Review Article

Hacking Covid-19 with Technology

Abstract

The development, implementation and advancement of technology solutions aimed at combating the COVID-19 outbreak are rapidly taking shape in India. Governments, Venture Capitalists, Academic Institutions, Incubators, Start-ups, and businesses large and small are all doing their part to deploy new innovative solutions as quickly as possible. Various databases were searched to look for different advancements in technology during the current coronavirus pandemic. It is seen that on one end nonpharmacological measure (social distancing, self-isolation, clean hands, and face masks) are time-tested and low-tech ways to help mitigate the viral spread. On the other end, Science and technology sector constituting of data science, machine learning, rapid diagnostic tests, mobile-first telehealth and computational simulation systems for drug development, artificial intelligence, virtual collaboration, and data tracking are complex ways of using the technology that have strengthened our pandemic response.

Keywords: *COVID-19, India, pandemics, technology*

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Introduction

COVID-19 pandemic is defining global health crisis of our time and the greatest challenge we have faced since World War II. Since its emergence in Asia late last year, the virus has spread to every continent except Antarctica.[1] It is a public health emergency with grave implications for whole of the world including India creating devastating social, economic and political crises.[2]

COVID-19 may be having a devastating impact on our industries, social lives, and personal grooming standards, but it is also prompting an outpouring of creativity in other arenas. The only reprieve, thanks to technological advancements, is that we are more equipped than any era in history to respond to a pandemic. During the time of the SARS (Severe Acute Respiratory Syndrome) outbreak in 2002, it took scientists more than a year to decode the genome of the virus, whereas thanks to tech advancements, the Coronavirus genome was identified within a month.[3,4]

Technology cannot prevent the onset of the pandemics; however, it can help prevent the spread, educate, warn, and empower those on the ground to be aware of the situation, and noticeably lessen the impact. Today, with converging technologies like mobile, remote monitoring cloud, analytics, robotics, Artificial intelligence/Machine Learning, 4G/5G, and high-speed internet, it has become possible to test several innovative approaches to pandemic response.[5] With despair lingering and the world in disarray, had it not been the effective and advanced technology solutions, we would have been staring at an unmanageable crisis.

Every cloud has silver lining and COVID-19 was a blessing in disguise for reinforcing our trust and belief on the power of technology. In times like these, not only developed countries but also developing countries like India is arming itself with ideas and innovations to fight the outbreak. It is not only engineers and doctors, but also students who are pitching in to make the best use of technology. The underlying theme of the technological transformation will revolve around creating business models that will survive in a "less-contact" society–a concept that will be etched in the collective memory of our society and would see prominence in the years to come. Hence, narrative review was planned.[3]

Aim and objective

To review technological advancements in India in the Covid-19 pandemic.

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Methods

As the purpose was to gather all the available reports for the evidence synthesis, we opted for academic search from the following databases: Pub Med, SCOPUS, Science Citation Index, Cochrane Library, Google Scholar, also extensive searches were done on official websites of World Health Organization (WHO), Indian Council of Medical Research (ICMR), Ministry of Health and Family Welfare (MOHFW), Worldindata, Centre for Disease Control and Prevention (CDC), European CDC. We accessed the published literature, grey literature, newspaper articles and print media interview, media reports, news channel bites, You Tube channels and blogs by individuals, universities with specific reference to Indian context focusing on Various Technological advancement during COVID-19 from 1st February 2020 till date 22 July 2020. The following key words. #1: 'Technology, 'Advancement', #2: 'COVID 19', 'Coronavirus', 'Pandemic', #3: 'India'.

