CONFRONTING HEALTH MISINFORMATION

The U.S. Surgeon General's Advisory on Building a Healthy Information Environment

2021

I am urging all Americans to help slow the spread of health misinformation during the COVID-19 pandemic and beyond. Health misinformation is a serious threat to public health. It can cause confusion, sow mistrust, harm people's health, and undermine public health efforts. Limiting the spread of health misinformation is a moral and civic imperative that will require a whole-of-society effort.

Vivek H. Murthy, M.D., M.B.A.
Vice Admiral, U.S. Public Health Service
Surgeon General of the United States

TABLE OF CONTENTS

ABOUT THE ADVISORY

A Surgeon General's Advisory is a public statement that calls the American people's attention to a public health issue and provides recommendations for how that issue should be addressed. Advisories are reserved for significant public health challenges that need the American people's immediate awareness. For additional background, visit SurgeonGeneral.gov.

BACKGROUND

During the COVID-19 pandemic, people have been exposed to a great deal of information: news, public health guidance, fact sheets, infographics, research, opinions, rumors, myths, falsehoods, and more. The World Health Organization and the United Nations have characterized this unprecedented spread of information as an "infodemic."[1]

While information has helped people stay safe throughout the pandemic, it has at times led to confusion. For example, scientific knowledge about COVID-19 has evolved rapidly over the past year, sometimes leading to changes in public health recommendations. Updating assessments and recommendations based on new evidence is an essential part of the scientific process, and further changes are to be expected as we continue learning more about COVID-19.[2] But without sufficient communication that provides clarity and context, many people have had trouble figuring out what to believe, which sources to trust, and how to keep up with changing knowledge and guidance.[3, 4, 5]

Amid all this information, many people have also been exposed to health misinformation: information that is false, inaccurate, or misleading according to the best available evidence at the time.[6, 7, 8] *
Misinformation has caused confusion and led people to decline COVID-19 vaccines, reject public health measures such as masking and physical distancing, and use unproven treatments.[5, 9, 10] For example, a recent study showed that even brief exposure to COVID-19 vaccine misinformation made people less likely to want a COVID-19 vaccine.[11] Misinformation has also led to harassment of and violence against public health workers, health professionals, airline staff, and other frontline workers tasked with communicating evolving public health measures.[12, 13]

Misinformation can sometimes be spread intentionally to serve a malicious purpose, such as to trick people into believing something for financial gain or political advantage. This is usually called "disinformation."[14, 15] But many people who share misinformation aren't trying to misinform. Instead, they may be raising a concern, making sense of conflicting information, or seeking answers to honest questions.[16]

Health misinformation is not a recent phenomenon. In the late 1990s, a poorly designed study, later retracted, falsely claimed that the measles, mumps, rubella (MMR) vaccine causes autism.[17] Even after the retraction, the claim gained some traction and contributed to lower immunization rates over the next twenty years.[18] Just since 2017, we have seen measles outbreaks in Washington State, Minnesota, New York City, and other areas.[19, 20, 21] Health misinformation is also a global problem. In South Africa, for example, "AIDS denialism"—a false belief denying that HIV causes AIDS—was adopted at the highest levels of the national government, reducing access to effective treatment and contributing to more than 330,000 deaths between 2000 and 2005.[22] Health misinformation has also reduced the willingness of people to seek effective treatment for cancer, heart disease, and other conditions.[1, 23, 24, 25]

This advisory focuses on health information specifically, not other kinds of misinformation. Defining misinformation is a challenging task, and any definition has limitations. See References for further discussion of the definition used in this Advisory, including the benchmark of 'best available evidence at the time.'

In recent years, the rapidly changing information environment has made it easier for misinformation to spread at unprecedented speed and scale, especially on social media and online retail sites, as well as via search engines.[26, 27] Misinformation tends to spread quickly on these platforms for several reasons.

First, misinformation is often framed in a sensational and emotional manner that can connect viscerally, distort memory, align with cognitive biases, and heighten psychological responses such as anxiety.[28, 29, 30] People can feel a sense of urgency to react to and share emotionally charged misinformation with others, enabling it to spread quickly and go "viral."[24, 31]

> *In recent years, the rapidly changing information environment has made it easier for misinformation to spread at unprecedented speed and scale.*

Second, product features built into technology platforms have contributed to the spread of misinformation. For example, social media platforms incentivize people to share content to get likes, comments, and other positive signals of engagement.[32] These features help connect and inform people but reward engagement rather than accuracy, allowing emotionally charged misinformation to spread more easily than emotionally neutral content.[33] One study found that false news stories were 70 percent more likely to be shared on social media than true stories.[31]

Third, algorithms that determine what users see online often prioritize content based on its popularity or similarity to previously seen content. As a result, a user exposed to misinformation once could see more and more of it over time, further reinforcing one's misunderstanding.[34] Some websites also combine different kinds of information, such as news, ads, and posts from users, into a single feed, which can leave consumers confused about the underlying source of any given piece of content.[35]

The growing number of places people go to for information—such as smaller outlets and online forums—has also made misinformation harder to find and correct.[36] And, although media outlets can help inform and educate consumers, they can sometimes inadvertently amplify false or misleading narratives.[37, 38]

Misinformation also thrives in the absence of easily accessible, credible information.[39, 40] When people look for information online and see limited or contradictory search results, they may be left confused or misinformed.

