STI SCIENCE TECHNOLOGY AND INNOVATION
COVID-19

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RIS Diary

— Research shaping the development agenda

From Director General, RIS

The debates are back on the table on the role of science and technology with regard to fighting COVID-19 which has thrown the entire world into an unprecedented health and safety crisis that is worsening day by day. All economic and social activities have come to a halt at global level. It is in these contexts, that RIS has come out with the Third Special Edition of RIS Diary on COVID -19. The issue contains articles on: "*Harnessing Science, Technology and Innovation in India for Tackling COVID-19*" by Arabinda Mitra; "*Science, Technology and Innovation - Fighting the COVID-19 Outbreak*" by Bhaskar Balakrishnan; "*Science Diplomacy : Covid and Beyond*" by Balakrishna Pisupati; "*Global Governance of Technology, Institutional Architecture and Indian Response to COVID-19*" by Sachin Chaturvedi; "*Science, Technology, and Innovation in Indian Systems of Medicine: An Exploration in the Context of COVID-19 Pandemic*" by T. C. James and Apurva Bhatnagar; "*Science, Technology and Innovation and the Challenge of Epidemic*" by Krishna Ravi Srinivas; "*Impact of COVID-19 on the World Economy*" by Biswajit Banerjee; "*Global Institutions and COVID-19*" by Atul Kaushik.

We hope that articles contained here and in the two previous special issues of RIS Diary would serve as useful references in the on-going discussions at different levels on issues related to the war against COVID-19. While hoping sincerely that humankind will come out of this dark tunnel soon to rejoin the normal course of various socio-economic activities, we would highly appreciate to hear from you about the contents of the Special Issues of RIS Diary.

Sachin Chaturvedi

Harnessing Science, Technology and Innovation in India for Tackling COVID-19

ARABINDA MITRA*

Introduction

The COVID-19 epidemic has resulted in greater collaboration among scientists and innovation throughout the world.[1] Many Academies of Science, including the Royal Society are actively engaged in providing policy advice, providing a voice

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to the scientific community and educating and informing the public on the scientific aspects in the fight against the epidemic and cautioning against undue fear and false claims and narratives.[2] In India the fight has resulted in many new initiatives, repurposing/refocussing the old ones, greater thrust on finding solutions to immediate problems and focussed approach in finding scientific solutions and promoting innovations.[3]

With lockdown in effect, better use of Information and Communication Technologies and greater co-ordination using digital tools has become inevitable. Given the spread of the virus across States, the involvement of research and academic institutions in different parts of the country to contribute in various initiatives taken by the Central and State Governments requires coordinated efforts. Optimal solution can be provided through mobilization of scientific resources and rapid deployment of technology led innovative solutions and at the same time it can lend evidence based policy guidelines to the government.

In India, this crucial role is being played by the Office of the Principal Scientific Adviser to the Government of India (O/o PSA) which co-ordinates among, government ministries/ departments, scientific institutions, academia and enterprises in ensuring that critical scientific and technological data and findings are shared and speedy decisions on Research and Development related issues to tackle COVID-19 epidemic are taken to support the government and the citizenry.

The O/o PSA constituted the Science & Technology Empowered Committee for COVID-19 on 19 March 2020. The committee is co-chaired by Prof. Vinod Paul, Member- Health, NITI Aayog and by Prof. K. VijayRaghavan, Principal Scientific Adviser. In addition, a Task Force on Vaccine Development and related S&T has also been constituted by the Prime Minister's Office with Prof. Paul and VijayRaghavan as Co-chairs. Given the multiple challenges involved in finding solutions and supporting outcome driven R&D, a coordinating mechanism has been developed which is helping to address various topical issues like:

- Development of Vaccine and Repurposing of Drug based on scientific evidence and existing strengths, technology readiness levels, status of IP, manufacturability in India etc. In depth information on various vaccine and drug candidates will help to allow informed decision making towards timely development and delivery. The regulatory/legal processes are also being addressed. This is crucial because all over the world collaborative R&D is being pursued on Vaccine development and also Repurposing of Drugs.[4] With its multifaceted scientific strength and infrastructure, India cannot afford to lag behind in this critical effort. Another reason is that India has the potential to emerge as a major manufacturer and supplier of both vaccines and drugs.
- Application of mathematical models to track the disease spread and use of models to

predict the medical equipment and auxiliary requirements of the COVID-19. This approach will combine telemedicine and digital health data with serological testing in specific areas and high-risk patients/health workers. One aim is that stratification of hot spots into red, green and orange can be made based on sero-epidemiology evidence.

- Prioritizing manufacturing of test kits, ventilators, PPE in India.

The Government of India on 29 March 2020 constituted 11 Empowered Groups of Officers, under Disaster Management (DM) Act 2005, to develop a well-planned and coordinated emergency response to ensure health and economic security of millions of Indians from COVID-19 outbreak. These Groups are empowered to identify problem effective solutions thereof; delineate policy; formulate plans; and take necessary steps for effective and time bound implementation for these. The Principal Scientific Adviser is a member of the Group responsible for coordinating with private sector, NGO, International bodies for response related activities. PSA is involved in, inter alia, in /with the following activities/ programs/ initiatives.

Mobilizing S&T Capabilities and Utilizing Infrastructure

The Empowered Committee on R&D has worked towards enhancing the testing facilities to meet COVID-19 related challenges by leveraging the existing resources (instruments and manpower) in Government of India laboratories. It has enabled ICMR to issue the required notification allowing institutions under Department of S&T, Department of Biotechnology, Council for Scientific and Industrial Research, Defense Research and Development Organization, Department of Atomic Energy, and Indian Institute of Science (IISc) to self-assess and prepare their Bio-Safety Laboratories (BSL) labs for research and testing of corona virus. For this O/o PSA has developed a "Handbook for COVID-19 testing in Research Institutions" which allows more such labs to self-assess its preparedness, in terms of equipment, staff and expertise required for COVID-19 testing.

This ensures that the institutions are well prepared for testing and upgrade their facilities. A detailed checklist has been outlined, which can be used by research lab to self-assess and indicate their preparedness for declaring the lab as a research and testing facility for COVID-19 after ICMR approval.

A "Science & Technology core team" has been set up in the office of the Principal Scientific Advisor to crowd source ideas and solutions from experts, companies, academia and citizens to tackle the spread of the COVID-19 virus in the country.

Innovation Promotion

The Office of the PSA has brought together, efforts across various government departments and programme to identify innovations that can tackle COVID-19 challenges. This has resulted in synergy and better solutions and has also reduced the communication gaps and facilitated better understanding among the stakeholders. DST, AIM, BIRAC, Start Up India and Accelerating Growth of New India's Innovations (AGNIi) have been brough together, to evolve common criteria for evaluation and short listing of best solutions

Office of PSA is sensitizing R&D and academic institutions and City Clusters to submit solutions for COVID-19 challenges. It is enabling, new potential technologies for testing at government labs/academic institutions. It is connecting with industry partners through CII for ensuring rapid manufacturing, In addition to these it is, channelling financial resources and other enabling

mechanisms for their implementation. As a result so far 22 Start-ups have been shortlisted for support by AGNIi team from more than 400 applications.

The O/o PSA worked with the Ministry of Corporate Affairs for issuing an enabling OM for the use of CSR funds for research and innovation projects for providing solutions to meet the COVID-19 challenges. This has ensured the speedy engagement of industries to support the COVID crisis with resources through available CSR in support of the O/o PSA is coordinating with R&D labs for accessing these funds as Healthcare and preventive healthcare are covered under Schedule VII of Companies Act as Specified CSR activity. The Office of the Principal Scientific Advisor has provided specific support to help understand and formulate regulatory requirements in the Indian context for ventilators and other medical equipment.

Converging Supply and Demand sides

COVID-19 critical medical supplies advisory cell is being enabled by a digital platform to facilitate administration with managing supply and demand of critical medical equipment, and enable efficient decision making with regards to timely procurement. The platform has been developed by Invest India in partnership with the O/o PSA. The portal will help:

- To know national Demand aggregation of critical medical equipment
- In providing access to Supplier information at one place – GeM, Invest India, Industry Association (FICCI, PHD Chamber of Commerce, CII etc)
- By enabling states to estimate numbers of critical medical equipment based on number of patients and health care workers
- Through a centralized query mechanism and online facilitation for States seeking advice on managing medical equipment demand/ supply/usage
- As a single source of information for people, and infrastructure resources prepared by NSDS
- In geo tagging of crises management infrastructure (health care centers, isolation centers, etc.) along with district-wise patient load.

Guidance to Citizens, Public Outreach and Communication

The O/o PSA has been instrumental in the launch and outreach of the Aarogya Setu App through NIC. The app built through public private partnership with knowledge input from academic institutions will help people assess themselves the risk for their catching the Corona Virus infection by tracking infected cases in the vicinity. This is a data protected App using cutting edge Bluetooth technology, algorithms and artificial intelligence tools. It has gained public acceptance with more than 50 million users within two weeks of its launch.

The App will help the administration to take necessary timely steps for assessing risk of spread of COVID-19 infection, and ensuring isolation where required. The PSA also serves on a committee constituted by the Cabinet Secretariat to evaluate and ensure development and launch of Citizen App technology platform to help citizens and government in combating this pandemic. The App is a pioneering initiative and is used for the first time in India in such conditions. The lessons learnt from this will be very useful in many ways, including, understanding role of digital health in controlling epidemics.

Wearing masks has been made mandatory in most places in India for anyone who wants to visit public places and interact with others. But availability of masks has been an issue and the lockdown has resulted in delays in masks getting distributed to users. But making masks is possible even at homes and it does not need much training or skills to make them. Sensing the need for guiding the public in making and use of masks, The O/o PSA has issued a detailed manual on making homemade masks for curbing the spread of Coronavirus.

The guide provides a simple outline of best practices to make, use and reuse masks to enable NGOs and individuals to self-create such masks and accelerate widespread adoption of masks across India. This has now become a part of the national advisory for citizenry issued by the Ministry of Health and Family Welfare (MoH&FW). The manual has been released in several regional languages. As it is available for free download, it has resulted in better understanding among the public and greater use of ordinary materials to meet the unmet needs for masks.

The O/o PSA issued illustrative guidelines with precautions and measures for controlling the spread of COVID-19 in densely populated areas on April 13, 2020. The frugal and simple measures which can be easily adopted in lockdown can greatly help in controlling the spread of the disease in resource constraint areas where toilets, washing or bathing facilities are shared.

The guidelines propose swift installation of do-it-yourself hand-washing stations that have been used world-wide to contain epidemics. Foot-operated stations not only reduce the chance of transmission by eliminating direct contact with potentially high infection areas, but also reduce the amount of water used by people during hand-washing. The designs proposed allow self-assembly by community volunteers and authorities, using affordable and locally available materials, even during lockdown and supply- chain challenges. An outline of good toilet practices to maintain sanitation and hygiene in communities have also been clearly outlined.