During this time, the Research and Development sector of the country stepped forward to take the onus of producing essential commodities in bulk and as quickly as possible and contribute solutions to fight the pandemic. Innovations are expected to continue to transform healthcare and change the way patients are cared for forever. Such innovations in India are:

A 'Compendium of Indian technologies for combating COVID-19' (Tracing, testing and treating)

It was prepared by National Research Development Corporation (NRDC) and launched by Council of Scientific and Indian Research (CSIR) and Department of Scientific and Industrial Research (DSIR), India. It carries information about 200 COVID-19-related Indian technologies, ongoing research activities, technologies available for commercialisation, initiatives and efforts taken by the Government of India such as digital and molecular surveillance database, rapid testing kit, mobile tracking application, Real-time PCR test, an antimicrobial fabric, UV Bot to disinfect hospitals, a Bio Body Suit and herbal products to boost the immune system.[6]

COVID-19 task force

The task force has been set up for mapping the COVID-19 related technology capabilities in start-ups, academia, research and development labs and industry. The task force comprises of members from NITI Aayog, Ministry of Ayush, ICMR, CSIR, Defence Research and Development Organisation (DRDO), Department of Science and Technology (DST) and Department of Biotechnology (DBT). Its primary aim will be to aid, support and speed up innovative work by academia and industry, as well as synchronized international efforts. This includes Artificial intelligence (AI) and Internet of Internet of Things (IoT) based solutions as well. India's top Venture Capitalists (Sequoia Capital, Accel, Matrix Partners, Kalaari Capital

and others) along with investors are setting up funds to support startups and develop products.[7,8]

Connecting people

Entrepreneurs and innovators from India have highlighted a good example via the triple helix model of connecting innovations, integrating efforts between universities, industries, start-ups, and the government, in response to Covid-19.[9]

Crowdsourcing ideas

Crowdsourced platforms have also proved to be essential channel for bringing together wisdom from universities, industry and government. Some examples are Covid-19 solution, BreakCorona and Coronasafe-Network launched by Government of India.[9]

COVID-19 research consortium program

Under this program, DBT and Biotechnology Industry Research Assistance Council (BIRAC), are also seeking proposals from industry, academia, industry-academia partnership for new innovations.[8]

New millennium Indian technology leadership initiative (NMITLI)

CSIR has constituted NMITLI, seeks proposals from industries for effective containment interventions, such as affordable ventilators, innovative diagnostics and testing kits, drugs or new vaccines, track-and-trace technologies, masks, alcohol-based sanitizers, personal protective equipment (PPEs), dress materials for frontline health workers.[8]

New innovations

Meanwhile, India's R&D labs have turned into war rooms where scientists are leading the charge, working round the clock to build their weapons. Moreover bureaucrats, doctor-turned-entrepreneurs, from regulators such as DCGI and ICMR to corporations such as Tata and Mahindra – are all joining forces to strengthen India's fight. Governments, Venture Capitalists, Academic Institutions, Incubators, Startups, and businesses large and small are all doing their part to deploy new innovative solutions as quickly as possible. Elite scientists, IITians, startup founders, top corporate executives, doctors, prominent members of the Indian diaspora and bureaucrats. Large corporations such as M&M, Tata, Hyundai, Maruti Suzuki and state-owned Bharat Electronics are joining forces. They are reconfiguring their plants to make products such as ventilators. Some of these new technologies and innovations have been summarized in theTables 1 and 2 below.

Table 1 depicts with the growing crisis, companies and researchers over the world are looking for the ways to address the challenges of this virus, to mitigate the spread and develop a cure for this disease. As a result, various technological advancements taken place for screening

Table 1: Application of modern technologies by Government and health care workers for care of individual and community in COVID-19 pandemic

