Review Article

How COVID-19 Pandemic is Shaping Our Preparations in India for the Next Pandemic by Emerging and Reemerging Infectious Diseases: A Review

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ABSTRACT

Emerging infectious diseases are those that have been newly identified in a population, have existed before, but are now increasing rapidly in incidence or geographical location. Remerging infectious diseases are those infections that were a problem in the past but then declined, and now they are again increasing in incidence due to various factors. Emerging infections of interest are SARS, COVID-19, Nipah, Bartonellosis, Lyme's disease, Cryptosporidiosis, etc. Examples of some reemerging infections are West Nile fever, dengue, tuberculosis, malaria, ebola, cholera, and plague. COVID-19, a pandemic that appeared all of a sudden but in a distant land, gave some space for preparedness. The challenges associated with a novel or emerging infection are a lack of diagnostic kits and trained personnel at grass-roots levels to use the newly developed tests. India, which was placed at rank 57 in the Global Health Security Index, fared much better than countries placed in the top 5. India has had a very successful implementation of vaccination programs in the past. That experience and infrastructure with trained personnel play a huge role in the implementation of the COVID-19 vaccination.

Key words: Covid-19, Emerging, Pandemic, Reemerging

BACKGROUND

A lot of interest is now getting generated about emerging infectious diseases (EID) and reemerging infectious diseases (REID) recently. Thanks to the COVID-19 pandemic, the world is now better prepared to handle the threat of EID and REID than before. In 1967, the then US surgeon general infamously quoted that the era of infectious disease might get over soon. He was very optimistic after the initial success of antibiotics.[1] That initial euphoria was short-lived, though, as soon as antibiotics resistance was discovered. By definition, emerging infections are those that have recently been identified, have occurred before but in a limited population, and now are increasingly or happened earlier, but the etiology is now known as a distinctive infection.[2] Remerging infections are those infections that were a problem in the past but then declined, and now they are again coming up due to various factors.[3] It's an interplay between the classical epidemiological

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triad of host, agent, and environment, which are at play; any imbalance in them can cause an infection to appear. It is estimated that the majority (2/3rd) of emerging infections are zoonotic in nature, and many of them can be vector borne.[1] Examples of emerging infections of interest are SARS, COVID-19, Nipah, Bartonellosis, Lyme's disease, Cryptosporidiosis, etc. Examples of some reemerging infections are West Nile fever, dengue, tuberculosis, malaria, ebola, cholera, plague etc.[4]

INDIA'S FIGHT IN COVID-19

India has had its own share of dealing with EIDs and REIDs in the past. Most of them are viral and zoonotic in nature. The prominent ones are discussed in Table 1.[5] The recent pandemic has tested the preparedness of the health infrastructure and preparedness for the pandemic. It is certain that future pandemics are going to be one of the emerging or reemerging infections.[6] COVID-19, a pandemic that appeared all of a sudden but in a distant land, gave some space for preparedness. The government anticipated the scale of the task at hand if the virus somehow permeated India from China. 1st week of January 2020 saw the meetings by the Ministry of Health and Family Health Welfare conducted and how a multipronged strategy to be formed. Multiple empowered groups were formed to tackle the future problem at hand.[7]

Planning at the top level of government management is necessary to handle a disaster of this magnitude. Effective leadership is also a top requirement. The eleven empowered groups were as follows:

1. Medical emergency management planning
2. Availability of hospitals, isolation and quarantine facilities, disease surveillance and testing, and critical care training
3. Ensuring the availability of essential medical equipment such as personal protective equipment, masks, gloves, and ventilators; production, procurement, import, and distribution.
4. Augmenting human resources and capacity building.
5. Facilitating supply chain and logistics management for the availability of necessary items such as food and medicines.
6. Coordination with civil society, the private sector, and international organizations.
7. Economic and welfare measures.
8. Information, communication, and public awareness.
9. Technology and data management.
10. Public grievances and suggestions.
11. Overall strategic issues relating to lockdown.

For effective management of any pandemic, the cornerstone lies in testing.