More broadly, misinformation tends to flourish in environments of significant societal division, animosity, and distrust. For example, distrust of the health care system due to experiences with racism and other inequities may make it easier for misinformation to spread in some communities.[41] Growing polarization, including in the political sphere, may also contribute to the spread of misinformation.[42, 43]

Additional research is needed to better understand how people are exposed to and affected by misinformation and how this may vary across subpopulations based on factors such as race, ethnicity, socioeconomic status, education, age, sexual orientation, gender identity, cultural and religious practices, hobbies and interests, and personal networks.[44]

WE CAN TAKE ACTION

Because it pollutes our information environment, misinformation is harmful to individual and public health. Together, we have the power to build a healthier information environment. Just as we have all benefited from efforts to improve air and water quality, we can all benefit from taking steps to improve the quality of health information we consume. Limiting the prevalence and impact of misinformation will help all of us make more informed decisions about our health and the health of our loved ones and communities.

> *Together, we have the power to build a healthier information environment.*

During the COVID-19 pandemic, there have been significant efforts to address health misinformation. Here are just a few examples:

- Trusted community members, such as health professionals, faith leaders, and educators, have spoken directly to their communities to address COVID-19-related questions (e.g., in town halls, community meetings, via social and traditional media)

- Researchers have identified leading sources of COVID-19 misinformation, including misinformation "super-spreaders" [45]

- Media organizations have devoted more resources to identify and debunk misinformation about COVID-19 [46, 47]

- Some technology platforms have improved efforts to monitor and address misinformation by reducing the distribution of false or misleading posts and directing users to health information from credible sources [48, 49, 50]

- Governments have increased their efforts to disseminate clear public health information in partnership with trusted messengers [51]

But there is much more to be done, and each of us has a role to play. Before posting or sharing an item on social media, for example, we can take a moment to verify whether the information is accurate and whether the original source is trustworthy. If we're not sure, we can choose not to share. When talking to friends and family who have misperceptions, we can ask questions to understand their concerns, listen with empathy, and offer guidance on finding sources of accurate information. [52, 53, 54, 55, 56]

It will take more than individual efforts, however, to address health misinformation. The threat of misinformation raises important questions we must answer **together**: How do we curb the spread of

harmful misinformation while safeguarding user privacy and free expression? What kinds of measures should technology platforms, media entities, and other groups adopt to address misinformation? What role is appropriate for the government to play? How can local communities ensure that information being exchanged—online and offline—is reliable and trustworthy? How can we help family and friends who may have been exposed to harmful misinformation?

Addressing health misinformation will require a whole-of-society effort. We can start by focusing on the following areas of action:

- **Equip Americans with the tools to identify misinformation,** make informed choices about what information they share, and address health misinformation in their communities, in partnership with trusted local leaders

- **Expand research that deepens our understanding of health misinformation,** including how it spreads and evolves; how and why it impacts people; who is most susceptible; and which strategies are most effective in addressing it

- **Implement product design and policy changes on technology platforms** to slow the spread of misinformation

- **Invest in longer-term efforts to build resilience against health misinformation,** such as media, science, digital, data, and health literacy programs and training for health practitioners, journalists, librarians, and others

- **Convene federal, state, local, territorial, tribal, private, nonprofit, and research partners** to explore the impact of health misinformation, identify best practices to prevent and address it, issue recommendations, and find common ground on difficult questions, including appropriate legal and regulatory measures that address health misinformation while protecting user privacy and freedom of expression

> *Addressing health misinformation will require a whole-of-society effort.*

WHAT INDIVIDUALS, FAMILIES, AND COMMUNITIES CAN DO

Learn how to identify and avoid sharing health misinformation. When many of us share misinformation, we don't do it intentionally: We are trying to inform others and don't realize the information is false. Social media feeds, blogs, forums, and group chats allow people to follow a range of people, news outlets, and official sources. But not every post on social media can be considered reliable. And misinformation can flourish in group texts or email threads among friends and family. Verify accuracy of information by checking with trustworthy and credible sources. If you're not sure, don't share.

Engage with your friends and family on the problem of health misinformation. If someone you care about has a misperception, you might be able to make inroads with them by first seeking to understand instead of passing judgment. Try new ways of engaging: Listen with empathy, establish common ground, ask questions, provide alternative explanations and sources of information, stay calm, and don't expect success from one conversation.