The guidelines have been recommended by the MoHFW on April 14th 2020 for adoption across the country.

The Office has been closely working with science communication agencies such as Vigyan Prasar. Covid Gyan (https://covid-gyan.in), a website dedicated to scientifically accurate COVID-19 content and resources, has been launched as a joint initiative of multiple research institutions.

Conclusion

PSA and his office have been working seamlessly in ensuring that nation is able to leverage the maximum from the concerted application of Science, Technology and Innovation (STI), to tackle this challenge. The O/o PSA is promoting evidence based policy making and scientific decision making required as critical guidance tool to various stakeholders in the country engaged in the fight against COVID-19.

Endnotes

1 https://blogs.scientificamerican.com/observations/how-covid-19-is-changing-science/

2 https://royalsociety.org/news/2020/03/coronavirus-covid-19/

3 https://www.natureasia.com/en/nindia/article/10.1038/nindia.2020.56

4 https://www.reuters.com/article/us-health-coronavirus-lifeline/reasons-for-hope-the-drugs-tests-and-tactics-that-may-conquer-coronavirus-idUSKBN21Z2HP

STI SCIENCE TECHNOLOGY AND INNOVATION
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Science, Technology and Innovation - Fighting the COVID-19 Outbreak

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Background

The current COVID-19 outbreak (caused by the SARS-CoV-2 virus) which began in Wuhan, China in late November 2019 has so far spread to 210 countries and territories and resulted in over 2 million cases and 137,000 deaths. It has led to socio-economic disruptions on a global and unprecedented scale. A global coordinated response to the outbreak was slow in taking shape. Policy makers underestimated the scope of the outbreak, and initially thought that it could be largely confined within China. The delays in disclosing information about cases from China, clamping down on international travel, and in declaring it a Public Health Emergency (on 30 January) and ultimately a pandemic (on 11 March) made control much more difficult. The resulting eruption of the outbreak has severely strained health systems world wide, and led to shortages of critical equipment such as protective masks and gowns, diagnostic kits, and ventilators.

About the SARS-Cov-2 Virus

The virus itself is not unknown. It belongs to the coronavirus family, which includes six other coronaviruses responsible for diseases in humans, such as MERS and the 2003 SARS outbreak. The original animal reservoirs are bats, and the virus is thought to have emerged as a human pathogen via an intermediate host such as the pangolin or the pig. The virion is medium sized, spherical in shape, of 50-200 nanometres diameter, encapsulating a single strand positive sense RNA virus[1] with a genomic length of about 30,000 base pairs. The other structural elements include the spike glycoprotein(S), envelope, membrane and the nucleocapsid (which contains the viral RNA). The virus attacks human cells by attaching the

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spike protein to a receptor ACE2 on the cell after which a sequence of events unfolds, leading to cell penetration, death and release of new virions. ACE2 receptors are more expressed in certain human cells found in the lungs, gastrointestinal tract, which is the reason for the SARS-Covid-2 virus's propensity to attack the lungs. Therefore, if we can block the fusion of the S spike protein with the ACE2 receptor, it would be a major advance.

The virus spreads mostly between people during close contact, via small droplets or aerosols produced by coughing, sneezing, or talking, aerosolization[2], or by touching a contaminated surface and then the face. Common symptoms include fever, cough and shortness of breath. Complications may include pneumonia and acute respiratory distress syndrome. The time from exposure to onset of symptoms is typically around five days, but may range from two to fourteen days. There is no known vaccine or specific antiviral treatment. Recommended preventive measures include hand washing, wearing face masks in public spaces, maintaining distance from other people, and monitoring and self-isolation for people who suspect they are infected.

Global Response to the Outbreak

Authorities worldwide have responded by implementing travel restrictions, quarantines, curfews and stay-at-home orders, workplace hazard controls, and facility closures. These have caused severe economic and social disruptions. Global socio-economic disruptions include the postponement or cancellation of political and cultural events, widespread shortages of supplies exacerbated by panic buying. Closures of educational institutions have affected 99.9 per cent of the world's student population. Misinformation about the virus has spread online, and there have been incidents of xenophobia and discrimination against people perceived as being from areas with high infection rates. Migrant workers have been doubly affected, firstly as a result of work stoppages leading to income reduction, and travel restrictions preventing them from returning to their original homes.

In the face of this situation, countries have launched major efforts to deploy science, technology and innovation to tackle the problems created by the outbreak. Economic policy measures and public information efforts are also under way

to tackle the economic and social consequences, but these will not be covered in this article. However it must be noted that efforts in all areas be it S &T, economic policy, social policy can be mutually reinforcing and produce synergies if properly managed.

Response to the Outbreak in India

The first case of the 2019–20 coronavirus pandemic in India was reported on 30 January 2020, originating from China. As of 16 April 2020, there were a total of 12,759 cases, 1,515 recoveries, and 420 deaths in the country. The infection rate of COVID-19 in India is reported to be 1.7, significantly lower than in the worst affected countries, probably due to energetic steps such as lockdown, face masks and social distancing promoted by the governments of the centre and the states. On 24 March, the Prime Minister ordered a nationwide lockdown for 21 days, affecting the entire 1.3 billion population of India.

On 14 April, the Prime Minister extended the on-going nationwide lockdown till 3 May. India is acknowledged to have tremendous capacity to deal with the coronavirus outbreak and, as the second most populous country, will have enormous impact on the world's ability to deal with it. But there is concern about the economic devastation caused by the lockdown, which has huge effects on informal workers, micro and small enterprises, farmers and the self-employed, who are left with no livelihood in the absence of transportation and access to markets. A gradual easing of restrictions is under way to alleviate these concerns.

India's External Engagement

On 26 February, India sent 15 tons of masks, gloves and other emergency medical equipment to China. On 13 March Prime Minister Modi proposed that SAARC nations jointly fight the pandemic, an idea that was welcomed by the leaders of Nepal, Maldives, Sri Lanka, Bhutan, Bangladesh, and Afghanistan. On 15 March, after a video conference of SAARC leaders, he allocated US$10 million of funds classified as COVID-19 Emergency Fund for the SAARC countries. This was welcomed by other SAARC countries and a further $ 11 million has been mobilised, including $ 3 million from Pakistan. On 11 April, India sent a team of 15 doctors and health care professionals to Kuwait to assist in its fight against Covid-19. India has sent 85 million hydroxychloroquine tablets and 500 million paracetamol tablets to 108 countries. In addition, 1 thousand tons of mixture have also been sent to make paracetamol tablets. Given India's large capacity for manufacture of drugs and pharmaceuticals, as well as medical devices and diagnostics, and protective equipment, telemedicine, human resources, and advanced medical care, it can make a major contribution to the global battle against COVID-19.

Global Research Road Map

WHO, in collaboration with the Global Research Collaboration for Infectious Disease Preparedness and Response (GLOPID-R), organised a Global Forum on research and innovation for COVID-19 ('Global Research Forum'). Over 400 participants from across the world participated. The Scientific Advisory Group of the WHO R&D Blueprint met on 2 March 2020 and reviewed the results, leading to the outcome document of a Global Research Roadmap with immediate, mid-term and longer-term priorities to build a robust global research response to the outbreak. Goals of the Global Research Roadmap are: (a) to facilitate that those affected are promptly diagnosed

and receive optimal care while integrating innovation fully within each research area, and (b) to support research priorities in a way that leads to the development of global research platforms pre-prepared for the next disease epidemic (an unexpected epidemic by a known or previously unknown pathogen); thus, allowing for accelerated research innovative solutions, and enabling R&D for diagnostics, therapeutics and vaccines as well as their timely equitable access. The coordinating role of WHO is essential to achieve optimum results from R & D efforts and access on affordable terms to the products and IPRs emerging from the R & D.

STI Actions across the World

There are several areas along which global STI efforts are focused. These are: (a) infection control and protection, related equipment, and contact tracing; (b) diagnostic tests and medical devices for treatment; (c) treatment with already approved drugs for other diseases and search for new drugs; and (d) development of vaccines and antibodies including those extracted from convalescent plasma. Research and development in all these areas is going on vigorously. Governments and other institutions have responded both with numerous STI programmes targeting COVID-19, as well as funding of STI. WHO recently announced a multinational clinical trial named SOLIDARITY for potential coronavirus therapies as part of an aggressive effort to jumpstart the global search for drugs to treat COVID-19.

There are multiple attempts in progress to develop a vaccine against COVID-19. The Coalition for Epidemic Preparedness Innovations (CEPI) – which is organising a US$2 billion worldwide fund for rapid investment and development of vaccine candidates – indicated in April that a vaccine may be available under emergency use protocols by early 2021. By April 2020, 115 vaccine candidates were in development, with two organisations having initiated Phase I-II safety and efficacy studies in human subjects. Five vaccine candidates were in Phase- I safety studies in April. Some 79 companies and academic institutions are involved in vaccine development. 10 different technology platforms were under research and development during early 2020 to create an effective vaccine against COVID-19.

STI Actions in India

India has engaged very actively in all the above areas of activity, with government and the private sector taking several initiatives. Among the many products being developed and other activities are affordable ventilators, area sanitising agents, disinfection gates and tunnels, IT applications such as Aarogya Setu, diagnostic devices and related IT applications, trials for repurposed drugs against Covid-19, vaccine development, etc. The list of these activities is growing rapidly as researchers across India are getting fully involved. NITI Aayog, Principal Scientific Adviser to the Government of India, ICMR are coordinating the effort, which includes many Ministries and research institutions. Many of these products and technologies have wide potential applications and relevance to other countries, especially developing countries. More detailed coverage appears in our fortnightly *Science Diplomacy Alerts*.

Conclusion

The struggle against COVID-19 is multisectoral, multidimensional, multinational and unprecedented. The SARS-Cov2 virus will most likely remain a long term threat to humanity. Achieving herd immunity while maintaining low mortality and morbidity requires the deployment of an effective and affordable vaccine which may take up to 18 months. Multiple waves of outbreaks of COVID-19 are likely. Therefore, R&D efforts must continue on a war footing along with social engineering to control outbreaks and availability of medical facilities to treat victims. There is no one size fits all solution and solutions must be tailored to conditions in each country. The prospect of emergence of new viruses from animal reservoirs will require more intensive R&D and efforts to elucidate the mechanisms through which viruses and pathogens can migrate across species. The regulatory framework for so-called "gain of function" research on pathogens needs to be strengthened to ensure that unfortunate incidents do not occur. International cooperation in all these areas is essential.

