

Strengthening the link between innovation and productivity at the national level

The example of health care in India

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Introduction

Research and innovation, fuelled by technology, are key catalysts for the kind of non-linear growth that will make India a USD 5 trillion economy by 2025. Digitalization, technological enablement and automation can propel India toward this aspirational GDP target and make it “future ready.” However, the health care sector in India remains an area where innovation-based productivity has not yet been fully measured and has an enormous potential for the country.

The Indian Government has identified research, innovation and technology as key drivers of its VisionIndia@2047 and is making significant investments in these three areas. The investments are having the desired impact. The results of Global Innovation Index (GII) 2022 show India (40th) overtaking Viet Nam (48th) as the top lower middle-income economy for innovation, and in so doing consolidating its position as a global innovation power house.

These investments are also generating social dividends. Digital technology has already enabled India to develop a mega population database with a Unique Identification Number-based (UID) system covering over a billion people. The UID system, named Aadhaar, is leveraging the foundational power of digital technologies to expand financial inclusion and improve health care delivery, among other things.

The Unified Payments Interface (UPI), which is based on Aadhaar, and public digital infrastructure around consent mechanisms and application programming interface (API)-based rapid interactions between various stakeholders, has truly democratized payments and furthered the cause of financial inclusion. It is noteworthy that over 5 billion transactions have been processed on the platform up until March 29, 2022, according to data released by the National Payments Corporation of India.

UPI brought together strong private innovation which was deployed on public digital infrastructure for an overall societal good. What has been learnt from UPI is being leveraged by the Indian Government to transform public health care.

During the COVID-19 pandemic, Aadhaar was used to create comprehensive and reliable databases for RT-PCR tests and vaccination. The pandemic accelerated the pace of health care reforms that India had launched prior to the crisis. To build a more resilient, agile and innovative health care system, India has been in the process of introducing several health care reforms. These reforms, along with a burgeoning health tech start-up ecosystem enabled by innovation, are ushering in next-gen capabilities that will be a differentiator in the decade ahead.

Historically in India, an inadequate level of investment in health has resulted in inadequate infrastructure and equipment, a high ratio of patients to doctors, a deficit in trained health care personnel, a shortage of hospital beds and inefficient health data management, especially in rural India. India spends approximately 4 percent of its GDP on health care, of which around 1.13 percent is public expenditure and 2.87 percent private.¹

Currently, India has 1.3 hospital beds for every 1,000 of the population. There is also a shortage of skilled health workers, with 0.65 physicians per 1,000 people (the World Health Organization standard is 1 per 1,000 people) and 1.3 nurses per 1,000 people. With respect to the availability of treatment services, up to 60 percent of health facilities are concentrated in only a handful of large cities across the country. While these challenges are daunting, technology is providing a tremendous opportunity to disrupt traditional health care models.

Technology-led innovations can help India leapfrog the traditional linear model and take health care to the next level. It can build a national health care system that is accessible, organized, accountable, affordable, and thus resilient.

Given India's value advantage and scientific excellence evident from India's ranking in GII indicators such as Graduates in science and engineering, and QS university ranking, the country can innovate and drive the technology frontier outward to boost productivity and efficiency in the sphere of health care, thus delivering affordability and accessibility, enabling preventive health approaches and driving value across the complete health care ecosystem.

A vast array of startups is already emerging in India to supply "future ready" solutions made possible by technological advances in the form of blockchain, artificial intelligence (AI), machine learning, quantum computing and the internet of things (IoT).

COVID-19: A catalyst for transformational change

When the COVID-19 pandemic struck, India was woefully underprepared to tackle the crisis. The country was completely dependent on imported RT-PCR kits for testing. Ventilator production capacity was pitifully low, as was production capacity for personal protective equipment, coveralls, hazmat (hazardous materials) suits, masks, gloves, hand sanitizers and so on. While India had a large vaccine production capacity, indigenous vaccine development for COVID-19 was in its infancy.

The COVID-19 crisis acted as a catalyst in the rapid evolution and uptake of innovative digital health care technologies in India. The country was able to swiftly build a robust digital technology backbone through mass-scale platforms like CoWin and Aarogya Setu, which combined mobile phones with individual IDs and one-time password-based verification to capture key data. These data were used to "track and trace" infection and create advanced databases and real-time dashboards to map the pandemic and deploy vaccines at scale.

The Aarogya Setu mobile app uses Bluetooth-based contact tracing to identify potential users who may have come into proximity with a COVID-positive person. By enabling early identification and preventing potential infection, Aarogya Setu ensured better safety for individuals and the community at large. The app also helped health authorities identify potential coronavirus infection hotspots and take necessary steps to curb its spread.

