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Commentary

The coronavirus disease 2019 (COVID-19) pandemic—Looking back and looking forward

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Eighteen months after the first case of coronavirus disease 2019 (COVID-19) was detected in the United States, and 6 months following the first US Food and Drug Administration (FDA) issuance of an Emergency Use Authorization (EUA) for a severe acute respiratory coronavirus virus 2 (SARS-CoV-2) vaccine, we find ourselves looking at a vastly different landscape regarding this pandemic than just 6 months ago. As the pandemic appears currently to be waning in the United States, now is an opportune time to take stock of how we have responded, assess what went well, document and categorize the missteps we have made, enumerate what pandemic concerns remain as we approach a possible recrudescence of COVID-19 in the fall, and try to discern how we can establish a 'new normal' state in the country. Her, we look, both retrospectively and prospectively, at the pandemic response in the US from the perspectives of 3 hospital epidemiologists who have discussed these issues almost weekly in the course of airing town hall webinars for the Society of Healthcare Epidemiology of America (SHEA). The views expressed in the manuscript represent the opinions and assessments of the authors as private citizens and do not represent those of their employers or the SHEA.

What went well in the pandemic response?

Hospital epidemiologists were well positioned to respond to the pandemic, in great measure because we had led our institutions in planning for and responding to pandemic influenza in 2009, SARS, and Ebola virus disease. Healthcare institutions relied on their emergency preparedness plans to generate brisk responses to the waves of COVID-19 as they have occurred throughout the pandemic. Because healthcare epidemiologists had to plan for those events, they were, in general, relatively better prepared and were able to develop strategies quickly to protect patients, staff, and visitors in healthcare facilities. This early response, most often led by hospital epidemiologists and infection preventionists, included the following aspects:

- Rapid implementation of syndromic screening of patients, staff, and visitors prior to or at the point of entry into medical facilities
- Prompt development of universal pandemic precautions (ie, universal masking, eye protection and hand hygiene) as the epidemiology of COVID-19 infection became apparent[1]
- Expert advice on management of shortages of personal protective equipment (PPE) such as extended use, and when needed, reuse (after disinfection) of respirators
- Frequent communication with colleagues in the healthcare epidemiology community to collect information and share experiences, and similarly, weekly, or more frequent, communication with colleagues at the Centers for Disease Control and Prevention (CDC) about new developments and to assure alignment
- Prompt implementation of classical infection prevention interventions (eg, isolation, contact tracing and quarantine) to allow safe and effective care of patients known, or suspected, to be infected with SARS-CoV-2
- Expert advice on development of COVID-19 units that allowed appropriate care of suspected or known COVID-19 patients while promoting safety of healthcare personnel (HCP) providing care to COVID-19 patients.
- Development of both more frequent and more effective communication with local and state public health authorities about events transpiring in our local communities.

Hospital epidemiologists and infection preventionists played central roles in maintaining patient and staff safety, and in so doing they often improved the standing of their own programs in the eyes of their institution's leadership. Hospital staff, some for the first time, recognized the value of healthcare epidemiology and infection prevention strategies and relied heavily on these programs in the pandemic. Despite the intense physical and mental health strain placed on healthcare facilities and their employees, HCP stepped up and delivered excellent, occasionally heroic, care.

Molecular biology, clinical, and research laboratories and genomic sequencers also worked well from the inception of the pandemic. The virus was first isolated January 7, 2020,[2] and its complete genomic sequence was made publicly available on January 12, 2020, just 5 days later.[3] The rapid identification of the causal agent also contributed to the rapid development and deployment of effective diagnostics, therapeutics, and vaccines, as well as effective infection prevention strategies.

The US Department of Health and Human Services and the federal government's COVID-19 Task Force empowered a public–private partnership (Operation Warp Speed) to facilitate and accelerate the development, manufacturing, and distribution of COVID-19 diagnostics, therapeutics, and vaccines. This partnership was successful in all of these areas, but it was particularly successful with respect to vaccine development and the design and conduct of appropriate clinical trials.