Endnotes

[1] According to the Baltimore classification of viruses

[2] Aerosolization involves dispersal of small sized particles containing the virus into the air, by for example, excessive shaking of contaminated gowns, etc. Such particles can remain suspended in the air for longer times and travel further up to about 10 metres depending on air speed.

Science Diplomacy: COVID-19 and Beyond

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If there is one time in the recent decades that science and scientists have received most attention, it is now! The novel corona virus that has brought the world to a standstill, eroding significant social and economic development gains in a matter of weeks, has proven to the world that countries are more inter-connected and dependent on one another now than before. Such lack of self-reliance is evident now when it came to use of science and its applications.

The mere collaboration of scientists across the globe to fight the pandemic has turned the discourse on multilateralism and diplomacy to unprecedented levels. Scientists and medical professionals, perhaps for the first time, started getting more media space than entertainers, sportspersons and politicians.

This point to one progressive direction – practicing science today needs collaborations, openness and diplomacy supported by trust and confidence. This article focuses on the trends and directions in science diplomacy and how the recent weeks it has evolved as well as how science diplomacy can help the future of development.

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Science Diplomacy

'Many of the challenges we face today are international and – whether it's tackling climate change or fighting disease – these global problems require global solutions . . . That is why it is important that we create a new role for science in international policymaking and diplomacy . . . to place science at the heart of the progressive international agenda.'

– Rt Hon Gordon Brown MP, Former Prime Minister of the UK

"Which world we will be living in" over the next decade was the lead topic in July/August 2018 issue of the publication *Foreign Affairs*, which presented six contrasting visions of a "grand narrative for an increasingly turbulent era". The key message from this publication is the future of the world can be a realist World, liberal World, tribal World, Marxist World, tech World, and warming World.[1] Science diplomacy has a role to play in all these future worlds. It can also help shape these worlds better.

After World War II, science diplomacy really got its start over the issue of nuclear weapons. Though not called so, scientists who engaged deeply on this issue with diplomats, security specialists and foreign colleagues did use diplomacy as a tool to deal with issues of non-proliferation.[2]

Governments, nongovernmental public health experts, diplomats and political leaders helped deal with challenges such as HIV/AIDS in Africa through the President's Emergency Plan for AIDS Relief (PEPFAR), launched in 2003 by the United States of America. Similarly, the spread of infectious diseases such as the Ebola and Zika viruses, "bird flu," MERS, and "swine flu" through coordinated global responses and the rise of antimicrobial resistance research through new international programs were all possible through science diplomacy.[3]

If we turn to current levels of success to deal with COVID 19, initiatives like the Global Initiative on Sharing All Influenza Data (GISAID), established in 2008, have proved to be the best results of science diplomacy wherein science based data and information is being shared freely and widely with enough safeguards for access to results and sharing the results and outcomes.[4]

In addition to undertaking specific and targeted research and development activities, initiatives such as the Forum for Indian Science Diplomacy (FISD)[5], Indian Technical and Economic Cooperation (ITEC)[6], Science Diplomacy programme of American Association for Advancement of Science (AAAS)[7] have all contributed enormously to promoting global and regional diplomacy using science.

Three dimensions of science diplomacy exists: (i) informing foreign policy objectives with scientific advice (science in diplomacy), (ii) facilitating international science cooperation (diplomacy for science) and (iii) using science cooperation to improve international relations between countries (science for diplomacy).[8]

Science in Diplomacy

Dealing with environmental, health and food security issues are now certainly multilateral where expertise from several countries would be needed. Science in these areas can hardly be self-sufficient though can be self-reliant. The role of science in diplomacy is best demonstrated during recent actions at various levels in managing development. Whether it is the Paris Agreement on climate change or the adoption of Sustainable Development Goals (SDGs), science played a critical role in reaching far-fetched agreements across countries. Successes through multilateral processes such as the Montreal Protocol were due to advancements in science. However, the key challenge that science faces, constantly, is the manner in which it is communicated to policy makers to seek diplomatic support that is strategic and timely.

Diplomacy for Science

Diplomacy for science facilitates key and strategic cooperation among countries to deal with complex, risky and high cost programmes and projects. International initiatives such as the Large Hadron Collider (LHC), the International Thermonuclear Experimental Reactor (ITER) are examples of complex science that is being pursued because of diligent diplomacy that has built the basis for collaborations, globally. Many bilateral, regional and multilateral cooperative programmes are built on diplomacy supporting need for cooperation in science.

Science for Diplomacy

Joseph Nye from Harvard University distinguished between 'hard power', which uses military and economic means to coerce the behaviour of other nations, and 'soft power', which builds on common interests and values to attract, persuade and influence as key to seek science support for diplomacy[9]. According to the Royal Society, the soft power of science interacts with international relations in several ways, ranging from cultural diplomacy to more traditional forms of negotiation and mediation.[10] Considering the need for focus on dealing with current and emerging challenges in conserving our ecosystems and biodiversity, countries around the world supported the establishment of Intergovernmental Panel on Ecosystems and Biodiversity (IPBES) on similar lines of the Intergovernmental Panel on Climate Change (IPCC). These initiatives, along with other 'soft' collaborations like provision of scholarships, training and others form the core of science working for diplomacy. The ITEC programme of Government of India is a brilliant example of showcasing India prowess in science and technology to the world by providing opportunities for number countries to study and get trained in India.

Science and COVID-19

At global and national levels academic, government, and industry labs mobilised too quickly and began to work collaboratively in unprecedented numbers across institutions and corporations to explore the potential for existing drugs to control the new virus. Research on diagnostics, vaccines and treatments is happening at lightning speed. Publications are being brought out in real time with social media serving as the vehicle of communication.

New experimental capabilities of genomics, proteomics, glycomics, high-throughput technologies, and fast-tracked clinical development strategies coupled with the pharmaceutical industry are looking for ways to accelerate the drug and vaccine development in matter of weeks if not months.

The pandemic is fought with the powers of science and technology (internet) which has enabled scientists and clinicians to share data and information using bioRxiv, medRxiv, ChemRxiv, and arXiv, all real-time servers used as the major medium by which scientific articles are being disseminated and evaluated by the community.

Current response also shows us how quickly innovation can move from laboratory to the clinic when there's an urgency to deliver. Whether it ismRNA vaccines, antibodies against the spike protein, novel coronavirus drugs, or new diagnostic tools, we have seen an incredible and rapid mobilisation of biopharma research and development, academic labs, government regulators, and the clinical community to expedite the path to testing and patient care.

The speed of developments in science and technology to mitigate the COVID-19 pandemic is unprecedented in the history of science. Synthetic biology, a new branch of science, has contributed to containing and treating the COVID-19 quickly.

DNA sequencing is crucial to fighting viruses like COVID-19. The sequence was available as early as 10 January 2020. On this day scientists from China shared with the public five full genomes of hCoV-19 via the Global Initiative on Sharing All Influenza Data (GISAID) open-access database. These sequences reveal the zoonotic origin of the novel coronavirus. As of April 18, 10,165 sequences of the virus from various parts of the world, including two from India have been added to the GISAID.

A report from the International Health Regulations (2005) Emergency Committee underlines the importance of the release of full viral genome sequences to a public platform to diagnose and contain infections early. Clinical trials of a COVID-19 vaccine have already started in more than three countries as of now. More information on the virus is coming on a daily basis.

Deficiencies in data-sharing mechanisms, which were highlighted during the 2013–2016 Ebola virus disease out-break in West Africa, raised the question of data access. It brought the issue to the forefront of the global health agenda. In September 2015, WHO reached an agreement on the need for open data-sharing, especially in public health crises like COVID 19. In 2008, GISAID went live, promoting the international sharing of influenza virus sequences, including clinical and epidemiological data associated with human viruses, geographical data, and species-specific data associated with avian and other animal viruses. Such information would help researchers understand how the viruses evolve, spread, and potentially become pandemics. In addition to the EpiCoV database, GISAID also hosts the EpiFlu database which 1,340,000 genetic sequences of influenza viruses.

The number of research collaborations related to COVID 19 is increasing on a daily basis. According to WHO, a global research roadmap has been prepared as of March 2020 to deal with COVID 19.[11] The number of activities currently underway to deal with the pandemic is being updated on a daily basis by the WHO.[12]

Science has played a crucial role in dealing with COVID 19 in an unprecedented fashion and has contributed enormously to enhanced diplomacy whether it is through provision of critical supplies or dealing with humanitarian support.

Conclusions

COVID 19 pandemic and the sudden but long-term impacts of the spread will certainly take months if not years to come to subside. Countries are caught unaware of the economic and social fallouts from the pandemic. The role of science has now been recognised as central to not only controlling the pandemic and treating the same but also preventing the same in the future. The situation has called for the need to create proper incentives for developing certain classes of medicines, like those for viral pandemics or drug-resistant microbes, so that effective therapies can be stockpiled in anticipation of when we need them. Anti-infective therapies can greatly benefit from new thinking and collaborations, including from those related to resistance therapies. Though this pandemic is a sad one, it sends a strong reminder that not everything needs to be cutting-edge science to have a big impact on health care. Overlooking the impact conventional interventions can have on patient care and disease protection - for example, the catastrophic impact of the shortage of basics like N95 masks and other personal protective equipment - are also important to deal with epidemics and pandemics.

Science diplomacy can help: (1) manage relations between countries, both developed and developing, (2) advance the values of the liberalizations in collaborations in the future, (3) achieve societal goals that capitalism misses, (5) maximise the opportunities and moderate the challenges associated with technological advance and (6) solve critical global challenges like climate change and ecosystem loss that potentially contributes to emergence of pandemics like CIVOD 19.[13]

In addition to finance and development ministries, foreign ministries should place greater emphasis on science within their strategies and draw more extensively on scientific advice in the formation and delivery of policy objectives of governments. Having scientific advisers in the foreign ministries is a critical need of the hour such as the one established in the UK where the mandate of the adviser is to integrate science across the Foreign and Commonwealth Office (FCO) priorities and develop stronger linkages with science-related policies in other government departments.[14]

Endnotes

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STI SCIENCE TECHNOLOGY AND INNOVATION
COVID-19

Global Governance of Technology, Institutional Architecture and Indian Response to COVID-19

SACHIN CHATURVEDI*

The origin and evolution of Corona virus is under intense debate at this point. Highly conflicting and polarising evidences, inferences and commentaries have appeared in scientific journals and across popular publications. There are also debates and discussions on whether it is a man-made virus or a naturally occurring one. When China reported about the spread of Corona virus and WHO declared it as a pandemic, scientific fraternity across the world started working on the genetic make-up of the virus.

The debates are back on the role of science and technology in relation to global security and safety. While there is no denying the fact that 'WHO declared pandemics' should not invoke biosecurity concerns, the current crisis has triggered global outrage on the origin of the virus and the need for governance of biosecurity. In this brief commentary, we first take an overview of prevailing global frameworks and then view the STI imperatives of COVID-19 in the Indian context and the last section suggests the way forward.

