Did Science Leadership Fail SARS-CoV-2 Vaccination Acceptance?

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ABSTRACT

The 21st century brought unprecedented challenges for academic medicine. Then, coronavirus disease 2019 (COVID-19) arrived—and has attributed to more than 600,000 deaths in the United States (US) alone. Two, readily available, US Food and Drug Administration (FDA)-authorized COVID-19 mRNA vaccines are more than 90% effective in preventing Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection. Yet, only 55% of all Americans have been partially vaccinated and 45% are fully vaccinated. Most new COVID-19 cases occur in unvaccinated people. In select regions across the US, intensive care units are, once again, overfilled. The impact of the COVID-19 pandemic has spread far beyond healthcare causing global socioeconomic disruptions and affecting overall human well-being. In my classroom, getting it less than 60% right earns a student an F grade. America has failed to convince its people of the vaccine benefit. How? Was it the government? It is no secret that most Americans don't trust the government. Did science leadership fail to communicate with the public? Should our educators have taught us more science? Did physicians fail to be open and transparent with their patients? Should we be a more trusting nation? Perhaps all –perhaps none—of these are contributing factors. Is human response behavior taking a toll on human life? One thing is for sure. It is a great injustice that American lives continue to be lost and that others continue to live in fear. More than two millennia ago, the philosopher Socrates argued that humility is the greatest of all virtues. In this report, I elaborate on humble leadership by scientists to improve the imperfect art of communication as a solution to heal our beloved nation.

Keyword: Science Leadership, SARS-CoV-2 Vaccination.

The Challenge

As of July 15, 2021 @ 7:21PM, SARS-CoV-2—the cause of COVID-19—has attributed to 188,843,580 cases of infection and 4,065,400 deaths worldwide. In the US, 33,973,919 cases of infection and 608,384 deaths have been confirmed. In Missouri, 647,237 cases of infection and 9,882 deaths have been reported.

The development of safe and effective vaccines to reduce the rate of SARS-CoV-2 infection and the burden of COVID-19 on the US healthcare system is a huge accomplishment. A recent retrospective study analysis of 136,532 individuals in the Mayo Clinic health system, including Arizona, Florida, Iowa, Minnesota, and Wisconsin, used polymerase chain reaction (PCR) testing data collected between December 1, 2020 and April 20, 2021 to conclude that BNT162b2 (Pfizer/BioNTech) and mRNA-1273 (Moderna) have real-world effectiveness in preventing SARS-CoV-2 infection of 86.1% (95% confidence interval (CI): 82.4%–89.1%) and 93.3% (95% CI: 85.7%–97.4%) (Pawlowski et al., 2021). This study, funded by n*f*erence, an artificial intelligence (AI)-based software company, further showed that BNT162b2 and

mRNA-1273 are 88.8% (95% CI: 75.5%–95.7%) and 86.0% (95% CI: 71.6%–93.9%) effective in preventing COVID-19-associated hospitalization, and both vaccines are 100% effective (95% $CI_{BNT162b2}$: 51.4%–100%; 95% $CI_{mRNA-1273}$: 43.3%–100%) in preventing COVID-19-associated intensive care unit (ICU) admission.

COVID-19 vaccine safety is being taken very seriously (Castells and Phillips, 2021), particularly in light of prior unsubstantiated reports of adverse events following vaccination for measles, mumps, and rubella (Spencer et al., 2017), and the Center for Disease Control and Prevention (CDC) continues to monitor safety of all approved vaccines: https://www.cdc.gov/vaccinesafety/ensuringsafety/monitoring/index. To date, all clinical data show that that BNT162b2 and mRNA-1273 are very safe, with mild-to-moderate pain at the injection site and rare occurrences of myocarditis reported as the most common and the most severe side effects (Ashworth et al., 2021; Kho et al., 2021; Navar et al., 2021; Pawlowski *et al.*, 2021; Polack et al., 2020; Shimabukuro et al., 2021; Skowronski and De Serres, 2021).