Address health misinformation in your community. Work with schools, community groups such as churches and parent-teacher associations, and trusted leaders such as educators and health care professionals to develop local strategies against misinformation. For example, invite local health professionals to schools or to faith congregations to talk about COVID-19 vaccine facts.

When many of us share misinformation, we don't do it intentionally: We are trying to inform others and don't realize the information is false...
If you're not sure, don't share.

WHAT EDUCATORS AND EDUCATIONAL INSTITUTIONS CAN DO

Strengthen and scale the use of evidence-based educational programs that build resilience to misinformation. Media, science, digital, data, and health literacy programs should be implemented across all educational settings, including elementary, secondary, post-secondary and community settings. In addition to teaching people how to be more discerning about the credibility of news and other content, educators should cover a broader set of topics, such as information overload, internet infrastructure (e.g., IP addresses, metadata), the challenges of content moderation, the impact of algorithms on digital outputs, algorithmic bias, artificial intelligence (AI)-generated misinformation (e.g., deepfakes), visual verification skills, and how to talk to friends and family who are sharing misinformation.

Educate students and the public on common tactics used by those who spread misinformation online. Recent research suggests that teaching people how to spot these tactics can reduce people's willingness to share misinformation.[57] Examples of misinformation tactics used by those who deny scientific consensus on health issues include presenting unqualified people as experts; misleading consumers with logical fallacies; setting impossible expectations for scientific research; cherry-picking data or anecdotes; and introducing conspiracy theories.[58]

Establish quality metrics to assess progress in information literacy. While there is substantial media and information literacy work being carried out across the United States, there is a need for more consistent and empirically evaluated educational materials and practices.

Media, science, digital, data, and health literacy programs should be implemented across all educational settings.

WHAT HEALTH PROFESSIONALS AND HEALTH ORGANIZATIONS CAN DO

Proactively engage with patients and the public on health misinformation. Doctors, nurses, and other clinicians are highly trusted and can be effective in addressing health misinformation.[59] If you are a clinician, take the time to understand each patient's knowledge, beliefs, and values. Listen with empathy, and when possible, correct misinformation in personalized ways. When addressing health concerns, consider using less technical language that is accessible to all patients. Find opportunities to promote patient health literacy on a regular basis.

Use technology and media platforms to share accurate health information with the public. For example, professional associations can equip their members to serve as subject matter experts for journalists and effectively communicate peer-reviewed research and expert opinions online.

Partner with community groups and other local organizations to prevent and address health misinformation. For example, hospital systems can work with community members to develop localized public health messages. Associations and other health organizations should offer trainings for clinicians on how to address misinformation in ways that account for patients' diverse needs, concerns, backgrounds, and experiences.

> *Associations and other health organizations should offer trainings for clinicians on how to address misinformation in ways that account for patients' diverse needs, concerns, backgrounds, and experiences.*

WHAT JOURNALISTS AND MEDIA ORGANIZATIONS CAN DO

Train journalists, editors, and others to recognize, correct, and avoid amplifying misinformation. Media organizations should develop in-house training programs and partner with journalism schools, nonprofits, technology platforms, and others to democratize access to high-quality training for all media outlets.

Proactively address the public's questions. When something is new—such as a vaccine—people will understandably have questions. By anticipating and proactively answering those questions, media organizations and journalists can help get ahead of misinformation and increase the public's health and information literacy.

Provide the public with context to avoid skewing their perceptions about ongoing debates on health topics. For example, when discussing conflicting views on an issue, give readers a sense of where the scientific community stands and how strong the available evidence is for different views. Consider questions like: How much disagreement is there among experts? Is a given explanation plausible even if it is unlikely? If evidence is not equally strong on all sides of an issue, avoid presenting it as such.

Carefully review information in preprints. Preprints are research papers published online before peer review. They can provide scientists and the public with useful information, especially in rapidly evolving situations such as a pandemic. However, because preprints have not been independently reviewed, reporters should be careful about describing findings from preprints as conclusive. If reporting on such findings,

include strong caveats where appropriate, seek out expert opinions, and provide readers with context.

Use a broader range of credible sources—particularly local sources. Research shows us that people have varying levels of trust in different types of people and institutions.[4] In addition to relying on federal and state public health authorities as sources, build relationships with local health professionals and local trusted, credible health organizations.