The International Framework

The prevailing debates have thrown up deeper policy insights as ethical and socio-economic

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issues are yet to be comprehensively addressed in the emerging frameworks for global governance of technology. Rise of technologies like information and communication technology, nanotechnology, new material sciences, biotechnology, including the synthetic biology, are spheres where convergence, multiplication, application of artificial intelligence and use of cyber tools with ability to scaleup have created new opportunities for social and economic development and new challenges for governance.

After the launch of Technology Facilitation Mechanism (as part of Agenda 2030) and launching of STI for SDGs at the Osaka G-20 Summit, while the world is looking at making technologies work for access, equity and inclusion (AEI), the other frontiers of governance are posing increasing threats to mankind and our civilization. Although nuclear and space technologies are areas where governance mechanisms have responded well, biosecurity has yet to receive due attention. Since the adoption of the Biological Weapons Convention (BWC) in 1975, adequate institutional and governance mechanisms for security and disarmament could not come up. Its linkage with other arms of the UN, like the WHO, has also left a lot to be desired. It is essential to address such matters *a priori,* instead of reacting in retrospect.

This year, the Biological Weapons Convention (BWC) is celebrating its 45th anniversary and the U N Secretary General made a very significant observation when he said, "Scientific advances are reducing technical barriers which earlier limited the potential of biological weapons…I therefore call on States, parties to urgently update the mechanisms within the Convention for reviewing advances in science and technology and to work together to improve biosecurity and bio-preparedness so that all countries are equipped to prevent and respond to the possible use of biological weapons. The Convention's Ninth Review Conference in 2021 is an opportunity to address these and other issues."

India has been consistently raising the issue of STI and disarmament for last several years at various meetings. In its statement on 26th March 2020, India suggested strengthening of the institutional architecture for greater effectiveness of the BWC. India again raised the issue of role of science and technology in the context of international security and disarmament.[1] This was actually building further on India's proposal of 2017 when, along with 18 other countries, it had proposed the need to explore challenges and concern areas related to the use of such technologies for military purposes. The proposal had also raised the issue of potential application of such technologies for enhancing assurance levels and confidence building as well as lowering

the costs of disarmament verification and arms control.

In these discussions at the BWC, views from India corresponded with the global South to a great extent. Several developing countries backed India. At the March 2020 event, US reaction was very sharp when Senator Chris Ford, Assistant Secretary, US State Department Bureau of International Security and Nonproliferation (ISN), tweeted, "We observe the 45th anniversary of the Biological Weapons Convention and reaffirm the importance of BWC Parties' commitments to preventing biological weapons. The Covid-19 pandemic highlights the importance of BWC Parties' commitments to reducing all biological risks." In such a polarising scenario, the future course of action would not be easy. India, however, would have to build national defence system and make clear policy choices.

Indian STI Strategy

The success of India's fight against COVID-19 would be an upshot of a multiple sectoral coordination among different agencies of health, technology and diplomacy. They played an extremely coherent role in supplementing sectoral efforts. The Indian Council of Medical Research (ICMR);National Institute of Virology (NIF), Pune; Department of Biotechnology and its affiliated institutions; and Council for Scientific and Industrial Research (CSIR) played the frontline role with coordination from the Ministry of Health and Family Welfare, Ministry of External Affairs and Ministry of Home Affairs with overall guidance of the PMO, the Office of the Principal Scientific Advisor (PSA), and NITI Aayog. The Indian Mission in Beijing also played a key connect in the whole exercise.

Though SARS, Nipah virus and Swine Flu had given India some preparedness at grass root level, This was the first test case of the national agencies for not only coordinating their own action but also factoring in the grass root agencies, State governments and private diagnostics entities.

The success is also tangible at the local level where technology is leveraged and, in several cases, with utmost satisfaction. In order to meet the basic reference framework - Test, Track, Isolate and Quarantine (TTIQ), the local administration and police relied on GPS, mining of mobile phones and surveillance footage from drones and various public places.

Salient Features

Needless to say, this mega exercise had limitations in terms of diagnostic kits (as India does not produce probes) and sufficient quantity of Personal Protection Equipment (PPE). However, there are some very important outcomes of this strategy, which increased the possibility of success. The policy decisions are being fully guided by the subject experts and leaders in the health sector. Economic and political factors were just kept aside. As the nation awaits the probable exit from the lockdown, there are four important outcomes for STI policy as discussed below:

Scientific Advice to Guide Policy Decisions

Even though the PM engaged himself with the national strategy and evolution of the response architecture, at no stage health professionals and their scientific roadmap was undermined. With the Health Minister himself being a medical professional, coordination seemed flawless. The Office of the Principal Scientific Advisor (PSA) has emerged as an important link across institutions. In addition, other national scientific agencies and WHO also worked in close cooperation with the government. The Indian Council for Medical Research (ICMR), National Virology Institute and CSIR also provided their inputs. The ICMR

remained the national lead agency for supporting the inputs on COVID19.

Institutional Dynamism

The Institute for Stem Cell Science & Regenerative Medicine (ISCSRM), an autonomous research body dedicated to collaborative research in stem cell and regenerative biology and supported by the Department of Biotechnology (DBT), came up with a proprietary germicidal-molecule that can be covalently attached to the cotton fabric (any type including household cotton). This fabric can be stitched into PPE such as a face mask. This novel germicidal molecule can be used on clothes and fabric of any kind to deactivate various infectious microbes. With the support of DBT, another institute, viz. Rajiv Gandhi Centre for Biotechnology (RGCB), Thiruvananthapuram, is in the final stages of developing a kit that promises to help detect SARS CoVID-19 infection. The interesting part is that the detection can happen as early as within four days of infection. This institute has also validated testing protocols for diagnosis of COVID-19 along with developing the standard operating practices for the testing process and transmission of results through a cloud based platform.

With proactive efforts, CSIR identified five broad verticals to its work programme. The first was to develop surveillance and that too backed by digital methods so that the labs get a chance to understand genetic basis. The second step focussed on developing cost effective diagnostic kits. Third was to develop new therapies including the development of vaccines, the fourth was to develop hospital assistance devices and the fifth related to the development of supply chain and logistics.

Strength of Start-ups

If any of the earlier programme, that has helped in these testing times, it is the scheme of Start-up India. Several of the firms that came up under this programme are now trying to come up with desired products. With an initial support and policy push to Start-up culture, results are becoming evident very swiftly. Biodesign Innovation Labs developed an affordable and accessible respiratory support device. Biodesign is a Bengaluru based medical device and healthcare technology company which has received funding and support from BIRAC, Government of Karnataka. This is supplemented by DST's Promoting and Accelerating Young and Aspiring technology entrepreneurs (PRAYAS), an initiative from DST to support initial gap funding.

STI and International Cooperation

India is Member of a working group established between high level officials such as Ministers and Chief Scientific Advisers from the following countries: Australia, Brazil, Canada, Germany, Japan, New Zealand, South Korea, Singapore, United Kingdom, Spain, Portugal and USA. The objective of this working group is to share research results and information on how science can assist in the decisions and measures that governments are taking to face the Corona virus that causes COVID-19. Prime Minister Narendra Modi and his Swedish counterpart Stefan Lofven agreed on the possibility of collaboration and data sharing between researchers and scientists of the two countries, a move which would contribute to the global efforts against COVID-19. Apart from initiating a $10 million SAARC Fund, India also hosted SAARC e-ITEC network training programme on COVID-19 management for healthcare professionals. More than 150 SAARC participants joined the course that began on 17^{t} April, 2020.

Role of Private Sector

Some of the actors in the private sector have quickly responded to several challenges that India was facing in terms of short supplies of

gears and medical instruments. Some of the public sector institutes have extended the much needed support. The Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad developed and transferred the process for the preparation of alcohol-based hand sanitising gel to a Rajasthan based MSME on 19th of March on non-exclusive basis. Similarly, the National Chemical Laboratory (CSIR-NCL), and 12 other CSIR labs emerged with hand sanitiser solutions. The CSIR-National Environmental Engineering Research Institute (CSIR-NEERI) contributed for PPE. In addition, fifteen of the specialised CSIR institutes across India have joined local governments in COVID testing.

Pandemic vaccine development is an area of core focus for the Hyderabad-based Bharat Biotech. It had earlier contributed vaccines for H1N1, Zika and *Chikun gunya* and has now announced partnership with the University of Wisconsin Madison and a US-based company FluGen to develop a vaccine, Coro-Flu, to battle against COVID-19. Bharat Biotech has around 16 vaccines in its portfolio.

Another interesting case is of Molbio Diagnostics, established in 2000, which emerged as a leading diagnostics company. It has partnered with Tata Trusts to roll out the COVID-testing kit at a reasonable price of Rs. 1,350. It has been working on diseases including tuberculosis and malaria. The test is called the TrueNAT Beta CoV test and has been approved by ICMR with due biosafety measures.

ICMR has certified performance evaluation of 31 commercial kits for detection of SARS-CoV-2 RNA by Real Time PCR. Most of these kits have been provided by private companies. Out of 14 firms, around 9 firms are within India and 5 from outside.

Way Forward: What Lessons?

From the science policy perspective, there are certain lessons that we may learn for evolving a long-term perspective.

First and foremost is to realise that the science agencies working on the biological part of the pandemic came together and delivered what we all have witnessed. However, a biosecurity framework with teeth is urgently required at an international level. Debates on how to tighten verification and control in this field are unlikely to move in any direction. Among the existing institutional architecture within the country, our weakest link is of biological sciences. The trinity of space, nuclear and defence R&D have had lot of attention since the Seventies. We must create an agile framework to cover the whole chain of public-health interventions - from scientific research and early warning to policy formulation, implementation, and evaluation. Bioscience expertise and knowledge networks should be urgently evolved in light of our national preparedness for biological warfare and STI would be a crucial component.

It is pertinent to institutionalise this national experience to create a National Authority on Biosecurity and Biological Emergencies (NABBE). This would not only lead but also coordinate by encouraging institutions to work together in well-defined supplementing roles, based on expertise and to not compete with each other and protect illusive turfs. With seamless coordination one can avoid loss of time in unnecessary approvals and egoist coordination. The NABBE would need to work closely with the NDMA, NSCS and other agencies including Defence, Home, Agriculture, Finance, etc.

The NABBE would help in keeping the country ever prepared for such pandemics in the future. At this stage, national preparedness requires

expertise from biological security perspective with due inputs coming from tracking of global developments in this area. The additional role that the NABBE may play is to consistently follow up for the formation of a global framework acceptable to all for wider and effective participation. Here Biological Weapons Convention (BWC) would play an important role.