The challenges associated with a novel or emerging infection are a lack of diagnostic kits and trained personnel at grass-roots levels to use the newly developed tests. Manufacturing a diagnostic kit early enough to impede an explosive situation is challenging enough. Robust research and development (R&D) in technological front, innovations, and data regarding the agent is needed to manufacture and validate the tests.[8] In a lot of ways COVID-19 has opened up a lot of avenues for innovations in development of kits. For a country that has a huge population, dense pockets, distribution and testing facility is a huge logistical nightmare. Just testing kits is not enough, highly trained man power resource is needed to test and it all adds to the challenge. And given the speed by which the virus spreads, due to fast pace of transport, the testing facility had to be ramped up at a war footage. The ramping up was in a scale proportional to the changing scenario for Covid. It is estimated that within 5 months the number of laboratories capable of testing COVID-19 increased from 14 to 1596. Testing capacity increment comes with its

Table 1: Various outbreaks of emerging and re-emerging infectious diseases in India between last 3 decades

Category of causative agent	Disease and causative agent	City and year of outbreak
Bacteria	Cholera (*Vibrio cholera* O139)	Chennai 1992
	Diphtheria (*Corynebacterium diphtheriae*)	Delhi (2000)
	Plague (*Yersinia pestis*)	Shimla (2002) Uttarakhand (2004)
Virus	Chandipura (Chandipura virus)	Surat (1994) Andhra Pradesh (2003) Gujarat (2004) Maharashtra (2007)
	Nipah (Nipah virus)	Siliguri (2001) Karnataka (2023)
	Chikungunya (Chikungunya virus)	Hyderabad (2005) Rayalseema (2005) Nalgonda (2005)
	H1N1 (influenza virus)	Hyderabad (2009)
	Crimean congo haemorrhagic fever -CCHF (crimean congo virus)	Gujrat (2011)
	Covid-19 (SARS CoV-2)	All over the globe 2020

own set of challenges. These include capacity building, supply chain constraints, skilled human resource, data monitoring. Apart from availability of resources, another challenge was affordability. Role of private players in both R&D and testing can't be undermined.[9] Infections may come and then go in appropriate time. But the capacity building, training, testing the supply chains and other facets will stay with us. In future the response rate to a similar type of an emerging infection is expected to be dealt with more swiftly and efficiently. From a mere few hundred tests a day, testing was increased to more than 140,000 in few months. Existing infrastructure came to good use in a few districts where good molecular testing labs were not available. For example, TrueNAT polymerase chain reaction (PCR) machines used for diagnosis of Tuberculosis was used for COVID testing.[7]

Apart from the health costs, a new infection will also test economic stability and reserves. There is also a human or social cost, which sometimes takes a back seat. The COVID pandemic saw lockdowns throughout the world. Our country also saw a relatively sudden announcement of a lockdown. The burnt of this sudden announcement was on a lot of migrant workers or people having temporary jobs. This caused a mass migration of several hundred to a thousand kilometers. Special Shramik trains organized by the Government of India and helped by local administrations took efforts by arranging lodging, food, etc. when the migrant population reached their destination. A lot of lessons were learned and will be useful in the case of similar things in future pandemics.[10]

Communication is key in this era of information and technology. Advancements in information and technology played a key role in helping to mitigate the disaster. All key information regarding precautions, vaccines, availability of hospitals, testing facilities, laboratory results was available on mobile phones. Government-aided or supported apps like "Aarogya Setu" also played a key role in tracing patients and aiding patients with all sorts of medical information. Just imagine if the pandemic happened during the pre-smart phone era. There would have been totally different dynamics. Smart phones helped in a long way to sustain the lockdown for relatively longer periods.