Consider headlines and images that inform rather than shock or provoke. Headlines are often what audiences will see and remember. If a headline is designed to fact-check a rumor, where possible, lead with the truth instead of simply repeating details of the rumor. Images are often shared on social media alongside headlines and can be easily manipulated and used out of context. Picture desk and social media editors should consider how provocative and medically inaccurate imagery can be a vehicle for misinformation.[60]

> *Give readers a sense of where the scientific community stands and how strong the available evidence is for different views.*

WHAT TECHNOLOGY PLATFORMS CAN DO

Assess the benefits and harms of products and platforms and take responsibility for addressing the harms. In particular, make meaningful long-term investments to address misinformation, including product changes. Redesign recommendation algorithms to avoid amplifying misinformation, build in "frictions"— such as suggestions and warnings—to reduce the sharing of misinformation, and make it easier for users to report misinformation.

Give researchers access to useful data to properly analyze the spread and impact of misinformation. Researchers need data on what people see and hear, not just what they engage with, and what content is moderated (e.g., labeled, removed, downranked), including data on automated accounts that spread misinformation. To protect user privacy, data can be anonymized and provided with user consent.

Strengthen the monitoring of misinformation. Platforms should increase staffing of multilingual content moderation teams and improve the effectiveness of machine learning algorithms in languages other than English since non-English-language misinformation continues to proliferate.[61] Platforms should also address misinformation in live streams, which are more difficult to moderate due to their temporary nature and use of audio and video.

Prioritize early detection of misinformation "super-spreaders" and repeat offenders. Impose clear consequences for accounts that repeatedly violate platform policies.

Evaluate the effectiveness of internal policies and practices in addressing misinformation and be transparent with findings. Publish standardized measures of how often users are exposed to misinformation and through what channels, what kinds of misinformation are most prevalent, and what share of misinformation is addressed in a timely manner. Communicate why certain content is flagged, removed, downranked, or left alone. Work to understand potential unintended consequences of content moderation, such as migration of users to less-moderated platforms.

Proactively address information deficits. An information deficit occurs when there is high public interest in a topic but limited quality information available. Provide information from trusted and credible sources to prevent misconceptions from taking hold.[40]

Amplify communications from trusted messengers and subject matter experts. For example, work with health and medical professionals to reach target audiences. Direct users to a broader range of credible sources, including community organizations. It can be particularly helpful to connect people to local trusted leaders who provide accurate information.

Prioritize protecting health professionals, journalists, and others from online harassment, including harassment resulting from people believing in misinformation.

WHAT RESEARCHERS AND RESEARCH INSTITUTIONS CAN DO

Strengthen the monitoring of health questions, concerns, and misinformation. Focus on a broader range of content and platforms, as well as on information flow across platforms. For example, examine image- and video-based content and content in multiple languages. To address existing research limitations, expand data collection methods (e.g., recruit social media users to voluntarily share data).

Assess the impact of health misinformation. There is an urgent need to comprehensively quantify the harms of health misinformation. For example, how and under what conditions does misinformation affect beliefs, behaviors, and health outcomes? What is the role of emotion, cognition, and identity in causing misinformation to "stick"? What is the cost to society if misinformation is left unchecked?

Prioritize understanding how people are exposed to and affected by misinformation, and how this may vary for different subpopulations. Tailor interventions to the needs of specific populations. Invite community members to participate in research design.

Evaluate the effectiveness of strategies and policies to prevent and address health misinformation. For example, can flagging certain content as misinformation have unintended consequences? Is it possible to build resilience to misinformation through inoculation methods such as "prebunking"? (*Debunking* involves correcting misinformation once someone has been exposed to it. *Prebunking,* or preemptively debunking, involves warning people about misinformation they might come across so they will be less likely to believe it when exposed.)[57]

There is an urgent need to comprehensively quantify the harms of health misinformation.

WHAT FUNDERS AND FOUNDATIONS CAN DO

Move with urgency toward coordinated, at-scale investment to tackle misinformation. Assess funding portfolios to ensure meaningful, multi-year commitments to promising research and programs.

Invest in quantifying the harms of misinformation and identifying evidence-based interventions. Focus on areas facing private and public funding gaps. Examples could include independent and local journalism, accountability mechanisms for platforms, and community-based health literacy programs.

Provide training and resources for grantees working in communities disproportionately affected by misinformation (e.g., areas with lower vaccine confidence).

Incentivize coordination across grantees to maximize reach, avoid duplication, and bring together a diversity of expertise. For example, encourage coordination around monitoring health misinformation across multiple languages.

Assess funding portfolios to ensure meaningful, multi-year commitments to promising research and programs.

WHAT GOVERNMENTS CAN DO

Convene federal, state, local, territorial, tribal, private, nonprofit, and research partners to explore the impact of health misinformation, identify best practices to prevent and address it, issue recommendations, and find common ground on difficult questions, including appropriate legal and regulatory measures that address health misinformation while protecting user privacy and freedom of expression.

Increase investment in research on misinformation. For example, more research is needed to better define misinformation, document and process its harms, and identify best practices for preventing and addressing misinformation across mediums and diverse communities.