In this respect we can also learn from the experiences of other countries, for instance, Denmark has established a Centre for Biosecurity and Biopreparedness (CBB) by an Act of the Danish parliament in pursuance of United Nations Security Council Resolution 1540.[2] The CBB is the national authority that follows biological research and products with dual use components. The Centre maintains a 24/7 vigil for possible response to any biological incident whether of accidental or malicious origins.

Secondly, developing countries like India have major institutional challenges that range from low budgetary allocation to low level of intra-agency coordination, intense fights for turfs and almost no effort to engage with other actors. India's response to COVID 19 from the STI perspective is extremely unique from all possible stand-points. The role of STI has certainly emerged as an important facet. As we move forward, this would have to be duly addressed for enhancing institutional efficiency.

Thirdly, now that some leading groups are on the EU supported Covid Moonshot project for crowd sourcing of ideas, India would have to step us cooperation across labs and national programmes. In this respect, Prime Minister's call to the young Indian scientists to deliver is very timely. In this regard the recently constituted high-level task force with the main objective of speeding up national and international efforts towards vaccine development to treat Covid. The Task Force would be headed by the PSA and NITI and would also include representatives of AYUSH ministry, ICMR, department of biotechnology, drug controller general of India among others.

Fourth, India's efforts to evolve robust STI response would have greater strength if India continues to support global STI efforts that have assumed much greater significance in situations like pandemics, where borders just don't matter. In this regard, pragmatic R&D linkage with WHO may be further explored. With several polarising views about the organisation, it cannot be missed that the WHO released around 50 technical documents and mobilised around 2 million protective equipment to 133 countries.

Endnotes

1 This issue was first added to the agenda of the First Committee in 1988, with India as the main sponsor. In introducing a draft resolution, the delegate recalled that increasing amounts of resources were being devoted to developing new weapon systems, which caused uncertainty and insecurity. Developments such as the graduated use of nuclear explosive power, miniaturisation and large-scale computing capabilities using micro-electronics, and fuel and laser technology were transforming the security environment.

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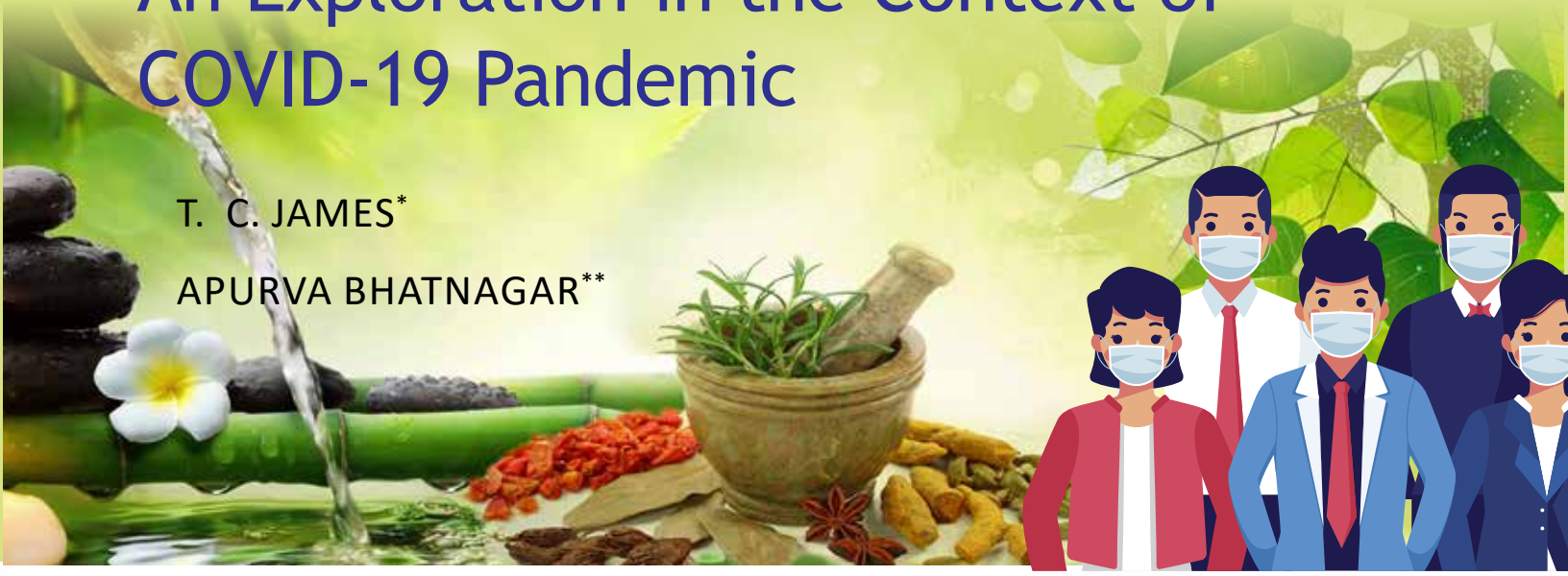
STI SCIENCE TECHNOLOGY AND INNOVATION
COVID-19

Science, Technology, and Innovation in Indian Systems of Medicine: An Exploration in the Context of COVID-19 Pandemic



T. C. JAMES*

APURVA BHATNAGAR**

Introduction

Times of stress are also times of creativity and innovation. Wars have spawned many scientific innovations or hastened the completion of on-going research projects. The Manhattan Project was an example. We are now living in difficult times. Such adverse situations can also bring out the best in the innovation front of the traditional medicine systems. Science, Technology and Innovation (STI) is also the path for Indian Systems of Medicine (ISMs) to progress. What is required for this is extensive resort to intensive and large research and development (R&D). Allopathy progressed because of validated research and advanced techniques (Chauhan *et al*, 2015). The New Corona Virus Disease - 2019 (COVID-19) epidemic gives an opportunity for the ISMs to re-orient many of its existing practices and give higher stress on the use of modern science, technology and innovation in product development and practices. The systems need to push for modernisation by making use of new advances in pharmacology and phytochemistry and also attempt to shake off the tag of traditional medicine which generally gives the impression of a not advancing medicine.

Epidemics like COVID-19 are generally boosters of medical research and innovation in modern medicine. They search for both preventive medicines like vaccines and curative medicines. Epidemiology is, therefore, very developed in Allopathy. ISMs do not have minute branches and sub-branches as in modern medicine (Samal, 2016). Traditional Medicine (TM) approach is based on development of immune system of the body. This alone may not be sufficient to tackle new epidemics, as humans also require time to develop immunity to new diseases caused by new bacteria or new virus. These micro-organisms

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might have developed new traits and adapted to changes in the environment. While fundamental principles of epidemiology in a system may remain, it will have to do research to find which practice or medicine is specifically efficient in fighting the new epidemic. That may cover both immunity boosters and curative medicines. This kind of a positive and open approach to science is required in the ISM sector.

The term 'Ayurveda', the most widely spread ISM, is derived from two terms 'Ayur' meaning life and '*Veda*' meaning knowledge or science, thus denoting 'science of life'. *Encyclopaedia Britannica* describes science as "any system of knowledge that is concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation."[1] It has to be a pursuit of knowledge and knowledge by nature is not static but dynamic and evolving. According to the Drugs and Cosmetics Act, 1940 (as amended upto 31 December 2016), the ISM drugs are those formulations as described in the authoritative books of Ayurveda, Siddha, or Unani Tibb systems of medicine or formulations containing only such ingredients as mentioned therein. As per the First Schedule of the Act, there are 59 such texts for Ayurveda, 31 for Siddha and 14 for Unani Tibb. But this does not deter further research or application of new technologies and development of innovations in the systems. In fact, the category "patent or proprietary medicine" as defined in Section 2 (h) itself paves way for innovation. So long as the innovations are within the broad concepts of the ISMs, they will fall under drugs of these systems. Of course, on the broad fundamental principles, the systems differ from those of modern medicine.

Status of Innovation in AYUSH Sector

Indian policy approach to the AYUSH (Ayurveda, Yoga, Unani, Siddha and Homeopathy) sector has always encouraged research and innovation in the area. The Government had recognised the need for systematic research on the Indian Systems of Medicine and Homeopathy (ISM&H) quite early and established the Central Council for Research in Indian Medicine and Homeopathy (CCRIMH) in 1969 as an autonomous body under Ministry of Health and Family Welfare. For around 10 years, this composite institution was the central apex body for all research and innovation in ISM&H, but given the diverse nature of ISMs, it was realised that separate research councils are needed to be created for different systems. In 1978, four different central councils, namely, the Central Council for Research in Ayurveda and Siddha, Central Council for Research in Unani Medicine (CCRUM), Central Council for Research in Yoga and Naturopathy (CCRYN), and Central Council for Research in Homeopathy were created. In September 2010, the Central Council

for Research in Ayurveda and Siddha was further bifurcated intro Central Council for Research in Ayurvedic Science (CCRAS) and Central Council for Research in Siddha (CCRS). Apart from these, the Central Council for Indian Medicine (CCIM) was established under the Indian Medicine Central Council Act, 1970, on August 1971 for promoting and overseeing medical education in these systems. Since then, CCIM has framed uniform curriculum and syllabi for undergraduate and postgraduate courses in Ayurveda, Siddha, and Unani Tibb. In 2012, Sowa Rigpa was also included in the framework of CCIM. Since 2014, all these autonomous institutions come under the Ministry of AYUSH, Government of India.

These research councils act as apex bodies for coordinating, formulating and promoting research in AYUSH sector along scientific lines. Under these central councils, there are various institutions/ centres located all over India as stand-alone units or within universities and other research bodies. Funding is also provided to research projects

outside the ambit of the Councils. An example is the FITM Fellowships granted since 2019 by RIS.

The research councils have been developing innovative drugs. Some examples are AYUSH 82 (for Type II Diabetes Mellitus) and AYUSH SG (for rheumatoid arthritis) by CCRAS, D5 *Choornam* (for Diabetes Mellitus) by CCRS, drugs for filariasis, hepatitis, ulcer, vitiligo and malaria by CCRUM.[2] These kinds of innovations will make the systems of contemporary relevance and the COVID-19 pandemic gives another opportunity for the systems to come up with innovative drugs.

In the devices sector also innovations have been happening, though only a few. Electro-*Trishoda*-Graphy (ETC) is a device that measures the *trishoda (Vadha, Pitta, and Kapha), Sapta dhatu*, and other fundamental elements of life as mentioned in Ayurveda text. The device is used for easy scan, evaluation, interpretation and diagnosis of diseases. The results of the computer scan are given in report form. The device has been tested and the Central Council of Research in Ayurveda Sciences (CCRAS), Ministry of AYUSH.

Another such an innovation is *Panchakarma* Machine. *Panchakarma*, which literally translates into five principles, is an important Ayurvedic procedure to cleanse the body. The IIT Delhi and CCRAS have invented a machine for the procedure.

