. doi:10.1371/journal.pone.0170550.
7. Beshears J, Choi JJ, Laibson DI, Madrian BC, Reynolds GL. Vaccination rates are associated with functional proximity but not base proximity of vaccination clinics. *Med Care*. 2016;54(6):578-583. doi:10.1097/MLR.0000000000000523.
8. Worksite Health: Seasonal Influenza Vaccinations Using Interventions with On-Site, Reduced Cost, Actively Promoted Vaccinations non-Healthcare Workers. The Community Preventive Services Task Force website. <https://www.thecomunityguide.org/findings/worksite-health-seasonal-influenza-vaccinations-non-healthcare-on-site>. Accessed December 6, 2020.
9. Harris K, Maurer J, Black C, Euler G, Kadiyala S. Workplace efforts to promote influenza vaccination among healthcare personnel and their association with uptake during the 2009 pandemic influenza A (H1N1). *Vaccine*. 2011;29(16):2978-2985. doi:10.1016/j.vaccine.2011.01.112.
10. Black CL, Yue X, Ball SW, et al. Influenza vaccination coverage among health care personnel—United States, 2017–18 Influenza Season. *Morb Mortal Wkly Rep*. 2018;67(38):1050-1054. doi:10.15585/mmwr.mm6738a2.
11. Luz PM, Johnson RE, Brown HE. Workplace availability, risk group and perceived barriers predictive of 2016-17 influenza vaccine uptake in the United States: a cross-sectional study. *Vaccine*. 2017;35(43):5890-5896. doi:10.1016/j.vaccine.2017.08.078.
12. What Vaccination Rates in Rural America tell Us About the Advent of COVID Vaccines. USA Today website. <https://www.usatoday.com/story/news/health/2020/12/06/flu-vaccine-rates-rural-covid-19-vaccine/3832618001/>. Accessed December 6, 2020.
13. The Flu Vaccine is Delayed This Year, and Doctors Are Worried It May Impact Youngest Patients. Newsweek website. <https://www.newsweek.com/flu-vaccine-delayed-1457862>. Accessed December 6, 2020.
14. O'Donnell C. Pfizer says supply chain challenges contributed to slashed target for COVID-19 vaccine doses in 2020. Reuters website. <https://www.reuters.com/article/us-health-coronavirus-pfizer-vaccine-idUSKBN28D3B9>. Accessed December 6, 2020.
15. Operation Warp Speed, U.S. Department of Health and Human Services, U.S. Department of Defense. From the Factory to the Frontlines: The Operation Warp Speed Strategy for Distributing a COVID-19 Vaccine. <https://www.hhs.gov/sites/default/files/strategy-for-distributing-covid-19-vaccine.pdf>. Accessed December 6, 2020.
16. Trump Administration Partners with Chain and Independent Community Pharmacies to Increase Access to Future COVID-19 Vaccines. HHS Press Office, U.S. Department of Health and Human Services website. <https://www.hhs.gov/about/news/2020/11/12/trump-administration-partners-chain-independent-community-pharmacies-increase-access-future-covid-19-vaccines.html>. Accessed December 4, 2020.
17. Kirkdale CL, Nebout G, Megerlin F, Thornley T. Benefits of pharmacist-led flu vaccination services in community pharmacy. *Ann Pharm Fr*. 2017;75(1):3-8. doi:10.1016/j.pharma.2016.08.005.
18. Chun GJ, Sautter JM, Patterson BJ, McGhan WF. Diffusion of pharmacy-based influenza vaccination over time in the United States. *Am J Public Health*. 2016;106(6):1099-1100. doi:10.2105/AJPH.2016.303142.
19. Trump's Operation Warp Speed promised a flood of covid vaccines. Instead, states are expecting a trickle. Washington Post website. <https://www.washingtonpost.com/business/2020/12/05/operation-warp-speed-coronavirus-vaccine-shortfall/>. Accessed December 6, 2020.
20. Ding H, Kahn KE, Black CL, O'Halloran A, Lu PJ, Williams WW. Influenza vaccination coverage among pregnant women in the U.S., 2012–2015. *Am J Prev Med*. 2019;56(4):477-486. doi:10.1016/j.amepre.2018.11.020.
21. MacDonald NE. Vaccine hesitancy: definition, scope and determinants. *Vaccine*. 2015;33(34):4161-4164. doi:10.1016/j.vaccine.2015.04.036.