Emerging technologies/ innovations	Few Examples	Applications/importance during Covid-19
Screening tool for Covid-19	Apple and the Centre for Disease Control (CDC) released a new screening tool[10]	Diagnosis and contact tracing
Make in India testing Kit	Abbott Laboratories: Developed a portable 5-minute COVOID-19 test kit the size of a toaster[10]	Diagnosis,
	MyLab: (RT-PCR) kit approved by ICMR[11]	Follow up
	First antigen based COVID-19 testing kit approved in India[12]	Seroprevalence
		cost effective
		Provide results quickly
	COVID 19 detection kits by start-ups through support of Centre for Augmenting WAR with COVID-19 Health Crisis (CAWACH) initiative of National Science and Technology Entrepreneurship Development Board (NSTEDB) and Department of Science and Technology (DST)[13]	To conduct rapid molecular tests at small clinics, points of entry like airports small laboratories,
	OmiX-AMP with technology Loop-mediated isothermal amplification (LAMP)	lab on palm platform for Rapid Antibody Test and test kit with a reader enabling direct antigen testing
	AnuPath' by PathShodh Healthcare	
	Prantae Solutions OPC developed test kit based on the technology called Localized Surface Plasmon Resonance Enhancement.	
	COVID-19 Detection KIT V2.0 Huwel contains three ready to use Oligo mix for detection of Corona Virus, along with Reverse Transcriptase Enzyme.	
Drugs	Coronil and Swasari (Ayurvedic) by Patanjali[14]	Prevention of spread and treatment of disease.
	FabiFlu (Allopathic) by Glenmark[14]	
	Covifor (allopathic) by Hetero[14]	
	ICMR and Biological E Limited, Hyderabad, have developed highly purified antisera (raised in animals) for prophylaxis and treatment of Covid-19[15]	
Vaccine research and development	Collaboration of ICMR with Bharat Biotech International Limited (BBIL)[9]	Help curb the spread of the novel coronavirus.
	Covishield vaccine: Serum Institute of India (SII) with the University of Oxford and Astra Zeneca.[16]	
	Mynvax: Using protein-based approach for vaccine production[9]	
	Indian Immunological Limited (IIL) collaborated with a University from Australia[9]	
	COVAXIN™ vaccine: By Bharat Biotech International Limited in collaboration with the Indian Council of Medical Research (in human phase trial)[17]	
	ZyCov-D Vaccine: By Zydas Cadila Healthcare Ltd (in human phase trial)[18]	
Early detection and diagnosis of infection	PATH deployed two innovations: qXR and qSCOUT[19]	Diagnosis, contact tracing and monitoring of cases
	AyuSynk: A digital stethoscope developed by IIT Bombay.[11]	Listen to heart beats from a distance and record them, minimising the risk of contact
	Wireless thermometer guns and other similar infrared body temperature measuring devices.[20]	Used at checkpoints of offices, airports, hotels, hospitals, train stations, shops, and other public places to minimize contact.
	Wearable Remote Health Monitoring Device by Electronics Corporation of India Limited (ECIL), Hyderabad, India in association with AIIMS Rishikesh.[21]	For monitoring Vital parameters

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Emerging technologies/ innovations	Few Examples	Applications/importance during Covid-19
	SenFlex.T by IIT Kharagpur[22]	Device synced with an android monitoring App through Bluetooth can continuously monitor breathing patterns, heart rate, and Oxygen saturation level for patients
Ventilators and other associated devices	Start-ups such as:	Develop low-cost, easy-to-use, and portable ventilators
	Nocca Robotics by IIT Kanpur[11]	
	Aerobiosys Innovations by IIT-Hyderabad[11]	
	AgVa Healthcare[11]	
	Prana Vayu developed jointly by AIIMS Rishikesh and IIT Roorkee has been tested successfully in AIIMS Rishikesh.[23]	
	Sree Chitra Tirunal Institute of Medical Sciences and Technology (SCTIMST), Trivandrum, has developed three new equipment:[20]	Acrylosorb, to collect body fluids and dispose of it safely,
	Acrylosorb	Isolation pod, a chamber, just like telephone booth, for examining COVID-19 patients
	isolation pod	bubble helmet, an alternative for the traditional oxygen masks
	bubble helmet	
	VAPCare automated closed loop system by InnAccel, Bengaluru[11]	Used for clearing oral secretions of ventilated patients
Sanitizing Machines	Trunk shaped device fitted with ultraviolet germicidal irradiation technology by IIT Ropar.[20]	To be placed at doorsteps and sanitise all items brought from outside
	Pendant device by Punjab's Lovely Professional University[20]	Has 'hand wash reminder' feature that beeps every 30 minutes to remind the user to wash hands and also has a temperature sensor
	GOassure device by MicroGO, Chennai[11]	Sanitise hands in 20 seconds
	Anti-aerosolization boxes and thermal scanners, automatic mist-based sanitiser dispensing unit (using infrared sensors to detect hands and dispense the sanitizer), Ultraviolet C Light-based sanitisation box: By Indian Army/Navy/DRDO.[24]	Sanitise hands in 20 seconds
Drones	Sagar Defence Engineering: Mumbai maker of drones[25]	These unmanned vehicles controlled by remote location can undertake
	Garuda Aerospace, Chennai[25]	Jobs of logistics providers
	Marut drones, Hyderabad[25]	Area surveillance
		Disinfecting remote locations
		Thermal screening
		Delivering public health message and instructions
Robots	Asimov Robotics by a start-up based in Kerala.[9]	Reduces the workload of health care workers
	Milagrow, the Gurugram based robotics company[9]	lessen contact exposure between patients and health care workers.
	Club First, Jaipur based industry[9]	Minimize shortage of PPE
	Corona virus shaped devices by a startup, Chennai[9]	At hospital entrance with thermal scanner to screen patients and staff
		Deliver food and medicines in Covid-19 wards
		Spraying of sanitizer
Other devices	Kawach (shield) by Punjab's Lovely Professional University[20]	Low cost and easy to carry Prevents direct contact of health care worker with patient
	Remote controlled trolley by Indian Army, Indian Navy and DRDO[24]	Deliver essential items to frontline healthcare staff equipped with a washbasin and dustbin.

