An All-of-Science Approach to Public Health

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Previous pandemics in the modern era were never long, severe or widespread enough to stimulate an all-of-science approach to beating them. SARS essentially ended after only several months in 2003[1], H1N1 caused approximately 18,000 deaths in 2009~2010[2], and Ebola was concentrated in West Africa in 2014~2016 and in the Democratic Republic of Congo in 2019~2020[3]. During these pandemics, the medical sciences fought back through genomic research, vaccine development and new treatments, but their limited nature did not trigger a response from non-medical branches of science.

COVID-19 is a much more severe pandemic, with no end in sight, more than a million deaths already, and affecting every country in deep ways. As a result, more branches of science are getting involved in the pandemic response, such as transport engineering[4], fluid mechanics[5], mathematical modelling[6] and even astronomy[7]. While politicians close borders to curb the spread of COVID-19, researchers in the medical and non-medical areas are breaking borders by communicating and working on the solution for COVID-19. This is on top of the decade-long partnership in pandemic responses between economists, sociologists and behavioral psychologists with public health experts and doctors.

This all-of-science response is both necessary and admirable. However, such energetic responses can and should be harnessed in several ways to fully maximize the benefits. This article proposes three over-arching principles for country-level governments and the self-governing global science community to consider.

1. Include health into the scientific research agenda

Historically and traditionally, scientific research has multiple objectives, such as human progress, creation of economic opportunities, or to increase national prestige. Health has always been important, but national research agendas may deprioritize health

in favor of the applied sciences, manufacturing, or artificial intelligence. Now, in the post-COVID era, there are several strong reasons to include health into the national research agenda as a high-priority item.

One, there is a need for the best brains in a country to focus on inventions and innovations that literally save lives during pandemic and non-pandemic times. Two, the global healthcare industry is expected to grow to nearly $ 12 trillion in 2022[8], which is a huge economic and job-creating opportunity. Three, this pandemic has sharpened the focus on the timeless truth that healthy populations require more than just doctors delivering oxygen or vaccines, but all scientists and researchers playing their own roles working in collaborative ecosystems.

Placing health higher on the scientific research agenda is more than just increasing funding to biomedical or clinical research, although newer antibiotics and more heat-resistant vaccines will be helpful. The core philosophy of research should emphasize on impactful research to add a new dimension of human health and development, instead of the more prosaic aims of intellectual properties, academic achievements or economic progress. It is time to ensure knowledge brought a sustainable change toward a healthier society.

In practical terms, this means several things. The metrics of scientific research should gradually evolve from just the hard statistic of patents and publications to the softer statistic of Disability-Adjusted Life Year (DALY) and Health-Related Quality of Life (HRQOL). Governments should create more inter-disciplinary grants for non-medical scientists and researchers to partner their medical and health colleagues. A centrally led research agenda can be powerful in converging the multiple disciplines together, in a research world that tends towards divergence.

2. Integrate research vertically

More innovations are needed to strengthen public health in several broad categories, and vertical integration can achieve greater impact. These include the use of disruptive technologies in the development of better vaccines, therapeutics and test kits. Their inclusive availability, affordability and accessibility to the poor and marginalized will be an added advantage. Provision of new solutions to increase the effectiveness of non-pharmaceutical interventions, such as tools to increase compliance to physical distancing, make handwashing a pleasant habit or comfortable yet safe fabrics for face masks also need attention. Better solutions combined with predictive analytics and block-chain are also needed to improve the effectiveness of quarantines, contact tracing and isolation.

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One COVID-19 success story is South Korea's test-kit diplomacy[9]. There was an accelerated yet safe and robust pathway from bench scientists to regulatory approvals to mass production, allowing South Korea to supply more than 100 countries in the early stages of the pandemic[10]. Such vertical integration of health research to healthcare services is a model for other scientific disciplines. These can be done in several ways.