Although science shows that BNT162b2 and mRNA-1273 vaccines are safe and they really work—getting vaccine shots into arms continues to be a pressing public health challenge (Ashworth *et al.*, 2021). The CDC director, Dr. Rochelle Walensky has claimed that "this is becoming a pandemic of the unvaccinated" (Anthes and Petri, 2021). According to a CBS/YouGov poll released on July 18, 2021, just 48% of unvaccinated or not fully vaccinated Americans said they "are personally concerned" about the Delta variant. By contrast 72% of those who are fully vaccinated said they are worried. Among the unvaccinated, 53% said that they would not get a shot because of concerns of side effects, 50% don't trust the government, and 45% said that they do not trust the science behind the vaccine (Salvanto et al., 2021). In analyzing these data, one cannot ignore the educational and partisan lines that are evident between vaccinated ('vaxxers') and unvaccinated ('anti-vaxxers') as the unvaccinated are disproportionately non-college educated, minority, and identify themselves as very conservative. [Incidentally, Peter Sokolowski, editor at large of Merriam-Webster.com, confirmed that Merriam-Webster's definition of 'anti-vaxxer' as "a person who opposes vaccination or laws that mandate vaccination" has remained unchanged since it was first introduced to the online dictionary in 2018 (MacGuill, 2021).] However, one certainly must recognize that COVID-19 vaccinations do come with risks—and these risks need to be "communicated transparently to maintain trust and uphold scientific ethics" (Remmel, 2021).

Clearly, there are multiple opportunities to improve vaccination acceptance. Some wonder what a better personal doctor-patient connection might do to boost confidence, but only 10% of the hesitant and unvaccinated say their own doctor's advice would make a difference (Salvanto et al., 2021). There is also concern that for some employees, especially for lower income or hourly wage workers, the process of getting vaccinated or the time it takes is less convenient than for those with more flexible schedules. Nonetheless, the enormousy of open communication –underscored by the marked dip in US public confidence in COVID-19 vaccine safety following the pause in single-shot doses of the Johnson & Johnson non-mRNA vaccine in April 2021 following reported blood-clotting side effects (Hamel et al., 2021) – cannot be ignored.

We have a credibility problem

Distrust in scientific expertise dangerously threatens lives, livelihoods, and lifestyles (Haerlin and Parr, 1999; Larson, 2000; Martin, 2020; Kennedy, 2019; Givetash, 2019; CTCA, 2017; Frenkel, 2020; Shapiro, 2019; Zadrozny and Edwards, 2019; Huang et al, 2017; DiResta, 2018; Starbird, 2019). This unfortunate phenomenon is not new to COVID-19, nor is it new to the 21st century. In 1999, in response to a bovine

spongiform encephalopathy (BSE), commonly known as mad cow disease, outbreak, it was published that "the relationship between the scientific community and the general public has never been worse in living memory" (Haerlin and Parr, 1999). This incidence was preceded by similar events, such as the debate about global emissions of chlorofluorocarbons (CFCs) and the ozone in the 1970 (Solomon, 2019) and the health and environmental assessment of Agent Orange used during the Vietnam War (Young et al., 2004). In each case, the role of corporate scientists was viewed, by stockholders, as less than admirable. In response, other scientific institutions began to "demand conclusive proof to justify preventative action" leading to amplified mistrust in science by the public. These incidences, and others, have fueled the development of the 'precautionary principle' by legislators to shift the burden of proof from protectors to perpetrators (Pinto-Bazurco, 2020).

Case Study: A Lesson learned from a tale of luck, public perception, and fast environmental change. "The unexpected discovery of a hole in the atmospheric ozone layer over the Antarctic revolutionized science and helped to establish one of the most successful global environmental policies of the twentieth century" (Soloman, 2019). In 1985, three scientists boldly published a manuscript that Earth's protective layer of ozone was thinning dramatically above Antarctica as a result of a rise in the amount of chlorofluorocarbons (CFCs) in the atmosphere (Farman et al., 1985). CFCs were commonly used as refrigerants and propellants at the time. This discovery – based upon a firm scientific foundation and vindicated by a confidence in the science –helped to convince scientists, chemical industries, policymakers, and the public to take immediate action leading to international negotiations, the signing of the Montreal Protocol, and global regulations limiting the production and consumption of nearly 100 man-made ozone depleting agents. The relative speed and unanimous adoption of the Montreal Protocol in 1987 is considered the most successful international agreement in history—and "showcases a worldwide unity of science, government and industry—the holy trinity of environmental lobbying" (Newman, 2018).

The Scientific Method

"Good policy decisions require reasonable and robust debate grounded in the best possible information" (Rosenberg et al., 2013). Most people encounter and benefit from science in their everyday lives, yet, outside of the scientific community, few consume scientific information regularly. Making sense of science is not easy.