Continue to modernize public health communications. Work to understand Americans' health questions, concerns, and perceptions, especially for hard-to-reach populations. Deploy new messaging and community engagement strategies, including partnerships with trusted messengers. Proactively and rapidly release accurate, easy-to-understand health information in online and in-person settings. Invest in fact-checking and rumor control mechanisms where appropriate.[62]

Increase resources and technical assistance to state and local public health agencies to help them better address questions, concerns, and misinformation. For example, support the creation of teams within public health agencies that can identify local misinformation patterns and train public health misinformation and infodemic researchers. Work with local and state health leaders and associations to address ongoing needs.

Expand efforts to build long-term resilience to misinformation. For example, promote educational programs that help people distinguish evidence-based information from opinion and personal stories.

Deploy new messaging and community engagement strategies, including partnerships with trusted messengers. Proactively and rapidly release accurate, easy-to-understand health information in online and in-person settings.

WHERE WE GO FROM HERE

We are all still learning how to navigate this new information environment. But we know enough to be sure that misinformation is an urgent threat, and that we can and must confront it together.

During the COVID-19 pandemic, health misinformation has sowed confusion, reduced trust in public health measures, and hindered efforts to get Americans vaccinated. And misinformation hasn't just harmed our physical health—it has also divided our families, friends, and communities.

While health misinformation has always been a problem, today it spreads at unprecedented speed and scale. We are all still learning how to navigate this new information environment. But we know enough to be sure that misinformation is an urgent threat, and that we can and must confront it together.

The only way to address health misinformation is to recognize that all of us, in every sector of society, have a responsibility to act. Every single person can do their part to confront misinformation. But it's not just an individual responsibility. We need institutions to recognize that this issue is their moral and civic responsibility, too, and that they are accountable.

We have the power to shape our information environment, but we must use that power together. Only then can we work toward a healthier information environment—one that empowers us to build a healthier, kinder, and more connected world.

REFERENCES

*   Note: Defining "misinformation" is a challenging task, and any definition has limitations. One key issue is whether there can be an objective benchmark for whether something qualifies as misinformation. Some researchers argue that for something to be considered misinformation, it has to go against "scientific consensus" (e.g., Chou, Gaysynsky, & Cappella (2020)). Others consider misinformation to be information that is contrary to the "best available evidence" (e.g., Johns Hopkins Center for Health Security (2021)). Both approaches recognize that what counts as misinformation can change over time with new evidence and scientific consensus. This Advisory prefers the "best available evidence" benchmark since claims can be highly misleading and harmful even if the science on an issue isn't yet settled. At the same time, it is important to be careful and avoid conflating controversial or unorthodox claims with misinformation. Transparency, humility, and a commitment to open scientific inquiry are critical. A second key issue is whether misinformation should include not only false information but also misleading information. This Advisory includes misleading claims in the definition. Consider an anecdote about someone experiencing a rare side effect after a routine surgery. The specific anecdote may be true but hide the fact that the side effect is very rare and treatable. By misinforming people about the benefits and risks of the surgery, the anecdote can be highly misleading and harmful to public health. Going forward, there is a need for further alignment on a shared definition of misinformation. However, we can meaningfully improve the health information environment even without a consensus definition of misinformation. For further discussion on definitions, see Vraga & Bode (2020).

1   WHO, UN, UNICEF, UNDP, UNESCO, UNAIDS, ITU, UN Global Pulse, & IFRC. (2020, September 23). *Managing the COVID-19 infodemic: Promoting healthy behaviours and mitigating the harm from misinformation and disinformation.* World Health Organization. https://www.who. int/news/item/23-09-2020-managing-the-covid-19-infodemic-promoting-healthy-behaviours-and-mitigating-the-harm-from-misinformation-and-disinformation

2   Branswell, H. (2021, April 21). *We know a lot about Covid-19. Experts have many more questions.* STAT News. https://www.statnews.com/2021/04/20/we-know-a-lot-about-covid-19-experts-have-many-more-questions/

3   Smith, R., Cubbon, S., & Wardle, C. (2020, November 12). *Under the surface: Covid-19 vaccine narratives, misinformation & data deficits on social media.* First Draft. https://firstdraftnews.org/vaccinenarratives-full-report-november-2020

4   Baum, M., Ognyanova, K., Chwe, H., Quintana, A., Perlis, R. H., Lazer, D., Druckman, J., Santillana, M., Lin, J., Della Volpe, J., Simonson, M.D., & Green, J. (2021). The COVID states project #14: Misinformation and vaccine acceptance. *OSF Preprints.* http://doi.org/10.31219/osf.io/w974j