Firstly, there are three broad datasets for science and technology researchers to embed into their research as they intersect with health and healthcare. These three datasets mirror the historical expansion of medical research aims over the past 50~70 years. Scientists and researchers can begin in any order of preference or familiarity, with clinical outcomes (such as improvement in average blood pressure readings), health economic outcomes (such as the cost savings or cost-effectiveness of a new innovation) or patient-reported outcomes (such as the Migraine-Specific Quality of Life scoring[11]). Clinical outcomes will persuade doctors, economic outcomes will persuade payers and insurers, and patient-reported outcomes will persuade the end-users of the innovation; all are important components of the healthcare system. Randomized controlled trials are the gold standard, but emerging use of real-world evidence (RWE) may be a necessary decision for researchers in the near future.

Secondly, governments can create collaborative networks of inter-agency task forces that combine researchers from multi-disciplines with lawyers (for patents and liability clauses), manufacturers (for iteration and mass production), commercial leaders (for commercialization and scale-ups) and end-users (like doctors, nurses or patients). These task forces will foster greater purpose, faster collaboration and seamless efforts, because researchers no longer work in a silo only to hand-off their finished work to another group of experts.

Thirdly, all researchers must embrace digital technology (eg 5G/6G) to remain relevant, especially in health. Artificial intelligence, bioscience technology, data analytics, block chain and the Internet of Things are only a few examples of the disruptions in science and research. These advances intersect with health through portable lifetime electronic health records[12], pharmacogenomics[13] and wearables, as only three examples. A vertically integrated and built-in digital capability will help take-up as well as increase impact of any innovation.

3. Embed research into systems, not as standalone products

Public health systems have undergone decades of under-investment. For example, the OECD spends only 7% of their health expenditure on preventive care and public health[14], but approximately 80% on curative services and pharmaceuticals. COVID-19 will change all that, with increasing amounts of money now being committed to public health, health systems strengthening, health policies and health services research.

This is welcome for several reasons. One, a better understanding of systems and services can improve population health by allocating resources more accurately and addressing systemic flaws. Two, a stronger and more resilient system can respond better to emergencies, disasters and pandemics. Three, governments can mount all-of-government and all-of-society responses to pandemics, instead of only relying on hospitals and health agencies to carry the entire burden of good health.

The broader science and technology community can respond to this emerging trend by embedding themselves within systems, instead of building and then handing over standalone products for the healthcare system's use. There are several ways to embed into health systems.

Firstly, researchers can include a health systems, services or policies expert. This can begin as early as the grant application process, which can increase the chances of success because multi-disciplinary teams are in increasingly higher demand. During the research process, a health systems, services or policies expert can introduce relevant outcomes to the research, monitor progress for these outcomes, and bring a real-world evidence component to the research. After the research is completed, this expert can advise on the relevant policy applications of the research.

Secondly, researchers should interact more closely with regulators and their agencies. Healthcare is more regulated than many other branches of science, with research outcomes undergoing rigorous scrutiny before and after approval for human use. However, the line between regulated products and consumer items can be unclear. For example, there is debate about whether a smartphone app can be considered a medical device[15] regulated by specialized agencies. Governments can help by creating "regulatory sandboxes" for researchers to innovate.

Thirdly, research into health systems, health services and public health will be demand-led for the foreseeable future. Governments, major funders, development banks and international aid agencies have started building or implementing research, investment and capacity-building agendas in these areas. The broader science and technology community can follow this trend by shifting their intellectual and organizational resources towards integrating with health systems in the first instance, not merely providing finished products to the end-users.

4. Health, not growth, is the ultimate metric

The post-1945 political economy emphasizes growth as the ultimate metric of a nation's success. That is reflected in the priorities of the world's research agenda, which aims in large part to advance a nation's competitive edge. Delivering economic growth and a competitive edge was necessary then, but is not viable in the 2020s and beyond.

Shifting research priorities towards improving public health is not only ethical and desirable, it is also necessary for governments to maintain their political legitimacy by providing stronger health services. The broader science and research community now has a historic opportunity to evolve their priorities, by leading an all-of-science approach to improve the health of all *Homo sapiens*.

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