Can COVID-19 innovations and systems help low- and middle-income countries to re-imagine healthcare delivery?

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SUMMARY

Several low- and middle-income countries (LMICs) have responded to COVID-19 much better than expected—despite little help from high-income nations. LMICs can learn from the COVID-19 experience and re-imagine healthcare delivery. Using Bangladesh and India as examples, we explain how COVID-19 investments and systems can be leveraged to fight endemic infectious diseases.

COVID-19 has presented before us a unique crisis in modern history, where local fights against the pandemic in every country will determine its fate across the globe. The urgency to address this acute crisis has unveiled the various strengths and weaknesses of communities in coming together and using existing resources most optimally to have the greatest impact.

In the early days of the pandemic, it was assumed that the rich nations in the Global North were the best prepared to fight infectious disease threats, but the past year has been a witness to the contrary.¹ North America and Europe have borne the brunt of COVID-19 deaths, with the US alone losing more than 500,000 people.

Several low- and middle-income countries (LMICs) have fared much better than expected, despite little to no help from the highest income nations. In fact, high-income countries have displayed little interest in ensuring equity by monopolizing COVID-19 vaccines; 10 countries account for 75% of vaccine purchases.² It is time for LMICs to dig deep, learn from the COVID-19 experience, and re-imagine their healthcare delivery systems.

What has worked well during the pandemic must be harnessed to fight other diseases, and what has not worked well must be fixed. In this commentary, using Bangladesh and India as examples, we cast light on how different local communities came together to fight COVID-19, and propose strategies of leveraging the investments made and collaborations built to conquer endemic infectious diseases.

Lessons from Bangladesh

Bangladesh, one of the most densely populated countries with 164 million people, detected the first cases of COVID-19 in March 2020. At that point, there was only one laboratory conducting only a few tests per day. However, within days, multiple laboratories around the country joined the testing efforts, and soon, Bangladesh was conducting ~20,000 tests/day. But ramping up testing was not a straightforward endeavor—the fundamental lack of infrastructure, capacity, and training posed a barrier at every step of the way. Many pieces, previously thought to be completely unrelated, had to come together, and so they did.

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https://doi.org/10.1016/j.medj.2021.02.008
As the importance of expanding testing was realized by the country as a whole, multiple groups of people with any basic laboratory training, including university students and teachers, started volunteering to provide hands-on support to hundreds of laboratory technicians on basic molecular biology techniques. Government and private research laboratories offered training on a sample collection across the nation. Local reagent and supply vendors solved supply chain puzzles to import supplies from different parts of the world. The teams of the Expanded Program of Immunization (EPI) and the local WHO office leveraged their expertise and network of distributing vaccines to instead transport samples for COVID-19 testing from all over the country to urban testing laboratories.

But sample collection and testing are not enough to guide evidence-based decisions, and this is where the rising Information Technology sector and the efforts made toward building a “Digital Bangladesh” came into play. Local data scientists worked with the government to build a public COVID-19 dashboard to monitor spatial and temporal distribution of cases in real time and raise awareness. Telephone hotlines were opened for patients to call in for information, COVID-19 test reports were delivered electronically through SMS, and phone follow-ups were conducted.

When many countries faced shortages of personal protective equipment (PPE), ready-made garments industries in Bangladesh provided a lifeline. This industry contributes to 12.4% of the GDP of Bangladesh and was on the verge of collapse due to the pandemic. However, they quickly and creatively adapted to making protective masks, gloves, and gowns for not only Bangladesh, but the entire world.3

The above efforts together presented the government and other stakeholders with the evidence required for making data-driven decisions, e.g., stricter lockdown measures were implemented in areas with the most cases. However, at the same time, vaccine candidates were entering clinical trials, all of which were designed based on SARS-CoV-2 genomic data from high-income countries (HICs). History has taught us that the circulation of pathogens can vary widely between geographies, and previous failures in including inadequate data from LMICs have led to low vaccine-strain/serotype coverage. Pneumococcal vaccines and serogroup B meningococcal vaccines are two such examples. We did not want history repeated, but the field of genomics is strongly dominated by scientists in HICs, and usually samples collected in LMICs are shipped to facilities in HICs for sequencing and data analysis.

On May 11, 2020, one group of scientists at a non-profit called the Child Health Research Foundation sequenced the SARS-CoV-2 sample in Bangladesh,4 and what followed was unprecedented. There was widespread media coverage of this effort to sequence one sample, raising widespread awareness of why genomic surveillance is key to fighting this pandemic. Within weeks, several groups volunteered to join the sequencing effort using their existing resources, and as of Feb 22, 2021, 911 SARS-CoV-2 genomes have been submitted to GISAID from Bangladesh (Figure 1). The speed and efficiency of the sequencing efforts of several LMICs was acknowledged in the media: “Countries with far fewer resources, including Bangladesh, Sri Lanka and Suriname, process samples more quickly than the United States does.”

