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Bringing Every Tool to the COVID-19 Fight—What We Need Now

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The COVID-19 pandemic has upended society for the past year, manifesting one of the worst-case scenarios that those in global health security have long feared and tried to prepare for. In the planning for a pandemic, [there has long been recognition that the toll on society would be felt broadly](#) (PubMed, 2006). Said differently, unlike other events (disasters, disease outbreaks, etc.) that we plan and prepare for, a pandemic would shift all of society, not just one (or a few). To demonstrate this point, I provide two examples of known expected impacts to a prolonged pandemic—impact to tourism sectors (and countries heavily dependent on tourism dollars) and impact to mental health and well-being. On the former, it has been made clear that a pandemic would ground most forms of transportation, seizing the growth of hospitality, tourism, and travel sectors, while also hurting the economies of countries—often small island nation states—dependent on tourism dollars. On the latter, countless pandemic tabletop exercises have demonstrated the mental health toll of a pandemic on many members of society, especially those most vulnerable to the economic and health impacts from the disease outbreak.

In fields such as emergency management and public health, we are encouraged to discover ‘unmet needs’ in a highly ambiguous context. And when there are unmet needs in every sector and for almost every population, the capacities of any one system to meet the requirements of a pandemic response are overwhelming. Before moving on, I want to pause and acknowledge the hard work that public health and emergency management experts do daily, especially during a crisis, to take on urgent and pressing tasks to address human needs with little to no clear immediate information available to them. For countless major or serious catastrophic events, there are dozens of responding teams that could describe having to make decisions ‘in the dark’ at some point in the event. And while the data picture may illuminate a clearer picture further into the response, there is certainly a need to use data science iteratively to improve assumptions and actions as operating periods evolve.

The field of pandemic preparedness and response has existed for decades, but has recently risen in prominence due to the COVID-19 pandemic. Pandemic preparedness plans—at the local, national, or global level—all consider complexities such as non-pharmaceutical interventions, medical countermeasure development, impacts to the economy and society, and many other factors. There has been a common understanding that without significant shifts in our cooperation and global investment, we would not be ready to effectively respond to a pandemic. The [investment in preparedness and response capacity](#) simply has been insufficient (National Academy of Medicine, Secretariat, 2016). (This one sentence deserves a full paper, but for now, I reference the work of several who describe the investments in the US pandemic response system, including [the Strategic National Stockpile](#), and the toll we bear for the lack of investment. [Stein, 2020]). It might seem strange to start with a layout of some many elements that seem evident or fully illuminated by the response today. Further, the lack of global and local public health investments (or lack thereof) that have brought us to where we are, but it is critical to understanding where we are, how we got here, and what we need to get out of the response. Cross-sector solutions are critical to address the immediate and near time

impact of this pandemic, including the role of an iterative data science approach, it is crucial to approach with a holistic understanding of far more than this singular pandemic response.

I suggest we begin this examination by orienting around the breadth of complexities that are presented by the spread of novel infectious disease, rather than orienting around the role of data science, in order to remain focused on the goal itself. The origin of this examination is a review of the opportunities to provide solutions during a pandemic, specifically the COVID-19 pandemic, that can alleviate immediate burden and contribute to ending the ongoing global outbreak. Rather than starting with a view on the use of data, there is an opportunity to reflect on the needs that evolve during a pandemic and the opportunities to resolve them. Said plainly, the pandemic has presented a host of challenges that require multi-sectoral solutions, some directly connected to the disease outbreak, and others as tangential challenges that emerged due to the pandemic. Additional information on notable challenges data science could be used to address follows in this response, but in this examination it is worth citing challenges related to data collection and the potential application of data science in solutions. A primary challenge—which stands to influence the imaginaries referenced and their application—involves the proper processes for collecting data and information generated and/or owned by private sector stakeholders (e.g., healthcare product manufacturers and distributors) and sharing it with public sector actors charged to managing a response (additional information on notable challenges follows). By focusing on the needs, rather than the tools we have to address them, we may be able to create new opportunities to infuse data science into the fight against COVID-19 pandemic.