(e.g., screening tools by Apple and CDC), diagnosis (e.g., testing kits by MyLab, Abbott), contact tracing (e.g., qXR and qSCOUT by PATH), prevention [various vaccines by ICMR, Serum Institute of India (SII), Indian Immunological Limited (IIL)] and treatment (drugs such as FabiFlu, coronil) of patients of COVID-19. Other innovations

Table 2: Various digital based technologies and their applications in fighting COVID-19 pandemic

Emerging technologies/ innovations	Few Examples	Applications/importance during Covid-19
Smart phone apps: Awareness and social control through Internet	COVID-19 Map by Microsoft Bing[5]	Provides information on the daily rise in Covid-19 cases, deaths and recovered patients in India, state wise as well as district wise
	Covid-19 India tracker app by My Govt[20]	
	Website covid19india.org[20]	
	WHO website (COVID-19 situation dashboard)[20]	
	Website of Ministry of Health and Family Welfare[20]	
	App Cova by Punjab government[20]	Helps communicate with frontline workers
	CovidGyan: A multi-institutional, multi-lingual science communication initiative[20]	Aims to bring scientific and factual aspects of this pandemic outbreak on the public domain
	GoCoronaGo to Sampark-o-Meter, by IITs and Indian Institute of Science (IISc)[20]	Contact tracing, tracking, calculating the risk
	GoK-Kerala: By Kerela Government[9]	Sends Covid-19 updates and travel information via phone notifications, and SMS
	Telecom operators like Jio, BSNL, Airtel, and more[20]	Using the caller tunes to spread awareness about the pandemic.
	Google, Facebook, and YouTube[5]	Working tirelessly to guide people to the right, verifiable information published by WHO or local authorities and government
	Vaccine web Portal and National Clinical Registry for Covid19 by ICMR[26]	To address queries of the people on vaccine development
		To collect systematic data on clinical signs and symptoms, laboratory investigations, management protocols, clinical course of COVID-19 disease, disease spectrum and outcomes of patients.
Digital and Contactless payments	In the form of cards or e-wallets[8]	Can meet most of payment and transaction needs easily with full security like money transfers, payment of utility bills, school/college fees, ordering home delivery of food items or buying from e-commerce market places, and even tax payments.
	UPI, Google Pay, Phone Pay, Pay Pal, Amazon Pay, Paytm are an instant real-time payment system	
Remote work/work from home	Remote work is enabled by technologies like:[8]	Reduced operating cost, and cost on office space
	virtual private networks (VPNs)	Reduced travelling cost and time
	face-to-face meetings or interviews with many app-based video calls on Zoom and Skype	Ensuring talent retention and domain knowledge preservation.
	voice over internet protocols (VoIP's)	Enables equitable distribution of wealth, better inclusivity (more women employees and employees with disability), reduction in migration to metros
	virtual meetings	
	cloud technology	Increased productivity and motivation
	work collaboration tools	
	facial recognition technologies.	
Distance/ online learning	Online classes i.e. smart classrooms/e-learning.[27]	Easily accessible and available
	Teachers are supplementing Moodle (an open-source learning-management system)	Budget friendly
	Online education is conducted in two ways. First is through recorded classes referred to as Massive Open Online Course (MOOCs).	No commuting required
	Second one is through live online classes conducted as webinars, or zoom sessions.	Flexible and can be personalized according to individual needs
	Google classroom, Microsoft Education and conferencing apps like Zoom and Google Meet.	Social distancing can be followed
	Various resources: Khan Academy, TEDed and Minecraft Education	Large number of choices from online courses to ed-tech and e-learning websites.
	Various e-learning portals: DIKSHA portal, e-Pathshala, Swayam	