5   Roozenbeek, J., Schneider, C., Dryhurst, S., Kerr, J., Freeman, A.L.J., Recchia, G., van der Bles, A.M., & van der Linden, S. (2020). Susceptibility to misinformation about COVID-19 around the

world. *Royal Society Open Science, 7*(10). http://doi.org/10.1098/rsos.201199

6 Chou, W.Y.S., Gaysynsky, A., & Cappella, J. N. (2020). Where we go from here: Health misinformation on social media. *American Journal of Public Health,* 110, S273-S275. http://doi. org/10.2105/AJPH.2020.305905

7 Vraga, E., & Bode, L. (2020). Defining misinformation and understanding its bounded nature: Using expertise and evidence for describing misinformation. *Political Communication,* 37(1), 136-144. http://doi.org/10.1080/10584609.2020.1716500

8 Sell, T.K., Hosangadi, D., Smith, E., Trotochaud, P.V., Gronvall, G.K., Rivera, Y., Sutton, J., Ruiz, A., & Cicero, A. (2021, March 23). *National priorities to combat misinformation and disinformation for COVID-19 and future public health threats: A call for a national strategy.* Johns Hopkins Center for Health Security. https://www.centerforhealthsecurity.org/our-work/publications/national-priorities-to-combat-misinformation-and-disinformation-for-covid-19

9 Chang, A., Schnall, A., Law, R., Bronstein, A.C., Marraffa, J.M., Spiller, H.A., Hays, H.L., Funk, A.R., Mercurio-Zappala, M., Callelo, D.P., Aleguas, A., Borys, D.J., Boehmer, T., & Svendsen, E. (2020). Cleaning and disinfectant chemical exposures and temporal associations with COVID-19 — National Poison Data System, United States, January 1, 2020–March 31, 2020. *MMWR Morbidity and Mortality Weekly Report,* 69, 496-498. http://doi.org/10.15585/mmwr.mm6916e1

10 Gottlieb, M., & Dyer, S. (2020). Information and disinformation: Social media in the COVID-19 crisis. *Academic Emergency Medicine,* 27(7), 640-641. https://doi.org/10.1111/acem.14036

11 Loomba, S., de Figueiredo, A., Piatek, S.J., et al. (2021). Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nature Human Behavior,* 5, 337–348. http://doi.org/10.1038/s41562-021-01056-1

12 Mello, M. M., Greene, J. A., & Sharfstein, J. M. (2020). Attacks on public health officials during COVID-19. *JAMA, 324*(8), 741. http://doi.org/10.1001/jama.2020.14423

13 Stone, W. (2020, June 3). *Local public health workers report hostile threats and fears about contact tracing.* National Public Radio. https://www.npr.org/sections/health-shots/2020/06/03/868566600/local-public-health-workers-report-hostile-threats-and-fears-about-contact-traci

14 Tucker, J.A., Guess, A., Barbera P., Vaccari, C., Siegel, A., Sanovich, S., Stukal, D., & Nyhan, B. (2018). Social media, political polarization and political disinformation: A review of the scientific literature. *SSRN.* http://doi.org/10.2139/ssrn.3144139

15 Chou, W.S., Oh, A., & Klein, W.M.P. (2018). Addressing health-related misinformation on social media. *JAMA, 320*(23), 2417–2418. http://doi.org/10.1001/jama.2018.16865

16 Jost, J., Van der Linden, S., Panagopoulos, C., & Hardin, C. (2018). Ideological asymmetries in conformity, desire for shared reality, and the spread of misinformation. *Current Opinion in Psychology*, 23, 77-83. http://doi.org/10.1016/j.copsyc.2018.01.003

17 Rao, T. S., & Andrade, C. (2011). The MMR vaccine and autism: Sensation, refutation, retraction, and fraud. *Indian journal of psychiatry,* 53(2), 95–96. http://doi.org/10.4103/0019-5545.82529

18 Hussain, A., Ali, S., Ahmed, M., & Hussain, S. (2018). The anti-vaccination movement: A regression in modern medicine. *Cureus,* 10(7), e2919. http://doi.org/10.7759/cureus.2919

19 City of New York Office of the Mayor. (2019, April 9). *De Blasio Administration's Health Department declares public health emergency due to measles crisis.* https://www1.nyc.gov/office-of-the-mayor/ news/186-19/de-blasio-administration-s-health-department-declares-public-health-emergency-due-measles-crisis/

20 Clark County Public Health. (2019, January 18). *County declares public health emergency due to measles outbreak.* https://www.clark.wa.gov/public-health/county-declares-public-health-emergency-due-measles-outbreak

21 Hall, V., Banerjee, E., Kenyon, C., Strain, A., Griffith, J., Como-Sabetti, K., Heath, J., Babta, L., Martin, K., McMahon, M., Johnson, D., Roddy, M., Dunn D., & Ehresmann, K. (2017). Measles outbreak — Minnesota April–May 2017. *MMWR Morbidity and Mortality Weekly Report, 66,* 713–717. http://doi.org/10.15585/mmwr.mm6627a1