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Regarding therapeutics, the partnership rapidly initiated clinical trials of a repurposed antiviral, remdesivir, that was subsequently shown to be of value in treating patients infected with SARS-CoV-2.[4,5] Working with pharma, Operation Warp Speed also fostered the development of monoclonal antibodies directed against the SARS-CoV-2 spike protein[6–8] and encouraged the collection of convalescent plasma, both of which were demonstrated to be of value in the treatment of early COVID-19 infection but of less value in severely ill patients with the disease.[9] In addition, Operation Warp Speed fostered studies of drugs intended to abrogate the cytokine storm associated with severe COVID-19 infection, including interlekin-6 receptor blockers, such as tocilizumab and sarilumab, and Janus kinase inhibitors, such as baracitinib and tofacitinib, though the precise roles for these compounds in the therapy of COVID-19 remains somewhat controversial.[10–12]

Perhaps the area in which Operation Warp Speed was most effective was in stimulating vaccine development. Vaccines have been developed on multiple platforms, including the novel messenger RNA (mRNA) platform (eg, Pfizer-BioNTech and Moderna); nonhuman adenovirus vectors (eg, Astra-Zeneca, Janssen), protein subunit platforms (eg, Novovax), and a host of others.[13] The speed with which these safe and efficacious vaccines were developed, tested in large clinical trials, and deployed under EUA was literally astonishing. The first EUA for a vaccine was granted December 11, 2020,[14] and the second was granted on December 18, 2020,[15] both less than a year from the initial isolation of the virus. Subsequently, a third vaccine, manufactured by Janssen Pharmaceuticals, was granted an EUA in February 2021.[16] The remarkable safety and efficacy of these vaccines were demonstrated in large, placebo-controlled, masked clinical trials[17–19] and have subsequently been validated by large effectiveness studies, with >300 million doses of these vaccines administered throughout the country and around the world.

Missteps and misinformation in the US pandemic response

In our opinion, several aspects of our pandemic response were suboptimal. We believe that the largest misstep was not having a centralized, coordinated US federal response. Oversight for the response was decentralized to states and municipalities. So, rather than a centralized, coordinated response, we had hundreds of approaches. In addition, the scientists from the CDC who are most knowledgeable about the management of epidemic respiratory infections did not lead our response; they were, in fact, largely inexplicably sidelined early in the pandemic. Additionally, the executive branch of the federal government consistently minimized and trivialized the risk of COVID-19, suggesting that we had the disease under control or that it would soon disappear. The United States also lacked alignment with World Health Organization (WHO) recommendations on several occasions and, in fact, withdrew from that organization in July 2020 for a short period.

From the very start of the pandemic, we discovered that the US public health infrastructure was woefully inadequate and lacked the human resources needed to support an aggressive pandemic response at the state and local levels. A National Academy of Medicine Discussion Paper[20] published in April 2021 notes that >66,000 state and local public health jobs were eliminated between 2008 and 2017. Depletion of these public health positions left us with highly limited ability to test the population and to trace contacts, as well as to implement and manage the quarantine process.

The slow development and scale-up of rapid, accurate, and widely available testing seriously hampered the US's ability to detect infections and blinded epidemiologists, public health surveillance systems, hospitals, and municipalities to the clusters of infections that were already taking hold in the country. The first test kit deployed from the CDC to state health departments was flawed, and distribution of an effective test was delayed for a month, leaving the country far behind in testing and slowing the public health response.

We also experienced some confusion about the epidemiology of COVID-19, especially in the early part of 2020. Some leaders may have assumed that the epidemiology would be similar to other acute coronavirus-caused illnesses, such as severe acute respiratory syndrome (SARS) as it occurred in the early 2000s[21] and the Middle East respiratory syndrome (MERS) in 2012,[22] with most transmission occurring from individuals who were symptomatically infected. The true pandemic potential of SARS-CoV-2 may have been initially discounted, based on the previous successes controlling SARS and MERS. Early reports and guidelines suggested that transmission occurred from exposure to droplets or fomites. The fomite risk was likely much smaller than initially anticipated, and the spread by aerosols may have been underestimated. The extent to which transmission occurred from presymptomatic or asymptomatic individuals was not initially appreciated but it has, almost assuredly, been a major contributor to pandemic spread.[23,24]

Perhaps to try to assure an appropriate supply of masks for healthcare providers, masking was initially discouraged for society at large, and the efficacy of source-control masking to abrogate the spread of respiratory viruses was not broadly appreciated. The change in public health stance around the efficacy and importance of source-control masking was seen as a reversal, and it undermined the public's confidence in guidance on masking, sowing the seeds of dissent from some segments of the population who did not believe that masking was necessary to prevent the spread of infection. Uneven application of mask mandates from state to state and a lack of a unified federal message on masking further undermined confidence in public health.