Over time, the regulatory authorities also realised the need for adopting new technologies in the ISM sector. An example is the amendment to Rule 169 of the Drugs and Cosmetics Rules, 1945 in 2008. The amended rule permitted the use of excipients along with their standards, i.e. additives, preservatives, antioxidants, flavouring agents, chelating agents, etc. for use in Ayurveda, Siddha and Unani drugs, provided they are permissible under Indian pharmacopeia, the Prevention of Food Adulteration, Act 1954 and the Bureau of Indian Standards Act, 1986. This amendment also permitted use of artificial sweeteners like Sucralose, Aspartame, Saccharine, and Acesulfame K. These changes were made to enable the ISM pharmaceutical industry to adapt to the commercial needs of the times in accordance with the growth in science and technology. The purists in the sector may have difference of opinion as to use of such excipients, especially if they happen to be synthetic. But the exigencies of a global market would demand such modification, apart from the fact that these are new technologies, which were neither available in ancient times, when the systems originated, nor required until recently when the practitioners were catering to local needs only. In fact, until very recently most of the Ayurvedic formulations,like *Kashaya,* were home prepared by a patient's family. Innovations can enhance the marketability of products.

Rationale for Innovation in AYUSH

The AYUSH sector can really progress only if they ensure their "contemporary relevance, accountability and affordability to contemporary Illnesses and conditions" (Srinivasan, 2004). As of now, the status of the systems is that of 'alternative' medical system, whereas, until the British colonial times, these were the primary healthcare systems in the country. In most parts of the country, particularly in the rural areas, where there is no access to modern medical care, people have no choice but to go to ISM practitioners. In urban areas also, more people use them only as wellness treatment, and not as the primary choice.

Some scholars hold the view that a large population of the rural and urban poor rely more on traditional medicine and public sector whereas the urban middle and upper-middle class

purchase allopathic medicine in the private sector (Burns. 2014). If people are to accept it as a main health care system, it will have to create confidence in their minds. This is possible only if the systems adopt modern scientific approaches and become innovative. The status of the system has to get upgraded from the current tag of 'traditional' medicine or 'home remedies' (WHO) to a formal scientific healthcare system.

Although there is no deniability that there is a vast pool of traditional medicinal knowledge and traditional medicinal practices of immeasurable value in India, one cannot overlook the advancement in technology and modern medical sciences and how it has changed our life for the better. It is imperative that traditional systems of medicine should not be looked as an alternative but rather as a complementary science to modern medicine.

With increasing levels of education and knowledge expansion in other fields, it is necessary that the ISMs keep abreast of them. The practitioners of these systems should be able to converse and dialogue with them in the jargons of science with ease and felicity. This will be possible only if the systems infuse into them science and technology in a big way. Wide-spread application of science and technology will naturally lead to great number of innovations.

Components of an Innovation Eco-system

Mind-set Change: In order to create an innovation eco-system for ISMs the first requirement is of mind-set change. Such change is required among the practitioners, the industry, the educationists and academia and in the policy-makers. The attitude of unquestioned acceptance of all the practices and prescriptions in the ancient texts will have to give way to scientific scepticism. This will naturally give rise to much research to understand the basic principles of the systems, to apply them in the contemporary situations and environment and to innovate, wherever needed. This requires massive awareness generation across the country involving all stakeholders.

*Institutional linkages:*Another aspect that is required to be nurtured to create proper eco-system is creating appropriate linkages among educational and research institutions, the practitioners and the industry. There are many disconnects among them as of now. They need to be ironed out and a harmonious relationship and forward looking approach need to be created. This would also need development of an international perspective in place of narrow local approaches. As per the 2019 report on Traditional and Complementary Medicine by WHO, Ayurveda system is reported to be practiced in 93 countries whereas Unani is being practiced in 82 WHO member countries.[3] Openness will have to be hallmark of the new approach.

Professionalization of the Sector: A third dimension of an innovation eco-system is an overhaul of the healthcare system and practitioners of ISMs. This will affect the ISM health care facilities and industry, the education and research systems and the practitioners. The sector should use modern management structures and principles. That would mean they will be accountable for the outcomes. Professional approach is likely to lead to constant upgrading. Research will have to be done as per the modern scientific protocols, wherever appropriate.

IPRs: Intellectual Property Rights (IPRs) always find a place in all discussions on innovation. While one need not embark here on a debate on whether IPRs are essential for innovation or not, one may have to factor in certain aspects of IPRs. Since only product and process inventions, which satisfy the triple criteria of novelty, inventiveness and industrial application [Article 27.1 of the TRIPS Agreement] are to be granted patents, existing ISM products and processes are outside the purview of patent protection. The Indian Patents Act made it doubly sure by the explicit provision in Section 3(p) that "an invention which in effect, is traditional knowledge or which is an aggregation or duplication of known properties of traditionally known component or components" is not an invention. When one looks into the background of the incorporation of this provision through an amendment in 2002 in the Patents Act, 1970, one finds that it was essentially meant to protect the traditional medical knowledge, under which the ISM knowledge will fall, even when they are available in texts. The provision, however, need not act as a bar to innovations based on such knowledge. In fact, earlier there were patents

granted for such innovations in the form of 'patent or proprietary medicines' (a term used in the Drugs & Cosmetics Act). But in the recent years, one does not find many applications for patent from the traditional medicine field in the Indian Patent Office. What is required is a more enlightened examination of patent applications in this field that would enable the grant of patents to genuine innovations in ISMs. If necessary, certain special provisions can be incorporated in the Act. That will give a boost to innovation in ISMs.

Areas of Innovation

While the ISMs have a long history behind them, there are many areas where new innovations are required. It would be a good idea to undertake work on the scientific basis of ISM principles to make them explainable in modern scientific terms. Research on the proper mode of action, pharmacology, pharmacokinetics, and pharmaco vigilance of the ISM drugs will make them more acceptable to the scientific community, the ordinary people and the health policy makers (Chauhan*et al*, 2015). Validation of ISM drugs could be done through reverse pharmacology. STI should be used for asserting the effectiveness and safety of the ISM drugs.

Modern health care systems are protocol based. This ensures accountability of practitioners and healthcare facilities. It will also create better confidence in the minds of the patients. Such protocols will not stand in the way of personal medicine, but ensures that all the required steps are taken to avoid mistakes and falls in the treatments. An area where innovation is required is the development of such protocols as appropriate for the fundamental principles of the systems. This equally applies to diagnostics.

Medicinal plants are the raw materials of the ISM drugs and formulations. As stated above, they are described in the authoritative texts, but most texts are centuries old. During the last many centuries, the soil and climatic conditions and their qualities might have changed much, mainly owing to industrialization. These changes may affect the qualities and properties of these plants (*Dravyaguna*). Research in this area can help in ensuring that the formulations and drugs have the same therapeutic effect as described in the ancient texts. Wherever there is difference in the qualities of the medicinal plants, alternatives can also be suggested.

Contamination of heavy metals is a complaint often made against ISMs by western countries. Many a time, this contamination may happen during the process of collection or harvesting and transportation. Innovation is needed to develop proper protocols for collection or harvesting, transportation and stocking. It is also necessary to create purifiers at the manufacturing facilities to remove any impurities that might have crept into the raw materials.

Many modern Ayurvedic firms have been using advanced technologies. However, an ethos that technology is a handmaid of ISMs also like any other system has to be created. The traditional view that drugs and other formulations have to be prepared exactly as described in the ancient texts may no longer be practical in the modern age. Almost all systems including ISMs have been commercialised. If we want to export the products and services, we will have to use enhanced technologies in manufacturing and packaging. Innovations will be required to increase the shelf life of the products.

ISMs can adopt in a big way technology relating to medical equipment and devices. Devices are mostly system-neutral. However, the ISMs may require certain adaptions in the existing ones and also modernisation of the equipment,

which they have been using for long. Innovation is the way forward.

Innovation in Healthcare Service Delivery through Start-ups

The start-up ecosystem that has developed in the last decade has the changed the way services are produced and delivered in India. From hospitality, goods delivery, to innovation in healthcare services, India has become a vibrant hub for start-ups. The NASCOMM 2019 Start-up Ecosystem report puts India as the third largest start-up hub in the world, after China and USA. The report states that the number of start-ups in India was expected to cross the 9300 mark in 2019, and has the potential to grow upto four times this number by 2025.[4] India's large consumers base with access to the cheapest internet in the world provides an ideal platform for the start-up businesses to take off.

In the health sector, projects like NetMeds and 1 mg, etc. have penetrated the Indian markets, ensuring availability of affordable medicine in the remotest part of the country. Most of these online pharmacies also employ doctors to cross check the prescription and provide online consultations to customers. Furthermore, there are also projects like Practo that provides easy information about nearest consulting and specialized doctors, rated and reviewed by verified patients. The app also allows for prior booking at clinics and hospitals, along with offering attractive discounts on consulting fees.

The time is right now that AYUSH sector also utilise the benefits of start-up ecosystem. For a holistic delivery of healthcare services, patients should have an option to consult with AYUSH practitioners even through virtual interactions such as the one provided by 1 mg and NetMeds. It should be noted that Practo also gives details about nearest AYUSH practitioners classified by ratings, reviews, consultation fees, etc. Provision of patient tested environment for choosing a healer gives the patient an opportunity to make informed decisions, and also helps countering the fraudulent healing claims that poses an imminent threat to the AYUSH sector. It is important that such projects, which positively impact the health of the population, should be incentivised by the Ministry of AYUSH through soft loans, tax rebates and training programmes. A welcome step already taken is the issue of *Telemedicine Practice Guidelines for Ayurveda, Siddha and Unani Practitioners* by the Central Council of Indian Medicine on 7 April 2020.

Conclusion

India has been encouraging application of science and technology in AYUSH systems as a policy. The development of ISM pharmacopeia is an on-going effort in this direction. However, much more is required and the challenges raised by the COVID-19 pandemic give an opportunity to modernise the systems through innovations effectively using science and technology. That will be to the benefit of the entire humanity.

Endnotes

1. https://www.britannica.com/science/science
2. As per written reply by Minister of AYUSH in the Lok Sabha on 4th August, 2017.
3. WHO global report on traditional and complementary medicine 2019, Online at: https://apps.who.int/iris/handle/10665/312342
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STI SCIENCE TECHNOLOGY AND INNOVATION
COVID-19

Science, Technology and Innovation and the Challenge of Epidemic

KRISHNA RAVI SRINIVAS*

In a recent twitter talk Principal Scientific Advisor (PSA) Professor K. Vijay Raghavan described some of the ideas used to tackle the innovation, including expediting review of proposals on innovative solutions and try to guide the prospective innovators on regulatory issues.[1] He also talked about caution against over-interpretation of findings and need for more evidence for theories and hypotheses proposed on aetiology link between immunity and vaccination and enhancing immunity. In such times, there is a need for caution against quick conclusions and to promote evidence-based policy making. The dilemma here is that evidence-based policy making in such circumstances cannot take too much time to arrive at policies and to implement them. Hence the Government should promote more interdisciplinary research and integrate decision sciences in this and link use of Artificial Intelligence (AI) and machine intelligence. The Tata Consultancy Services (TCS) is using AI to find drugs for Corona.[2] It will be better to bring together groups working on AI and health. We may need teams of experts from various disciplines to analyse new findings and infer them for policy making. As the government is promoting open access and collaborative research in this issue, the idea of strategic collaborations among institutions, industry and academic establishments can be thought of.