In order to vaccinate India's huge population the government needed a robust technological backbone. The CoWIN platform helped India's health authorities plan, implement, monitor and also evaluate COVID-19 vaccination across the entire country by not simply tracking vaccinations in real-time, but also unused doses of vaccine, so as to mitigate waste. The platform acted as a database ensuring a person was administered the same vaccine as a first and second dose, but also collected vital data on potential side-effects. As of mid-May 2022, more than 1.91 billion doses of COVID-19 vaccines had been administered in India. The country now tops the list of countries with the most people to have been vaccinated with at least one dose.

Last year, India made CoWIN open source for all countries to access, adapt and use.² By having the public sector develop the software platform and open it up free of charge to the rest of the world, India has emerged as a strong ambassador for technological innovation and enhanced its ability to add speed and efficiency to public health care delivery, while increasing accessibility to services. CoWin is unquestionably the world's biggest COVID-19 vaccination database and is already being leveraged as a health data stack. Data generated from the nationwide COVID-19 vaccination drive, RT-PCR tests, sero-surveillance and genome sequencing programs have been analysed in order to track and trace COVID-19 infection and vaccination doses, and, importantly, reinfection linked to sequenced variants. Besides providing health authorities with a strong

surveillance-based COVID-19 management tool, CoWin has enabled data-driven and evidence-based decision-making in public health. Beyond COVID-19, an innovative and powerful digital platform like CoWin could be leveraged to manage both communicable and non-communicable diseases in real time.

Startups contributed to the COVID fight

India's Department of Biotechnology brought together academia, industry, start-ups and micro, small and medium-sized enterprises to facilitate the indigenous capacity building of reagents, raw materials and new technology platforms for diagnostics, vaccines and therapeutics for COVID-19 and beyond. The Government's COVID-19 Research Consortium promoted nearly 80 industry and academic collaborations, ranging from diagnostics, discovery of therapies and the repurposing of drugs to support for vaccine development, and so on. As a result, the Indian biopharmaceuticals industry underwent a rapid increase in research and development productivity, with products making the "lab-to-market" journey at an unprecedented speed.

Several cost-effective vaccines were produced at scale to immunize a billion people. They included indigenously developed vaccines such as Bharat Biotech's Covaxin, Zydus Cadila's DNA shot ZyCoV-D and Biological E.'s Corbevax, as well as doses of Covishield (AstraZeneca) and Covovax (Novavax), both manufactured under license by the Serum Institute of India. Vaccines generated about USD 7 billion in domestic sales. From just one test conducted in a lab at the National Institute of Virology Pune in January 2020 to nearly 0.8 billion (Indian Council of Medical Research data) COVID-19 tests conducted as of March 30, 2022, India has grown its testing capacity exponentially, resulting in a domestic market of approximately USD 10 billion. Moreover, several therapies, including the anti-viral drug Remdesivir, CD6-targeting Itolizumab and steroids, were mass produced and used to treat patients suffering from severe COVID-related symptoms, generating an estimated USD 5 billion in sales in India. Over one hundred clinical trials were approved in the country in 2021 – the most for a decade – as vaccine and pharma companies rushed to test their products' safety and efficacy. These trials generated business of around USD 1 billion for clinical research organizations in India.

Improving health outcomes through reliable patient data

Data are becoming the lifeblood of health systems globally. Yet, health care in India has long suffered from a lack of reliable data. The National Digital Health Mission, currently known as the Ayushman Bharat Digital Mission (ABDM), seeks to remedy this critical deficit by helping create a digital platform to capture patient data electronically and facilitate, with patient consent, secure data exchange with intended stakeholders within the health care ecosystem.

To allow the flow of digital health records, unique digital health IDs are being generated for Indian citizens under ABDM. The Ayushman Bharat Health Account (ABHA) number, which acts as a unique health ID, consolidates the health care records of an individual, including prescriptions, discharge summaries, lab reports, hospital records and whatever else. By March 2022, over 190 million ABHA numbers had been generated.³

Doctors, hospitals and other stakeholders can access individual electronic health records (EHRs) only once patient consent has been granted. Having control of their personal data through EHRs and a unique health account identifier is empowering patients and enhancing their ability to identify those health care services best suited to them. Storing patients' EHRs over time is also making it easier for doctors and health care workers to get a good and customized view of an individual's medical history.

The digital health ecosystem created by ABDM is thus seamlessly supporting continuity of care across primary, secondary and tertiary health care, thereby enabling greater efficiencies and introducing productivity growth potential into health service delivery. EHRs are reducing the need for repeated diagnostic tests, bringing down the cost of care. This innovative model can ensure digital health care services are accessible in rural areas and also in remote parts of the country where specialist care may not be available.