22. Nowak GJ, Sheedy K, Bursley K, Smith TM, Basket M. Promoting influenza vaccination: insights from a qualitative meta-analysis of 14 years of influenza-related communications research by U.S. Centers for Disease Control and Prevention (CDC). *Vaccine*. 2015;33(24):2741-2756. doi:10.1016/j.vaccine.2015.04.064.
23. Quinn SC, Jamison A, Freimuth VS, An J, Hancock GR, Musa D. Exploring racial influences on flu vaccine attitudes and behavior: results of a National Survey of African American and White Adults. *Vaccine*. 2017;35(8):1167-1174. doi:10.1016/j.vaccine.2016.12.046.
24. Freimuth VS, Jamison AM, An J, Hancock GR, Quinn SC. Determinants of trust in the flu vaccine for African Americans and Whites. *Soc Sci Med*. 2017;193:70-79. doi:10.1016/j.socscimed.2017.10.001.
25. Guidry JPD, Austin LL, O'Donnell NH, Coman IA, Lovari A, Messner M. Tweeting the #flushout: beliefs, barriers, and threats during different periods of the 2018 to 2019 flu season. *J Prim Care Community Health*. 2020;11:2150132720932722. doi:10.1177/2150132720932722.
26. Lu P, Srivastava A, Santibanez TA, et al. Knowledge of influenza vaccination recommendation and early vaccination uptake during the 2015-16 season among adults aged ≥18 years – United States. *Vaccine*. 2017;35(34):4346-4354. doi:10.1016/j.vaccine.2017.06.074.
27. Earnshaw VA, Eaton LA, Kalichman SC, Brousseau NM, Hill EC, Fox AB. COVID-19 conspiracy beliefs, health behaviors, and policy support. *Transl Behav Med*. 2020;10(4):850-856. doi:10.1093/tbm/ibaa090.
28. Romer D, Jamieson KH. Conspiracy theories as barriers to controlling the spread of COVID-19 in the U.S.. *Soc Sci Med*. 2020;263:113356. doi:10.1016/j.socscimed.2020.113356.
29. Kreps S, Prasad S, Brownstein JS, et al. Factors associated with US adults' likelihood of accepting COVID-19 vaccination. *JAMA Netw Open*. 2020;3(10):e2025594. doi:10.1001/jamanetworkopen.2020.25594.
30. Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? *Vaccine*. 2020;38(42):6500-6507. doi:10.1016/j.vaccine.2020.08.043.
31. Fisher KA, Bloomstone SJ, Walder J, Crawford S, Fouayzi H, Mazor KM. Attitudes toward a potential SARS-CoV-2 vaccine: a survey of U.S. adults. *Ann Intern Med*. 2020;173(12):964-973. doi:10.7326/M20-3569.
32. Intent to Get a COVID-19 Vaccine Rises to 60% As Confidence in Research and Development Process Increases. Pew Research Center Science & Society website. <https://www.pewresearch.org/science/2020/12/03/intent-to-get-a-covid-19-vaccine-rises-to-60-as-confidence-in-research-and-development-process-increases/>. Accessed December 4, 2020.
33. Jamison AM, Quinn SC, Freimuth VS. You don't trust a government vaccine": narratives of institutional trust and influenza vaccination among African American and white adults. *Soc Sci Med*. 2019;221:87-94. doi:10.1016/j.socscimed.2018.12.020.
34. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. *EClinicalMedicine*. 2020;26:100495. doi:10.1016/j.eclinm.2020.100495.
35. CDC Digital Media Toolkit: 2020-21 Flu Season. U.S. Centers for Disease Control and Prevention website. <https://www.cdc.gov/flu/resource-center/toolkit/index.htm>. Accessed December 6, 2020.
36. COVID-19 Vaccination. U.S. Centers for Disease Control and Prevention website. <https://www.cdc.gov/vaccines/covid-19/index.html>. Accessed December 30, 2020.
37. Dooling K, Marin M, Wallace M, et al. The Advisory Committee on immunization practices' updated interim recommendation for allocation of COVID-19 vaccine — United States, December 2020. *MMWR Morb Mortal Wkly Rep*. 2021;69(5152):1657-1660. doi:10.15585/mmwr.mm695152e2.
