

# nature india

## COVID-19 CRISIS

Nature India  
examines the  
pandemic



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Why patient data  
matters

**Vaccine race**  
The most promising  
approaches

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## From the editor

Subhra Priyadarshini introduces this special COVID-19 issue of *Nature India*.

For most of us, 2020 will be marked as the year of great imponderables. We seem to know as much about the new coronavirus SARS-CoV-2 and its effects on the human body and societies at large, as we don't. Ever since the virus broke out, 'uncertainty' is one of the most commonly used words in conversation, news reportage and emails.

Across the globe, very few lives have been untouched by the direct or indirect effects of the novel coronavirus. China, the most populous nation on Earth, bore its brunt as the virus jumped into human populations in the country's Hubei province in late 2019. Though China reacted quickly to contain it, the contagion had spread via international travellers.

India, the world's second most populous nation, reported the first case of the novel coronavirus on 30 January 2020. The number of people becoming infected by the virus began to rise quickly, prompting the government to impose a two-month complete shutdown of the country – the longest ever in its history.

An enormous population, a weak healthcare system, and traditionally meagre investments in scientific research and development meant there was enough reason to worry. However, the severe economic and social fallouts, like elsewhere in the world, forced the government to allow a regulated easing out of lockdown.

*Nature India* started reporting on COVID-19 in India from the outset. As the pandemic began unsettling every facet of life from healthcare to education and community life to businesses, our coverage embraced a new normal, going beyond pure science to a parallel reflection of its links with society, culture and life.

*Nature India's* special issue on COVID-19, therefore, seeks to consider answers from the future. In a rapidly evolving pandemic, some of the articles in this special issue bear a time stamp. However, they will hopefully remain relevant for a long time to come as chronicles of the biggest human crisis any of us has faced in our lifetimes. As we scrutinize India's response to the mammoth healthcare challenge, we also look at vaccines and drugs being tested across the world in a hope to arrest the respiratory infection. We dive into the science of how the immune system responds to the virus and question whether submitting genome sequences to global repositories at record speeds makes any sense without accompanying patient data. We explore how the packaging of the future would look, and explain how to care for the elderly and critically ill in times when hospitals are struggling to accommodate COVID-19 patients.

Everyone has a COVID-19 story to tell. We feature some extraordinary everyday stories – a doctor on the frontline handling COVID-19 patients in a Delhi hospital, a scientist in the southern state of Kerala who hasn't been able to start her dream laboratory due to the lockdown, and an Arctic explorer who endured months of darkness and isolation in the north pole before coming back to a world struck by a new virus.

This special issue also features the story of Ayurveda, and why it is time for India to apply scientific rigour to the study of the ancient system of medicine. We talk of the importance of socially influential groups, scientists, and religious leaders, in spreading the right messages and scotching misinformation in a public health emergency.

In many countries including India, the pandemic is testing the limits of science and of human perseverance. It is taking a toll on our mental health – how we live, work and communicate are set to change for a long time to come.

Science will hopefully find a solution to this unprecedented human suffering soon.

**Subhra Priyadarshini**

Editor-in-chief



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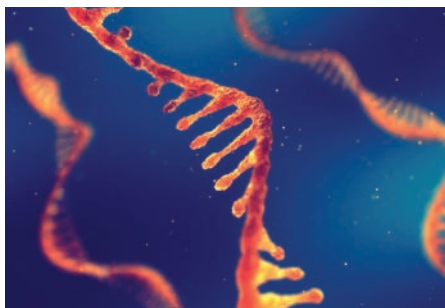
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# INDIAN SCIENTISTS IN VITAL SEARCH FOR SOLUTIONS

Finding rapid approaches at all levels to protect the world's second largest population will be crucial.

By Vanita Srivastava

India's scientists are racing to find interdisciplinary solutions in the country's high-stakes fight against the novel coronavirus pandemic.

With an unprecedented demographic challenge at hand and struggling with the traditionally limited budgets allocated to science, the country's researchers are working overtime to provide small and big solutions – from predicting statistical trends and making mathematical models to developing rapid paper-based test kits and low-cost ventilators.

Some are mass-producing masks and hand sanitisers while others repurpose drugs and ambitiously work towards a vaccine to flatten the curve of the disease.

Soon after Prime Minister Narendra Modi announced a nation-wide lockdown (from 25 March 2020), India's Department of Science and Technology (DST) set up a COVID-19 Task Force to hunt for leads in its R&D labs, academic institutions, start-ups and small enterprises. Of the 200 proposals this task force received, DST identified 20 for swift funding to scale up promising products in diagnostics, drugs, ventilators and protection gear.

"We mapped their supply along with that of breathing aids, disinfectant systems, rapid inexpensive diagnostics and monitoring technologies, and will try to match the demand," DST secretary Ashutosh Sharma told *Nature India*.

In Bengaluru, the Department of Biotechnology's bioincubator Centre for Cellular and Molecular Platforms (C-CAMP) quickly catapulted a technology accelerator in partnership with the United Nations Health Innovation Exchange (UNHIE) and the non-profit firm, Social Alpha, to help innovators, start-ups



**WE ARE WELL EQUIPPED TO TAKE A VACCINE CANDIDATE FROM THE LABORATORY TO INDUSTRY."**

and entrepreneurs. C-CAMP chief executive, Taslimarif Saiyed said innovators will be able to take advantage of an ecosystem of scientists, regulators, investors and industry in "closing last-mile gaps in commercializing their technologies".

Faced with the public health emergency, a group of scientists urged the government to devise measures that can bolster coronavirus-related research in India. "During this lockdown, we request the government to keep those research laboratories operational which are working on finding a cure for the disease," the scientists said in a joint statement on 31 March 2020. "Many scientists are attempting to create social awareness about the disease. We urge the government to take advantage of the resources and expertise available within the scientific community."

## Rapid testing

India has been criticized for its poor mass testing capability owing to a shortage of testing kits. The government has now created a

multi-agency empowered committee to speed up research and development decisions in view of the critical need to increase testing facilities for COVID-19.

Scientists at the CSIR-Institute of Genomics and Integrative Biology (IGIB) may have found a solution that can be scaled up. A team led by Souvik Maiti and Debojyoti Chakraborty has designed a paper strip-based testing assay that can detect the viral RNA of the novel coronavirus SARS-CoV-2 within an hour, "making any lab with a thermal cycler capable of performing this test," Chakraborty said.

The paper-strip test uses CRISPR-Cas9 technology – the assay works by converting the viral RNA into DNA, amplifying it, and deploying the Cas9 complex to detect any genetic material from the virus. "It can work with very low RNA copies in the sample. The kit would cost less than 500 rupees," Chakraborty said.

IGIB director Anurag Agrawal said the institute was also developing a 'sample to sequence' strategy, where test samples can be diagnosed by next generation sequencing (NGS). This could help surveillance efforts to track the spread of the virus.

"Sequencing can strengthen genomic epidemiology, genetic variants linked with virulence, evolution and transmission pattern," said Rajesh Pandey, who is leading this genomics effort. His team is using a combination of sequencing platforms to meet the dual target of scale and sensitivity for any India-specific strain. "It is important to ascertain the genomic sequence of strain(s) prevalent in India vis-a-vis other geographical locations and symptom spectrum. This information would be important to correlate specific strains with virulence or aggressive nature of



A patient in Kashmir has his temperature tested.

the virus, and tailor-make contingency plans for India," he said.

Pandey and colleagues are developing sequencing strategies, combining the number and length of sequences, for mass barcode-based screening. "It's a multi-pronged sequencing strategy, which in conjunction with other epidemiological data, would help public health authorities manage the outbreak and design potential regions or targets for screening," Pandey said.

### Taming the virus

Another group of virologists at the National Institute of Virology in Pune is focusing its energies on how the virus interacts with its host by imaging virus infected host cells with ultrastructural tools. NIV Deputy Director Atanu Basu told *Nature India* that they are also trying to identify key cellular sites of replication, virus morphogenesis and development. "This will give us better knowledge to supplement studies by drug development groups," Basu said.

Basu's team was the first to image the novel coronavirus from an Indian patient using a transmission electron microscope. "Native images in clinical material can be very useful for pathogenesis studies," he said. NIV is looking to collaborate with structural biology groups and to pool resources, especially in the area of cryoelectron microscopy, to study the replication and organization of this virus in depth. "We should prioritize development of *in-vitro* and *in-vivo* animal models for bioassays. Besides, we should aim at antiviral

drug development through public-private partnership, creating biomarkers for disease severity," Basu said.

Epidemiology research should take centre stage, said clinician-scientist Gagandeep Kang. That would help understand where the disease has spread and to what extent. Kang, who is the executive director of the Translational Health Science and Technology Institute (THSTI) in Faridabad, said that her institution is working on an ELISA test for serological studies across the country which will essentially help understand how much the disease has spread in India.

"The Indian population is dense and there are so many poor people," she said. Social distancing, therefore, may be a difficult proposition. The first task should be boosting public health research to help control the spread. The next step should be research for developing additional diagnostic tools, drugs and vaccines, Kang said.

"We are also working on rapid diagnostic tests," she said.

The Indian Council of Medical Research (ICMR) maintains that India will soon start manufacturing serological testing kits. "We are hopeful that India will be able to develop at least one serological diagnostic testing tool in the next few months," the council's chief epidemiologist and communicable disease expert R R Gangakhedkar told *Nature India*.

Delhi-based National Institute of Immunology (NII) is procuring viral samples and blood from recovered patients. "We will analyse the antibody quality in the blood with an aim to

develop an antibody-based therapy," said NII director Amulya Panda. Studies are also underway on the spike protein of the novel coronavirus to develop a vaccine. "We have previously developed an immunomodulator for leprosy and are well equipped to take a vaccine candidate from the laboratory to industry," he said.

### Private enterprise

Beyond the action in government laboratories, technologists are devising interesting ways to stop the spread of the virus. One such government-led effort is the 'Corona Kavach' app that can alert users when they come in proximity of a confirmed coronavirus positive person. Many state governments, including Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala, have launched similar tracking apps.

Another team of researchers at the Indian Institute of Technology Delhi has developed an app that alerts the user to a population suspected to be infected.

"The app uses bluetooth technology to identify people who may have come within the range of two metres around a coronavirus-infected patient," said Vikas Upadhyay the lead researcher of the team. The secure server data can be analysed to identify, trace and monitor social distancing norms.

Private players are also chipping in to provide testing solutions. A Pune-based molecular diagnostics company Mylab Discovery Solutions developed the first COVID-19 testing kit in India and is producing about 200 kits a day, each kit capable of testing 100 samples.

"We are delivering these kits to government-authorized labs," said Gautam Wankhede, Mylab's director for medical affairs. The kit can give test results within 2.5 hours. The company's executive director, Rahul Patil said in emergency conditions, they can ramp up production to enable 50,000 tests a day.

NovaLead Pharma, another company from Pune in Maharashtra, the state with the highest number of novel coronavirus infected people in India, has deployed computational technology for identifying existing drugs potentially effective against the SARS-Cov2 virus as well as for minimizing its impact on the human body.

Through a complex and extensive computational study involving 2010 approved drugs and 30 potential viral and human targets, NovaLead has identified 42 existing drugs which may be helpful to patients at different stages of SARS-Cov-2 infection. "Use of existing drugs already approved by the regulators can offer a huge relief in the short to medium term, if found effective against Covid 19," said NovaLead managing director Supreet Deshpande.



# A lifeline vaccine must be universal

Arun Kumar and Tung Thanh Le

It is time to revamp global supply mechanisms to ensure everyone has access to a coronavirus vaccine when it becomes available.



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When a safe and effective vaccine against COVID-19 is licensed for use, there will be a global clamour for access to supplies.



**T**he COVID-19 pandemic has triggered more than 115 vaccine projects around the world.

After the Ebola outbreak of 2014 in West Africa, international research bodies and governments, including of India and Norway, the Bill and Melinda Gates Foundation, the Wellcome Trust, and the World Economic Forum, joined forces in the search for new vaccines and formed The Coalition for Epidemic Preparedness Innovations (CEPI).

CEPI is now facilitating the development of nine COVID-19 vaccines, including those by Moderna, CureVac, Inovio, the University of Oxford, Insituit Pasteur/Themis Biosciences, Novavax, the University of Hong Kong, the University of Queensland, and Clover Biopharmaceuticals, across six platform technologies. At the time of writing, three candidates have started phase I clinical trials.

Vaccine development demands exploratory and preclinical research, clinical

development, regulatory review, and manufacturing – each step can take several years. Some novel platform technologies and approaches are reducing these long timelines, and could provide a universal framework for vaccine design, manufacturing and analytical protocols for known and unknown pathogens. When these standardized and validated processes are applied across multiple vaccine targets, they could help with accelerating animal and clinical testing, engagement of critical partners and license processes across jurisdictions. Implementation of several steps in parallel, could also accelerate the vaccine development process.

### **DNA and RNA vaccines**

Vaccines based on genetic instructions (through DNA or RNA) offer advantages over traditional approaches because of speed, ease of antigen design, and a generic manufacturing process. These vaccines avoid the use of cell culture, are fully synthetic, and can be directly delivered into the cells where protein synthesis takes place.

**“Implementation of several steps in parallel could accelerate vaccine development.”**

Messenger RNA (mRNA) vaccines (consisting of RNA strands coding the antigenic part of the pathogen) are very attractive because of the short-half life and direct delivery of antigen-encoded sequence into the cytoplasm. A chemically modified mRNA vaccine (mRNA-1273) against SARS-CoV-2 has been developed by Moderna and has started a phase I trial. The previous phase I trial based on this technology induced robust immune responses. Demonstrating the speed of this platform, just after sequence identification, Moderna started the vaccine development process and within 63 days initiated a phase I trial.

Another mRNA-based COVID-19 vaccine candidate in pre-clinical stages is being developed by CureVac, a company based in Tübingen, Germany. CureVac’s technology uses naturally occurring nucleotides and recently has shown that the one microgram formulation of its Rabies mRNA vaccine can induce a strong immune response in humans. Additionally, CureVac is in the process of developing a fully automated proprietary mobile manufacturing platform, the RNA Printer, which may further enhance speed and help with rapid responses to the outbreak globally. Very recently, BioNTech in partnership with Pfizer started phase I/II clinical trials for a COVID-19 vaccine, BNT162. Other advanced vaccine development

**Continued on page 10**



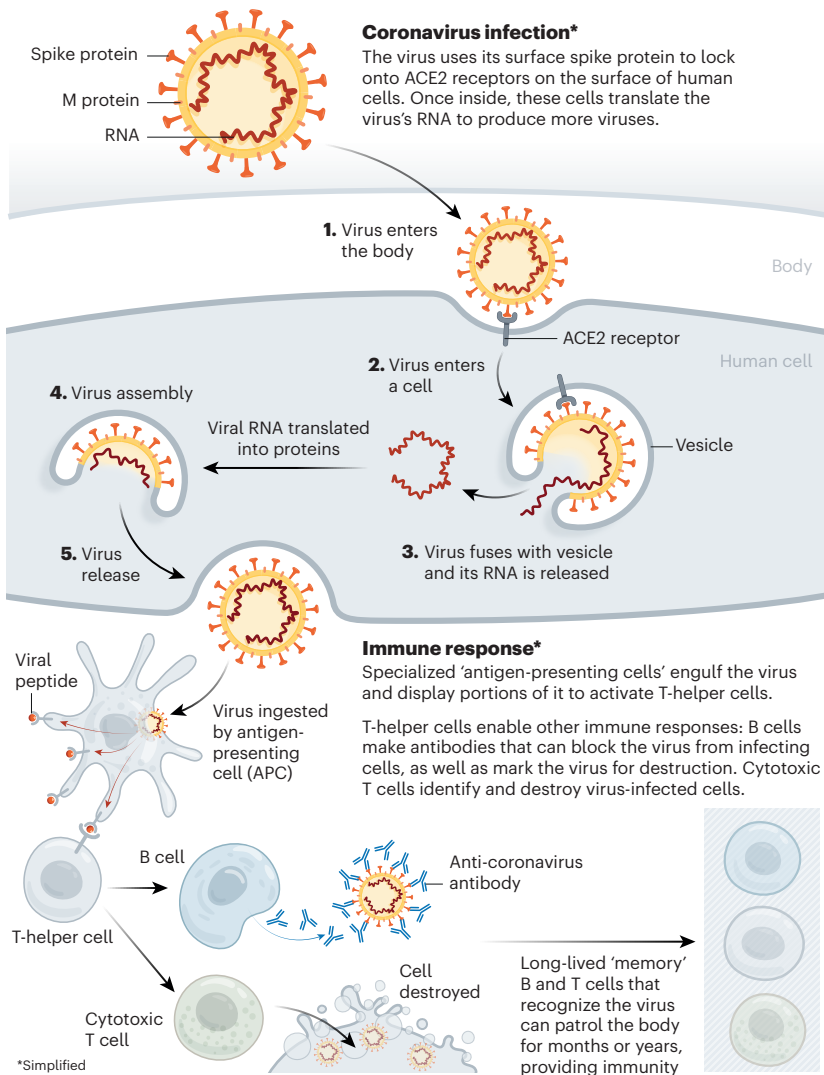
# THE RACE FOR CORONAVIRUS VACCINES

By Ewen Callaway; design by Nik Spencer.

Multiple vaccines are being developed against SARS-CoV-2 by research teams in companies and universities across the world. Researchers are trialling different technologies, some of which haven't been used in a licensed vaccine before. At least six groups have already begun injecting formulations into volunteers in safety trials; others have started testing in animals. *Nature's* graphical guide explains each vaccine design.

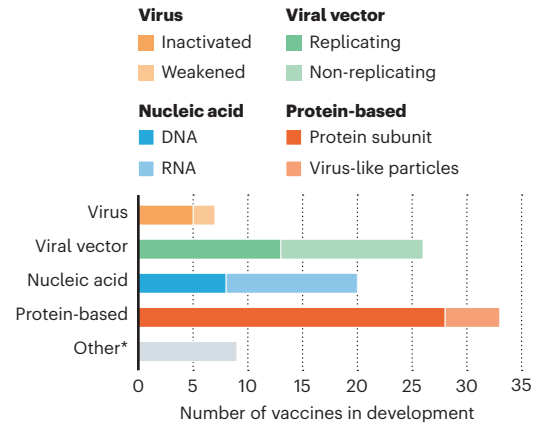
## VACCINE BASICS: HOW WE DEVELOP IMMUNITY

The body's adaptive immune system can learn to recognize new, invading pathogens, such as the coronavirus SARS-CoV-2.



## AN ARRAY OF VACCINES

All vaccines aim to expose the body to an antigen that won't cause disease, but will provoke an immune response that can block or kill the virus if a person becomes infected. There are at least eight types being tried against the coronavirus, and they rely on different viruses or viral parts.