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Emerging technologies/ innovations	Few Examples	Applications/importance during Covid-19
Online entertainment	One of the biggest gainers of the lockdown has been Over the top (OTT) or video-streaming platforms.[28]	Keeping people busy during lockdown so they might not feel lonely and depressed.
	Indians top the list for the highest number of downloads of apps for ludo, carrom and Mobile Premiere League (MPL).	Preventing domestic violence on female and children
		Preventing quarrels among family members
	Amazon India showed that there is a surge in orders for games like chess, Smartivity, Minecraft and Lego too.	
Telehealth	Governments, hospitals, e-pharmacies and even corporates have adopted to telemedicine[29]	Including voice, audio, text and digital data exchange and most importantly allowed doctors to prescribe medicines
		Minimizing contact risk with patients
	KlinicApp and Practo[9]	Providing Covid-19 tests at home and online consultation with doctors
	O Doc India: Mobile-based platform[30]	Connects patients with registered doctors and healthcare professionals for video or audio consultation.
	eSanjeevani: Browser-based application[31]	Facilitating both doctor-to-doctor and patient-to-doctor tele-consultations
		Anyone can seek medical advice and medication through audio and video.
Covid-19 Tracking app	Arogya Setu[9]	Digital monitoring of movement of people in real-time and their contacts in hotspots.
	It has been integrated with telemedicine	
Technologies of Industry 4.0	Artificial Intelligence (AI)[32]	Detecting virus, individuals with fever, and suspected symptoms of COVID-19 and accordingly advice for the treatment.
		Has brought down the time of genetic detection to minutes.
	Cloud computing[32]	All necessary information is stored at a computing platform and made available to the users with the help of the internet and helps in making decisions in disease modeling.
	Internet of Things (IoT)[32]	All devices are connected to the internet in the hospital and strategic locations.
		This helps to inform the medical staff of any errors and change to make in the treatment process
	Big data[32]	Can be highly useful for analysing and forecasting the reach and impact of the coronavirus on people.

include low cost portable ventilators (e.g., Nocca Robotics by IIT Kanpur, Prana Vayu by AIIMS Rishikesh and IIT Roorkee), drones (e.g., Garuda Aerospace, Chennai, Marut drones, Hyderabad), sanitizing machines, robots and various other devices. These innovations were done to lessen patient contact and to ease the work of health care workers.

With the COVID-19 pandemic causing massive disruptions in our healthcare system, many Indian innovators are rising to the challenge. Table 2 depicts various digital-based innovations taken place during this pandemic in India such as smart phone apps (like COVID-19 map by Microsoft Bing telecom operators like JIO, Airtel, BSNL), distance learning (by ZOOM, Google meet, DIKSHA portal),

telehealth (telemedicine, eSanjeevani app), Covid-19 tracking app (e.g., Arogya Setu) and many more. These were introduced to keep the public updated regarding daily track of Covid-19 cases, what all precautions to be taken during this pandemic time, to be in touch with health care workers.

Conclusions

While the headline of COVID-19 is going to be the unfortunate mass destruction it has brought to nations in terms of lives lost and economic rout, the footnote of COVID-19 could very well be the technological and business transformation it will bring along, which may have a long-lasting impact beyond COVID-19. In a world

that could be known as 'Post Covid-19 Era', we will see technology playing an enhanced role that will shape and reshape business conduct and consumer behaviour. With lockdowns and other social distancing measures in effect in many countries, and with more people relying on the Internet for information and advice, governments will deploy effective digital technologies to contain the outbreak. Together, WE CAN OVERCOME! Together, WE ARE STRONGER. Big or small, every effort counts and it will all have a great impact on our future lives.

Conflicts of interest

There are no conflicts of interest.

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