38. Thomson K, Nachlis H. Emergency use authorizations during the COVID-19 pandemic: lessons from hydroxychloroquine for vaccine authorization and approval. *JAMA*. 2020;324(13):1282. doi:10.1001/jama.2020.16253.
39. Burki T. The online anti-vaccine movement in the age of COVID-19. *Lancet Digit Health*. 2020;2(10):e504-e505. doi:10.1016/S2589-7500(20)30227-2.
40. Taylor S, Landry CA, Paluszek MM, Groenewoud R, Rachor GS, Asmundson GJG. A proactive approach for managing COVID-19: the importance of understanding the motivational roots of Vaccination Hesitancy for SARS-CoV2. *Front Psychol*. 2020;11:575950. doi:10.3389/fpsyg.2020.575950.
41. Bonnievie E, Rosenberg SD, Kummeth C, Goldberg J, Wartella E, Smyser J. Using social media influencers to increase knowledge and positive attitudes toward the flu vaccine. *PLoS One*. 2020;15(10):e0240828. doi:10.1371/journal.pone.0240828.
42. Need a Coronavirus Test? Being Rich and Famous May Help. The New York Times website. <https://www.nytimes.com/2020/03/18/us/coronavirus-testing-elite.html>. Accessed January 1, 2021.
43. Schoch-Spana M, Brunson EK, Long R, et al. The public's role in COVID-19 vaccination: human-centered recommendations to enhance pandemic vaccine awareness, access, and acceptance in the United States. *Vaccine*. 2020;S0264-410X(20):31368-2. doi:10.1016/j.vaccine.2020.10.059.
44. Guide to COVID-19 Vaccine Communications – A practitioner's Guide to the Principles of COVID-19 Vaccine communications. Center for Public Interest Communications, University of Florida website. <https://covid19vaccinescommunicationprinciples.org/>. Accessed December 6, 2020.
45. MacDonald NE, Butler R, Dubé E. Addressing barriers to vaccine acceptance: an overview. *Hum Vaccines Immunother*. 2017;14(1):218-224. doi:10.1080/21645515.2017.1394533.
46. Trump Claims the Worsening U.S. Coronavirus Outbreak is a "Fake News Media Conspiracy" Even As Hospitalizations Rise. CNBC website. <https://www.cnbc.com/2020/10/26/coronavirus-trump-claims-the-worsening-us-outbreak-is-a-fake-news-media-conspiracy-even-as-hospitalizations-rise.html>. Accessed December 8, 2020.
47. "It will disappear": the disinformation Trump spread about the coronavirus – timeline. The Guardian website. <http://www.theguardian.com/us-news/2020/apr/14/trump-coronavirus-alerts-disinformation-timeline>. Accessed December 8, 2020.
48. Texas Lt. Gov. blasts Fauci as state coronavirus cases rise: 'I don't need his advice'. Fort Worth Star-Telegram website. <https://www.star-telegram.com/news/coronavirus/article243923302.html>. Accessed December 8, 2020.
49. States Vow Extra Scrutiny of Coronavirus Vaccine. The New York Times website. <https://www.nytimes.com/2020/11/16/us/coronavirus-vaccine-states-trump.html>. Accessed December 8, 2020.
50. Trump admin has yet to launch push to promote trust in Covid vaccines. NBC News website. <https://www.nbcnews.com/health/health-news/trump-admin-has-yet-launch-promised-effort-get-americans-trust-n1250194>. Accessed December 8, 2020.

51. Biden Says He'll Publicly Get a COVID-19 vaccine, Keep Fauci. Reuters website. <https://www.reuters.com/article/usa-biden-idUSKBN28D2J3>. Accessed December 8, 2020.
52. Former Presidents Obama, Bush and Clinton volunteer to Get Coronavirus Vaccine Publicly to Prove It's Safe. CNN website. <https://www.cnn.com/2020/12/02/politics/obama-vaccine/index.html>. Accessed December 8, 2020.
53. Pelosi, McConnell get COVID-19 vaccine, Urge Others to Do so. AP News website. <https://apnews.com/article/mitch-mcconnell-michael-pence-coronavirus-pandemic-nancy-pelosi-09a6fc068a653d02eca3f534fb801f1b>. Accessed December 30, 2020.
54. Washington HA. *Medical Apartheid: The Dark History of Medical Experimentation On Black Americans from Colonial Times to the Present*. New York, N.Y.: Doubleday; 2006.

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