\* Other efforts include testing whether existing vaccines against poliovirus or tuberculosis could help to fight SARS-CoV-2 by eliciting a general immune response (rather than specific adaptive immunity), or whether certain immune cells could be genetically modified to target the virus.

## VIRUS VACCINES

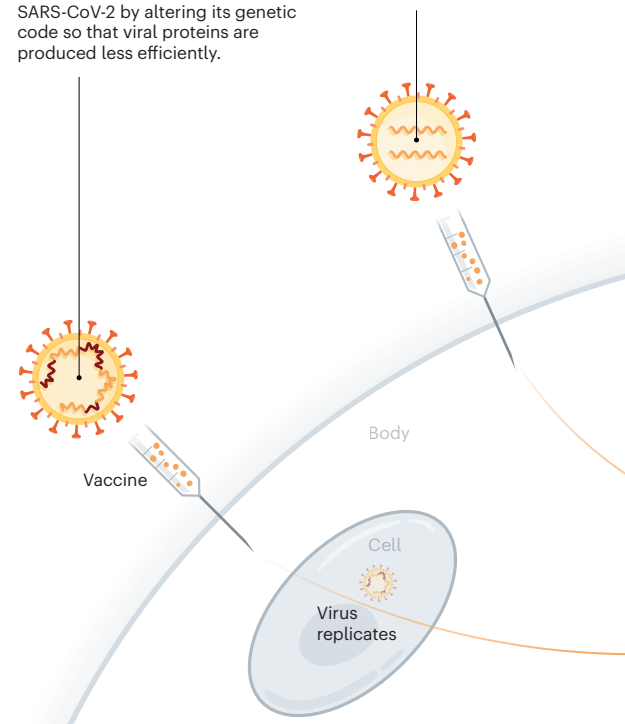
At least seven teams are developing vaccines using the virus itself, in a weakened or inactivated form. Many existing vaccines are made in this way, such as those against measles and polio, but they require extensive safety testing. Sinovac Biotech in Beijing has started to test an inactivated version of SARS-CoV-2 in humans.

### Weakened virus

A virus is conventionally weakened for a vaccine by being passed through animal or human cells until it picks up mutations that make it less able to cause disease. Codagenix in Farmingdale, New York, is working with the Serum Institute of India, a vaccine manufacturer in Pune, to weaken SARS-CoV-2 by altering its genetic code so that viral proteins are produced less efficiently.

### Inactivated virus

In these vaccines, the virus is rendered uninfected using chemicals, such as formaldehyde, or heat. Making them, however, requires starting with large quantities of infectious virus.

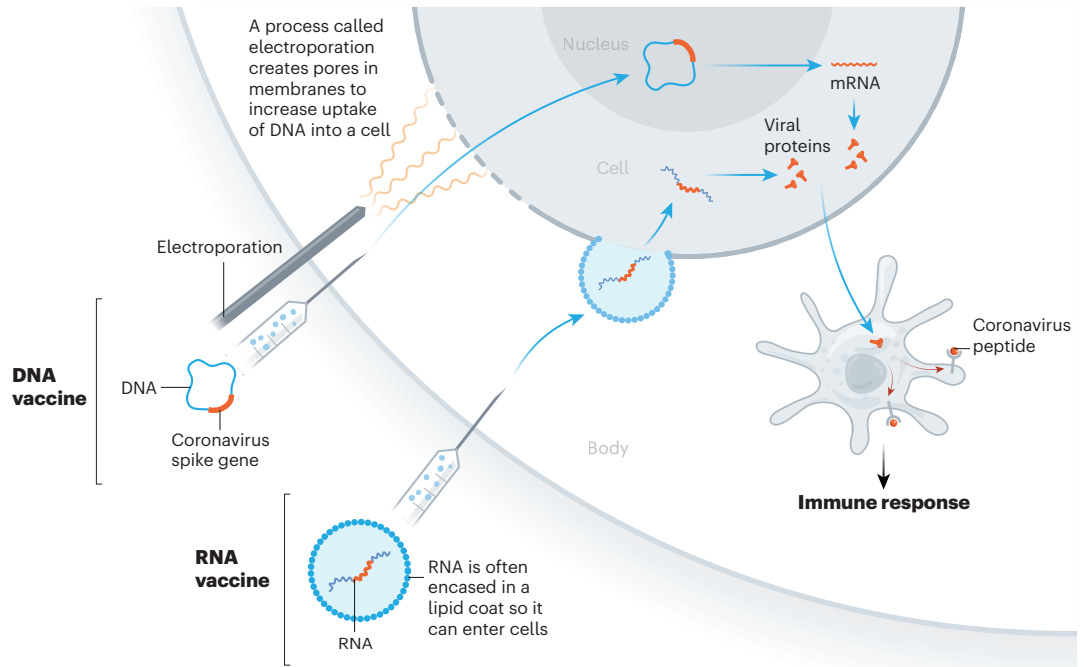




## NUCLEIC-ACID VACCINES

At least 20 teams are aiming to use genetic instructions (in the form of DNA or RNA) for a coronavirus protein that prompts an immune response. The nucleic acid is inserted into human cells, which then churn out copies of the virus protein; most of these vaccines encode the virus's spike protein.

RNA- and DNA-based vaccines are safe and easy to develop: to produce them involves making genetic material only, not the virus. But they are unproven: no licensed vaccines use this technology.



## VIRAL-VECTOR VACCINES

Around 25 groups say they are working on viral-vector vaccines. A virus such as measles or adenovirus is genetically engineered so that it can produce coronavirus proteins in the body. These viruses are weakened so they cannot cause disease. There are two types: those that can still replicate within cells and those that cannot because key genes have been disabled.

### Replicating viral vector (such as weakened measles)

The newly approved Ebola vaccine is an example of a viral-vector vaccine that replicates within cells. Such vaccines tend to be safe and provoke a strong immune response. Existing immunity to the vector could blunt the vaccine's effectiveness, however.

### Non-replicating viral vector (such as adenovirus)

No licensed vaccines use this method, but they have a long history in gene therapy. Booster shots can be needed to induce long-lasting immunity. US-based drug giant Johnson & Johnson is working on this approach.

## PROTEIN-BASED VACCINES

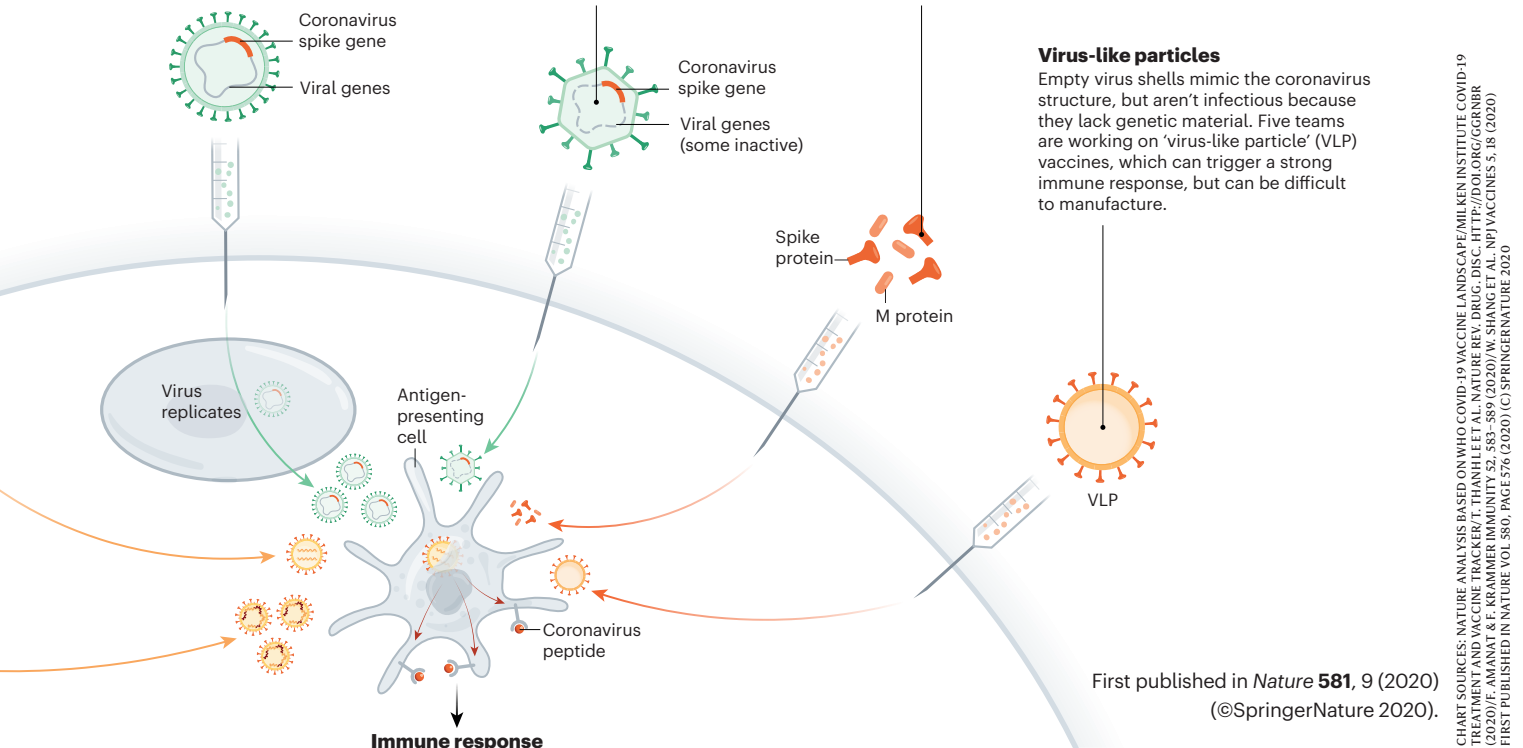
Many researchers want to inject coronavirus proteins directly into the body. Fragments of proteins or protein shells that mimic the coronavirus's outer coat can also be used.

### Protein subunits

Twenty-eight teams are working on vaccines with viral protein subunits — most of them are focusing on the virus's spike protein or a key part of it called the receptor binding domain. Similar vaccines against the SARS virus protected monkeys against infection but haven't been tested in people. To work, these vaccines might require adjuvants — immune-stimulating molecules delivered alongside the vaccine — as well as multiple doses.

### Virus-like particles

Empty virus shells mimic the coronavirus structure, but aren't infectious because they lack genetic material. Five teams are working on 'virus-like particle' (VLP) vaccines, which can trigger a strong immune response, but can be difficult to manufacture.



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## Comment

candidate based on RNA technology, including Imperial College London, Tongji University/Chinese Centre for Disease Control and Prevention and Translate Bio/Sanofi, are also progressing with impressive speed.

Inovio's DNA vaccine (INO-4800) against COVID-19, initiated phase I trials within 86 days. Scientists at Inovio started to design and synthesize a DNA vaccine, which consists of a DNA plasmid containing genes encoding for the SARS-CoV-2 spike protein. This vaccine can be given through the skin with the help of a next-generation electroporation device, which allows smooth entry of DNA into the human cells with the help of an electric current. In previous preclinical and clinical studies, Inovio's platform technology induced robust T-cell and antibody responses. Zydus Cadila has recently been recommended for funding support from India's Department of Biotechnology (DBT) for advancing its DNA-based COVID-19 vaccine.

### Vaccines based on viral vectors

Viral-vectors being exploited for gene delivery and vaccines based on this approach offer a high level of protein expression, extended stability and provoke strong humoral (antibody-mediated) and cellular (T-cell mediated) immune responses. Antigens of interest can be expressed efficiently. China's CanSino Biologics with its recombinant COVID-19 vaccine based on Adenovirus Type-5 vector (Ad5), has moved into a phase II trial. The University of Oxford started the development of a COVID-19 vaccine based on a replication deficient ChAdOx1 platform (chimpanzee adenovirus vector) and began phase I/II clinical trials on 23 April 2020. The Serum Institute of India partnered with the University of Oxford and was slated to start production of vaccine within 2-3 weeks. Additionally, AstraZeneca will also team up with Oxford for mass production of the COVID-19 vaccine. Several clinical trials have proved that it induces immunity and is safe to use against a range of pathogens. Another CEPI funded consortium led by the Institut Pasteur, Themis Biosciences and University of Pittsburgh is developing a COVID-19 vaccine based on the Measles vector. The low cost of manufacturing and production of large quantities in less time makes viral vectored vaccines favourable for use in low-income and middle-income settings.

### New platforms

Recombinant nanoparticles are non-infectious particles and mimic conformational and structural properties of the native virus but lack genetic material. These properties make them a potential platform technology for vaccine development. Novavax developed a COVID-19

vaccine (NVX-CoV2373) based on proprietary recombinant nanoparticle technology. The NVX-CoV2373 vaccine is designed to make a stable form of prefusion form of spike protein. Immunization of NVX-CoV2373 in animals showed strong immunogenicity. Novavax is expecting to start phase I clinical trial in mid-May (within 125 days after sequence identification). This platform has the potential to rapidly generate and manufacture vaccine candidates within 90 days (from the identification of gene sequence), as seen in an influenza A/Anhui/1/2013 (H7N9) and Ebola vaccine candidates. Medicago is another advance VLP candidate with ready material for pre-clinical studies.

### Traditional methods and adjuvants

Traditional methods such as inactivated and live attenuated approaches are among the most advanced candidates for COVID-19 vaccines. Recently, an inactivated vaccine developed by Sinovac commenced a phase I trial, meanwhile, Wuhan Institute of Biological Product's vaccine began a phase II trial. Indian vaccine developer Bharat Biotech along with the University of Wisconsin has started development of a COVID-19 vaccine based on self-limiting version of influenza virus, CoroFlu.

## “Fair allocation of vaccines must be urgently and collectively addressed.”

Scientists at the University of Hong Kong (HKU) developed a novel rapid response technology based on live attenuated influenza vaccine platform, DelNS1 LAIV. The non-structural protein 1 (NS1) element, which makes the flu virus strongly immunogenic and less virulent, was deleted in DelNS1 LAIV. Their COVID-19 vaccine candidate was developed by incorporating the receptor binding domain (RBD) of SARS-CoV-2 into DelNS1 LAIV on its surface. Use of RBD domain only may avoid induction of antibody dependent enhancement of disease. This vaccine could prevent both SARS-CoV-2 and influenza infections and can be administered by nasal route. A phase I trial is expected to start in July.

The University of Queensland (UQ) has developed molecular clamp technology that keeps the spike protein of SARS-CoV-2 in stable form, which allows the immune system to be able to recognize it. Influenza, Nipah, and MERS coronavirus are some of the vaccine candidates that are currently under development based on this rapid response platform technology. Scientists at UQ were able to generate the COVID-19 vaccine candidate within 21 days after publication of

SARS-CoV-2 sequence. CEPI just announced a partnership with the Clover Pharmaceuticals for development of a SARS-CoV-2 spike (S)-protein subunit vaccine candidate based on innovative Trimer-Tag<sup>®</sup> technology. Vaxine, SK Bioscience and G+Flas Life Science are also working towards development of COVID-19 vaccines based on the recombinant approach.

When combined with recombinant protein-based vaccines, adjuvants (substances that modulate and enhance immune response when combined with antigen) can help in boosting stronger and long-lasting immunity. Furthermore, adjuvants also reduce the dose required, allowing more vaccine doses to be made available, which is especially important in a pandemic. GlaxoSmithKline, Seqirus and Dynavax have committed to making innovative licenced adjuvants (ASo3, MF59 and CpG 1018), respectively available to partners supported by CEPI to enhance the development of effective vaccines against SARS-CoV-2.

### Vaccines for all

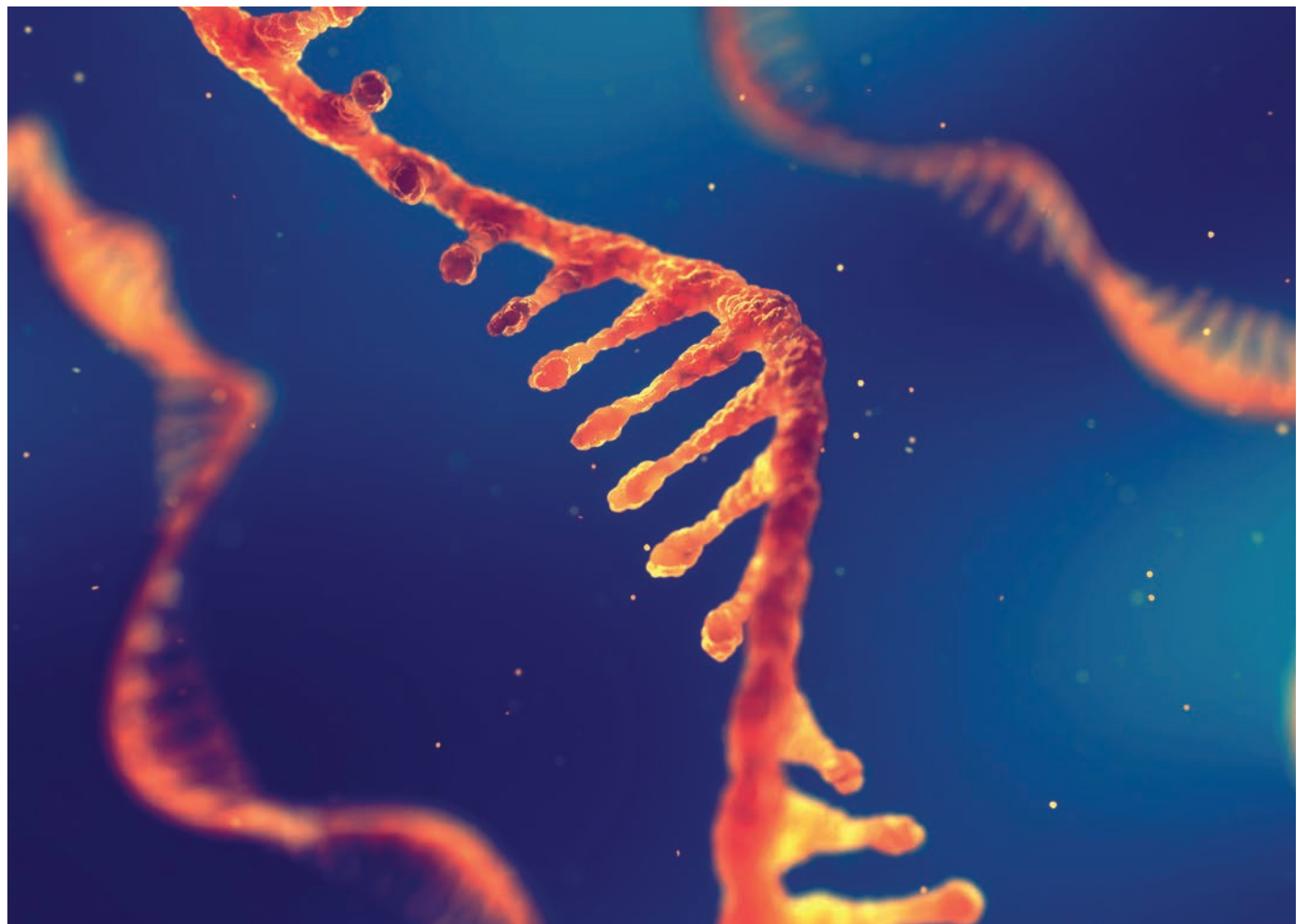
Both novel and traditional approaches to COVID-19 vaccine development offer different value propositions in relation to speed of development and scale of manufacture over short and long terms. CEPI has a diverse portfolio of candidates based on a wide range of vaccine technologies – including novel platform technologies and other more established approaches – to maximize its chances of success.