Furthermore, hospitals and clinics typically rely on 'just-in-time' supply chains; however, this approach failed miserably in the face of massive demand associated with the waves of infection. Most hospitals experienced severe shortages of personal protective equipment (PPE) and other supplies. Especially early in the pandemic, we would also likely have benefitted from the Defense Production Act being invoked to attempt to provide an adequate supply of PPE, swabs, testing reagents, and other critical items. Again, the lack of a coordinated federal response or a robust pandemic stockpile to ensure an adequate supply of PPE for the healthcare workforce led to bidding wars, the widespread use of crisis standards of care, such as extended use of PPE and reprocessing of single-use PPE items, and vulnerability to counterfeit devices and profiteering.

Despite one of the earliest clusters of COVID-19 occurring in a long-term care facility,[25] many states did not focus on these facilities. As a result, some of the most vulnerable individuals in the country living in these congregate settings were at extraordinary risk for infection and, unfortunately for them, were also at highest risk for the severe sequelae of COVID-19.

Finally, some recommendations for COVID-19 care were a bit impractical and did not reflect the needs or experience of healthcare organizations at the ground level. For example, although N95 respirators or powered, air purifying respirators (PAPR), were recommended for individuals providing care for COVID-19 patients,

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these devices were in short supply. Plans from state and federal agencies to distribute the small number of these items from the federal stockpile did not consider the need to fit test N95s to ensure proper fit, a practice which can sometimes use up much of the supply. In addition, the expectation that healthcare providers in all care settings could manage complex PPE, such as PAPRs for long periods, was unrealistic and had the potential to cause harm due to the risk of self-contamination due to improper use or doffing. Because institutions did not have a supply line for N95s, they generally accepted whatever model they could find. Fit-testing staff on several different models of respirators during the pandemic was simply neither practical nor possible.

A major problem laid bare by the pandemic is that a substantial fraction of the US population participates in science denialism or holds beliefs in conspiracy theories that appear to be contributing to vaccine hesitancy and resistance to public health guidance or mandates. The problem is complex, informed by distrust and fear, and requires a thoughtful approach from public health and government agencies.

Lessons learned

At the very least, the pandemic has been instructive. We have learned the hard way that preparedness is absolutely essential and that preparedness requires substantial practice and attention to detail during drills. Preparedness drills must be treated as if every aspect of the drill is real. Pandemic preparedness must be an integral part of any emergency preparedness program.

We have learned that constant reassessment is critical to the early response to the pandemic. In our institutions, as we prepared for infected patients, we met with hospital departmental leadership 3 times a day or more to assess barriers identified and procedures that needed to be modified and to make the necessary mid-course corrections that are key to a resilient response.

We have also learned that we must be cognizant of health disparities in medicine. This pandemic has taken a terrible toll on communities of color and those who have limited access to health care. Many racial and ethnic minority groups have been inequitably affected by the pandemic, placing them at increased risk for infection[26] and for the severe sequelae of infection, including increased mortality, from the disease.[27]

Another important lesson learned is the critical nature of what we term, 'transparent qualified communication.' To foster confidence in the system, transparency is critical—sharing what we know at any given time, qualified by saying that this is what we have learned to date and that additional information may result in changes to these recommendations. Furthermore, if the recommendations must be modified, we will provide the new information and the rationale for the modified recommendations.

One of the most important lessons we have learned is best summarized by an old economic phrase, "the tragedy of the commons." This term was initially expressed by an economist, William Forster Lloyd, who wrote in 1833 about shared resources being depleted by people acting in their own self-interest. As applied to the COVID-19 pandemic, the tragedy we experienced were individuals neglecting society's well-being to pursue their own personal needs. Whereas focusing on one's own health and personal freedom and those of one's family and friends makes implicit sense, we believe that we also have a substantial responsibility to focus on common or societal good. If our leaders recommend staying home, masking, or physical distancing, we should attend to these recommendations to help protect the society, despite personal inconveniences.