**Lessons from India**

2020 was a tough year for India, which had to deal with COVID-19 as well as a shrinking economy.5 Like Bangladesh, India also struggled to ramp up testing in the early phase of the pandemic but managed to achieve this over time. India’s famous generic pharmaceutical industry (often referred to as the “pharmacy of the world”) came through with the production of COVID-19 vaccines, and two vaccines are currently being rolled out in an ambitious campaign that aims to vaccinate 300 million people by August. India is also engaged in vaccine diplomacy and has donated COVID-19 vaccines to several countries, including Nepal, Bangladesh, Myanmar, the Maldives, Sri Lanka, the Seychelles, and Afghanistan. India is expected to become the world’s second-largest COVID-19 vaccine maker.

Even before the COVID-19 pandemic, India produced about 60% of the world’s vaccines, and has indigenously developed vaccines (e.g., Rotavirus and typhoid vaccines). Indian-made generic medicines are critical for the global fight against diseases such as tuberculosis (TB), HIV, and malaria.

Given the innovation and effort displayed by Bangladesh and India with COVID-19, it seems surprising that they have yet to solve the challenge of many endemic diseases. All of the work on COVID-19 was made possible by creative utilization of existing technologies and resources—there were no ground-breaking “new innovations” or “disrupting healthcare” requiring millions of dollars. Instead, these countries repurposed existing technologies, driven by a sense of urgency to address an acute national and global crisis.

One reason why such efforts are usually not seen in the field of public health is because, historically, scientific research and goals toward disease elimination in LMICs has been a colonial field strongly influenced by the research agendas of researchers and donors from HICs. While places like Bangladesh have been a hot field for clinical research and epidemiology, much of it has been conducted through parachute epidemiology, with little to no capacity building and public ownership. Consequently, endemic diseases become accepted as the status quo, with slow progress in reducing...
disease burden being the best-case scenario. However, with HICs preoccupied by their own research during COVID-19, countries in the Global South have successfully worked out the path of being independent. But this brings forth an important question—can we imagine a world where the work and investments made during COVID-19 are extended to fight other diseases that plague our communities?

**Beyond COVID-19**

As an example, childhood pneumonia, with an estimated 138 million cases and 0.9 million deaths every year, continues to be one of the main causes of hospitalization and death in children in LMICs. However, the causative agents of a large proportion of pneumonia cases remain undetermined, specifically the viral etiology. For instance, there is little data from LMICs on the burden of respiratory syncytial virus (RSV), a predominant cause of viral pneumonia, due to lack of systematic surveillance and capacity to conduct qRT-PCR tests. The infrastructure used to collect samples and conduct testing for RSV is essentially similar to that for SARS-CoV-2 and thus, can be easily adapted and led by in-country teams.

Furthermore, the in-country expertise built for sequencing during COVID-19 can be leveraged to ensure clinical samples are not shipped out to HICs. This will be specifically important for tracking circulating viruses, and the rising antimicrobial resistance in Gram-negative bacteria against which new vaccines and therapeutics are in the pipeline. However, as this work develops, further investments will be required to build bioinformatic capacity and sufficient computing resources for real-time analysis.

India and Bangladesh are among the countries with the highest burden of TB in the world. But both now have the opportunity to leverage innovations and systems from COVID-19 to tackle this ancient killer infection. For example, both countries can leverage the molecular diagnostics laboratories to test for TB and use apps to improve contact investigation and patient education. Because of lockdowns and social distancing requirements, tremendous advances have been made in the area of tele-medicine, online consultations, house calls by doctors, use of call centers, e-pharmacies, use of digital adherence technologies (e.g., video observed therapy, smart pillboxes), and home delivery of medicines using health workers, ride-sharing services, etc. All of these can and should be leveraged for TB at a larger scale than what is currently happening. Most TB programs still rely on annual reports and paper-based reporting systems that are no longer fit for purpose. COVID-19 shows us the power of real-
time data aggregation, analysis, and usage.

Every year, Bangladesh, India and many countries in South Asia and Latin America, experience deadly mosquito-borne dengue outbreaks. Dengue can be prevented by mosquito control in high-risk areas. Dashboard built for COVID-19 can be re-purposed to track dengue cases, facilitating the institution of data-driven actions to control/eliminate mosquito breeding grounds at geographic areas that will have the most impact. As seen during COVID-19, real-time data visualization and analytics are strong incentives for stakeholders to take action.