Currently, there is no global entity responsible for financing or ordering vaccine manufacture, nor is there a globally fair allocation system for any vaccines produced. It will be vital that such a system is in place to ensure that everyone that no one is left behind. In response, the WHO and global leaders from around the world launched the Access to COVID-19 Tool (ACT) accelerator, of which CEPI is a founding member, to speed up development, production and access to vaccines and therapeutics.

Globally fair allocation of vaccines is a challenge that must be urgently and collectively addressed by governments, global health leaders, and regulators, while the race for a COVID-19 vaccine picks up pace.

\*The authors are from the Coalition for Epidemic Preparedness Innovations (CEPI), Oslo, Norway.





A single-stranded RNA virus.

# CORONAVIRUS SEQUENCING EFFORTS URGENTLY NEED PATIENT DATA

Unless each sequence of the virus in the global open repositories comes with additional patient information, the practical benefits of such record sequencing are lost. **By Subhra Priyadarshini**

**R**esearchers mapping the genetic blueprint of the novel coronavirus SARS-CoV-2 have by now shared more than 55,000 genome sequences from across the world on the open platform Global Initiative on Sharing All Influenza Data (GISAID). The repository has seen unprecedented activity since December when the first sequence from Wuhan in China came in. On NCBI's GenBank, more than 20,000 nucleotide and protein sequences of the virus have already been submitted.

The virus is set to become the most sequenced ever.

Researchers, however, warn that unless the sequences are accompanied by de-identified data from patients, the billions of dollars being spent in sequencing the virus globally will not be of much clinical or epidemiological value, a crucial need during a rapidly evolving pandemic.

Laboratories, clinicians, epidemiologists and governments wanting to quickly use this gold mine of information are meeting a stumbling block as they look for more granular data that should ideally supplement the primary sequence data.

## Feature

“We badly need de-identified meta-data from the patients from whom these sequences came so that it makes sense for any kind of analysis,” says Seshadri Vasana, who leads the Dangerous Pathogens team at the Australian Animal Health Laboratory and is senior principal research consultant for Health and Biosecurity at the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia’s national science agency.

De-identified data does not reveal the identity of the patient. Vasana says the minimum set of de-identified data that researchers need is the patient’s age, gender, if they had a mild, moderate or severe form of the disease and if they survived. Questions around lifestyle and comorbidities, such as whether they smoke, have a pre-existing respiratory illness or diabetes, are also important to add meaning to this data. “We usually get information on country and city, but it may be beneficial to have post-code and ethnicity data too,” he says.

India has announced an ambitious 1,000-genome sequencing project to better understand the viral and host genomics of the COVID-19 outbreak. India’s Council for Scientific and Industrial Research (CSIR), which undertook a 1,008-human genome sequencing project last year, has been leading the sequencing efforts in India.

Scientists at the Centre for Cellular and Molecular Biology (CCMB), Hyderabad; the Institute of Genomics and Integrated Biology (IGIB), Delhi; the Institute of Microbial Technology, Chandigarh; the National Institute of Virology, Pune, and the Gujarat Biotechnology Research Centre, Gandhinagar are sequencing

the viral genome. The Central Drug Research Institute (CDRI), Lucknow and IICB, Kolkata are also gearing up to sequence the viral genome.

With the 1,000-genome project, about 10 more facilities across the country will be pulled in to sequence the virus.

Virologist Mitali Mukerji, a genomic scientist at IGIB who is coordinating CSIR’s sequencing efforts says at the moment scientists are only trying to analyse the strain of the virus and where the sequences came from. “Clinical history is not getting submitted from any place. It’s very important since this is not the end of the outbreak,” she says. Epidemiologists need to identify people who might be more at risk and analysing clinical information will be crucial, she says.

IGIB director and clinician scientist Anurag Agrawal, who is overseeing a molecular and digital surveillance project around the genome sequences from India, says it would be extremely useful to know the viral loads and numbers of symptomatic versus asymptomatic cases. “Nothing is meaningful for molecular epidemiology or our knowledge of clusters unless these clinical parameters are well defined in the data,” he says.

The biggest barrier, he says, is coordination among researchers sequencing the data and agencies uploading it on to the databases. “We work with the National Centre for Disease Control (NCDC), who have the underlying patient information and since they upload the sequences, they do add much more value to the data.”

Upasana Ray, a virologist at the CSIR-Indian Institute of Chemical Biology (IICB) whose

team recently analysed the genome sequence from a COVID-19 patient from Gujarat, agrees. “This remains a concern for most of us – to correlate this data with our analysis,” she told *Nature India*. “It is extremely important for us when we want to assign clinical significance to our sequencing efforts,” she says.

The reason this additional data is needed is that the same viral strain could be fatal for one person, and result in mild, moderate or severe symptoms in others. “And some strains could also be more or less virulent than others,” Vasana adds.

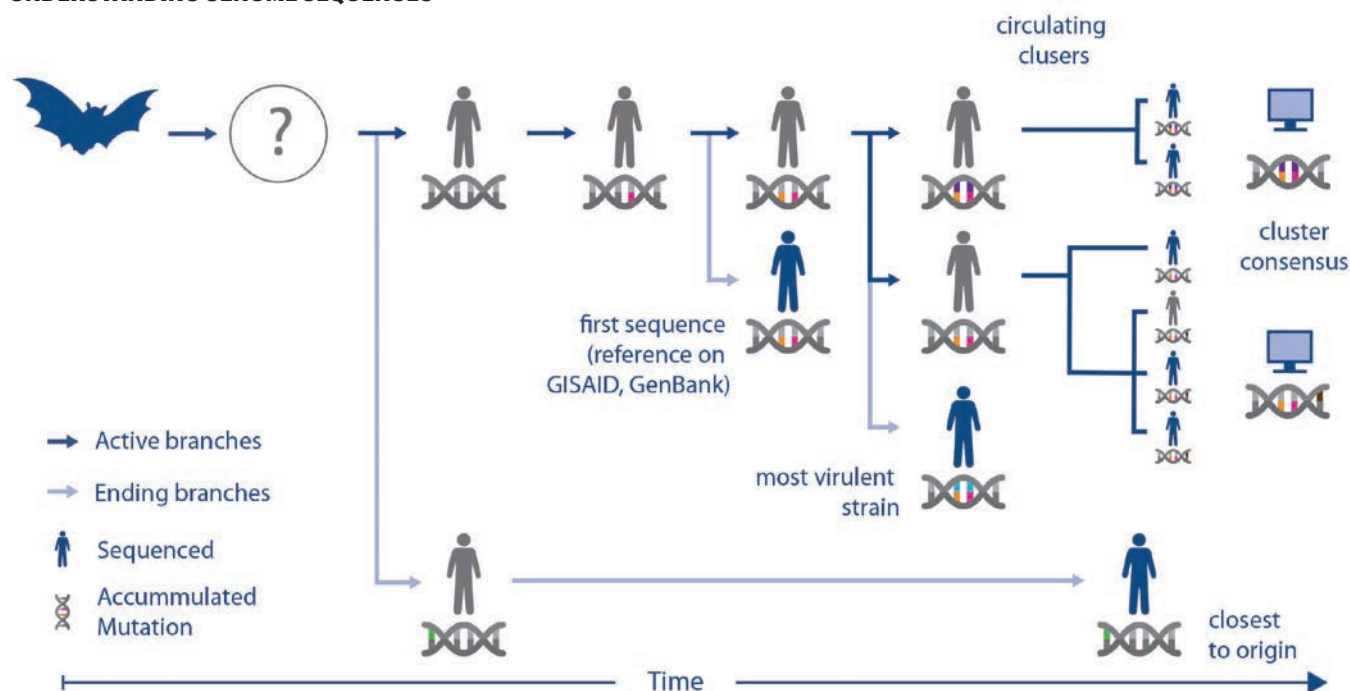
Vasana, says the World Health Organization should lead this effort to standardize the meta-dataset that can be followed globally, with consistent definitions to categorize severity and outcomes of COVID-19. “No country can solve this problem in isolation. It is important for the WHO to specify the minimal meta-dataset not just for SARS-CoV-2 but also a future ‘Disease X,’” he told *Nature India*.

In the absence of patient meta-data “we don’t know how the disease is progressing, how long the virus shedding occurs in different settings and what kind of immunity levels exist in individuals or populations,” says epidemiologist Giridhara R Babu from the Public Health Foundation of India (PHFI).

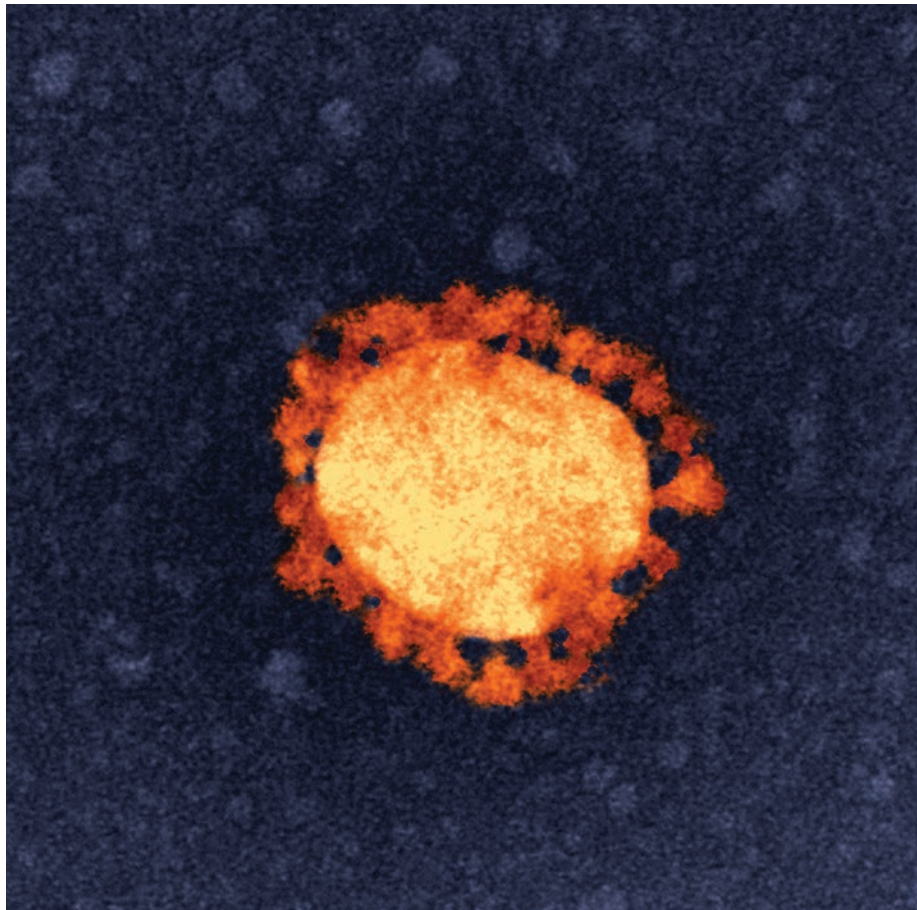
“We have to be very careful in improving the quality of the meta-data and, more importantly, have it unbiasedly assessed by people who don’t run the clinical trials,” Babu told *Nature India*. That way measurement errors and selection biases can be removed from the data to make it more useful.

Information on the severity of symptoms

### UNDERSTANDING GENOME SEQUENCES







Transmission electron microscope image of SARS-CoV-2.

and disease progression dynamics would be immensely helpful when combined with the genomic sequences. “For instance, one could actually know if there is a sub-group of asymptomatic people who never go on to develop the disease. They would be way more useful to design a disease modifying mechanism or immunomodulation, instead of the quest for a vaccine as the endgame.”

Disregarding all these data elements eliminates the possibility of other non-pharmacological interventions to disrupt the transmission of the virus, Babu says.

### Evolution, mutations and clades

The global effort to peer into the genetic make-up of the pandemic-causing virus since the start of the COVID-19 outbreak has provided real-time understanding of the organism. Databases such as the GenBank and GISAID provide ammunition to researchers trying to understand the evolution and mutations of viruses. They are also solid tools for the research and development of drugs and vaccines against the virus.

The data so far reveals some minor mutations in the virus which may have no functional consequence, Vasan says. “For instance, when we looked at 388 sequences from Australia, only 162 had protein-changing mutations,” he says. However, his team was unable to



**WE MAY FIND CLUSTERS WITH VARIED VIRULENCE IN ALL COUNTRIES.”**

determine clinical or epidemiological impacts of these minor mutations without the underlying meta-data. Only 14 out of these 388 sequences had clinical annotations, the rest were either annotated as unknown or not at all.

CSIRO has developed a novel visualization platform – similar to the one used to analyse the human genome – to pinpoint differences among the thousands of individual genetic sequences of COVID-19 now globally available. The data visualization platform highlights evolving genetic mutations of the virus as it continues to change and adapt to new environments.

“Analysing global data on the published genome sequences of this novel corona virus will help fast track our understanding of this complex disease, how changes in the virus could affect its behaviour and impact,” Vasan says. “Assessing the evolutionary distance

between these data points helps researchers find out about the different strains of the virus – including where they came from and how they continue to evolve,” he says.

Vasan, whose team has analysed the first 181 published genome sequences from the current COVID-19 outbreak says the RNA virus can “evolve into a number of distinct clusters that share mutations.” The analysis has already helped determine which strains of the virus are suitable for testing vaccines underway at the Australian Centre for Disease Preparedness in Geelong, Victoria.

RNA viruses, Vasan adds, generally evolve into clusters and show ‘quasispecies diversity’, meaning not just a single genotype but an ensemble of related sequences. Quasispecies arise from rapid genomic evolution powered by the high mutation rate of RNA viral replication. The novel coronavirus, an RNA virus, emerged from China and restrictions on air travel and movements of people did not come into place for a while after the outbreak in Wuhan. “Therefore, the clusters do not correspond to countries. For instance, the first 181 published genomic sequences could be grouped into three clusters (with three more emerging), and Australian isolates can be found in each of them,” he says.

For this reason it is unhelpful to call the virus ‘an Indian strain’ or ‘Australian strain’ or ‘Chinese strain’ or make claims that one regional strain is more virulent than the other.

“Over time, we may likely find clusters with varied virulence in all countries. The real question is whether we can link the accumulated mutations in the genome to clinical meta-data and find clinically/epidemiologically meaningful correlations,” he says.

A GISAID statement says the circulating virus strains globally can be classified into different number of clades based on genetic variation. “These are part of the natural evolution of the virus currently not known to be associated with any differences in virulence,” it says. Data from the early outbreak period is not enough for a detailed interpretation of the early history of global transmissions from a few genomes, according to GISAID.

Ray, whose team reported in a preprint paper two novel mutations in the spike protein of the SARS-CoV-2 isolate from Gujarat as compared with the Wuhan virus isolates, says these mutations have a somewhat different origin. “One of the mutations is exclusive in the virus obtained from Gujarat whereas the other was also seen in North American and European isolates.”

To date, almost 95% of the strains reported in global databases are from Wuhan in China where the outbreak began. “The remaining 5% are from the rest of the world. So some descriptions of virulence being low or high in a particular region are wishful thinking at best,” Giridhara Babu says.

# A tug of war in the immune system

Lakshmy Ramakrishnan

Developing an understanding of the root of SARS-CoV-2 is proving complicated, despite its urgency.

**T**he emergence of new pathogens in humans, that originated in animals, has been a disturbing trend. Disruption in wildlife habitat and changes in human behaviour are significant contributors to pathogens crossing the species barrier, with globalization an accelerant. Disease-causing microorganisms, that once infected only animals, have enhanced their infective repertoire to accommodate humans.

The 2019 SARS-CoV-2 outbreak is reported to have originated in a wet animal market, reliant on poaching and the trafficking and trade of wildlife. The demand for wild animals, which are used as exotic foods and in traditional forms of medicine spurs trade in wildlife. Within these markets live animals and humans come in close contact. Such situations can create a breeding ground for zoonotic viruses to jump from animals to humans through mutations.

The consensus among scientists is that SARS-CoV-2 was transmitted from bats to humans, with pangolins acting as the link. This however is not a simple process. Coronaviruses interchange between cycles of active virus production and inactive quiescence during persistent virus infections in bats. The latter acts as a means to avoid detection by the bat immune system, whilst the former triggers immune responses against the virus. Such responses include the production of reactive oxygen species, such as superoxide and hydrogen peroxide, which, in turn induce mutations in the SARS-CoV-2 genome. This virus-host interaction generates quasi-species pools of virus, with adaptive potential, including the ability to infect humans.

Despite there being regulations overseeing international wildlife trade, sceptics argue that CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) is simply an agreement between nations and call instead for a complete ban on illegal trade of wildlife. There was a failure to heed the warnings of the emergence and spread of influenza and coronaviruses more than a decade ago, particularly during the 2009 H1N1 swine flu pandemic and during the SARS-CoV and MERS-CoV outbreaks of 2002

and 2012. Many bodies have been calling for a ban on wildlife trade ever since

## Dangerous liaisons

Viruses are thrifty organisms; they possess only two major biological molecules, protein and nucleic acids, and yet can do enormous harm. The proteins carry out the processes of infecting cells and diverting the cell's resources to its own requirements, while the genetic material replicates, producing more virus particles. SARS-CoV-2 possesses a large RNA genome, which shares significant similarity with that of SARS-CoV. This explains the similarity between the two viruses in infection pattern and their disease outcome in humans.

## “Scientists and clinicians have elucidated three stages of the infection cycle.”

Transmission of SARS-CoV-2 from humans to humans is through direct contact or through respiratory droplets transmitted from infected individuals. SARS-CoV-2 enters into the respiratory tract and lungs through the mucosal membranes of the nasal passage and larynx. It is not yet clear whether it can be transmitted through the oral-faecal route, and uncertainty remains over its infectious potential on inanimate objects.