22 Chigwedere, P., Seage, G. R., Gruskin, S., Lee, T. H., & Essex, M. (2008). Estimating the Lost Benefits of Antiretroviral Drug Use in South Africa. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 49(4), 410–415. https://doi.org/10.1097/qai.0b013e31818a6cd5

23 Swire-Thompson, B., & Lazer, D. (2019). Public health and online misinformation: Challenges and Recommendations. *Annual Review of Public Health, 41,* 433-451. http://doi.org/10.1146/annurev-publhealth-040119-094127

24 Chou, W.S., & Budenz, A. (2020). Considering emotion in COVID-19 vaccine communication: Addressing vaccine hesitancy and fostering vaccine confidence. *Health Communication, 35*(14), 1718-1722. http://doi.org/10.1080/10410236.2020.1838096

25 Wang, Y., McKee, M., Torbica, A., & Stuckler, D. (2019). Systematic literature review on the spread of health-related misinformation on social media. *Social science & medicine (1982), 240,* 112552. http://doi.org/10.1016/j.socscimed.2019.112552

26 Suarez-Lledo, V., & Alvarez-Galvez, J. (2021). Prevalence of health misinformation on social media: Systematic review. *Journal of Medical Internet Research, 23*(1). http://doi.org/10.2196/17187

27   Scales, D., Gorman, J., & Jamieson, K. (2021). The Covid-19 infodemic — applying the epidemiologic model to counter misinformation. *New England Journal of Medicine.* http://doi.org/10.1056/NEJMp2103798

28   Karanian, J.M., Rabb, N., Wulff, A.N., Torrance, M.G., Thomas, A.K., & Race, E. (2020). Protecting memory from misinformation: Warnings modulate cortical reinstatement during memory retrieval. *Proceedings of the National Academy of Sciences, 117* (37), 22771-22779. http://doi.org/10.1073/pnas.2008595117

29   Acerbi, A. (2019). Cognitive attraction and online misinformation. *Palgrave Communications, 5*(15). http://doi.org/10.1057/s41599-019-0224-y

30   Freiling, I., Krause, N., & Scheufele, D. (2021). Believing and sharing misinformation, fact-checks, and accurate information on social media: The role of anxiety during COVID-19. *New Media & Society.* http://doi.org/10.1177/14614448211011451

31   Vosoughi, S., Roy, D., & Aral, S. (2018). The spread of true and false news online. *Science, 359,* 1146-1151. http://doi.org/10.1126/science.aap9559

32   Lindström, B., Bellander, M., Schultner, D.T., Chang, A., Tobler, P.N., & Amodio, D.M. (2021). A computational reward learning account of social media engagement. *Nature Communications,* 12(1311). http://doi.org/10.1038/s41467-020-19607-x

33   Brady, W., Gantman, A., & Bavel, J. (2020). Attentional Capture Helps Explain Why Moral and Emotional Content Go Viral. *Journal of Experimental Psychology,* 149(4), 746-756. doi:10.1037/xge0000673

34   Tang, L., Fujimoto, K., Amith, M. T., Cunningham, R., Costantini, R. A., York, F., Xiong, G., Boom, J. A., & Tao, C. (2021). "Down the rabbit hole" of vaccine misinformation on YouTube: Network exposure study. *Journal of Medical Internet Research, 23*(1), e23262. http://doi.org/10.2196/23262

35   Donovan, J. (2020). Concrete recommendations for cutting through misinformation during the COVID-19 pandemic. *American Journal of Public Health, 110,* S3. http://doi.org/10.2105/AJPH.2020.305922

36   Pickard, V. (2020). *Democracy without journalism?: Confronting the misinformation society.* Oxford University Press.

37   Tsfati, Y., Boomgaarden, H.G., Strömbäck, J., Vliegenthart, R. , Damstra, A., & Lindgren, E. (2020). Causes and consequences of mainstream media dissemination of fake news: Literature review and synthesis. *Annals of the International Communication Association, 44*(2), 157-173. http://doi.org/10.1080/23808985.2020.1759443

38 Phillips, W. (2018, May 22). *The oxygen of amplification: Better practices for reporting on extremists, antagonists, and manipulators.* Data & Society. https://datasociety.net/library/oxygen-of-amplification/

39 Golebiewski, M. and Boyd, D. (2019, November). *Data voids: Where missing data can be easily exploited.* Data & Society. https://datasociety.net/wp-content/uploads/2019/11/Data-Voids-2.0-Final.pdf

40 Cubbon, Seb. (2020, December 15). *Identifying 'data deficits' can pre-empt the spread of disinformation.* First Draft Footnotes. https://medium.com/1st-draft/identifying-data-deficits-can-pre-empt-the-spread-of-disinformation-93bd6f680a4e