The pandemic also illuminated the weakness of our existing public health infrastructure, especially the inadequate numbers of trained personnel to be able to rapidly provide contact tracing with appropriate testing, and if indicated, isolation or quarantine. The pandemic exposed an exigent need to reinvigorate the public health infrastructure to make it possible for us to respond to the next set of challenging circumstances. The public health infrastructure should be expanded to include not only more people who have cutting-edge skill sets but also substantially improved data systems that can be integrated with clinical and healthcare institution data streams, laboratory systems, sequencing data, as well as local and regional public health information. In addition, the public health infrastructure should be bolstered with enhanced laboratory capabilities, including broad-scale access to rapid genomic sequencing.

Another important lesson we have learned is the clear need for detailed postpandemic evaluations of situations that transpired during the pandemic. Systematic analysis, especially of situations and circumstances that did not proceed as planned, as well as instances in which unanticipated events occurred can provide a stimulus for effective preparedness planning for the future. Each of our institutions, as well as state and local public health authorities, should carefully assess their experiences and conduct detailed evaluations of situations that are worthy of scrutiny.

The pandemic has taken a personnel toll on the nation's healthcare workforce as a result of more than a year of working in crisis, both as a direct result of caring for COVID-19 patients and as a result of the many delays and disruptions in the care of non–COVID-19 patients. Pre-existing problems with inadequate staffing and a short supply of healthcare personnel have accelerated during the pandemic. Burnout and disengagement among the healthcare workforce increases the risk of medical errors and poor compliance with infection control practices. We have learned the importance of supporting resiliency within the healthcare workforce, and we must continue to advocate for policies that protect healthcare personnel from practices that lead to burnout.

Finally, an important lesson we have learned is that, whereas our political system funds the public health enterprise, public health responses should not be political. Pandemics are apolitical; our national response should be guided by science and scientists and not by political interests, again focused on the overall societal good.

Remaining pandemic concerns

Table 1 provides a short list of remaining pandemic concerns. The highest priority concern at the present is vaccine hesitancy and vaccine resistance. The fact that, as of the end of June 2021, we have been able to vaccinate fully <47% of the US population[28] is a direct result. With a substantial fraction of the population unvaccinated and at risk, the likelihood that new and more aggressive SARS-CoV-2 variants will continue to evolve is almost certain. Currently, a significant outbreak of the delta variant is ongoing in southwestern Missouri. If a substantial fraction of our population remains susceptible, the risk for yet another surge in the fall season is increased. All of us need to work to try to encourage the vaccine hesitant to be vaccinated.

Another area of concern relates to the fact that we do not have vaccines with emergency use authorization for administration to children under the age of 12 and for individuals who are pregnant or lactating. Clinical trials in these populations are currently

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Table 1. Major Remaining Pandemic Concerns

• Science denialism
• Vaccine hesitancy and resistance
• Vaccinations for children and pregnant people
• Evolution and spread of more highly transmissible and/or virulent variants
• Post-COVID-19 clinical issues
• Lack of public support for public health interventions (eg, lockdowns and mask mandates) if or when another wave or new agent arrives
• Need for recurring boosters
• Unanticipated challenges

ongoing in the United States, so we are optimistic that we will have a solution for this concern by the late fall or early winter.

A major continuing pandemic threat is the evolution and spread of highly transmissible and/or virulent SARS-CoV-2 variants. As noted above, the large fraction of the population that remains unimmunized and susceptible provides a breeding ground for the evolution of new variants. In addition, patients who are immunologically unable to clear the infection may also provide a fertile breeding ground for the evolution of variant strains.[29]

Many patients who have ostensibly recovered from the acute phase of SARS-CoV-2 infection develop persistent symptoms. This population of patients who recover incompletely or have recurring symptoms long after infection with SARS-CoV-2 have been dubbed the 'long haulers.' Such individuals are also a matter of substantial concern. Many of their persistent symptoms are poorly understood, and we do not yet have a clear understanding of the pathophysiology of these manifestations.[30] The CDC has recently updated its website to provide more information about these patients and their recommended management.[31]

Another continuing pandemic concern relates directly to the "tragedy of the commons." At this point in the pandemic, we are uncertain whether our country could generate sufficient public support for more public health interventions (eg, a lockdown and/or revised mask mandate if such interventions become warranted) either to control a new variant or a new virus. Adherence to these recommendations would require substantial sacrifice from a population that is already quite pandemic weary.