However, the major challenge now is to find effective solutions quickly and ensure that they are widely adopted. The use of open innovation can help in this and innovation challenges can be organised for specific themes/problems. Another approach would be prize fund to address and solve a particular issue. For example, a prize for a low-cost ventilator suited for Indian conditions can be announced and the innovator can be rewarded with a prize. But given the commercial scope of the innovations, mere prizes won't be attractive unless the price money is huge and very attractive. Hence prize plus help in commercialising will be a better incentive. Or in addition to the prize, the government can buy the technology and related IP, out right and license them. Or the innovator can be encouraged to license and transfer the technology.

This is the time to promote reverse engineering and identify problems that can be better

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solved through reverse engineering. Given the phenomenal capacity in reverse engineering for processes in India, it is time to identify problems that can be better solved through reverse engineering. Here too the focus should be on timely solving of problems and rewards for it.

Through ATAL Innovation Mission (AIM) and similar schemes, a culture of innovation is being inculcated by the Government of India. On the other hand, we have thousands of students who have been receiving fellowships from INSPIRE.[3] The Government can try to link these and see how best such facilities that are developed under AIM can be used by INSPIRE Fellows and how AIM can also contribute to finding solutions to the epidemic. For example, Maker labs can be used to develop prototypes and substitutes.

3D printing has been used during the crisis to produce spare parts for ventilators at very affordable prices in Italy. Although there are IP issues, using this crisis, opportunities for using 3D Printing to develop substitutes, spares and innovative products should be created. In fact, we would suggest that given the huge need for ventilators and other equipment and other items used, wide spread use of 3D Printing can be promoted. The current ones can also be harnessed for this. Using this opportunity government can develop a plan for harnessing 3D Printing in health sector, particularly in bio-medical engineering.

PSA mentioned about finding solutions to problems like maintaining hygiene in shared facilities and how to maintain social distance when limited space has to be used by many. In addressing such problems, frugal innovation approach can help. The frugal innovations are generally meant for Bottom of the Pyramid population or for areas where facilities available are not adequate for implementing typical and standard solutions. We suggest that such problems can be first identified and listed and then the scope for frugal innovation can be examined. Some of the available ones may be tweaked while working on new ones can be promoted.

In this context, it should be pointed that through the Science For Equity, Empowerment and Development (SEED) division, the Department of Science and Technology (DST) has supported many NGOs and innovations working with women, tribal groups and rural areas. They have a wide range of innovative products and technologies.[4] Some of the technologies may be examined for their relevance in addressing this crisis. It is also suggested that their innovative capacity can be harnessed to develop products and technologies.

Open access to information and data has been promoted so that research groups can access, publish and share without constraints. This is a welcome development. But open access to information and data from/in India should be linked with globally available information and data, on one hand, and with open access tools, protocols and libraries (of chemicals, biological materials) and data so that there is synergy. To facilitate this, the Government of India should promote open source projects and groups working in Corona. Such groups and projects can be interdisciplinary and can work together to develop open access tools, processes and products. The Open Plant SynBio Project in Cambridge University is a good example.[5] It combines Open Source with Do-It-Yourself Biology and encourage open source hardware and instruments. Although the epidemic may be conquered in the short run, in the long run it is desirable to have an Open Source Project on epidemics so that all aspects are addressed and solutions are found.

Finally, it is time to revisit the Open Source Drug Discovery (OSDD) model.[6] While CSIR launched OSDD project in 2007 to find cures for TB, a similar project can be launched now to meet the challenges of the epidemic. This new project can be a collaborative one involving other developing countries and other stakeholders such as foundations and industry.

Endnotes

1 https://twitter.com/abhayjere discussion on 8th April 2020

2 https://www.thehindu.com/sci-tech/science/coronavirus-tcs-uses-ai-for-drug-discovery/article31257352.ece?homepage=true

3 https://online-inspire.gov.in/

4 https://dst.gov.in/seed-home

5 https://www.openplant.org/

6 Krishna Ravi Srinivas 2010 ,' Open Source Drug Discovery: A Revolutionary Paradigm or A Utopian Model?' In 'Incentives for Global Health: Patent Law and Access to Essential Medicines Series: Connecting International Law with Public Law: Edited by Thomas Pogge, Matthew Rimmer and Kim Rubenstein- Cambridge University Press 2010- Pp 263-283

STI SCIENCE TECHNOLOGY AND INNOVATION
COVID-19

Impact of Covid-19 on the World Economy

BISWAJIT BANERJEE*

The Covid-19 pandemic is wreaking havoc on the world economy. The global economic outlook was already fragile prior to the outbreak of the coronavirus crisis. Initially, when the outbreak emerged in China, it was thought that the negative impact on the global economy would be small —mainly limited to the output contraction in China and its knock-on effect on global supply chains, tourism, and commodity markets. However, with the rapid spread of Covid-19 across the world and the consequent imposition of containment measures and restrictions, all countries are experiencing severe supply and demand shocks that are independent of their links to global supply networks. In every country, the containment measures have adversely impacted all sectors of the economy to varying degrees. Production has plummeted, investment plans are being shelved, consumer spending has fallen sharply, and job losses have surged. Financial market sentiment has deteriorated, foreign direct investment inflows are dropping, and emerging market countries are experiencing large capital outflows. The global economy is now entering in a recession which is likely to be far deeper than during the Global Financial Crisis in 2009.

The imposition of containment measures has been a game changer for global economic performance and outlook. Reflecting the immediate impact of these measures on production, consumption and confidence, the composite Purchasing Mangers' Indices (PMI) of manufacturing and services in major economies dropped below 50 to their lowest ever levels in March, suggesting that a severe economic contraction is underway. Based on an analysis of sectoral output and consumption patterns across

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advanced economies and major emerging market economies, the OECD has estimated that the initial direct impact of the containment measures could be a decline in the *level* of output ranging from 15 per cent to 30 per cent (slightly below 20 per cent for India and around 25 per cent for G7 countries).[1] The variations in the impact across economies reflect differences in the composition of output.[2] Further, the OECD estimates that for each month that the containment measures continue, the drop in output is equivalent to a decline in *annual GDP growth* of up to 2 percentage points.[3] Thus, if the containment measures were in place for three months - a reasonable assumption if one takes into account that in Wuhan (China) the lockdown lasted for 76 days - annual GDP growth could be between 4-6 percentage points lower than it otherwise might have been (the OECD's projection in early March for world GDP growth was 2.4 per cent). On this basis, global output could likely contract between 1.6 per cent and 3.6 per cent in 2020. The latest projections of the International Monetary Fund and Economic Intelligence Unit for world GDP growth in 2020 (–2.9 percent and –2.5 per cent, respectively) fall within this range.

Rating agencies, investment banks and multilateral agencies have revised downward the growth outlook for India substantially following the imposition of the lockdown measures. Apart from the resilience of agriculture and allied activities, most of other sectors of the economy are adversely impacted by the containment measures. The latest projections of GDP growth for the Indian economy in FY21 range from –0.5 per cent (Nomura) to 2.5 per cent (Moody's). The Economic Intelligence Unit projects a quarter-on-quarter growth of –9.3 per cent in Q2, 2020. If the social distancing measures remain in place for a relatively extended period and it takes time for business and consumer confidence to return and normal business operations to resume, then GDP growth in FY21 might well be toward the lower end of the range.

The containment measures in response to the Covid-19 pandemic has contributed to a severe decline in employment in both developed and developing countries. Almost 10 million people in the United States filed initial jobless claims in the last two weeks of March, and the numbers have increased significantly since then. The number of new claims also increased many fold in Europe in the same period. Data released by the Center for Monitoring the Indian Economy show a three-fold increase in the unemployment rate since the imposition of lockdown: from 8.4 per cent in week ending March 22 to 23.4 per cent in the week ending April 25, with the increase being higher for urban areas than for rural areas. Much of this spike happened within a week of the imposition of the lockdown. Workers in the informal sector, including self-employed persons, have been affected particularly hard from the containment measures.

The International Labour Office (ILO) estimates that containment measures will likely result in a reduction in working hours worldwide by about 6.7 per cent (equivalent to a loss of 195 million full-time workers) in Q2, 2020 compared with Q1, 2020, reflecting both lay-offs and other temporary reductions in working time. The ILO projects the decline in working hours to be highest in the Arab states and Asia-Pacific region, and concentrated in sectors such as accommodation and food services, manufacturing, retail, and business and administrative activities.[4]

Countries have already initiated measures to contain the fallout from the Covid-19 pandemic. The measures are summarised in the Covid-19 policy trackers that have been launched by both the IMF and OECD.[5] These measures include increasing resources to the health care sector, providing support to businesses and workers (including self-employed persons) most affected by the decline in economic activity, expanding liquidity to banks and easing monetary policy stance to facilitate lending to the non-financial sector. The IMF and World Bank are also providing support through their various lending facilities to financially constrained countries facing health and funding shocks, and with weak health systems.

Strong multilateral policy coordination and cooperation will also be required to overcome the effects of the Covid-19 pandemic and facilitate a swift rebound in economic activity. But, progress on this front may be protracted. Financially constrained countries will need continued multilateral assistance, including access to concessionary financing, grants, and debt relief. At the recent G20 Extraordinary Trade and Investment Ministers Virtual Meeting, the Secretary-General of UNCTAD highlighted the sharp decline in foreign trade and foreign direct investment, and emphasised the need to avoid lasting damage to global production networks and supply chains.[6] In this context, most G20 countries underlined the importance of a rules-based multilateral trading system with a reformed WTO at its center. However, the meeting did not lead to any specific commitments to de-escalate trade tensions or avoid introducing additional trade barriers.

The timing of the resumption of growth and the speed of recovery are uncertain. Much will depend on the duration of the containment measures, the exit strategy from the lockdown, and the success of the policy responses in restoring business and consumer confidence. Even if the lockdown measures are successful in containing the spread of infected cases, there may be continued fear about the resurgence of infection until a safe and effective vaccine is developed and made available widely. This could increase precautionary savings among households and delay business investment, and thereby hinder growth.[7]

Endnotes

1 See https://read.oecd-ilibrary.org/view/?ref=126_126496-evgsi2gmqj&title=Evaluating_the_initial_impact_of_COVID-19_containment_measures_on_economic_activity Full shutdowns are assumed in transport, manufacturing and personal services; declines of one-half are assumed for output in construction and professional service activities; and declines of three-quarters are assumed in all the other output categories directly affected by shutdowns.