## Target practice

Viruses possess specific proteins, such as the spike protein in the case of SARS-CoV-2, that recognize and target specific types of host cells, thereby helping viral entry into the cell. SARS-CoV-2 targets a protein on human cells, namely angiotensin converting enzyme 2 (ACE2). It is expressed primarily in lung tissue, kidneys and the gastrointestinal tract. The function of this important enzyme whose function is to regulate blood pressure and protect the host from worsening of lung injury. On entry into the cell, the virus is able to hijack the host cell's machinery for its own needs.

Despite the unknowns around this novel coronavirus, scientists and clinicians have

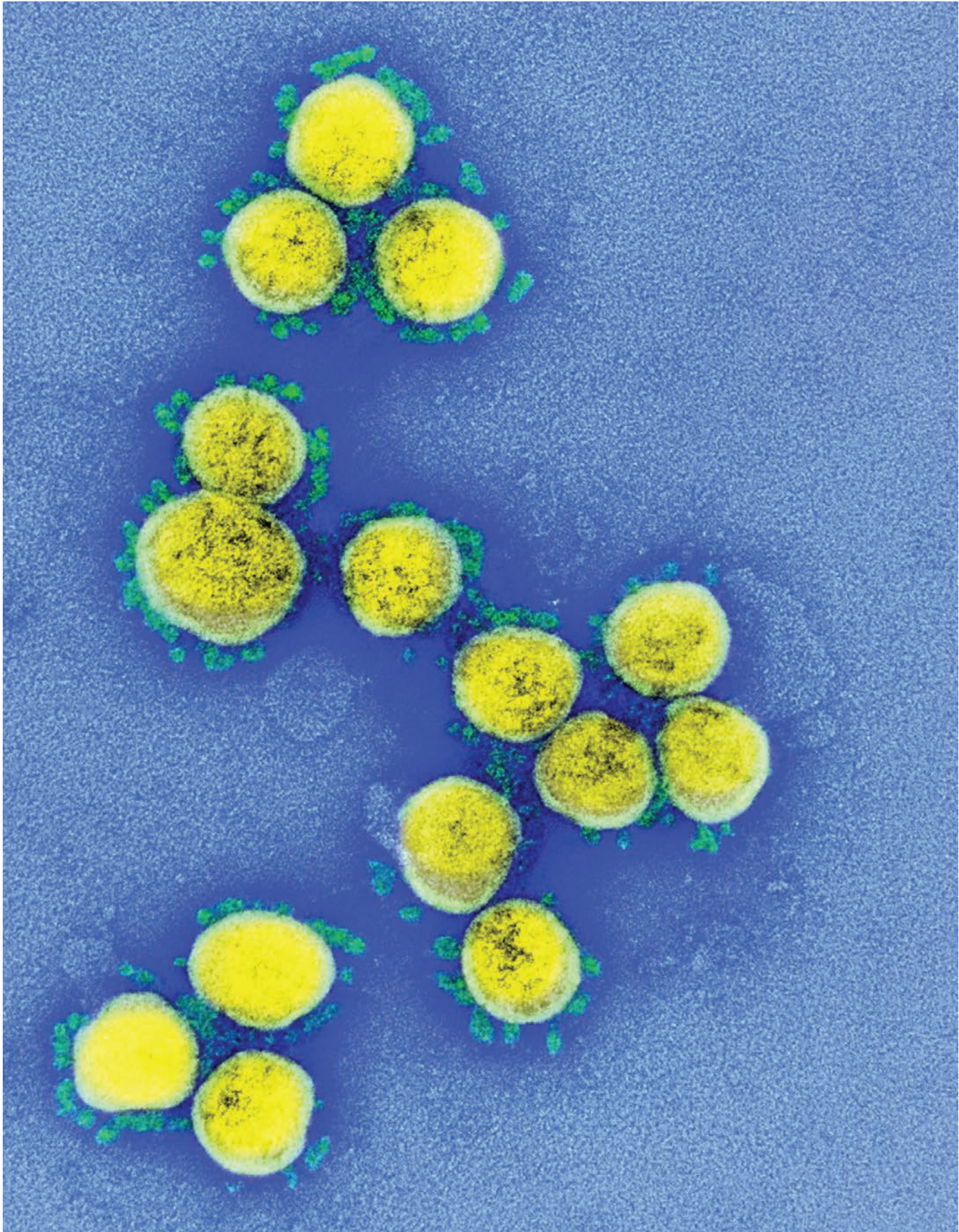
elucidated three stages of the SARS-CoV-2 infection cycle: the asymptomatic stage with detectable or undetectable viral loads, non-severe symptomatic stage with detectable viral load, and severe disease with high viral load. Onset of symptoms takes place five to six days after infection, but studies have reported incubation periods varying from 14-30 days in some individuals. Symptoms range from mild fever, sore throat, cough, myalgia, fatigue, lymphocytopenia and radiographic signs of pneumonia. Mild cold and flu-like symptoms, along with reports of afebrile cases, had initially pointed at a broader spectrum of causative agents, such as dengue infection. This in turn, had delayed diagnoses in the early days of the pandemic. However, when the severe disease stage emerged, the fine line between 'flu-like' and severe became unclear. Severe disease can lead to shock, acute respiratory distress syndrome, acute cardiac injury, acute kidney injury, and death.

## Fighting back

Infected people recover when their immune system elicits a directed and durable response during the first two stages of SARS-CoV-2 infection. It is hypothesized that this protective anti-viral immunity mainly occurs under the setting of overall good health, in the absence of underlying diseases, and in the presence of an appropriate genetic background.

SARS-CoV-2 infection results in severe disease and fatality when there is an imbalance in the immune response: a tug of war between a protective immune response and a dysregulated inflammatory response ensues. The former induces protective anti-viral immunity, while a dysregulated inflammatory response leads to cell death and tissue damage. Such an inflammatory response occurs when there is uncontrolled viral replication, a delay in the production of immunomodulators, an increased infiltration of neutrophils, and an increased influx of pro-inflammatory mediators. The respiratory tract is a major site of viral attack and this is supported by the observation of high ACE2 expression in the lungs. Oxygen transfer between the tiny air sacs (alveoli) and the capillaries that





NIAID

Transmission electron micrograph of SARS-CoV-2 virus particles.





Medics wearing protective suits in a swab sample collection centre.

line the alveoli is impeded due to an influx of inflammatory mediators and cells. This results in the formation of dead cells along with pus, which contributes to the clinical presentation of coughing, fever and shallow breathing, leading to pneumonia. Oxygen therapy alleviates symptoms for some patients, who are able to recover, while others struggle, a fall in blood pressure ensues, vascular leakage occurs, blood clots form, and organ failure sets in. This immunological cascade of events results in acute lung injury (ALI) and acute respiratory distress syndrome (ARDS). Ultimately, pulmonary infiltration of inflammatory cells and mediators is the major cause of fatality in severe SARS-CoV-2 infections.

SARS-CoV-2 may also be striking the cardiovascular system: there have been reports of heart attacks and ischemia (blood vessel constriction) in fingers and toes. It is suggested that the virus attacks blood vessels and cardiac muscle, with reports identifying blood clots lodged in the lungs and brain. This leads to pulmonary embolism and stroke, respectively, which have been one of the major causes of morbidity in critical patients. It is thought that there are other targets on the cardiovascular system, which are yet to be identified. This is of importance in the case of patients suffering from hypertension, diabetes, and chronic lung disease, as they are considered to be more vulnerable to such attack.

The kidney is another target of SARS-CoV-2,

where there is a high expression of ACE2. Patients suffering from kidney failure are more susceptible to acute kidney injury (AKI) as a result of infection.

Another worrying target is the central nervous system (CNS); some patients have reported loss of smell and developed strokes or seizures. These symptoms suggest the virus has penetrative power into the brain and spinal cord or these symptoms manifest as a result of the dysregulated immune response. A combination of both would most likely be the case as SARS-CoV was able to enter the CNS and cause encephalitis.

Patients have also reported diarrhoea, vomiting and abdominal pain, which was most often diagnosed as a stomach bug, but when





WITTHAYA PRASONGSIN/MOMENT/GETTY

Working on the race for the much-needed vaccine.

## “Personal hygiene and respiratory etiquette is the gold standard individual strategy.”

and, in patients with severe infection, the administration of a therapeutic modulator of host inflammatory responses.

### The conundrums

An alarming observation is the presence of the virus in patients who have recovered from SARS-CoV-2. This reappearance of the virus occurs suggests that the host immune response may be partial or the virus has found a mechanism to remain hidden and escape detection, possibly reactivating later on.

Another difficulty in combating SARS-CoV-2 is the presence of viral mutant strains. Several lines of thought have delved into the possibility of multiple SARS-CoV-2 strains in circulation, this suggests that the viral genome may be unstable and may diversify to infect different populations or it may alter its virulence.

Owing to a contrast in the incidence of disease in different regions of the world, a predisposition to severe forms of disease or an inherent resistance to virulent forms have also been taken into consideration. Genome-wide studies are indicative of this, but require a deeper understanding. This could lead to the development of targeted vaccines to specific groups of individuals. Collectively, these anomalies point to the challenges to vaccine design and therapeutic interventions.

### Tackled to the ground

Prevention is the only response in the current situation. Physical distancing, the approach

used by public health agencies, is highly relevant considering that airborne transmission, i.e. transmission of the virus while talking or breathing, has not been completely ruled out and the infectious dose has not been determined. Researchers suggest increased ventilation indoors and reduced recirculation of air can keep the virus at bay. Use of masks is discouraged in some countries owing to increased demand in healthcare settings, while some countries believe their use adds an extra layer of protection. Encouragement of proper personal hygiene and respiratory etiquette is the dominant approach currently in play.

A strategy several European countries have set out to implement is the phenomenon of herd immunity, a concept that suggests that if a significant proportion of the population is immunized with a specific pathogen, for instance, by a vaccine, then the remaining unvaccinated individuals are unlikely to become infected, owing to a decrease in the spread of the disease. Proponents of herd immunity are relying on natural immunity to kick in and provide an indirect blanket of immunity to the rest of the population. Considering the enormity of the unknown facts about this virus, it is a huge gamble.

### Humility in the face of death

The last few months have forcefully stifled society and halted the consumption of the fruits of globalization. There is uncertainty about what lies ahead, but this period serves as a time for introspection and evaluation. Despite advances in science, technology and medicine, we are in uncharted territory.

**Lakshmy Ramakrishnan** is a science writer based in India.

coughing was also reported, SARS-CoV-2 was found to be the culprit. Endoscopic images show that gastrointestinal tract injury occurs as a result of viral replication. This does pose the question of oral-faecal route of transmission, but studies have not confirmed this.

Hospitalized patients have also reported conjunctivitis of the eye and have been observed to suffer liver damage, the latter is most likely due to an overworked immune system and the effect of xenobiotic administration during the course of treatment.

These observations suggest the need for therapeutic interventions for varying effects. Initially, administration of an agent that can boost the natural host immune response in patients who are undergoing mild infections,

The Bangalore Bioinnovation Centre is the largest hub for life science start-ups in India.

# A CATALYST FOR BIOINNOVATION

The Bangalore Bioinnovation Centre (BBC) is **INCUBATING LIFE SCIENCE START-UPS** that are hoping to play a role in the rapid growth of India's biotechnology sector.

## A MESSAGE

— **Jitendra Kumar, managing director of the Bangalore Bioinnovation Centre**

*India has a huge population of aspiring innovators — and our research ecosystem is maturing.*

*The Indian government has recognized the country's ability to play a vital role in the international biotechnology industry and aims to grow its current 3% share of the global market to 19% by 2025.*

*The COVID-19 pandemic has also seen support for life science innovation increase at both the central and state levels.*

*As a result, more bioincubation centres, similar to the Bangalore Bioinnovation Centre (BBC), are being created across the*

*country. Recently, BBC received 70 applications from innovators working to find solutions to ease the burden of the pandemic. Of these, it is nurturing about 30 projects, ranging from diagnostics to therapeutics and vaccine development.*

*But BBC's start-ups were hard at work before the pandemic. At the Global Bio-India 2019 conference, three launched products, including String Bio's poultry feed production technology fuelled by waste methane, Yostra Labs' handheld device for diabetic neuropathy detection, and Next Big Innovation Labs' latest 3D bioprinter. At only four years old, we predict there are many, many more BBC products on the horizon.*

**"INDIA HAS A HUGE POPULATION OF ASPIRING INNOVATORS"**

**The centre:** BBC is one India's leading bioincubators for life science start-ups. Based in the south-western state of Karnataka, BBC is an initiative of Karnataka Innovation and Technology Society (KITS) and the Government of Karnataka's Department of IT, BT and S&T, with liberal funding coming from the Government of India's Department of Biotechnology (DBT). Since its establishment in 2016, BBC has helped

successfully commercialize 15 socially impactful products.

**Facilities:** BBC's international-standard Central Instrumentation Facility (CIF) is one of the best-rated in India. It includes modular plug-and-play laboratories, proteomics and small molecule analysis systems, and centrifuge, microbiology, molecular biology, microscopy, cell culture and fermentation facilities. Its Technical Advisory Resource Group (TARG) assesses proposals and mentoring innovators through each project stage.

**Funding:** Start-ups at BBC have access to a range of funding options. For example, the



Sustainable Entrepreneurship and Enterprise Development (SEED) Fund, an initiative of India's national Biotechnology Industry Research Assistance Council (BIRAC), provides capital to many early-stage start-ups. Since 2017, BIRAC has also funded a medical technology accelerator at BBC that helps entrepreneurs develop start-up pitches, go-to market strategies and initiate commercial activities as part of its biotech development programme, Bio-NEST. BBC has also been involved in a number of key initiatives from the Government of Karnataka, including ELEVATE 100, which selected the top 100 technology-based start-ups from across the state to provide with comprehensive entrepreneurship support. The initiative taps into 400 million rupees (approx. \$US5.3 million) of government funds. This is the largest pool of funds ever offered by any Indian state government to start-ups.

### Some BBC graduates

#### Jana Care Solutions Pvt Ltd

is a company that was formed by Harvard University alumni to develop diagnostics and programmes for chronic diseases. Its point-of-care diagnostic platform, Aina, tests blood sugars, lipid profiles and haemoglobin. New tests for NT-proBNP (a peptide that can indicate ventricular dysfunction) and serum creatinine (linked to kidney dysfunction) are in development. In collaboration with leading academic medical centres globally, the company has also developed the Habits Program, a digital coaching system for patients with diabetes and congestive heart failure.

**BonAyu Lifesciences** has developed thin film platforms for the biodegradable delivery of health supplements and cosmetics. It has also launched

several innovative products in weight management, vitamins and minerals, and skin and oral care, using ingredients such as caffeine, curcumin and glutathione topical films. The company was awarded the Top Innovator Award in the healthcare sector at the Global Bio-India 2019 conference.

### Some BBC incubatees

**String Bio** has developed a gas fermentation process using engineered bacteria and methane waste to make protein cakes for use in the food and agriculture industries. It won the BIRAC Innovator Award (2018), L'Oréal Innovation Runway award (2017), Best World Wide Deep Tech Startup (2017) and Future Food Asia Award (2017).

**SN Lifesciences** has recently developed, among its other offerings, an automated RNA isolation and isothermal amplification kit that could potentially reduce the cost of COVID-19 test kits to as low as 500 rupees (approx. US\$6.60).

**OmiX Labs** offers a platform for early detection and more accurate identification of infection-causing organisms. This start-up is working on a COVID-19 rapid detection kit based on isothermal amplification, without the requirement of preparing samples using reverse transcription-polymerase chain reaction.

**Pandorum Technologies'** bioinspired corneal ink could be used to print replacement lenticule tissue (a part of the cornea) to treat corneal defects. It has the potential to restore vision to many. In addition, a mini liver platform they have developed may be able to be used as a model in pre-clinical drug screenings to reduce drug discovery costs.



Team Bangalore Bioinnovation Centre.



Director, BBC  
Jitendra Kumar, PhD, MBA.



A state-of-the-art plug and play laboratory at the Bangalore Bioinnovation Centre.

### Next Big Innovation Labs

(NBIL) have developed Innoskin®, a 3D cultured skin product that will allow companies to test chemicals affordably and reliably, without using animals. NBIL's patented 3D bioprinting technology allows it to position cells with micron-level precision, enhancing cell-to-cell interaction within tissue constructs and reducing the chances of batch inconsistency.

### VNIR Biotechnologies

develops live cell imaging innovations using red/near infra-red fluorescence detection. Diagnostic kits and devices that can detect Alzheimer's, malaria, kidney failure at an early stage are in development.

**Atrimed Biotech** is working on technologies that include plant-based molecules used to treat psoriasis and acne, and for pain management. It has created a self-learning engine based on Ayurveda that produces research leads for treatments

for skin diseases, diabetes and circulation issues. Currently, its researchers are working to prevent systemic absorption of topical treatments.

**Yostra Labs** have launched NeuroTouch, a point-of-care screening device for peripheral neuropathy. Kadam is another product already on the market which reduces the healing time of chronic wounds.