Often in my training, I recall professors chiding the uses of tools, reminding us that ‘when you have a hammer, everything becomes a nail.’ And this, is in fact true. The thrill of the opportunity to address every societal issue with the tools provided by data science is quite real. And during the COVID-19 pandemic, quite necessary. The imaginaries, as described by Leonelli are quite apt, but potentially limiting. The range of challenges presented by the COVID-19 pandemic, and future pandemics, are wide-reaching. And while the contributions of data science can certainly be scoped around the healthcare and public health needs, it should not be limited to them.

In the fall of 2019, I recall attending and participating in versions of the tabletop exercise created and ran by the Johns Hopkins Center for Health Security, [Event 201](#). This tabletop exercise, executed in multiple parts, walked the group of players and observers through a disease outbreak of a novel infectious disease which quickly spread across the world. While there are a few elements that were poignant, the most telling takeaways were that the actions and outcomes that the principles that public health would expect and have proven to be true during the COVID-19 pandemic:

- The cost of pandemic response is so high that needs resulting from cascading impacts from the pandemic are likely to be deprioritized;
- While the focus is public health response, the impacts will be felt society-wide, making any type of ‘hierarchy of needs’ functionally useless;

- There will be a challenge to collect good, verifiable data and information to inform the actions of every sector.

This tabletop exercise, and every piece of pandemic planning prior to this pandemic, has made one simple thing clear: there would be far more required to tackle this pandemic than traditional public health alone. Managing, analyzing, and creating the data and tools that are required to inform these decisions is paramount to any pandemic response, including again COVID-19. So, while we can develop and parse out the imaginaries of the use of data science in the pandemic response, I struggle. It appears, at least from my view, that there simply is not a place where data science would serve a critical role. As if it is true that data science is a necessary ‘hammer,’ we cannot afford to apply the constraints on where and how to use it.

The flow of data and information, and the science to process and understand that information, is one of the greatest opportunities in the global public health and emergency management space(s). For the first time, we are managing a pandemic with data being created, collected, and moved at rates that rival the virus itself. The movement of information and misinformation—commonly referred to as the [COVID-19 infodemic](#)—has added additional complications to the pandemic. There is need for an interdisciplinary approach to address the needs of health and society during a public health emergency. Data scientists are a necessary part of this process, as both innovators and intermediaries, bridging various fields with tools that allow us to see beyond sectors and understand the world fully. Data scientists represent a rare opportunity to open the aperture of the pandemic response and understand how behaviors, policies, actions, investments, or other interventions can impact society across sectors. The challenge, however, is accomplishing this goal without creating more silos or hurdles in cooperation that could end up hindering the COVID-19 pandemic response. The ultimate question for data scientists to consider in the moment, I think, is how to best harmonize and integrate data science in a manner that allows us to collectively move forward, without further fragmentation.

Understanding the criticality of this moment should leave every technical expert with a sense of concern, and tremendous responsibility. The chasms of needs that have emerged from the COVID-19 pandemic should spur an impetus to address some portion of the challenges using every available talent and resource that we can bring to bear. At the time of this writing, there have already been more than 375,000 deaths in the United States and 1.94 million worldwide, with multiple days of COVID-19 deaths reaching 4,000 daily in the United States alone. There is no space for silos and no space for inefficiencies. While the metrics shared above use mortality as the impact measure, it is important to acknowledge that COVID-19’s impact is not limited to fatalities; there are several metrics that could also be used to show the impact that it has made on society, across economic, housing, and even other health measures.

A pandemic, and the opportunities to assist with a pandemic response, can be vast and overwhelming. It is difficult to look at such an immense problem and neatly scope the potential areas for impact, and then act on them. This, I recognize, is part of the role that the imaginaries can play. In order to provide some potential framing for the role of data scientists, I provide a few examples of challenges that have emerged from the

COVID-19 pandemic and the opportunities for data scientists to support. While this list is far from exhaustive, the data science solutions that could be brought to these challenges are multifactorial and could immediately inform thinking, strategy, and policy development.