Individuals must choose whether to accept scientific advice about vaccines. And policy makers are faced with making decisions based on imperfect information and predictions that invariably involve uncertainties. Because individuals and groups differ in knowledge and skills, the ways that they interpret information will vary and influence how they are likely to respond to scientific information. Effective communicators of science must be responsive to an individual's need for the information as well as their utilization of the science to make decisions. Adding to this complexity is that science changes with new discoveries and people's needs and opinions of science can change as their engagement with science increases. Sound science evolves over time, and must be communicated with rigor to present the certainty of the data, the uncertainties of the knowledge, and the assumptions underlying the conclusions.

Often, there are no clear scientific answers to questions asked by the public. When asked, an ethical scientist may honestly respond with "We do not know". Such honest responses could benefit the

credibility of science. It is also important to recognize that an honest scientific respond may change as new data is collected and the interpretation of scientific evidence changes. Science answers questions, it is not the sole arbiter of policy making, and any assumptions that it is will undermine trust in the science. Haerlin and Parr (1999) propose that "the main culprits in the devaluing of scientific authority are not necessarily scientists themselves but corporations and politicians, keen to rely on the illusory picture of authoritative scientific arbitrators—individuals that are no longer perceived exclusively as guardians of objective truth, but also as smart promoters of their own interests in a media-driven marketplace." Today's rapidly changing integration of innovative academic research into the market is unfortunately further constraining open and honest dialogue between scientists, placing an unfair price on the credibility of honest scientists and ethical science. Concepts such as transparency, rigorous examination of ideas, review and critique by qualified peers, free speech and open exchange, and protection against retaliation for one's findings have all been cited to be key for reinvigorating the role of science in policymaking (Rosenberg *et al.*, 2013). Perhaps, new insight-driven approaches are needed to rethink alternative research and development strategies to overcome the challenges of scientific independence and conflicts of interest.

Dilemma of Coordinated Inauthentic Behavior and Disinformation

Earlier this year, the Biden Administration called for "a whole of society approach to our COVID-19 challenge" and the US Surgeon General, Dr. Vivek Murthy, called out major technology companies for "failing to adequately prevent the spread of COVID-19 disinformation". On May 26, 2021, Facebook released a "threat report" on what it calls "influence operations" on its social media platform, and defined influence operations as "coordinated efforts to manipulate or corrupt public debate for a strategic goal". But dealing with "coordinated inauthentic behavior" is challenging (Ingram, 2021) and disinformation is "not as cut-and-dried as most people assume" (Starbird, 2019). Disinformation often uses the rhetoric and techniques of critical thinking to foster nihilistic skepticism and convert reasonable doubt into unreasonable incredulity (Starbird, 2019). Disinformation campaigns are designed to overwhelm our capacity to rationalize information. They tend to attack us where we are most vulnerable, such as at the heart of our core values, and the goals of social-media platforms, such as 'building communities'. Starbird argues that perhaps one of the most dangerous misconceptions about disinformation is that it "targets only the unsavvy or uneducated, that it works only on others". She states that "as individuals, we need to reflect more on how we interact with information online, and consider that efforts to manipulate us may well be coming from within our own communities, and as researchers and policymakers, we have to go beyond trying to measure the impact of individual disinformation campaigns using simple models of inputs (for example, messages posted by bots or trolls) and outputs (such as likes, retweets or even votes)." Preventing COVID-19 disinformation is solvable, but it will take a level of collaboration across platform designers, policymakers, and business developers with scientists who are willing to employ great scientific diplomacy to effectively communicate the complexity of the science.

A Plan for Healing—Scientific Diplomacy

David Novak elegantly elaborated—"an effective leader possesses strong communication skills, perseverance in the face of failure, and level headedness and reactiveness in times of crisis" (Novak). Did science contribute to America's failure? Yes—we failed to educate congress on how science works and we lost the trust of the public. Importantly, COVID-19 crisis did not create, but it did expose, limitations

in our leadership skills—particularly effective communication and relationship building. Can US scientists advance America's recovery? Absolutely! How? We need to become more than just scientists. We need to get involved outside of the laboratory, classrooms, and clinics and do the following.

(1) Ensure that scientific evidence is an essential component of policymaking and effectively advocate for honest relevant research! For instance, thus far, a combined total of more than 339,190 million doses of mRNA vaccines have been administered in the US under the Emergency Use Authorization of the Food and Drug Administration (FDA). These shots successfully administered so far have yielded a positive result. A final decision for approved use by the FDA is not far off. Scientists have a responsibility, not an opportunity, to assure that this decision is not rushed or based upon selective and fragmented data, includes vaccine efficacy and safety, and assures the highest manufacturing quality. Oliver and Cairney (2019) have recently reviewed eight factors that impact the ability of academics to influence policy: (1) high quality research; (2) research that is relevant and readable; (3) understanding of policy-making processes; (4) accessibility to policymakers; (5) honest advocacy; (6) building relationships with policymakers; (7) entrepreneurship; and (8) constant reflection.