### Biofi Medical Healthcare

**India Pvt Ltd** has developed an economical, non-invasive diabetic profiler. Using near-infrared wavelengths highly specific to blood glucose, it is able to detect blood glucose levels and associated diabetes complications. ■

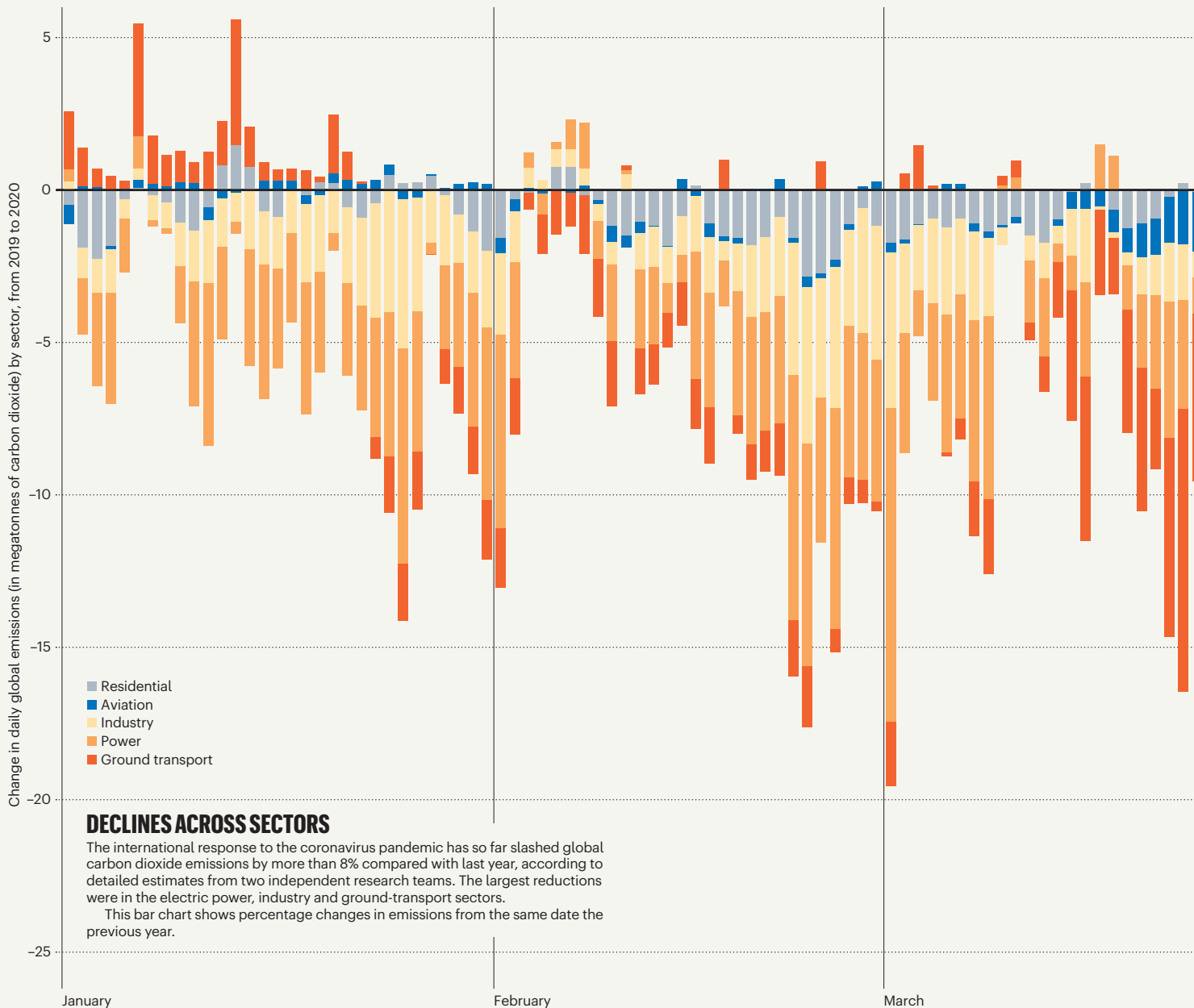


# CARBON IN THE TIME OF COVID-19

Near-real-time data show which sectors, countries and events had the most impact on slashing carbon emissions, but it is unclear how long the dip will last.

By Jeff Tollefson. Design by Paul Jackman.

First published in *Nature* 581, 9 (2020) ©SpringerNature 2020).

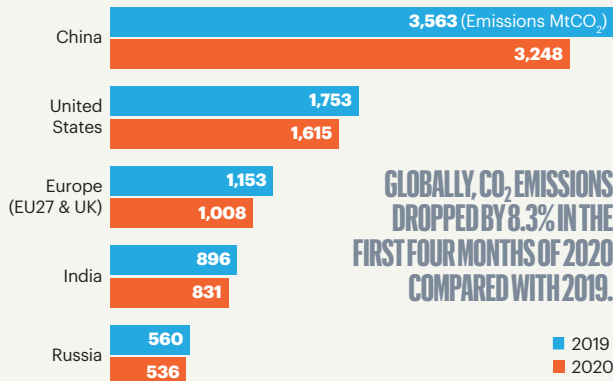


SOURCE: V-SHAPED RECOVERY: C. LE QUÉREÉ ET AL. NATURE CLIMATE CHANGE HTTP://DOI.ORG/GGWR9W (2020); ALL OTHER CHARTS: Z. LIU ET AL. PREPRINT AT HTTP://ARXIV.ORG/ABS/2004.13644 (2020)

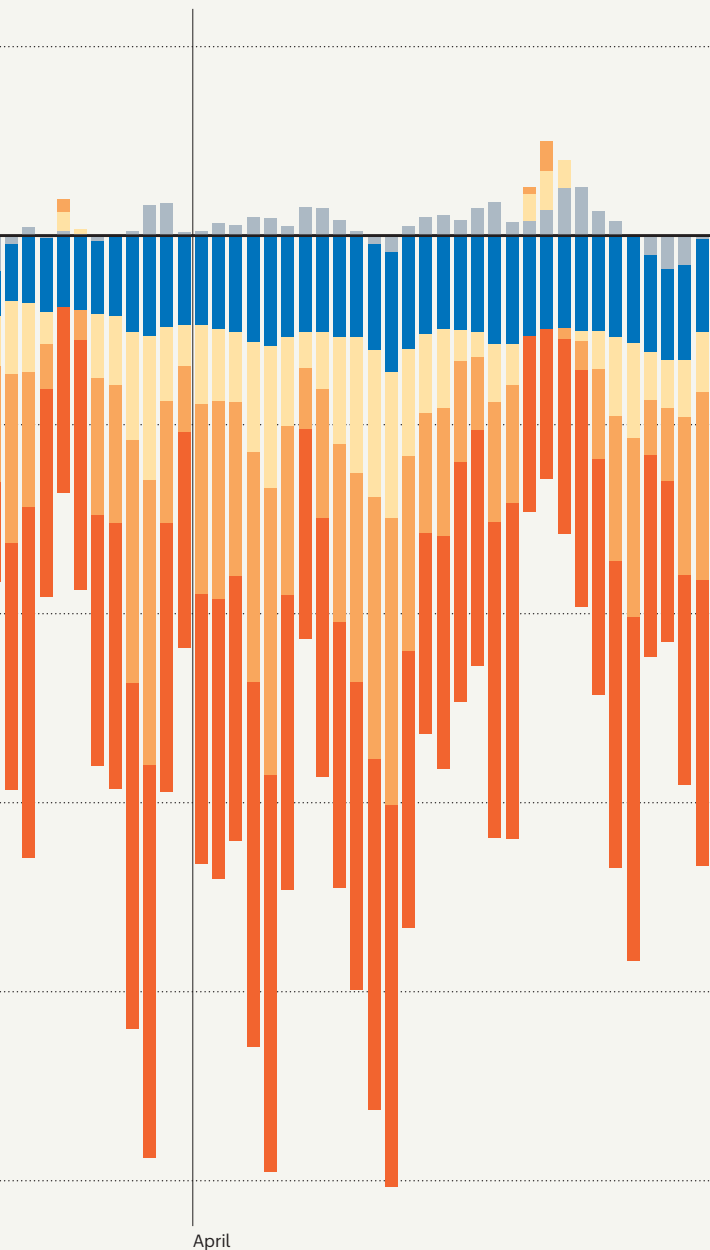


## CHINA LEADS

The country with the largest impact on emissions was China, where CO<sub>2</sub> emissions declined by an estimated 315 million tonnes — roughly the annual carbon emissions of France. Figures started to fall in January, coinciding with the Lunar New Year, and they stayed low, accounting for a 10% reduction until the end of March compared with last year. As economic activity picked up in China, other countries went into lockdown mode, depressing global emissions throughout April.



**GLOBALLY, CO<sub>2</sub> EMISSIONS DROPPED BY 8.3% IN THE FIRST FOUR MONTHS OF 2020 COMPARED WITH 2019.**

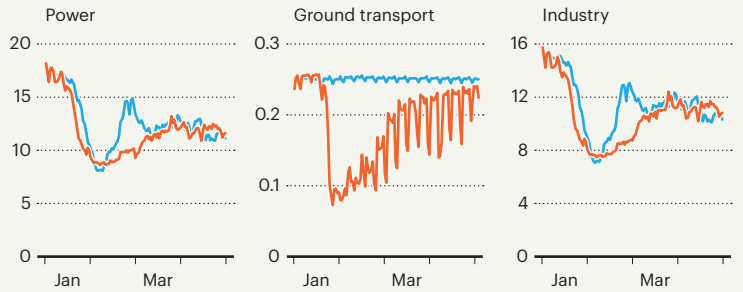


## DIVERGENT PATHS

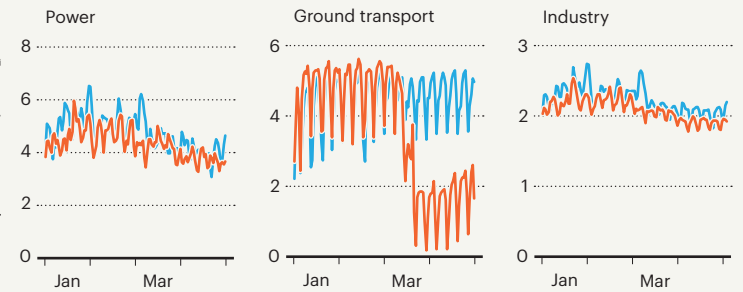
Pulling information from a range of sources — including energy and weather reports, satellite-based observations and traffic data collected by vehicle-navigation systems — both research teams produced detailed assessments of various sectors in several countries. After China's initial decline, industrial and power emissions there sprang back. In Europe and the United States, the largest declines have been in the transport sector.

■ 2019 ■ 2020

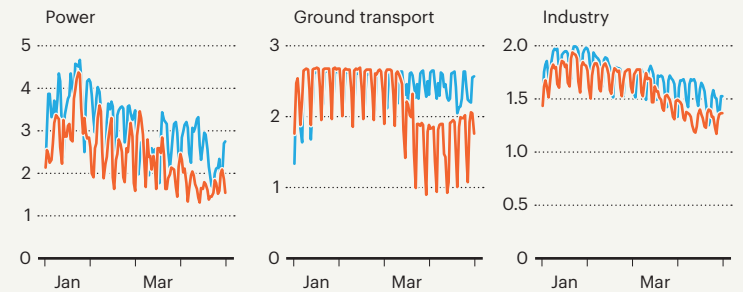
### China



### United States

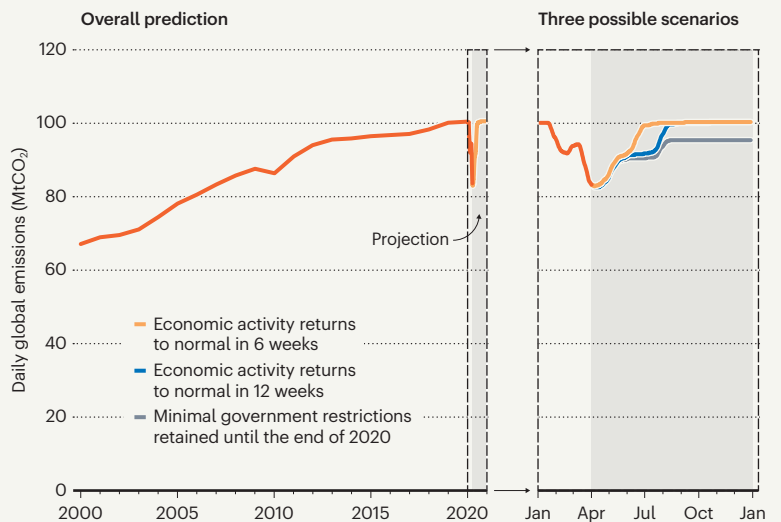


### Europe (EU27 & UK)



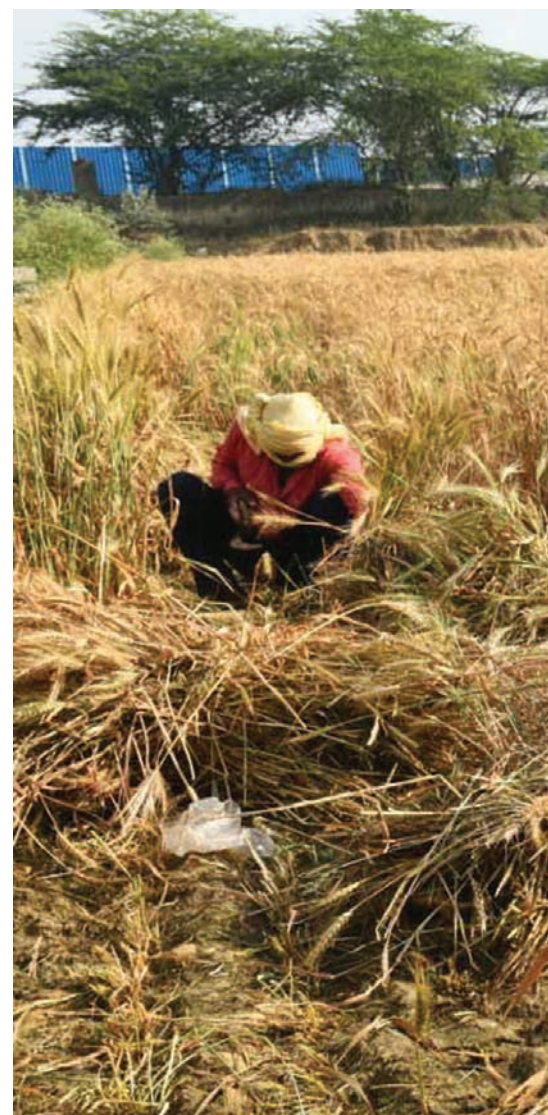
## AV-SHAPED RECOVERY?

The scale of the emissions reduction this year could be similar to the annual cuts required to meet the objectives of the 2015 Paris climate agreement, which seeks to limit global warming to 1.5–2°C above pre-industrial levels. If the 2008 economic recession is any guide, however, emissions could recover quickly.



# A CALL TO SOW SEEDS FOR NUTRITION SECURITY

India announced free food grains for more than 800 million people during the COVID-19 lockdown. However, nutrition security is more important than food security during this crisis and beyond, experts say. **By Sandip Das**



**A**s one of the largest producers of rice, wheat, sugarcane, cotton, vegetables, and milk, India was faced with a tough agrarian challenge when farming activity halted following the lockdown, just ahead of the harvest and sowing seasons. Earlier, Prime Minister Narendra Modi unveiled a package promising to provide free food grains to 800 million beneficiaries under the National Food Security Act (NFSA). Along with their existing monthly entitlements of five kilograms of subsidized food grains, these beneficiaries were to be given an additional free five kilograms for three months (April to June 2020).

The Food Corporation of India (FCI) has swung into action to transport at least 10 million tonnes of food grains every month from India's grain surplus states such as Punjab, Haryana, Madhya Pradesh, Chhattisgarh, Odisha, Andhra Pradesh, and Telangana to grain deficit states such as Uttar Pradesh, West Bengal, Bihar, and Karnataka. Under

the world's biggest food security programme, FCI procures and supplies around 60 million tonnes of rice and wheat grains annually.

## A nutritious basket

Agricultural scientists say that although India has enough food grains to meet any eventuality triggered by the pandemic, it is time to enlarge the food basket to include crops such as sorghum and millets to also ensure immunity-providing nutrition.

"We should also enlarge the purchase and Public Distribution System (PDS) so that whatever we purchase from the farmers can be distributed," said Monkombu Sambasivan Swaminathan, father of India's 'Green Revolution' responsible for exponentially increasing the wheat and rice production of the country in the early 1970s.

Swaminathan said merely providing food security will not be enough. The country needs to move swiftly to provide 'nutritional security' to a large number of people. While around 800 million people are provided with

'calories' through NFSA, the focus should now shift to production and consumption of pulses, oil seeds, vegetables and other commodities such as fish and eggs, he told *Nature India*.

India is also one of the global leaders in the production of pulses, legumes and millets, which are rich sources of nutrition. The COVID-19 pandemic necessitates nutritious food for the masses now more than ever before, according to Rajeev Varshney, research programme director for genetic gains at Hyderabad-based International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). "It's high time to include other coarse cereals as they are highly nutritious. We need to keep all the people of India healthy, and with stronger immune systems," Varshney told *Nature India*.

Securing food for a mammoth population would require solving the problems of 140 million farm families, mostly small and marginal. "Give small farmers enough incentive to continue in agriculture. This is particularly





HINDUSTAN TIMES/CONTRIBUTOR/GETTY

Farmers harvesting wheat in New Delhi during the national lockdown.

important for young farmers – they should feel that agriculture is technologically interesting and also economically rewarding,” said Swaminathan, who chaired the National Commission on Farmers, which was set up in 2004 to assess the extent of India’s agrarian crisis.

India’s rich genetic resources, distinct agro-climatic zones and rainfall variations provide a unique landscape to optimize the use of available land. The coronavirus pandemic provides a fresh perspective and many lessons for agriculture, Varshney said.

“With shrinking natural resources such as arable land and increasing vagaries of climate change, we must accelerate the development and adoption of varieties that promise higher gains in farmers’ field,” Varshney said.

### Calamity-proofing agriculture

Swaminathan said India must now have an early warning system network to understand early on any possible damage to crops, either because of the weather, climate, drought, floods or pests or pandemics.



## THIS IS A GOOD TIME TO STRENGTHEN THE COUNTRY'S NATIONAL NUTRITION PROGRAMME.”

The lockdown in India saw thousands of migrant agricultural labourers return to their villages. “The labourers have gone home and this poses a challenges to the farmers, procurement, storage and marketing,” Swaminathan said.

He suggested that such an eventuality could be avoided by adopting some of the policies pioneered by Verghese Kurien, responsible

for India’s ‘White Revolution’ steeped in the concept of cooperatives in milk procurement. “Community harvesting, community storage, community marketing and the government ensuring that a fair price is given. We should do the same thing in agriculture,” he suggested.

In order to tide people over through any COVID-19 related insecurities, India must ensure an operational food supply chain, pay smallholding farmers in advance for uninterrupted farming operations and avoid any price inflation of farm products, Varshney said.

“This is a good time to strengthen the country’s national nutrition programmes and ramp up support from local level NGOs and workers,” he added.

Varshney emphasized that it is also a good time to revisit India’s agricultural research policies. “We can develop new and better varieties through genomics-assisted breeding. But there should be supportive policies to accelerate the release of new crop varieties in the national system.”



# Protecting the elderly from the risks of isolation

Debanjan Banerjee

The physical and psychological health of our senior citizens demands urgent attention, now more than ever before.

**"T**hey talk about social distancing. My wife had a stroke and needs constant care. My son is stranded abroad. My daily help has stopped coming, and the care providing agency is not able to provide an alternative due to the lockdown. You tell me doctor, what type of distancing can I practice?"

This is a phone conversation I had with a patient's husband, regarding his response to the World Health Organization's three-pronged strategy – social distancing, hand and respiratory hygiene.

The lockdown was necessary but sudden, and no-one was adequately prepared, least of all the elderly, who are as vulnerable to the virus as to the isolation needed to contain it.