The National Health Authority (NHA) – the apex body of the Indian Government heading the implementation of ABDM in concert with various public and private stakeholders – recently invited developers from the open source community, especially those from within the digital health space, to participate in the building of a Unified Health Interface (UHI).⁴ This UHI has been conceptualized as a set of “digital building blocks,” with each block a “digital public good” that can be used or accessed by any entity within the digital health ecosystem. Digital building blocks include the Healthcare Professionals Registry, the Health Facility Registry and the consent-based Health Information Exchange between patients and health care providers.

Private players can build new, innovative health care service delivery solutions that address many of the resource constraints faced in India today. This has the potential to unleash the kind of technological innovation required to transform the way health care is delivered in India, especially in rural areas.

Giving health care an AI edge

Artificial intelligence is disrupting every walk of life by enabling people to rethink how information is integrated and data analysed, the resultant insights being leveraged to improve decision-making. Scientists worldwide have used AI and data analytics tools extensively to accelerate the search for COVID-19 vaccines and therapies. AI-based innovations have replaced traditional methods requiring expensive equipment and specialist human technicians with quicker testing and screening modalities.

AI was quickly deployed intensively across India to read CT scans and predict health risks during the pandemic. The technology was used to rapidly detect the extent of lung damage when the Delta variant of the SARS-CoV-2 virus led to a rapid deterioration in pulmonary health. It aided rapid diagnosis by identifying COVID-associated pneumonia, as well as distinguishing non-COVID-related pneumonias in patients to a high level of accuracy.

The Indian Government is presently working to develop AI tools able to track disease outbreaks across the country. The National Centre for Disease Control (NCDC), together with a private player, is currently developing a tool to scan every media report relating to health in order to create a database on the outbreaks of 33 diseases, several of which have the potential to become epidemics. These will be monitored under the Integrated Disease Surveillance Programme.⁵

The NHA is planning to allow companies to provide AI and machine learning technologies to health care providers through the ABDM Software as a Service (SaaS) solution.⁶ Going forward, AI-based primary health care centers could become equipped to provide screening, wellness, awareness and diagnosis in resource-scarce settings. Using AI, health care providers will be able to reach patients more effectively and, in some cases, even triage their needs.

Improving care through smart, connected health technologies

COVID-19 has created opportunities for the wider use of technology in daily life. As social distancing became the norm during the pandemic and demand for “contactless” services grew exponentially, the health care sector in India and across the globe witnessed an increased uptake of teleconsultations and e-pharmacy sales.

E-pharmacies

In India, there was a lot of initial resistance to e-pharmacies. However, during the COVID-19 pandemic, e-pharmacies ensured the uninterrupted supply of quality medicines to the consumer’s doorstep. With ease of use, increasing mobile internet penetration and consumer literacy, e-pharmacies are now becoming almost indispensable. In 2020, the Indian e-pharmacy market was operating through approximately 50 e-pharmacies and accounted for 14 percent of the total revenue of e-pharmacies in the Asia and the Pacific region.⁷ Due to rapid advances in technology and logistics services, e-pharma services are now spreading beyond urban areas.

In addition to improved availability, e-pharmacies introduce an additional element of safety. Handwritten prescriptions have often been known to lead to problems related to illegible or poor handwriting and wrong doses. In addition, the medications provided by a pharmacy are reliant upon the availability of particular brands. With the right kind of regulation, e-pharmacies can eliminate many of the inadequacies in the later parts of the drug-delivery supply chain.

In recognition of the critical role played by e-pharmacies during the COVID-19 crisis, federal and state authorities in India have issued orders designating medicine delivery through e-commerce as an essential service. Moreover, the Indian Government is reportedly working to introduce a law to monitor new retail avenues and the regulatory demands that have emerged in recent years. The proposed law will replace the existing Drugs and Cosmetics Act of 1940 and comprehensively address areas like medical devices, hospital equipment, e-pharmacies and others, according to media reports.⁸

Telemedicine

Telemedicine offered a lifeline to many patients at the height of the pandemic. Data show a dramatic increase in the volume of telehealth visits during COVID-19, as patients sought to safely obtain outpatient care over the internet and doctors increasingly adopted online tools.

The Indian Government's teleconsultation services, including eSanjeevani, leveraged information and communication technology (ICT) to enable remote diagnosis, treatment and the management of disease. In March 2022, the eSanjeevani telemedicine service reached a milestone of 30 million tele-consultations. It also set a record by completing 170,000 consultations in a day.⁹ By enabling millions of teleconsultations, it played a significant role in boosting the acceptance of telehealth services within the country.

