

Reimagining public health infrastructure in the 21st century

By Susan J. Blumenthal
and David Sun Kong

The coronavirus pandemic has ushered in the opportunity for a once in a generation reimagining of America's public health infrastructure. To meet this opportunity, a new multidisciplinary academic field of public health technology should be established to integrate diverse expertise in public health, technology, engineering, data analytics, and design to help build the products, programs, and systems necessary to modernize the nation's public health infrastructure and ready it for 21st-century challenges and opportunities.

The pandemic exposed significant deficiencies in early warning systems of disease surveillance and real-time data collection, with notable gaps in the gathering of racial and ethnic information, testing, contact tracing, antiviral and vaccine availability, and new-device development, as well as the sustainability of the supply chain for producing and distributing medical equipment and resources. Furthermore, there were many coordination challenges between federal and state agencies and other key stakeholders in pandemic response, and our public health communication system faced enormous challenges addressing an infodemic of misinformation surrounding the pandemic.

Many of these problems were caused — or made more acute — by federal and state governments' inability to rapidly and effectively leverage technology solutions. Or, in some cases when promising new technologies were developed — be it powerful mRNA vaccines, created in record time, or digital contact tracing tools — the full suite of expertise necessary to realize their most effective use, from science communication to community engagement, were inadequately mobilized. Tradition-

al disciplinary boundaries separating technologists from public health and other experts proved to be significant barriers to the development and deployment of life-saving cutting-edge technologies as well as communication about their effectiveness.

Consequently, many of our best defenses against the coronavirus when it emerged remained old-fashioned: social distancing, masking, and good hygiene — similar to those used in 1918 to combat the Spanish flu pandemic. Yet, fast-forward a century later: While these public health practices still work well, in the midst of a scientific and technological revolution, the new and powerful tools of the digital age were not being effectively or innovatively applied at the onset of the pandemic. Consider the long waits in online queues to find a vaccine in your community, or being advised to use one-size-fits-all cloth masks that were not certified for their viral particle filtration effectiveness.

These results should not surprise us; only 3 to 5 percent of America's \$3.5 trillion dollar health care budget before the pandemic was spent on government public health programs. Without significant and sustained investment in integrated public health and technology solutions, we'll continue to be impeded in our ability to rapidly and effectively address big problems like future pandemics, chronic disease prevention, and other global concerns — including the impact of climate change on health.

At the MIT Media Lab, where we are both affiliated, traditional disciplinary boundaries are blurred, and scientists, engineers, artists, and designers work together to design and build technologies of the future. A similarly multidisciplinary philosophy is necessary to modernize America's public health infrastructure and foster the global collaboration required to address health threats that face the world.

An important step forward would be to convene a group of leading technology, public health, medical, and design experts to collectively explore establishing a field of public health technology. Together, they could define integrated pedagogies and curriculums that combine their respective disciplines and create a roadmap for the architecture and requirements needed to establish certificate and degree programs and schools. These programs could be seeded at engineering, public health, and other relevant professional schools as well as at institutions that grant online education degrees. Diversity, equity, inclusion, and accessibility must be values central to this new field.

This field could build on the surge in interest from technology experts seeking to apply their skills to address the myriad public health challenges arising from the pandemic. We are beginning to see the effective use of wastewater surveillance technologies to monitor for not only the presence of pathogens like SARS-CoV-2 but also substances like opioids, whose use has become epidemic in some communities.

A host of low-cost, open-source technologies have been developed for pandemic response, including at-home saliva-based diagnostic tests and pulse-dose oxygen-saving devices. Novel data analytics are being used to optimize the efficacy of science communication strategies. A new generation of vaccines was developed and administered at a historic pace. These and other exciting emerging collaborations between technologists and public health professionals could lead to significant innovations in disease surveillance and forecasting; contact tracing; drug, device, and vaccine development; and advanced materials for personal protective equipment, medical supply chain resilience, and public health communications, to name a few.

With modernized real-time data collection that can better reveal and quantify the inequities and vulnerabilities in our health system — there is currently a 20-year life expectancy dif-

ferential in communities across America, based on your zip code — we might be better positioned to identify the sociocultural determinants of health and develop important interventions to address them. And we hope this is just the beginning — these new collaborations can serve as a model for how public health and technology experts can, and must, work together to respond to both our current crisis as well as the health threats of the future.

Ultimately, a key goal is to inspire a generation of multidisciplinary innovators to apply their diverse skills to help build the public health infrastructure of the 21st century. Reinventing this infrastructure will take significant and sustained investment, innovation, and leadership across the public and private sectors. We believe establishing a new field of public health technology will accelerate this process and equip a new generation of leaders with the multidisciplinary skills necessary to build an integrated public health system capable of responding rapidly and seamlessly to health challenges facing communities in the United States and around the world.

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