Bangladesh is an exemplar of vaccine distribution and coverage because of its strong immunization program and the culturally ingrained pro-vaccine attitudes. The country had also played a significant role in smallpox eradication in South Asia by manufacturing smallpox vaccine in a government facility. However, vaccines are no longer manufactured here. The global intellectual property (IP) regime has been a choke point in vaccine manufacturing and distribution. Bangladesh has a strong pharmaceutical industry comprised of at least 250 companies, and >90% of all drugs used in the country are locally manufactured.9 With the required support from the government and international vaccine manufacturers, Bangladesh also has the potential to manufacture COVID-19 vaccines for the region and beyond. This is not a far-fetched idea, since India, the neighbor, is one of the largest manufacturers of the world’s vaccine supply. In fact, Bangladesh currently possesses the second highest doses of COVID-19 vaccine (7 million) in South Asia due to the manufacturing capability of India. More recently, a pharmaceutical company in Thailand signed an agreement with AstraZeneca to manufacture millions of doses of the vaccine.10

To realize their potential, LMICs must invest in health and science

At the beginning of the pandemic, many world-renowned researchers and epidemiologists had predicted that the countries in the Global South were unprepared to face infectious disease outbreaks.11 One year into the pandemic, most countries worst hit by the pandemic, in contrast to prevailing notions, appear to be the richest. This pandemic is a living proof that expertise and the power to fight infectious diseases is not concentrated in historically rich countries. The field of global health and research cannot and should not be the same in the post-COVID-19 world. It is time that we start the discussions on how to leverage the in-country expertise and strength to fight diseases relevant to the residents of LMICs.

For this to happen, it is clear that LMICs will need to invest more in their own healthcare and meet the Sustainable Development Goal of universal health coverage (UHC) by 2030. Currently, India only spends about 1.5% of its GDP on health, while Bangladesh spends 2.3%. This low investment in public health has resulted in large and mostly unregulated private health sectors in both countries, with high out-of-pocket expenditure and highly variable quality of care. Both countries must therefore not waste this crisis and build a comprehensive and equitable health system that will serve all people, not just those who can afford to pay for medical care. Without UHC and a stronger public health system, it will be impossible to prevent future pandemics and eliminate long-standing endemic threats.

In addition, LMICs in general must increase their investments in science and technology and build quality research institutions. The traditional mindset in global health that expertise flows from north to south, is reflected in research, training, and technical assistance. This colonial model needs to be disrupted.12 Building quality research and teaching institutions in LMICs is critical, to reduce dependence on HICs, and to improve the overall quality, depth, and relevance of scientific training and research.

DECLARATION OF INTERESTS

The authors declare no competing interests.

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Achieving path-dependent equity for global COVID-19 vaccine allocation

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Committing to global access for COVID-19 vaccines is key to avoiding a resurgence of the pandemic. However, agreements between countries and vaccine manufacturers have undermined a globally coordinated approach, and the ongoing vaccine rollout highlights long-standing inequities in health. Yet, the surest path out of this pandemic is one toward greater equity.

In a globalizing world, pathogens cross borders readily, as do the expectations of life-saving vaccines, but the products often lag behind. This asymmetry in globalization gives rise to health inequity. Delays in life-saving treatments arriving in low- and middle-income countries (LMICs) years after they have become available in high-income countries is not new, but COVID-19 has shone a spotlight on this.

In fact, the delay between first approval in a high-income country and final approval in Sub-Saharan Africa for products preventing or treating communicable diseases has historically added 4 to 7 years.1 To bring such products from bench to bedside, productive development partnerships and financing mechanisms like advanced market commitments have helped to speed or scale their development; collaborative procedures for accelerated registration have expedited their approval in countries that can take advantage of work already carried out by stringent drug regulatory authorities; and agencies like United Nations International Children’s Emergency Fund (UNICEF) have worked to procure and scale these products. The key difference now is that there is urgency in delivering COVID-19 vaccines not only to LMICs, but also to the entire globe—both to address humanitarian needs and also to stamp out the risk of pandemic resurgence and of variants emerging.

Just as it has highlighted disparities within countries, COVID-19 has exposed the gulf between countries as well. Before the first vaccine received US FDA Emergency Use Authorization, just over half of pre-market purchase commitments of COVID-19 vaccines were reserved by high-income countries comprising 14% of the world’s population.2 Canada, Australia, the United Kingdom, Japan, the European Union, and United States all had reserved more than one vaccine course per person for their respective populations. However, financing for the COVAX Facility—the vaccines pillar of the World Health Organization (WHO)’s Access to COVID-19 Tools (ACT) Accelerator—was still coming together then, and 40% of the projected capacity for vaccine production by the end of 2021 among leading manufacturers had not been bought up by that time.3 Hedging their bets, countries arguably were responsibly diversifying their risks by investing across a range of candidate vaccines, because no one knew which would eventually succeed.

As vaccines are now administered, this disparity has only widened, and the rift in global solidarity has become glaringly obvious. Opening the WHO’s Executive Board in January, Director-General Tedros Adhanom Ghebreyesus related, “More than 39 million doses of vaccine have now been administered in at least 49 higher-income countries. Just 25 doses have been given in one lowest-income country. Not 25 million; not 25,000; just 25.”4 After three months of COVID-19 vaccine distribution, the United States and China account for nearly half of all vaccinations globally, and nearly 60% of all vaccines have been administered in high-income countries (see Table S1).

The WHO put forward an approach to equitable allocation based on ensuring COVID-19 vaccine doses proportional to population, prioritizing high-risk

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https://doi.org/10.1016/j.medj.2021.03.004