At least 2 of the vaccine manufacturers have said publicly that they are working on booster doses of their vaccine to deal more effectively with variants; however, the need for such boosters remains uncertain. Recent studies suggest a long-lived response in the bone marrows of vaccinees[32] and also document robust immunity in patients recovered from infection, and particularly among those who recovered and then subsequently received mRNA vaccines after recovery.[33] Furthermore, we need to rapidly assess whether additional vaccine doses (boosters) would lead an improved immune response in immunocompromised patients (as suggested by initial studies[34–38]) and whether this improved response would translate into improved vaccine effectiveness.

To date, the COVID-19 vaccines have proven to be highly effective and very safe. However, ongoing surveillance has suggested that COVID vaccines may be associated with thrombosis with thrombocytopenic syndrome (TTS)[39–41] or myocarditis.[42,43] These adverse events have varied by the specific vaccine administered. However, the benefits of vaccination clearly remain greater than rare serious side effects. Continued safety monitoring is critical to assure the public of the long-term safety of COVID-19 vaccines,

Finally, we need to continue to be prepared for the unexpected as the pandemic rolls on. As variants evolve, we will likely be forced to deal with additional unanticipated challenges. Healthcare epidemiologists and public health officials must remain vigilant to be able to address new challenges as they arise.

Charting a course toward a 'new normal'

As the country appears to be emerging from pandemic constraints, we believe that we all should take this opportunity to assess which aspects of our pandemic response should become part of a 'new normal' going forward. For example, many people have been successful and highly productive while working from home in their jobs. Although not all positions can support this approach, employees whose jobs lend themselves to working from home are likely to want to continue this practice, and employers may also see the benefit of not having to provide office space for these individuals. Another aspect of the pandemic response that has worked well is telehealth and telemedicine. We envision that some routine clinic visits and follow-up appointments may lend themselves to a video appointment without sacrificing any aspect of clinical care or clinical quality.

We also envision that source control masking will likely become a standard part of a hospital epidemiologist's armamentarium. Studies have shown convincingly that source control masking decreases the risk for spread of seasonal respiratory viruses.[44] Particularly in respiratory virus seasons for which significant influenza and other respiratory viral (eg, RSV) activity is forecast, we could easily envision implementing source control masking for all patients and clinical staff in our facilities to preclude the spread not only of influenza but also parainfluenza, adenovirus, rhinovirus, respiratory syncytial virus, and seasonal endemic coronaviruses. During the COVID-19 pandemic, most institutions noted a substantial decrease in the occurrence and transmission of seasonal respiratory viruses.

A major focus of a 'new normal' must center on vulnerable populations, being specifically mindful of health disparities. This pandemic has underscored the health inequities present in our current systems of healthcare delivery. Any new normal must be both substantially more inclusive and substantially more responsive than our current system. As part of the challenge of the focus on vulnerable patients, the new normal must focus early prevention efforts on vulnerable people living in congregate settings: long-term care, extended care, long-term acute care, as well as homeless shelters, jails, and prisons.

Another important issue that each of us has had to manage during the pandemic is the issue of 'presenteeism.' Historically, HCP have viewed coming to work—rain or shine, sick or well—as a responsibility. During this pandemic, we all were adversely impacted by having staff who were symptomatic decide to come to work, either because they minimized their symptoms or because they felt responsible. These cases almost uniformly resulted in patient exposures, staff exposures, and substantial effort in contact tracing and quarantine implementation. We must educate our staff to no longer view 'presenteeism' as heroic or even socially acceptable. Presenteeism is a major patient and staff safety issue. The message is clear: If you have symptoms, stay home!

Finally, we must deal with COVID-19 vaccine hesitancy among our HCP. As is occurring in the community, younger HCP and members of traditionally disadvantaged groups in some locations

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will be less likely to accept immunization. A variety of methods have been demonstrated to improve vaccine coverage among HCP.[45] However, requiring a COVID-19 vaccine as condition of employment or service in a healthcare facility (eg, students, volunteers, and contract workers) may be the only method to reach high coverage levels.[45] We believe it reasonable to allow exemptions for vaccine contraindications and religious objections after individual case review.

Summary

The pandemic has placed enormous strain on the systems of healthcare delivery in our country. Despite some identified shortcomings and missteps and miscalculations, HCP have provided exemplary care for COVID-19 patients from the beginning of the pandemic. The pandemic has exposed several areas in need of substantial improvement. Over the next several years our country will have the opportunity to revise its pandemic approach and improve our infrastructure for public health.

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