1. *Analysis of behaviors and actions that mitigate against the spread of SARS-CoV-2 (COVID-19).*

Continually building a clearer picture of the actions that healthcare professionals, essential workers, and members of society are willing to take to mitigate the spread of SARS-CoV-2 would help inform targeted trainings and public information campaigns, and even help understand where future cluster outbreaks may be possible due to resistance to adopting such behaviors.

Clarifying this picture at local, state, regional, and nation-state levels would allow public health practitioners to better understand where their efforts are most needed, and where information and education campaigns (or different types of efforts) would be most needed.

2. *Tracking the movement of misinformation campaigns to identify potential amplifiers of misinformation, and opportunities to stop the flow of misinformation.*

The speed and impact of misinformation is a grave challenge, obstructing the COVID-19 response. There are dozens of potential actions that would be useful here, but ultimately tracking, stopping, and redressing the many types of misinformation that continue to hinder the COVID-19 response (from the prevention of transmission, to available treatment, to vaccinations) is needed urgently.

3. *Illuminating the range of economic – household, business, sector, regional – challenges and needs that were caused by the pandemic.*

Recognizing that a pandemic causes widespread pain and damage to all facets of society, it is not enough to focus on the direct health impacts. Society will continue to suffer. Efforts to better identify, characterize, and eliminate suffering across other groups and sectors is necessary.

Beyond recognizing these pain points, bridging gaps across sectors and decision makers to ensure that policies or actions that are intended to prevent the spread of COVID-19 do not cause unintended (or avoidable) damage across other sectors is another opportunity space.

4. *Building tools that can track and predict potential housing insecurity to enable government action to prevent loss of stable and safe housing.*

In most pandemic plans, the most common non-pharmaceutical intervention is remaining at home for larger periods of time. How awful and harmful does this intervention become when one's home is neither safe nor secure? Building national pictures of the needs of those with unstable or unsafe housing,

alongside possible solutions that could resolve issues of safety and well-being, is an area of incredible need.

5. *Analysis of the inequitable impact of COVID-19 on people of color (especially Black, Brown, and Indigenous people), women, and youth.*

Truly, the more coordinated our work in this area, the better. The toll that the COVID-19 pandemic has taken on people of color, women, and youth will take years to fully characterize and generations to rectify. A clearer characterization of the toll of COVID-19 across various measures, with an attempt at determining which interventions or actions would begin to address these inequities across various systems, should be a requirement for immediate action.

6. *Strategies for COVID-19 recovery, especially with an emphasis on alleviating suffering for human populations, geographic regions, and sectors of society most impacted by the pandemic.*

Recovering from a catastrophic event, no less a pandemic which has shaken every part of the globe, requires concerted action and decades (yes, decades) of intentional investment. There must be a collaborative effort to analyze what the world will look like after COVID-19, and begin to measure the impact of the pandemic across various sectors. That picture will be pivotal in determining which actions are required for the future years of pandemic recovery that await us.

As we think about which questions and challenges could benefit from data science, it is also imperative that we consider how we gather, analyze, and reflect back that data. Community engagement is indeed crucial to obtaining robust data and robust use and outputs, and it is paramount that researchers be able to share their analysis with collaborators and community members in a way that allows them to realize the benefit of the data science they contribute to. But researchers must also consider the burden that their research may place on their collaborators within communities, and should take care to ensure that they are able to access the fruits of their collaboration. This is especially the case during a pandemic or other disaster, during which community members—especially those from marginalized groups—are already engaged in responding to the event themselves. Furthermore, community engagement is not just a feature of effective data collection or big data itself, and instead characterizes the approach that the field of emergency management and public health should take when preparing for or responding to any disaster, pandemic or otherwise.

It is difficult to pause in the midst of a pandemic response and provide reflections, especially with the goal of orienting us to respond immediately and effectively. Any further consideration of the role that the data science field—or data scientists themselves—can bring to the COVID-19 pandemic response is important.

Recognizing that the middle of a pandemic response is not the time for future gazing (at least in my view), I want to conclude with an urging to take these reflections as an immediate call to action, not lessons that may be imparted in the fight against a future pathogen. In the time it took me to reflect and then write this piece, more

than 10,000 lives have been lost to COVID-19, leaving a gaping hole in the lives of many families. There is a critical need to act, and act now.

Disclosure Statement

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