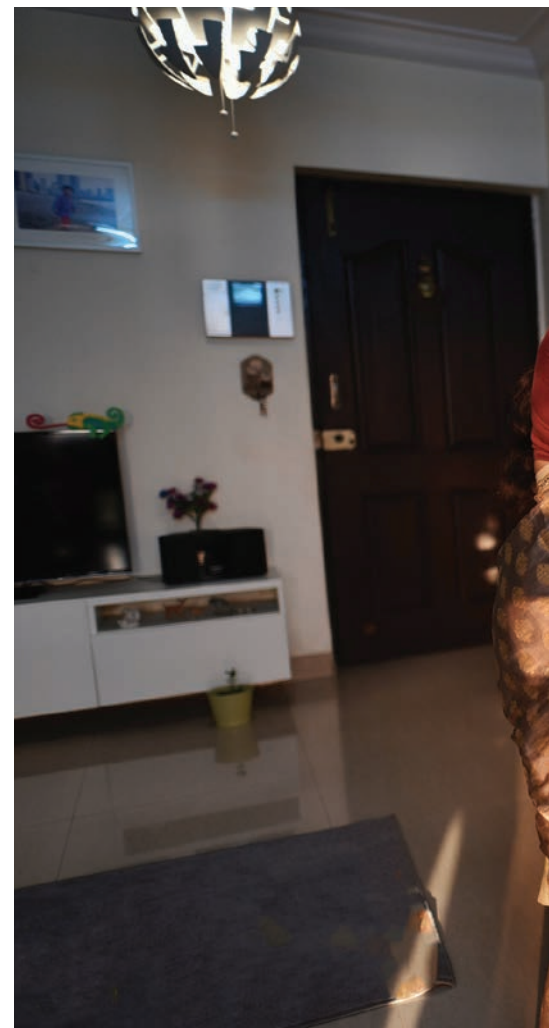
## Age and ageism

A majority of COVID-19 infections are mild, but some involve pneumonia and Acute

Respiratory Distress Syndrome (ARDS), which can eventually lead to death. Also, the severity and fatality of the infection is higher in the elderly, immunosuppressed, and people with pre-existing respiratory illnesses, chronic medical problems as well as under-detection of symptoms. The elderly are at a unique risk of all these vulnerabilities together.

An age-comparative study among hospitalized cases of COVID-19 also shows that those aged over 55 had increased duration of hospital stay, delayed clinical recovery, increased lung effects, faster illness progression, and greater fatalities. The need for mechanical ventilation and oxygen therapy was doubled in the elderly age-group and their blood also showed decreased lymphocytes and C-reactive protein, both markers of adequate immune response to the virus. Issues with mobility,

chronic illnesses (like diabetes, hypertension, pneumonitis, osteoarthritis and cognitive decline), multiple medications



## CARING IN CRISIS

Families and caregivers should be aware of guidance to keep the elderly healthy, and mentally strong

- 'Physical distancing' rather than social distancing: Regular telephone contact to ensure adequate emotional support.

- Considering vulnerability. It's better that the elderly don't go out to meet too many people. Additional effort is necessary to supervise hand and respiratory hygiene.

- It is better to avoid hospital visits during the pandemic. Tele-consultations have been instituted by most places including central Government institutes like NIMHANS (Bengaluru), AIIMS (New Delhi), PGI (Chandigarh) and CMC (Vellore).

- All elective surgeries like cataract, hernia or knee-replacements (unless urgent) are better to be postponed.

- The elderly have the right to remain updated. The status of the pandemic and necessary precautions need to be explained in simple terms, especially for those with sensory or cognitive difficulties.

- Those in isolation or quarantine need special care: telephonic counselling, digital contact with family, and ensuring adequate nutrition is vital.

- Family members need to be aware of the early symptoms of COVID-19 and make sure

to be tested if concerned.

- The elderly should not self-medicate with any drug (antivirals, hydroxychloroquine, any herbal supplement or remedies) as preventive or curative strategies for COVID-19. Seek doctor's opinion.

- It is natural to be stressed, but signs of excessive panic, depression, sleep problems or suicidality need urgent attention from a mental health professional.

- The elderly need to be involved in decision making about their own lives, even in times of crisis. Their rights, self-respect, and dignity must be preserved and protected.





## THE VULNERABILITY OF ADVANCING YEARS

The COVID-19 pandemic has brought into sharp focus some vulnerabilities of the elderly:

- Frailty (the age-related biological and psycho-social vulnerability of the individual) related to movement restriction, malnutrition and poor immunity.
- Loneliness, neglect, isolation and poor nutrition (more acute in old-age care homes and institutions).
- Sensory problems that can prevent the taking of adequate precautions.
- Chronic illness, use of multiple medicines, increased health-care needs and physical support.
- Impaired cognitive abilities (memory, processing speed, thinking and language) that worsen with age, can thwart comprehension and adherence to instructions. People affected with dementia might have behavioural problems and wandering tendencies that can add to challenges of keeping them isolated.
- Social distancing might not always be possible (exposure to various people involved in their care, including domestic help for those who stay alone).
- The elderly might not be aware of the latest infection guidelines, and may be at risk of misinformation.
- Less testing and consequently lower detection puts the elderly at risk of being asymptomatic carriers.
- Existential issues related to the fear of death.
- Psycho-social vulnerability, especially at times of lockdown and quarantine: loneliness, anxiety and uncertainty can give rise to depressive disorders, insomnia and chronic stress. Grief and bereavement due to loss or distancing from loved ones can be significant and prolonged. Elderly people are also at increased risk for post-traumatic stress syndrome. Suicide risk is also higher in the elderly population and is often under-reported.

Caring for a partner can be isolating for an elderly person without support

and increased need for hospitalizations due to other factors further increase susceptibility.

The elderly also suffer due to the prevalent stigma of ageism.

In general, the elderly are marginalized even though traditionally humans are taught to respect and take care of the older generation, the innate fear of ageing, losing vitality and death are real.

**“Seniors might be vulnerable and frail due to age, but they are not weak. Their resilience can be amazing.”**

Society equates ageing with loss of charm and beauty and of youth, that can lead to contempt and neglect. Such stigma can flare up during an outbreak which has an age-specific vulnerability.

Common conversations surrounding the susceptibility of the elderly are stigmatizing.

They are prone to chronic bronchitis, obstructive lung disease and the common cold leading to coughs, sore throat and flu-like symptoms which are in common with COVID-19. These can be mistaken for the virus symptoms, leading to social segregation and impaired esteem and well-being. Overcrowding, and poor self-care in old-age homes are other contributing factors.

Stress impacts immunity and can increase risk of infection. Autonomy and self-dignity can be hampered during a lockdown further impacting the mood, appetite and sleep of senior citizens. Many elderly people live alone and are struggling with access to basic amenities like food, domestic utilities and hygiene, along with fear of the pandemic.

The WHO and CDC have updated data and precautions for the elderly during COVID-19. The seniors might be vulnerable and frail due to age, but they are not weak. Their resilience can be amazing, if adequately cared for, and we can all borrow from their strengths.

**Debanjan Banerjee** is a geriatric psychiatrist at the National Institute of Mental Health and Neurological Sciences, Bengaluru.

# AS COVID-19 TAKES ITS TOLL, BURDEN OF OTHER HEALTH CRISES TOO HEAVY TO BEAR

Doctors struggle to treat those with compromised immunity as the pandemic stretches healthcare system capacity. **By Biplab Das**

**S**uman Devi, a patient with pancreatic cancer, waited on the footpath outside the All India Institute of Medical Sciences as her husband queued up for charity food nearby. Devi's ongoing treatment at the Delhi hospital brought them there from a small town in Uttar Pradesh, but a nationwide lockdown on 25 March 2020 hindered their travel back home.

Devi is among hundreds of other critically-ill patients who spent days on the footpath waiting their turn for treatment before being shifted to quarantine facilities. Getting an appointment with doctors for most of these patients has been difficult as healthcare professionals were diverted to COVID-19 wards.

Kenyan national, Agnes Kiminza, who has breast cancer, was stuck in Bengaluru for days after her last radiation therapy ended. She and many others from her country, visitors to private hospitals in India for treatment, were living in cheap hotels, waiting for air travel restrictions to lift so that they could go back home.

As the COVID-19 pandemic puts more pressure on healthcare facilities in India, uncertainty grips people suffering from other critical illnesses – cancer, diabetes, chronic lung and kidney diseases, liver disease, cardiovascular diseases, morbid obesity, HIV, and high blood pressure. Their anxiety is compounded by the fact that these diseases make them more vulnerable to the novel coronavirus infection.

A study from Wuhan in China shows that cancer patients, with compromised immunity, are at greater risk of viral infection. Elderly people with cancer are also more likely to end up on ventilators or die due to the viral infection.

“Just because a lot of resources are being put into COVID-19, we don't want a rebound of other diseases. We need to be extra cautious about that,” says Anant Bhan, a visiting

professor in the Department of Community Medicine, Yenepoya Medical College, Mangaluru. “Of course, we need to ensure that we are adequately resourcing for a COVID-19 response, but not at the cost of basic services at a minimum level.”



**THOSE WITH LOW-GRADE MALIGNANCIES ARE REQUESTED NOT TO VISIT THE HOSPITALS.”**

## Crisis time cancer care

Oncologists are struggling to protect and treat cancer patients amidst the pandemic. Manju Sengar, an oncologist from the Tata Memorial Centre in Mumbai says home caregivers need to be educated on how to control the spread of COVID-19 with basic hand hygiene, physical distancing and cough etiquette. “Cancer patients should be screened for COVID-19 symptoms such as fever, sore throat, cough and difficulty in breathing,” she says.

Sengar says oncologists should delay extensive surgeries. Instead, they could prioritize surgeries for rapidly proliferating and life-threatening brain tumours. Decisions on chemotherapy should also be taken cautiously. “It is better to switch to oral anticancer drugs,” Sengar points out. Steroid use should be limited and doctors should try to manage patients using a single anticancer agent or fewer drugs, she says.

A set of guidelines for managing cancer patients drawn up by international researchers suggests that oncologists could postpone, discontinue or modify radiation therapy. Some patients may be given the option of home infusion of chemotherapy to minimize the risks of infection. Stem-cell therapy for cancer patients can be reasonably delayed during the COVID-19 crisis, the researchers say.

“Certain cancers, such as acute leukemia, could be life threatening, if not treated early,” says Kolkata-based haemato-oncologist Pranatar Chakrabarti. “If the patient is young, has a chance of getting cured, and does not have significant comorbidities, we administer chemotherapy – that’s the standard protocol Indian haematologists are using,” he says. All such patients are screened for COVID-19 before therapy. Those with low-grade malignancies are being requested not to visit the hospitals and use home or day care based treatments as much as possible.

Patients are also concerned about what would happen if they stop, delay or switch cancer treatment. “Many of them are asking for tele-consultations, but that is not practically possible,” says Abhishek Shankar, an oncologist from the Lady Hardinge Medical College in New Delhi. Consultations, he points out, are based on tests to assess their condition and progress of the disease, chemotherapy and radiotherapy, every week, especially for aggressive types of cancer.

## Diabetics and COVID-19

Diabetes has emerged as a major risk factors responsible for increased mortality due to COVID-19. In India, sometimes called the world's diabetes capital, the lockdown has meant less exercise, increased snacking and decreased availability of glucose-lowering drugs for patients. These factors may increase blood glucose and blood pressure.





A view of the Delhi State Cancer Institute (East), which struggles to perform usual services during the pandemic.

“To make up for the lack of exercise, I walk in a long corridor or rooftop of my house,” says Sudip De Sarkar, a 68-year-old diabetic patient from Kolkata. “I avoid snacking, monitor my blood glucose levels using a sugar-testing machine and send the data to my physician through WhatsApp,” he adds.

During lockdown, telemedicine may prove useful for the management of patients with chronic diseases such as diabetes, a study in India says. Diabetics could connect with the physicians through messaging apps or video calls on chat platforms, the study suggests.

“More than 90% of people living with diabetes in India suffer from type-2 diabetes (T2DM), which is primarily a lifestyle disorder,” says Satinath Mukhopadhyay, a diabetologist from the Institute of Post Graduate Medical Education and Research in Kolkata. T2DM is all about self-management and self-care, and telemedicine may be effective, he says.

“Besides training patients how to self-monitor blood glucose, telemedicine can be used to

train them to recognize and treat glucose-lowering episodes on their own,” says Deep Dutta, a diabetologist from the Seth Sukhlal Karnani Memorial Hospital in Kolkata.

A person with type-1 diabetes may develop diabetic ketoacidosis, a life-threatening problem when the body starts breaking down fat at a rate that is much too fast with the liver making a huge amount of blood sugar. “Telemedicine is not suitable for such patients because they need hospital care, adequate intravenous hydration and modulation of insulin therapy,” Dutta adds. Telemedicine is also difficult for the elderly or those without technical skills.

### The critically ill

Patients suffering from asthma, cardiovascular diseases and HIV are also highly vulnerable to COVID-19 infection.

People with moderate to severe asthma may be at higher risk of getting very sick from COVID-19 since it can affect the respiratory tract, cause an asthma attack, and possibly

lead to pneumonia and acute respiratory disease.

Analysis shows that people with chronic obstructive pulmonary disease (COPD) are associated with a significant, more than five-fold higher risk of severe COVID-19 infection.

Like other viral illnesses such as the flu, COVID-19 can make it harder for the heart to work. Persistent immune activation in predisposed patients, such as the elderly and those with cardiovascular risk, can lead to secretion of specific immune molecules, leading to multi-organ failure. Inflammation, particularly in the muscular layer of the heart, can result in myocarditis, heart failure, cardiac arrhythmias, acute coronary syndrome and sudden death.

HIV patients with a low count of CD4 cells, a type of white blood cells which trigger immune response, are at a higher risk of getting very sick from COVID-19. Patients receiving standard anti-HIV drugs might not have increased risk for COVID 19.



# PACKAGING THE FUTURE OF INDUSTRY

Safe delivery of materials is key to successful resumption of economic activity. **By Kowthamraj Sangappillai**

**A**s India relaxes the lockdown, resuming economic activity will be dependent upon local and global delivery of raw materials, intermediates and finished products. One of India's largest employment sectors – small and medium enterprises – are now looking to the country's research community for solutions for safe packaging.

From local delivery of *masala dosa* to intercontinental shipping of aeroplane parts, safe packaging is a key requirement across industries and businesses. Questions over whether the packaging can be trusted might slow down the return of free trade. A SARS-CoV-2 resilient packaging material that is cheap and scalable could be a game-changer for the country's flow of goods.

Around the world, restaurant orders have fallen as people are worried about surface SARS-CoV-2 contamination. This fear might extend to global shipments as well, as studies indicate that the virus may stay on surfaces from three to nine days. This is where packaging and material technology comes into play.

Studies indicate that the novel coronavirus is most stable on plastic and stainless steel. Most packaging involves some plastic material, and shipping containers are made of a variety of stainless steel called 'corten steel'. Evidence also suggests that the virus does not survive long on copper, as copper ions kill the microbes landing on the surface. The ions prevent cell respiration, disrupt the viral coat and destroy the genetic material inside. This latter property is important as it means that no mutation can prevent the microbe from developing resistance to copper. Copper foils could replace aluminium foils for food wrappings, as large scale copper foil manufacturing is a mature industry.

Scientists are looking for a range of alternative packaging materials. "We are looking



**RECLAIMING THE TRUST OF GLOBAL CONSUMERS REQUIRES MORE THAN JUST TECHNOLOGICAL INTERVENTIONS."**

at advanced anti-viral coatings, especially for personal protective equipment of frontline health-workers, as they risk infection while de-robing from PPEs," said Aravind Kumar Chandiran, an assistant professor at the Indian Institute of Technology Madras and a former materials scientist at the University of California, Berkeley. Such solutions, if adapted for scaled delivery, could help make spray coatings for shipping containers resistant to SARS-CoV-2.

To begin testing for coronavirus-free packaging materials, researchers should evaluate a wide variety of permutations and combinations to arrive at viable candidates. The testing method (half-life) is simple and inexpensive, though availability of viral strains may be a bottleneck. The knowledge of properties needed for an anti-SARS-CoV-2 material, however, is robust and should help narrow down the candidates. "Lessons from food packaging studies, such as understanding the relationship between size of pores on surfaces and the survival of the virus might prove crucial in designing a packaging material of the future", said Naveen Kumar Balakrishnan, an advanced bio-materials researcher at the Maastricht University in the Netherlands.

Zinc oxide is a familiar antiviral material,



known to inhibit viral activity, including that of H1N1. "However, little has been explored in coating these materials on existing packaging systems," Chandiran said. To use this low-cost material, the researchers should explore the possibility of making robust thin film coatings on various packaging materials, and their ability to disinfect pathogens under varied temperatures and humidity conditions.

Besides research, standards also need to be in place for packaging shipments so that the potential spread of any virus or disease-causing pathogens can be checked, he said. "Specifically, the time taken by the antiviral coating to disinfect the pathogens and stability of the coating under different environments should be standardized immediately," Chandiran said.

Many industrial facilities across the world are gradually resuming operations. Car





Researchers should quickly start looking for viable coronavirus-free packaging materials.

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manufacturers such as Toyota, Renault, Hyundai, Volkswagen, and Volvo are among those that have opened or are preparing to restart production in Europe. India is an integral part of the global value chains (GVCs) of international production sharing, a process where production is broken into activities carried out in different countries. A UN estimate suggested that GVCs governed by trans-national corporations account for 80% of world trade each year, underscoring the length and breadth of a truly globalized supply chain ecosystem, which relies on safe packaging.

### Post-pandemic packaging

Reclaiming the trust of global consumers requires more than just technological interventions. Imagine a scenario where a 'virus

free' certification for products is the recommended best practice by the World Health Organization (WHO) and goods are mandated to be packed with SARS-CoV-2 resilient material to qualify for the certification, alongside shipping containers, which must either be covered in a special material or sanitized using robotic UV decontamination.

According to US-based trade finance company Drip Capital, the Christmas/Holiday season in the US and the European Union has historically driven demand for Indian exports. A weak rupee against the dollar could very well give a short boost to Indian exports, once global trade gets back on track.

India is a leading exporter in agricultural and other essential commodities such as pharmaceuticals, which will be in demand during and in the aftermath of the pandemic.

Saurabh Mukherjea of Marcellus Investments Managers correlates a fall in global oil prices, lower yields of the US government's 10-year bonds and a simultaneous contraction in the US economy. These occurrences have traditionally been followed by a strong economic recovery in India. Based on Mukherjea's analysis, there is still hope for a recovery for Indian exports in the coming months.