41 Collins-Dexter, B. (2020, June). *Canaries in the coal mine: COVID-19 misinformation and black communities.* Technology and Social Change project (TaSC) and Shorenstein Center. http://doi.org/10.37016/TASC-2020-01

42 Boxell, L., Gentzkow, M., & Shapiro, J. (2020, January). *Cross-country trends in affective polarization* (NBER Working Paper No. 26669). National Bureau of Economic Research. http://www.nber.org/papers/w26669

43 Hameleers, M., & van der Meer, T. (2019).). Misinformation and polarization in a high-choice media environment: How effective are political fact-checkers? *Communication Research, 47*(2), 227-250. http://doi.org/10.1177/0093650218819671

44 Seo, H., Blomberg, M., Altschwager, D., & Vu, H. (2020). Vulnerable populations and misinformation: A mixed-methods approach to underserved older adults' online information assessment. *New Media & Society.* http://doi.org/10.1177/1461444820925041

45 Center for Countering Digital Hate. (2021, March 24). *The disinformation dozen: Why platforms must act on twelve leading online anti-vaxxers.* https://www.counterhate.com/disinformationdozen

46 New York Times. (2021). *Daily distortions.* https://www.nytimes.com/spotlight/disinformation

47 Poynter. *Fighting the infodemic: The #CoronaVirusFacts alliance.* https://www.poynter.org/coronavirusfactsalliance/

48 Facebook. (2021, May 26). *Taking action against people who repeatedly share misinformation.* https://about.fb.com/news/2021/05/taking-action-against-people-who-repeatedly-share-misinformation/

49 Twitter (n.d.). *COVID-19 misleading information policy.* Twitter. https://help.twitter.com/en/rules-and-policies/medical-misinformation-policy

50 Beckerman, M. (2021, February 24). *TikTok's H2 2020 transparency report.* TikTok. https://newsroom.tiktok.com/en-us/tiktoks-h-2-2020-transparency-report

51 U.S. Department of Health and Human Services. (2021). *We Can Do This COVID-19 public education campaign.* https://wecandothis.hhs.gov/about

52 Larson, H.J. (2020). A call to arms: Helping family, friends and communities navigate the COVID-19 infodemic. *Nature Reviews Immunology, 20,* 449–450. http://doi.org/10.1038/s41577-020-0380-8

53 Southwell, B., Wood, J., & Navar, A.M. (2020). Roles for health care professionals in addressing patient-held misinformation beyond fact correction. *American Journal of Public Health, 110*(S3), S288-S289. http://doi.org/10.2105/AJPH.2020.305729

54 Chen, X., Sin, S.C., Theng, Y-L., & Lee, C.S. (2016). Deterring the spread of misinformation on social network sites: A social cognitive theory-guided intervention. *Proceedings of the Association for Information Science and Technology.* http://doi.org/10.1002/pra2.2015.145052010095

55 Bode, L., & Vraga, E. (2021). Correction experiences on social media during COVID-19. *Social Media & Society, 7*(2). http://doi.org/10.1177/20563051211008829

56 Vanderpool, R.C., Gaysynsky, A., & Chou, W.S. (2020). Using a global pandemic as a teachable moment to promote vaccine literacy and build resilience to misinformation. *American Journal of Public Health, 110,* S284-S285. http://doi.org/10.2105/AJPH.2020.305906

57 Basol, M., Roozenbeek, J., Berriche, M., Uenal, F., McClanahan, W.P., & van der Linden, S. (2021). Towards psychological herd immunity: Cross-cultural evidence for two prebunking interventions against COVID-19 misinformation. *Big Data & Society, 8*(1). http://doi.org/10.1177/20539517211013868

58 Diethelm, P. & McKee, M. (2009). Denialism: what is it and how should scientists respond? *European Journal of Public Health,* 19(1), 2-4. https://doi.org/10.1093/eurpub/ckn139

59 Brenan, M. (2018, December 20). *Nurses again outpace other professions for honesty, ethics.* Gallup. https://news.gallup.com/poll/245597/nurses-again-outpace-professions-honesty-ethics.aspx/

60 First Draft. (2021, February). *The building blocks of reporting and discussing Covid-19 vaccines.* https://firstdraftnews.org/wp-content/uploads/2021/02/FD0102_Snapshot-3.pdf

61 O'Connor, C., & Ayad, M. (2021, April). MENA monitor: *Arabic COVID-19 vaccine misinformation online.* Institute for Strategic Dialogue (ISD). https://www.isdglobal.org/wp-content/uploads/2021/04/MENA-Covid-Vaccine-Misinformation-Monitor-1.pdf

62 Masterson, M., Zaheer, A., Small, C., Cable, J., John, J. (2021, May 4). *Rumor control: A framework for countering vaccine misinformation.* Virality Project Policy Analysis. https://www.viralityproject.org/policy-analysis/rumor-control