The implementation of a modern ICT-based health care system in India will help leverage modern diagnostics in primary health care for early detection and treatment, with telemedicine bridging a deficit of specialists at the primary care level. A robust mobile phone infrastructure that allows fast and cost-effective data sharing will mean that well-trained specialists can treat hard-to-reach patients in distant parts of the country using telemedicine. It will also reduce the burden on secondary and tertiary level hospitals.

Such a system can also be used for the cloud-based data collection needed to collate epidemiological and patient-centric data in order to profile and map disease burden down to the level of the smallest administrative unit. Comprehensive databases and disease registries will enable better evaluation of the incidence and diversity of diseases at an epidemiological level and thereby allow for more effective health care interventions. This can, in turn, ensure equitable access to health care services of an assured quality, safety, efficacy and cost effectiveness for every section of society.

Smart and connected health technologies can be very effective in delivering better health care at reduced costs, and in so doing prove a game changer in India.

Applying genomics to eliminate health disparities

Genomics is helping scientists understand disease at a cellular and genetic level in order to deliver personalized diagnostics and therapies.

Whole-genome sequencing has become a common tool for pathogen identification and tracking, the establishment of transmission routes and outbreak control. To study viral transmission and evolution using genome sequencing, the US Government set up the SARS-CoV-2 Sequencing for Public Health Emergency Response, Epidemiology and Surveillance (SPHERES), while the UK Government established the COVID-19 Genomics UK (COG-UK) Consortium. India set up the Indian SARS-CoV-2 Genomics Consortium (INSACOG) as a national, multi-agency consortium of genome-sequencing laboratories in December 2020 to detect new mutant variants of SARS-CoV-2 within the country. In September 2021, the Indian Government brought in private sector laboratories to significantly scale up genomic surveillance within the country in order to detect novel coronavirus variants.

In the West, genomic testing has become part of the health care lexicon as a result of the cost of genomic testing coming down steeply. Today, whole genomes can be sequenced at a fraction of what it cost to complete the first sequencing of a human genome. Genomic tests are being used in many key areas, such as disease prevention, diagnosis and treatment.

As advances in technology bring down the cost of genome mapping, innovative health startups are making such medical advances more accessible and affordable for patients in India. Mapmygenome, a startup based in Hyderabad, is offering a full range of tests to identify an individual's genetic predisposition to lifestyle, metabolic, cardiovascular, ocular, skin and hair, orthopaedic and gender-specific conditions. By combining genetic report and health history with genetic counselling, Mapmygenome helps people reduce health risks through lifestyle modification.

Wider participation by stakeholders and scientific experts in both the public and private sectors will increase the development and dissemination of genomic methodologies and tools for the prediction, diagnosis and prevention of disease, and thereby contribute to improving the health of the nation. Improved infrastructure and technology utilization across channels has the ability to deliver faster and more integrated data and metadata to assist in using genomic surveillance for public health responses to fend off any future waves of COVID-19 or another pandemic.

Conclusion

Through the reforms being implemented by the federal government, the groundwork for a digital transformation of health care in India is being laid. These reforms seek to enable and support innovative startups and businesses that think locally but have the potential to make an enormous global impact. The pandemic has brought the competency of India's health care industry to the fore. It has also led to the emergence of local startups able to develop low-cost, scalable and rapid solutions. At the same time, it has forced changes in consumer behavior, persuaded doctors to become tech-savvy, prompted the health care industry to invest in user-friendly digital solutions, and pressured governments to bring in more flexible health care-related regulation. Such tectonic shifts have created a fertile environment for the emergence of low-cost, technology-led innovations anchored in affordability and accessibility.

To reap the full benefit of this digital disruption of health care, India will have to coordinate policymaking, funding and implementation. It will need to put in place appropriate regulatory frameworks that foster patient trust and safeguard privacy, as well as enabling a speedier adoption of emerging technological innovations. The Indian Government has a unique opportunity to make health care a national priority and help build a future-ready industry; one which is innovative, quality conscious and can be scaled up to meet global demand. The resulting spurt in technological innovation will empower patients, address the needs of underserved populations and ensure universal access and affordable care for all Indians.

Notes

- 1 NITI Aayog, 2019.
- 2 *Hindustan Times*, 2021.
- 3 Software Freedom Law Center, 2022.
- 4 Ministry of Health and Family Welfare, 2022b.
- 5 Gosh, 2022.
- 6 Jain, 2022.
- 7 EMIS India, 2021.
- 8 Dei, 2021.
- 9 Ministry of Health and Family Welfare, 2022a.

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