The biggest ever healthcare challenge for humanity necessitates an ambitious roll-out of SARS-CoV-2 resilient packaging to save industries and help them thrive.

\*The author is a Young Professional in the Energy and International Co-operation vertical of NITI Aayog, a policy think-tank of the Indian government.

# Time to bring scientific rigour to the complex challenge of Ayurvedic medicine

Jitendra Kumar and Pradip Sinha

A look at traditional approaches in the context of the COVID-19 pandemic.

**A** disclaimer first – herbal supplements and Ayurvedic medicines are not synonymous

The ongoing COVID-19 pandemic shows that age, co-morbidities and the quality of available healthcare impact the rate of recovery. Given that no vaccine or targeted therapeutics for COVID-19 are in ready sight, India's Ministry of AYUSH, which focuses on traditional Indian medicines including Ayurveda, has called attention to traditional medicines for alleviating symptoms of COVID-19<sup>1</sup>. However, in the absence of scientific evidence of cure and safety, Ayurvedic medicines cannot become part of the standard of care for COVID-19 therapy or management. Can there be a way forward toward scientifically rigorous examination of potential benefits of Ayurveda in COVID-19 management or therapy?

The advertized benefits of herbs in many Ayurvedic products fall in the realm of nutritional supplements where wellness industries thrive. Such wellness products neither claim, nor are their regulatory approvals based on, any definitive therapeutic, medicinal or disease curative benefits. Ayurvedic medicines should not be confused with nutraceuticals, the latter only means food supplement with potential health benefits. Ayurvedic medicines or formulations on the other hand are prescribed by practitioners who claim a curative therapy against a given disease.

And therein lies the barrier to their acceptance as scientifically proven safe medicines for the disease in question: traditional medicinal mitigations of severe acute respiratory infections (SARI), like COVID-19, have not been scientifically proven<sup>2,3</sup>.

## Reductionism and the streetlight effect in validating Ayurveda

While traditional medicines from Ayurveda or traditional Chinese medicine (TCM) encompass the use of traditional medicinal concoctions, they are also known sources of discovery for phytopharmaceuticals<sup>4,5</sup>: that is, individual chemicals isolated from a given medicinal herb that can mitigate a disease or its associated symptoms. In the latter approach, chemists try to identify

the key molecules from a herb for its ability to mitigate, say, disease symptoms that are demonstrable in an animal model or in cell lines – in the parlance of the conventional drug industry, they seek the active pharmaceutical ingredient. Recent approval for a clinical trial of phytopharmaceuticals for COVID-19 is one such example<sup>6</sup>. The molecule, AQCH, is derived from the broom creeper, *Cocculus hirsutus*, a plant traditionally used for its medicinal benefits.

Pursuing such a 'reductionist' methodology is not surprising since mechanisms of actions of individual phytopharmaceuticals are relatively easier to resolve than those of Ayurvedic medicines, which are often combinations of multiple herbs that are believed to act in synergy and prepared by complex traditional

## “They could form cohorts for control trials to validate Ayurvedic alleviation of COVID-19.”

methods. And the merit of a reductionist, phytochemical, approach is not unfounded. The anti-malarial drug, artemisinin, after all was discovered by this approach, starting with a medicinal herb, *Artemisia annua*.<sup>7</sup> Therefore, approaches to discover phytopharmaceuticals from traditional medicines, TCM or Ayurveda, are likely to bring tangible rewards when pursued with sufficient scientific rigour. These promises notwithstanding, this approach may hit a road block when seeking a treatment for COVID-19, in which clinical presentation of patients is complicated by co-morbidities that are unlikely to be addressed by a single phytopharmaceutical agent.

Moreover, this approach to phytopharmaceutical discovery calls to mind Noam Chomsky's observation on the scientific method: “Science is a bit like a joke about the drunk who is looking under a lamppost for a key that he has lost on the other side of the street, because that is where the light is. It has no other choice”

Thus, when pathogenesis is partly recapitulated in a cell line, its mitigation by a given

phytopharmaceutical is considered therapeutically relevant – what is visible under the 'streetlight' of a screening procedure. Other potentially useful phytopharmaceuticals – epistemologically speaking – are then discarded by ignorance.

This approach is also antithetical to Ayurvedic principles wherein the totality of the entire medicine/formulation cannot be reduced to its individual components. By the same Ayurvedic rationale, what a patient suffers is the sum total of a host of bodily manifestations, which cannot be reduced to only a single symptomatic manifestation.

## Repurposing Ayurvedic medicines

Ayurveda is founded on traditionally inherited knowledge and is based on empirical evidence. Given the recent origin of COVID-19, an Ayurvedic treatment is therefore not available. New Ayurvedic medicines also cannot be discovered – unlike in a drug discovery programme of conventional medicine. Thus, cure or management for COVID-19 – if these were to be found in Ayurvedic pharmacopeia of India – would fall under the category of drug repurposing or therapeutic switching, again, in the parlance of the pharmaceutical industry.

The concept of repurposing of medicine is not alien to Ayurveda. The list of medicines, or the combination thereof, that an Ayurvedic practitioner may use to treat symptoms of COVID-19 is not inexhaustible and most practitioners would make overlapping, if not identical, recommendations from the available list of Ayurvedic medicines. Their choice of medicines would be guided by the framework of mapping pathogenesis set out in Ayurvedic classifications of a patient's constitution and the co-morbidities presented, along with those of COVID-19. Even within this finite choice of medicines, the prescriptions will be customized for individual patients: indeed, there is no universal fit in Ayurvedic therapy.

However, one needs to ask whether such rationale and personalized procedure for Ayurvedic therapeutics could be timely and effective during a pandemic. While one can draw a rosy picture of traditional medicinal panacea for COVID-19, the realities could be





A selection of foods and plants used in traditional medicines.

challenging. COVID-19 symptoms can escalate precipitously in many patients, requiring emergency care, foreclosing the option of slow-acting Ayurvedic interventions. Also, here is cautionary advice against the use of herbal or traditional medicines for COVID-19<sup>2,3</sup> even though their potential is documented<sup>4,5</sup>.

### A clinical trial on Ayurvedic COVID-19 management?

Thus, while Ayurvedic treatment for COVID-19 cannot be suggested, the opportunity presented by the pandemic could be used to rigorously design clinical trials to test the claims of Ayurvedic medicine. Many COVID-19 positive patients display mild symptoms and recover under quarantine with no further treatment, since none may be available yet. These patients, not requiring hospitalization, could form ideal cohorts for randomized control trials to validate Ayurvedic alleviation of COVID-19. A clear and realistic definition of anticipated outcomes from such clinical trials

and their rigorous design might answer questions including whether Ayurvedic therapy can help early and improved recovery of COVID-19 patients, or whether such an intervention can reduce the number of patient requiring critical care.

### Animal models

Safety and toxicity assessments of Ayurvedic medicines are possible using the standards of evaluation practiced in mainstream pharmaceutical sciences: for instance, by using animal models to assess toxicity and also recapitulation of severe acute respiratory infections in mouse models for testing actual mitigations. Ayurvedic medicinal claims can also be tested in carefully constructed animal models of human diseases to assess the cross-talk between Ayurvedic medicines and immune system and gut microbiome, an overlooked field, to reveal as yet mysterious ways of working of Ayurvedic medicines. Quality assurances to overcome the varying medicinal

properties of plants under different geographical conditions can also be resolved. These steps can address the major concerns about efficacy and safety of Ayurveda, while technological breakthroughs in the coming years may turn on the many streetlights to illuminate the space of complex Ayurvedic formulations.

**Jitendra Kumar** and **Pradip Sinha** are from the Bangalore Bioinnovation Center, Bengaluru and the Indian Institute of Technology Kanpur.

1. Ministry of AYUSH. Government of India Gazette notification F. No. L1101/8/2020/AS (21 April 2020).
2. Cyranoski, D. *Nature* <https://doi.org/10.1038/d41586-020-01284-x> (2020).
3. Yang, Y. *Lancet* **395**, 1689–1690 (2020).
4. *Nature Plant*, **6**, 177 (2020).
5. Cui, H.-T. et al. *Traditional Medicine Research* **20**, 65–73 (2020).
6. ICgeb with Sun Pharma: Phase-II clinical trial on AQCH for treatment of COVID-19 patients <https://www.icgeb.org/icgeb-with-sun-pharma-for-phase-ii-clinical-trial-on-aqch-for-treatment-of-covid-19-patients/>
7. Tu, Y. *From Artemisia annua L. to Artemisinins* (Elsevier, 2017).



## Misinformation and myths go viral

Sandhya P. Koushika

From the belief that drinking tea will protect against COVID-19, to confusion with tragic outcomes, such as poisonings, misunderstanding and hoaxes are common in this time of uncertainty.

Life as we know it, whether in luxury air-conditioned homes or in overcrowded slums, has been upended. As always, a weaker socioeconomic status makes for poor outcomes, be it access to sanitation and healthcare, or brutal enforcement of lockdown guidelines. Socioeconomic disruption and uncertainty contribute to an environment that breeds myths and hoaxes, which feed on these tremendous psychological vulnerabilities. A myth can offer solace when little else is available and is often adopted without verification.

Nowadays myths spread faster than the coronavirus, on WhatsApp and other digital platforms. In a social media era, rumours

appear faster than they can be dispelled, travel faster than fact, and can seem indestructible.

Myths promoting the use of a variety of herbs, formulations and medicines as cures or prophylaxis are widespread. Typically, such myths originate in traditional beliefs with little modern scientific evaluation.

The HoaxBuster team of the Indian Scientists' Response to COVID-19 (ISRC) said that there is insufficient or no evidence that garlic, tea, applying oil, or steaming protects against COVID-19. Several herbs are said to boost immunity in general. The ability to 'boost immunity' is dependent on the adaptive (acquired) arm of our immune system. We acquire immunity against a specific disease either through getting that disease or through a vaccine.

SUMITA NANDA



A person who thinks of 'boosting immunity' is probably just seeking good overall health to fight off any disease in general and for this, diet is but one aspect. For most well-nourished people, a regular healthy diet along with exercise and sufficient sleep will do more to promote good health than drinking five cups of tea a day.

The false sense of security provided by unproven remedies can be doubly dangerous because it can sideline the importance of implementing behavioural changes that have been proven to help. Moreover, myths can be exploited by quacks to make money by selling products that are useless if not actually harmful. Even if one judges certain remedies suggested on social media as harmless and decides to follow them, mitigation strategies that are known to work like physical distancing, wearing masks and good hygiene must still be consistently followed.

A second popular group of myths about India's fight against COVID-19 is that Indians have stronger immunity; the virus will not persist in a hot and humid climate like ours; and the virus in India is weaker. These are particularly attractive since they would mean our outcomes are likely to be much better than the rest of the world.

However, no scientific data suggest that the virus behaves in India or in Indians in unusual ways. The major source of coronavirus is infected people in whose respiratory tract this virus grows and from where it is poised to infect others. It is too early to know what role, if any, temperature plays when a highly infectious new virus is tearing through a population with no current immunity to it. Finally, the sequenced genomes of the virus in India show no features suggesting that it is behaving differently than elsewhere.

Myths in the final group are conspiracy theories that target someone or something as being responsible for COVID-19. The most popular ones are that the virus was created in a lab, that bats spread the virus, and that a particular community spreads the virus.

The virus genome sequence shows no evidence to suggest the virus was created in a lab, so bats, and the trees they nest on should not be disturbed. Zoonosis, a microbe jumping from one species to another, is more likely to occur when we disturb ecosystems leading to greater contact between wild animals and humans.

Finally, singling out communities does little to stop the virus, but much to divide people when what we need is community engagement to fight this pandemic. Blaming specific groups stigmatizes them, and this mindset has even led to discrimination against frontline workers, people we depend on to care for our most seriously ill patients.

We will not contain this epidemic if we ignore either the science, or our humanity.

Several efforts have been made to combat the tsunami of misinformation: the government's use of the *Epidemic Diseases Act, 1897* and *Disaster Management Act, 2005* to combat fake news, infographics by MyGov, efforts by ISRC, CovidGyan, TNSF, AIPSN, etc. Traditional media outlets have also stepped in to combat these myths. The resources in Indian languages lag behind those in English, but concerted efforts are being made in this direction.

Scientists have unique qualifications to combat misinformation, yet they are often hamstrung by their own training. First, scientists are comfortable with uncertainty and nuance. There is a difference between there being no evidence for a claim, not enough evidence, the claim being likely to be false, and it being false. But such distinctions are not always appreciated by someone who wants to know if turmeric milk works for COVID-19. Does 'not enough evidence' mean it works but scientists do not know? Does 'likely to be false' come from personal prejudice? A straightforward answer is not easy for a scientist to provide, yet is desired by the public to make a clear decision.

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**“We will not contain this epidemic if we ignore either the science or our humanity.”**

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Second, scientific progress is typically slow and measured. Ideas are tested and argued over years, sometimes over decades, before conclusions are drawn. The pandemic has accelerated this process and exposed it to public view. A recent retraction from *The Lancet* on hydroxychloroquine treatment outcomes exposes several fault lines in doing science under pandemic pressure. Frustration with the normally slow progress of research can lead to rapid publication of results, and withdrawing published research reduces confidence in scientists.

Meanwhile, societies are facing long-term economic and social costs, while scientists have little to offer except masking, handwashing and physical distancing.

Lastly, many scientists hesitate to step outside their areas of expertise, built over several years with the commensurate ability to evaluate the smallest detail. The current pandemic needs expertise in several areas like epidemiology, immunology, medicine, physics, engineering, etc. The amount of time to gain sufficient understanding, when scientists too are struggling like others to keep their personal and professional lives moving, is considerable.

Despite these difficulties it is well worth the



People were poisoned after drinking liquor made from 'virus-shaped' Datura seeds.

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effort for scientists and scientific institutions to invest time in myth-busting.

I found myth-busting an intellectually rewarding process, involving several fierce discussions on data with a diverse group of scientists and science communicators. But I believe there are larger issues at stake. Unless scientists communicate how the research process works, convey complex ideas in a simple manner, and share how current understanding evolves and changes as new information comes in, the public cannot be expected to trust scientific information, or use it to make good personal choices.

The pandemic has shown that science must engage more with society to build trust and has forced some scientists to think about how to communicate the value of science. Not just by advertising the latest cool findings but also by promoting critical thinking, for example by allowing the general public to question and assess information. This is hard, but important if we hope to contribute to and keep the support of society.

All healthy societies have a plurality of opinions and vigorous debates, but debates devoid of data and its critical analyses are flawed, as are debates that do not include a discussion of values which underpin our public policies. Indian scientists and scientists-in-training need greater exposure to and meaningful engagement with the local communities where their institutions are based. I hope we can work with social scientists and lay citizens to foster ways to have an inclusive scientific dialogue.

**Sandhya Koushika** volunteers with the ISRC and is a team member of CovidGyan. Views expressed do not necessarily represent those of her employer, TIFR. She thanks Edward Hynes, Susan Parker, Shubha Tole, Jitendra Kumar and Kaushal Verma for comments.

# Spreading the word in times of fear

Sima Barmania and Michael J. Reiss

Religious leaders can help disseminate important messages in the COVID-19 crisis.

**T**here was much discussion about religion as the world celebrated major festivals – Pessach, Easter, Vaisakhi, Navratri, Buddha Purnima and Ramadan – under lockdown. Public health policy-makers were sceptical about whether physical distancing, the key strategy for most countries struggling to contain COVID-19, could be achieved during religious festivities traditionally marked by large gatherings. And yet, with a few notable exceptions, religious adherents complied with the new normal of physical distancing. Religious leaders will play a major role in deciding the future spread of the virus.

In the UK, all places of worship have been closed. The UK's Chief Rabbi, Ephraim Mirvis, said on national radio that there is both a "religious and a moral imperative" to "stay at home". The Archbishop of Canterbury, Justin Welby, broke from tradition and delivered his Easter Sunday address from his kitchen, commending churches across the country for "responding to this challenge in innovative ways".

However, in some countries, religion undermined the public health response to the COVID-19 pandemic. In the US, Florida Governor Ron DeSantis designated religious services as 'essential activities', days after a pastor within the state was charged with unlawful assembly and violation of a public health emergency order. New York City mayor, Bill de Blasio, criticized a large congregation of mourners at a Hasidic Jewish funeral, igniting strong condemnation from members of the community.

In South Korea, the Shincheonji Church, is thought to have been the origin of thousands of first cases in the country. In Malaysia, a gathering of 14,000 delegates of the Islamic mission Tablighi-Jamaat in Kuala Lumpur is widely considered the cause of the second wave of the pandemic in the country. Attendees returning to Brunei, Indonesia and Cambodia from this gathering later tested positive for COVID-19. An Islamic gathering in the mission's Delhi headquarters also saw thousands infected with the novel coronavirus.

## Enabling public health

Some religious communities believe that

certain public health initiatives are directly opposed to their freedom to worship and could feel that they, rather than the virus, are under attack. However, religions can be enablers of public health, and religious organizations can be important partners, especially in less secular societies.

On 7 April 2020, the World Health Organization issued an interim guidance titled 'Practical considerations for religious leaders and faith-based communities in the context of COVID-19'. The WHO acknowledged that "religious leaders, faith-based organizations, and faith communities can play a major role in saving lives and reducing illness related to COVID-19".

**"Religious leaders often have connections with those who are vulnerable and harder to reach through 'official' channels."**

There have been many examples in the past where religion had a positive role in tackling infectious diseases. In India and Pakistan, religious leaders helped increase the uptake of polio vaccines; in Nigeria, religious leaders played a key role in mitigating the effects of Ebola, through the provision of health, education, and social support.

The WHO guidance also points to the "special role of religious leaders", faith-based organizations and communities in education, preparedness and response to COVID-19. The organization can help by sharing evidence-based information and avoiding large gatherings.

## The science-religion balance

Atheists may find it absurd that a person disregards substantial risk of infection in order to attend an 'in person' service. And while services may not be seen as 'essential' by some, they will be for others, especially given that religion can serve as an important coping



mechanism and a source of emotional support. This is one place where religion comes into play, by understanding a rationale for noncompliance with social distancing. But religious leaders are often central to communities and have extensive networks within which to disseminate public health messages, including the rapidly evolving COVID-19 related guidelines.

Religious leaders often have connections with those who are vulnerable within their communities, such as the elderly, the poor, or migrants, who may be harder to reach





While religion brings great solace, gathering for worship in the pandemic brings great risk.

through 'official' channels. Religious leaders as respected figures can make decisions earlier than governments to suspend congregational events. For example, the annual Hajj pilgrimage, which saw more than two million pilgrims descend on Mecca last year, has been restricted to no more than 10,000 this year.