(2) Support new advanced technology to facilitate surveillance of new viral outbreaks to minimize human transmission. Some consider that the number of deaths in New York City could have been cut from 17K to 3K if the city had simply been shut down one week earlier. But the governor did not have any data to do this. Pilot studies are now developing new technology to monitor the global distribution of viruses – these apparatuses are similar to our weather system. It is speculated that highly sensitive tests to detect the presence of SARS-CoV-2 could be as simple as opening up an app on your smart phone (Larremore et al., 2021a; Larremore et al., 2021b; Mina et al., 2021). Importantly, it is essential to listen to our stakeholders and get public input on the development, distribution, and use of these devices.

(3) Hold policymakers accountable. Accountability is at the core of democracy—in fact, the US Constitution begins with "All political power is inherent in the people". According to the Organization for Economic Cooperation and Development (OECD), for COVID-19, the US naturally focused on two key areas of response to the COVID-19 outbreak: immediate containment and rapid development of a cure (Lazarus et al., 2020). The manufacturing of vaccines was successful. However, improved mutual relationships—based upon transparency and trust—between scientists and stakeholders is needed to better leverage pertinent, high quality and unbiased data into public policy in order to increase vaccine acceptance. Without doubt, improving science literacy and evidence-based communication will facilitate relationship building enabling policymakers to make informed decisions with public acceptance. Schedule a town hall congressional meeting and inform congress how science works to shape policy on facts! The American Association for the Advancement of Science (AAAS) has recently published some helpful hints: https://www.american.edu/spa/scicomm.

(4) Engage with the public and partner to educate. There is no way around it, clear communication is fundamental to combat this crisis. The general population is not fully aware that considerable uncertainties are, by necessity, involved in scientific advice that is provided in making public policy. The public is also not generally aware of benefit to risk ratios that underlie scientific advice. Given the novelty of COVID-19—it is essential that America (and the world) understands that the science surrounding this virus is still evolving. Until this scientific evidence is collected and evaluated, data from past pandemics and more-studied viruses is an important component of setting science-based public policy. It is essential that the public understands that advice from scientists may change as new data is collected and

evaluated. Organize and engage in a virtual community science happy hour! World Science Day for Peace and Development - celebrated the 10th day of every November – highlights the significant relevance of science in our daily lives and offers an opportunity to strengthen the link between science literacy with a sustainable society.

In conclusion, science is complex and will continue to evolve. New discoveries will be made. New changes will continue. More important than ever, it is critical that scientists continue to conduct high quality, unbiased, and relevant research; communicate their results; and build open, transparent, and trusting relationships with the public, including policymakers. In closing, every human begin has a right to good health backed by sound science, but science only helps if people trust it.

Note by the author

I am an immunologist at the at the University of Missouri (MU) School of Medicine with six years of post-doctoral training at the National Institutes of Allergy and Infectious Disease (NIAID) at the National Institutes of Health (NIH) in Bethesda, MD. On July 15, 2021, exactly three months to the day after being struck by an automobile driver who failed to follow traffic laws, I sat, in my wheelchair, in front of the Missouri Orthopedic Clinic waiting for my transportation to arrive. A copy of the *Columbia Daily Tribune* was lying on the pavement. I picked it up. I hadn't read a copy of the "*Tribune"* for months. I opened it to Page 4A—the Editorial section. I was blessed to find two incredible articles. I first read "Missourians are dying from COVID-19 misinformation" by Dr. Stevan Whitt, M.D., Chief Clinical Officer of MU Health Care and an MU physician specializing in infectious diseases and critical care. I followed this by reading the second editorial "Missouri's pediatric behavioral health crisis" by Dr. Trish Loll, M.D., President, St. Louis Children's Hospital; Dr. Paul Kempinski, President & CEO, Children's Mercy Hospital Kansas City; Dr. Steven Burghart, President, SSM Health Cardinal Glennon Children's Hospital; and Dr. Joseph Kahn, M.D., President, Mercy Children's Hospital St. Louis. The implications for better leadership were made clear. The floodgates opened. I put my fingers to the keyboard. This paper came to be.

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