2 For example, countries in which tourism is relatively important potentially could be affected severely by the containment measures, while countries with relatively sizeable agricultural sector would be affected less.

3 Banque de France estimates the negative impact of containment measures on GDP growth in France to be higher. For every two weeks that the lockdown continues, annual GDP growth would decrease by 1.5 percentage points.

4 See https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/briefingnote/wcms_740877.pdf

5 See https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19 and http://www.oecd.org/coronavirus/en/#country-tracker

6 https://unctad.org/en/pages/SGStatementDetails.aspx?OriginalVersionID=250)

7 The IMF projects that the global economy could contract by as much as 6 percent in 2020 if containment measures continue in the second half of the year and the direct domestic economic impact from Covid-19 disruptions are broadly similar across countries.

STI SCIENCE TECHNOLOGY AND INNOVATION
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Global Institutions and COVID-19

ATUL KAUSHIK*

In this era of 'missing in action' United Nations Organisation, a dysfunctional World Trade Organisation and now cash strapped World Health Organisation, lack of adequate global coordinated action against the new Corona virus reminds us of the need for robust institutions.

Writing for *The Economist* on 15 April 2020, Kevin Rudd, former Australian Prime Minister and currently President of the Asia Society Policy Institute at New York opines that much of the complex web of national and global institutions established to deal with global pandemics and economic implosions has failed. While his solution of urging some countries to come together as M7 to establish a new global order may raise more questions than answers, he raises the key issue of abdication by powers of yore of their responsibilities during such a crisis.

Daron Acemoglu and James A Robinson, authors of *Why Nations Fail – The Origins of Power, Prosperity and Poverty*, take you through scores of stories criss-crossing geography and history of this planet to assert that to prosper, citizens, and nations, need inclusive institutions which create virtuous circles of innovation, economic expansion and more widely-held wealth. Particularly instructive is the story of England, which started a process to create inclusive institutions in 1688 through the Glorious Revolution and continued for generations through a slow, arduous process to emerge a strong wealthy nation that shaped the history of the planet for more than two centuries. Similarly, it took the French Revolution to develop inclusive political and economic institutions in 1789 that resulted in the creation of the most noted western democracy of its times, and gave us the three buzzwords of modernity: liberty, equality, fraternity. Half a century later Germany brought into the development lexicon the concept of welfare state, thus providing the much needed social security to the working classes. No wonder, then, that these are three of the M7 Kevin Rudd proposes to rope in, others being the European Union, Japan, Canada and Singapore.

Retired Additional Secretary to the Government of India who has served the country as a trade negotiator.

Bringing such epochal changes at the national level requires a statesman and a visionary who understands the pulse of his nation. To replicate such metamorphosis at the international level requires much more than statesmanship and vision: the ability to wield power amongst sovereigns while at the same time a readiness to share the power equitably for global benefit. It also requires, equally importantly, a buy in by the wealthiest of nations and, in the post-industrial world, by the corporate top rungs.

Without the United States of America, it would have been inconceivable to create institutions like the UN, NATO, the WTO, or even the European Union. Since Trump's accession to the US presidency, however, multilateral institutions have fallen by the wayside like ninepins. His America First campaign call translated into a particularly forceful form of unilateralism that affected the way everyone reacted to his administration, be they NATO, the United Nations, WTO, or now WHO. For one, nations and international bodies avoided confrontation while at the same time showing their disinclination to join hands. Also, the pundits at large started perceiving it as a gradual abdication of its global leadership by the Unites States, and the latter did nothing to correct course. The manner in which the new administration receded from the post-ISIS Syria-Iraq and then Afghanistan was understood more as blunderbuss than the action of a statesman staking any claim to global influence.

The stubborn US intransigence in refusing to agree on appointing Appellate Body members of the World Trade Organisation since 2017, rendering its dispute settlement mechanism dysfunctional by 2019 demonstrated its willingness to shoot itself in the foot and open up myriad possibilities of its trading partners cocking a snook at it even if the US wins in the WTO court. Around the same time the US started a trade war with China, not based as much on well established multilateral principles that the WTO has religiously nourished in the past quarter of a century to the benefit of every member country and its businesses, but on unilaterally announced assessment of the trade behaviour of a trading partner on whom most of its businesses depended for raw materials, intermediates and final goods alike. To add insult to injury, tariff walls were raised on many other countries too, equally unilaterally. The result was that China retaliated. And others followed suit, either by actual or threatened tariff increases, or seeking dispute settlement panels demanding the US takes back its tariff hikes. With the trade war in suspended animation, the only implication for businesses has been added costs and lack of predictability of trade rules, and the only implication for other trading nations has been to look askance at the future of the multilateral trading system and to look around for an alternative to the US for leadership.

No one would dispute the hypothesis of Acemoglu and Robinson that inclusive institutions, whether at the national or the global level, are a pre-requisite for economic growth and consumer welfare. The hypothesis, however, also commends that statesmen, not despots, are needed to create such institutions.

The global leader and prime mover of international action since the end of the cold war, the United States is no longer considered invested enough in this endeavour. The latest action of President Trump, to suspend a measly 400 million US dollar contribution to the World Health Organisation, pending an investigation into whether it showed a bias in favour of China in the Corona outbreak, shows the lengths to which he can go to show his wrath with or without a fair conversation with the parties concerned. And it shows why the world can no longer depend upon the United States to preserve, much less create, inclusive global institutions whether in the field of politics, economics or health. Hence it is natural for the likes of Kevin Rudd to recommend a new global order with new players calling the shots.

Reaching out for the other variable in the power matrix intrinsic to global deal making, one cannot ignore China. With its rank as the second wealthiest nation by GDP and by far the engine of global growth in the 21st century, China should be the natural successor to step into the shoes of the US as a global deal maker. Having started late yet almost conquering the coronavirus related challenges to its economy with a restart of industry and business in its Hubei Province, it is also becoming the default source of equipment needed by the world to tackle the crisis, from personal protective equipment and masks to test kits and active pharmaceutical ingredients for manufacturing hydroxychloroquine and other medicines.

Unfortunately, wealth and ability to step up to immediate needs of trading partners alone do not make a global leader. China has not been able to garner the trust required to lead a global effort even in a health crisis much less in other geopolitical challenges. With its non-democratic domestic governance system, opacity in data sharing, economically inexplicable state interventions in capital and currency markets, and lack of any experience in leading a coordinating role on international affairs, neither has China offered any overt leadership in handling matters relating to the virus nor the way to retrieve the WHO from its current trust deficit. And given the Sino-US relationship and Trump's haranguing on China's complicity in emergence of the virus outbreak, even if China were to try, it would fail to lead such an enterprise.

It may, therefore, be conceded that there may be a point, howsoever specious from the point of view of global power centricity, in excluding both the US and China as candidates for global leadership on the ground that their infighting will mar prospects of success of any grouping with either. But if one were to choose from the G-20, as Kevin Rudd has done, which of the members have shown leadership in recent times? It was, after all, Saudi Arabia and not any of the M7 that took the initiative to call a G20 meeting on the Covid outbreak. It was France that called the G7 to order to address the issue, even though the presidency of G7 is with the US this year. This, after the European Commission President Ursula Von der Leyen rebuked EU members for looking out for themselves alone. It was the Indian Prime Minister Narendra Modi who set aside the perennial squabble with Pakistan and called a SAARC meet to address the crisis within South Asia. So much for initiative. So, is it possible to ignore power centricity in these tumultuous times and look instead to the ability to get nations together for a common cause?

As the largest democracy and an emerging economy that may be more closed than desirable in terms of liberalisation, but at least democratic, open and transparent, India does not have the credibility crisis that both China and the US have. Modi has also shown the ability to lead coalitions of the willing, whether it was the Paris Agreement on Climate Change or the Solar Alliance. India also has been at the vanguard of developing countries' initiatives in various multilateral forums, having successfully sewn up, along with Brazil, a coalition of agriculture exporting developing countries, the G20 on Agriculture in the WTO, in 2004 that enabled WTO to stay on the development dimension path of the Doha Round of negotiations. It has not demurred in leading coalitions where its own expertise gives such leadership legitimacy, such as the Coalition for Disaster-Resilient Infrastructure in the United Nations as recently as in 2019. India, therefore, does have the ability to garner like-minded nations together for a common cause.

India, even before its independence, has been the proverbial prodigy of the global compact, having been a founding member of the United Nations and the Bretten Woods twins. It was at India's initiative that the Non-Aligned Movement came into being, a coalition that enabled the emergence of a multi-polar idea in juxtaposition to the starkly bi-polar power politics of the 1950s. No wonder, then, that India has always been in favour of multilateralism and has benefitted from it immensely, whether through the United Nations, the WTO or the WHO. Therefore, India is sufficiently invested in the need for reviving our multilateral institutions to their past glory.

India has been appreciated by the WHO and others alike for timely action on coronavirus, and has built a reputation of decisive leadership. It is time for India to step up on the global platform and take a leadership role, starting with ensuring that WHO is adequately funded after the suspension of funding by the US, and go on to create the necessary climate for revival of the WTO and other international intergovernmental institutions so that better coordinated efforts are seen in future for tackling crisis like the current coronavirus pandemic.

Nevertheless, it is also true that India does not have the financial muscle or a claim to the hot seat to ratchet up a coalition of the willing. Mere statements of intent will not deliver, even in these trying times. But then, it is eminently suited to take up the gauntlet and initiate a process of coordination and consolidation of global need of the hour. Prime Minister Modi has watched the *Garba* performance and ridden the swing in his home town with US and Chinese leaders alike with equal ease. No doubt, he will need his diplomatic corps to spread the word and coordinate global response. And they have shown their worthiness for such a enterprise in the Covid crisis as much as on other occasions, what with reaching out to 55 countries across the globe with hydroxychloquine within a week, reaching as far as the Dominican Republic, Peru and Madagascar.

The world is reeling under the adverse economic impact of the virus, and financial muscle of a single nation may not drive a good idea to fruition in these times. But collective effort may. All the European nations in the M7 of Kevin Rudd are focussed on fighting the virus in their own domains, as are Canada, Japan and Singapore, and may not be able to take up the cudgels individually, but together they may become a serious attempt to rescue the world from unilateralism and towards multilateral responses. Nor can India, but it can and should step in to initiate the coordination and we may see an opportunity arising out of this adversity: to restore multilateralism on the planet yet again.

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