Religious leaders can play a direct role in implementing health policy. After attendants at a religious gathering in Malaysia failed to come forward to be tested, the Minister for Religious Affairs issued a statement

saying that it was a religious obligation to be tested. Religion and science are not necessarily opposed.

Many religions have laws that are compatible with public health strategies and allow the 'lesser harm' or 'public interest' to prevail. So, empathic, proactive and early engagement with religious leaders and communities can play an important role in public health emergencies.

For their part, health professionals and medical scientists must ensure that there is effective communication and a serious attempt to

enhance health literacy. If not, we may alienate religious groups, rendering them less inclined to comply with the public health guidance crucial for tackling COVID-19. Public health policy will ignore religious communities at great risk.

**Sima Barmania** is a consultant at the United Nations University-International Institute of Global Health, London/Kuala Lumpur. **Michael J. Reiss** is a Professor of Science Education at the University College London.



# Vishnu Nandan From deep freeze to a lockdown

Polar scientist, Vishnu Nandan, recently returned to Canada from a four-month lockdown in the Arctic. After being in one of Earth's most isolated places, he talked to *Nature India*, about coming back into a world fighting a pandemic.

Vishnu Nandan is a radar remote sensing expert on Arctic and Antarctic sea ice, and a post-doctoral researcher at the Centre for Earth Observation Science (CEOS) at the University of Manitoba, Canada. He lived on the German research icebreaker *RV Polarstern* as part of the MOSAiC International Arctic Drift Expedition, one of the biggest scientific expeditions to the Central Arctic Ocean.

### What was it like to be locked down in the Arctic darkness for four months?

I have undertaken more than 15 expeditions to the polar regions but this one had its own challenges. We were in the middle of a frozen ocean enveloped by complete darkness for 80 days, temperatures plummeting to  $-55^{\circ}\text{C}$  with wind chill and sometimes stormy weather.

Working with small metallic nuts, bolts and screws under extreme cold required a lot of effort. When we reached *Polarstern* on 13 December 2019 on the Russian ice breaker, *Kapitan Dranitsyn*, I was anxious. We did not want the ice to break up with two ships standing next to each other. Towards the end of February 2020, sometimes the skies were clear and sometimes illuminated by the full moon with Venus in its precincts.

At one point, darkness became a way of life for me. Now after returning home, I miss the darkness. I would say that such prolonged periods of darkness have their own beautiful flavour.

### How did you handle emerging into the pandemic that gripped the rest of the world?

With the COVID-19 crisis, there was a lot of uncertainty about our returning home. Our whole group was in isolation from the outside world for many months, and we did not have a clue about the seriousness of this situation. With all countries closing their borders on us, we were worried about our safe return home.

At one point, I was even ready to stay back for the next leg, for several more months, But



The German research icebreaker *RV Polarstern*, Nandan's home for the expedition.

then we were allowed to return to our families while following all protocols.

### What is the main objective of the MOSAiC expedition, and how is it different from the previous Arctic expeditions?

The primary goal of the MOSAiC expedition is to investigate the principal components of the Arctic climate system — the atmosphere, sea ice, ocean, ecology and biogeochemistry. The focus is on the Arctic, as the epicentre of global warming, and to gain fundamental insights to better understand global climate

change. Previous Arctic expeditions focused on specific periods for a few months. The data collected from the MOSAiC expedition will cover all seasons (annually) and a large area (as the *Polarstern* moves with the sea ice). As many as 300 scientists will be on board *Polarstern*, rotated in six different legs. I was on leg two. Scientists from 20 nations are participating on and off board *Polarstern*.

### What is the focus of your work? How are you going to take this forward?

I am a sea ice scientist, specializing in radar





LARS BARTHEL, STEFFEN GRAUPNER

**“Our group was in isolation for many months and we did not have a clue about the seriousness of this situation.”**

remote sensing. My expertise has always been in using satellite- and ground-based radar remote sensing data to improve the accuracy of critical snow and sea ice parameters, such as snow depth, sea ice thickness, freeze- and melt-onset (i.e. when sea ice starts forming

and melting). For MOSAiC, my research work focused on deploying radar sensors on ice, operating at multiple radar frequencies, to improve the accuracy of retrievals of these parameters, which will ultimately help the radar satellites to provide improved and accurate estimates.

**How do these experiments help understanding of global climate?**

Although scientists conduct yearly field-based experiments in the Arctic for studying and answering questions about our planet,

all these experiments are short term. They don't fully capture long-term changes over large areas. MOSAiC is unique. *Polarstern* is anchored on to a sea ice piece. As she moves along with this piece, propelled by the transpolar drift for one whole year, we will be able to measure critical parameters along the whole corridor, which covers a lot of area.

Between the beginning and end of our leg, we had drifted a meandering distance of 675 kilometres, and a straight line distance close to 410 kilometres. These parameters from our measurements will help us improve climate models which help us accurately predict weather, monsoon timing in countries, such as India, and extreme events such as cyclones and flash floods. We had 64 scientists on board from 12 nationalities. I was the only Indian national on board, representing Canada.

**What were the working challenges you faced?**

Sometimes we had to troubleshoot and repair instruments on the ice. Some of the instruments were not meant to be operated under extreme conditions. So we had to improvise. Refurbishing instruments under such conditions was extremely challenging. We even had to work with an instrument which stood 15 feet tall and weighed close to 300 kilograms.

**What kind of communication channels did you have? What did you do for entertainment?**

We were lucky to have WhatsApp access on board, with restrictions (only text, no pictures or videos). We had a gym, swimming pool and sauna. We celebrated many birthdays, including mine, celebrated the northernmost Christmas and the New Year. We saw movies, played board games and organized camping trips, where we set up tents. And every Wednesday evening, we went group skiing and hiking on the ice.

**What was the first thing you did after returning home?**

The first thing I did was to eat a sumptuous meal made by my wife. And then I got on with following the Canadian rule of 14-day mandatory self-isolation.

**Interview by Vanita Srivastava**

# For doctors, intensive care takes on a whole new meaning

**When Viny Kantroo, a respiratory diseases specialist, started seeing COVID-19 patients in her Delhi hospital, a worrying reality unfolded, professionally and personally.**

**M**y heart skips a beat thinking of Thursday. That's the day my scheduled week-long duty starts in COVID-19 wards and intensive care units (ICU) every fortnight.

The rotation means constantly staying awake, or rather alert, even when you close your eyes in the ward to catch a few winks. The phone usually rings the moment you fall asleep. The mind works constantly with the adrenaline rush that comes with attending to COVID-19 patients.

On one day in the second week of April 2020, I had to get to my hospital late in the evening to insert a chest tube in a COVID-19 patient with collapsed lungs (pneumotho-



Viny Kantroo prepares for duty.

rax). I was worried about hurting the patient, and creating complications because of limited vision resulting from the elaborate eye gear of my personal protective equipment (PPE), but more overwhelming was the fact that I was in the middle of a contagion, dealing with a disease with no treatment. Suddenly, I felt like a student again.

I was also constantly battling the fear of carrying infection home. When on COVID-19 duty, I cover myself up, or rather my fear, with an extra layer of surgical mask above my N-95 mask.

This actually hampers my breathing. I start panting while speaking, but at least my mind stays calm and focused on

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My parents taught me the science of fomites and their importance long before I studied medicine.”

Viny Kantroo is a Respiratory, Critical Care & Sleep Medicine specialist at Indraprastha Apollo Hospitals, New Delhi, India.

patients. It triggers a vicious cycle inside the brain. This experience has given me empathy for what my non-COVID asthma and Chronic Obstructive Pulmonary Disease (COPD) patients feel when they become short of breath every winter.

Coming back to that late evening scene in the COVID-19 ward, I stood mustering all my courage, my hands trembling as I punched in the code to open the ICU door. The smell in there is peculiar, different from outside these areas. Smell always has a strong relationship with emotions. It sets off a chain reaction inside my imaginary world, that the air is full of virus. But I have to make way to the donning room, and preferably not touch the door handles or the door itself.

This comes naturally to me though. My parents taught me the science of fomites and their importance well before I studied medicine. I would wash my hands after touching lift buttons, electrical switches, door handles, and staircase railings, even in normal times. This has made me a villain at home many times, but I have made this practice very clear to both family and friends.

So while my colleagues are still coming to terms with the changed reality, I am way more confident of navigating through doors and touching handles. Also, getting ready within 15 to 20 minutes without exposing any part of your skin is a mental rather than a physical task. It requires sealing the gaps between eye sockets and visors.

I could feel a pronounced silence as I entered the patient area that evening. I had to be in very close contact with the patient. This was more than the normal daily ICU rounds. All I could see were the dark corners and a foggy tunnelled central vision. This was partly the physical reality, partly the constant fogging of my visors, and mostly psychological. I instantly thought of music. I had brought in a bluetooth speaker the previous day with me to leave in the ICU for everyone.

I inserted the chest tube in about 25 minutes, way longer than it normally takes. The extra layers above my coveralls made me sweat profusely. I desperately wanted some air.

I saw the other patients on the ward, and sorted out their medication where needed. I checked ventilators and asked my staff if there was anything else I could do to help them (not that I was more capable than them, but sometimes asking makes all the difference). I left the area for the designated doffing region and slowly removed the body suit and other layers, in 15 minutes, to avoid creating aerosols.

Each time I came out of the ICU after attending to patients, I felt a strange sense of relief. Whether this is because I helped somebody, or because I could breathe better, I don't know. But I surely have started to value the small little things in life much more than I ever did in the past.

One thing which remains universal among healthcare workers across the globe is everyone wants to breathe. Everyone is just tired of the FFP 1, 2, 3s and N-95s. It has never been so tough before, taking care of your own breathlessness and that of your patients', simultaneously.



# Starting a lab in a pandemic

**On the brink of starting her first laboratory, COVID-19 threw Poonam Thakur's lofty plans into disarray.**

**A**fter years of insecurity with short term post-doctoral contracts, international moves, and personal sacrifices, I had finally landed a coveted faculty position in a reputable institute. I was over the moon. I had finally 'made it' in the highly competitive world of academia, beating all odds. For the first time, I was going to start a life that won't be uprooted, at least for two to three years.

In early March 2020, I joined the Indian Institute of Science Education and Research (IISER) Thiruvananthapuram – a vibrant campus in the lush green hills of India's western ghats – with lofty dreams of unrolling my neuroscience research and teaching programme. The first three to four days flew by in administrative formalities and in dealing with the realization of becoming a principal investigator with more responsibilities, including furnishing the workplace and planning for the courses I would teach in the upcoming semester.

In the middle of this frantic activity, an email landed about the precautionary measures the institute was undertaking against the spread of COVID-19 as it was beginning to escalate in India. Classes were suspended and students living on the campus were asked to go home. Faculty living on campus were advised not to go out unless extremely necessary. No outsiders were allowed on the campus.

A few days later, the Indian government announced a countrywide lockdown. That led to the closure of on-campus daycare leaving many of my colleagues in difficult circumstances. All research plans and purchases came to a halt. Soon the labs started to shut down or operate with reduced capacity as most support staff was gone. A campus bustling with life only a few days before, was deserted. We were in middle of a pandemic.

A constant barrage of news on the rapidly deteriorating situation worldwide began making me anxious. As a researcher, I was trained to be perennially productive. I was concerned about the inevitable delay in starting my research programme and losing precious time from my research grant.

I wasn't trained either in the techniques that may help in COVID-19 diagnostics nor in studying the virus structure or finding a cure. In addition to the frustration of not being able to jumpstart my lab, I was fighting the feeling of inadequacy and helplessness as a scientist for not being able to help humanity during this crisis.

## Joining the cause

For me, the hardest part was to deal with my own expectations. I had the words of the Roman emperor, Marcus Aurelius to draw on: "You have power over your mind, not outside events. Realize this, and you will find strength". Once I was able to acknowledge that it was reasonable to feel agitated, frustrated or unproductive in



**Although I could not fight the pandemic from the bench, I tried to help in other ways."**

**Poonam Thakur** is a DBT/Wellcome Trust India Alliance Early Career Fellow and joined IISER, Thiruvananthapuram as an Assistant Professor in March 2020.



**Poonam Thakur in her lab at IISER Thiruvananthapuram.**

these extraordinary circumstances, it was easier to put everything into perspective.

Although I could not fight the pandemic from the bench, I tried to help in other ways. I volunteered to translate infographics on coronaviruses and COVID-19 in my regional language and shared them through social media. I talked about the disease to my non-scientist friends, neighbours and family, and tried to dispel COVID-19 related myths in close circles.

I started contacting vendors to obtain quotes for the equipment I would need to start my lab. Luckily, several were still answering calls and responding to emails. I interacted with my colleagues living in the campus. They offered me not just advice and experience on setting up labs but also offered to share their lab equipment and resources until I set up my own. These interactions helped me immensely as I quickly developed collegiality. Under normal circumstances, it would have taken much longer with everyone busy in their teaching and research schedules.

## Life beyond lockdown

Gradually, I started to take the lockdown in my stride. I finally had time to step back, pause and reflect on my long-term research goals and strategies. With a fresh mind and fewer distractions, I started working on the book chapter I had been procrastinating on.

I was able to focus on preparing material for the courses I would eventually teach. I took to running, taking advantage of the huge campus surrounded by forests and falls. Being close to nature, has indeed helped me find peace amidst all the chaos.

Being a neurophysiologist, I am reminded of the story of Alan Hodgkin and Andrew Huxley, pioneers in the study of action potential in nerves. Shortly after their first recordings of intracellular action potential, they had to take part in war-related activities and suspend primary research for seven long years. Once the war dust settled, they were reunited and resumed work on action potentials that ultimately won them the 1963 Nobel Prize in Physiology and Medicine.

Although we don't know when the lockdown will be over, like everyone else I hope for a pandemic-free world where normal life can resume. Despite the fear that a battered economy may affect research funding, I am looking forward to conducting research with stronger resolve.

# World view



By Ashley Shew

## Let COVID-19 expand awareness of disability tech

**The pandemic's disruption shows how much academia could learn from the disability community.**

**D**isabled people including myself have long campaigned for accommodations to help us live our lives. The COVID-19 pandemic shows that these are not as impractical as we have always been told. Supermarkets, restaurants and pharmacies (even outside cities) can deliver; remote working, medicine and education are possible for many; and social lives can be rewarding without requiring us to leave home.

All around me, I see academic colleagues adopting disability-led hacks and long-sought accommodations. I wish everyone had thought about these workarounds – and about disabled people at all – earlier. When lockdowns end, we must not forget these lessons, not least because the pandemic will disable people, and the impacts will be felt most by the most vulnerable parts of society.

Academia is paying for its ableism. At many universities, in-person research with human participants and in laboratories has been curtailed. If these projects had considered disabilities, they might be better off: disabled academics already plan in short increments, with built-in flexibility.

In 2014, I returned to my job as an assistant professor, newly multiply-disabled – a hard-of-hearing amputee battered by chemotherapy and more. I felt out of place. I could no longer access many spaces, including most of my colleagues' offices, and I sought the camaraderie of other disabled faculty members, staff and students. My disabled comrades and I recognize the diversity of disabilities: congenital and acquired; ranging from cognitive to sensory, mobility and more; apparent and not. Many of us pursue research that emphasizes how disabled people are the best experts on the technologies and structures that meet our needs.

One of my projects examines accounts of disabled people's lived experiences with technologies, and how they differ from those of the scientists and engineers behind the tech. I planned my work intending to recruit disabled students among my researchers. Most of the studies can be done remotely, even from bed, and on a funky, asynchronous timetable as needed. Last year, when I had lung surgery, my group shifted gears without worry. And because of its disability-led design, my team's project is pandemic-proof.

Another project, to gauge the experiences of students in civil-engineering classes, was designed to include participants with a range of disabilities. So we obtained approval for flexibility in communication format: we conduct our interviews by text, e-mail, Zoom and other means. Because we planned for disabled people to lead and participate in

**Academia is paying for its ableism.”**

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the research, we're well prepared for the current situation – or for any other.

Many disabled people are also adept at managing our energy, and forgiving ourselves for not always meeting conventional metrics of 'productivity'. My non-disabled colleagues are now struggling to adjust, but my team appreciates that 'clocks should bend to our bodies', not the other way around. Some disabled people call this concept Crip Time, reclaiming a derogatory term in pride (much like 'queer' for many LGBT+ people).

The disability community creates and lobbies for technologies and infrastructure that work better for all. Deaf and disabled people fought hard for things such as captioning on television, which has since become ubiquitous in sports bars and airports and can now be appreciated by people streaming media while those they live with rest or work.

The bitter irony is that, at the moment when non-disabled – or not-yet-disabled – people are beginning to normalize these disability hacks and hard-won infrastructure, society's disregard for disabled people is clear. We are dying of COVID-19 in greater numbers than are non-disabled people, in rehabilitation facilities, state institutions (including prisons), group homes and care homes.

Many accommodations demanded under COVID-19 were implemented within weeks, including the ability to work from home, to have flexible schedules, to get what we need without excessive and demeaning documentation, to share and celebrate creative adaptation, to work with the knowledge that all schedules can change. These are all things that disabled and chronically ill people have wanted for a very long time. I hope that when we've flattened the curve and saved as many people as possible, we don't return to a world in which disabled people are ignored (especially when COVID-19 will probably produce more of us).

So start making changes that should have been standard all along. Plan creatively and accessibly to allow more work offsite, and to include people whose clocks aren't steady. Welcome suggestions from disabled colleagues and students about how to make the environment work best for their neurotype and schedule. Be ready to take criticism: too often, work is set up as dictated by convention, rather than by calling on relevant experiences and possibility.

Make your teaching and scholarly materials multi-modal: produce formats that work for people with different physical conditions and ways of reading and communicating, sharing and contributing. Think about multiple ways to allow participation in your funding, reviewing, research and engagement. Let's see an end to patronizing objectification and assumptions about what we want and need: include disabled people in boards, teams and studies, and learn from us. We have had to become masters of invention. The pandemic has made the value of that clearer than ever.





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“The centre is supporting innovators who are developing technologies and products to fight novel corona virus - COVID19”

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**12**

Elevate 100  
Winners

**17**

Graduates

#### BBC OFFERINGS

1. Central Instrumentation Facility by DBT, Government of India
2. Mentorship (K-SAP Bio 50 Program)
3. Infrastructure: Large, small, bench space & associate incubation suites
4. Funding (Elevate 100) and BIRAC seed fund
5. MedTech Centre by BIRAC under BioNEST
6. Branding / Networking (Events & Workshops)

#### AREAS OF SUPPORT

- 1 Healthcare (Med tech/ Pharma)
- 2 Agriculture BT
- 3 Food/Nutrition
- 4 Environmental BT
- 5 Industrial BT



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