It was as if the advances in science, innovations, and information technology in the last 20 years have been a blessing for this pandemic. All these made the lockdowns easier to sustain for a lot of professions and professionals. Schools and colleges could be shut down for a prolonged period because of the availability of mobiles, the internet, and applications. The distribution and percolation of all these to the lowest strata of the population also helped immensely. Without these, the imposition of restrictions for a prolonged period would have been next to impossible.[11] The use of mobiles devices comes with its own set of issues. Mobile phones can be addictive in nature for all age groups. An increase in screen time can have long-lasting effects on mental health, especially in children.[12] This is something that requires a look because, during normal times, phone addiction is also real health challenge. Lack of physical activity in children and adults was also concerning during COVID-19. Even with cheaper mobile sets and internet connections available in a country like India, the relative lack of equitable distribution of these played a role in the disparity of knowledge distribution in schools. The less privileged were left behind during that period.

The improvement in diagnostics, especially the improvement in molecular technology, helped immensely to curb down the pandemic in a relatively shorter duration. One of the cornerstones of managing the pandemic is the rapid and reliable diagnosis of cases. This will ensure that few of the infected cases are left to infect the untouched population. Being a viral infection, the reliance on PCR for diagnosis is immense. The culture of viruses for diagnostic purposes is not only time-consuming, physically demanding, costly, and requires highly trained personnel but also its lack of availability limits its use. Recent advances in molecular technology have brought in newer generations of rapid and accurate molecular assays for the detection, quantification, and genetic characterization of viruses.[13] With advancements in real-time PCR, more can be achieved in less time. The product can be seen in lesser time, can be quantified, is less-labour intensive, and carry-over contamination is negligible.[14] As a result, a laboratory with optimum manpower can carry out of thousands of tests every day, as opposed to rate limitations in conventional PCRs. The post-analytical part, which takes care of report despatch, is a very vital step in information dissipation. A sound system of it helped it to trace persons who were ill or carried the virus to be isolated from airports, etc., so that the spread of viruses could be limited. The Aadhar card, a unique identification number for citizens of India, played a key role in COVID-19 mitigation. Vaccines, which proved to be a cornerstone for India's response to COVID. It depended a lot on the effective delivery of COVID-19 vaccines to all corners of India.[15] For ramping up the RT PCR tests after initial periods of pandemic, it was necessary to use the existing resources available at hand or to build upon a minimum structure in a very limited period of time. Who better than a large number of medical colleges to carry out this difficult ordeal. It

was a win-win formula for both the government and the medical colleges. The government got trained workers and robust infrastructure, while medical colleges got a much-needed boost for a higher testing facility (BSL-2) for testing, research, and return on investment.[16] It is in a sort of preparation for not only COVID-19, but now the infrastructure is such that any pandemic or outbreak in the future can be dealt with efficiently with the things in place. It is often taken for granted the ability of the lower- and middle-income countries to deal with the pandemic of this scale. The real challenge, though, will be the utilization of the workers and laboratories now that the pandemic has subsided. They must be utilized in the diagnosis and research of other often endemic, neglected viral infections. So that the system is always ready and the precious trained workers are not lost in oblivion.

The global health security index, which sees the countries preparedness for such eventualities ranked India at a modest 57. But contrary to expectations, it fared much better than even countries placed in the top 5. This was shown by the way India was able to scale up testing and treatment facilities.[17] On the treatment front, India was able to increase the intensive care unit bed capacity by more than 3 times, the number of isolation beds, and the number of COVID care centers.[18] Oxygen, which is such a vital drug used in the management of severe respiratory tract infections, was again a hallmark of a lot of emerging infections that were in huge strain or scarce during the crisis. It was due to the unprecedented increase in the requirement, as a huge number of patients were admitted for respiratory distress. The demand reached a level of 16398 MT by the end of 2021. A lot of hospitals started instilling plants to meet the increasing demands. For shortfalls, transport like trucks and special trains played a huge role, along with cooperation from local administration and traffic personnel. Green corridors were made for seamless supply.[19]

Vaccination had a huge role to play in the fight against COVID-19. Vaccines are not new, and their development has an interesting history. In a lot of ways, they have actually shaped the human story. Vaccines have changed the dynamics of the fight against infectious diseases. The path to effective vaccines has been a treacherous one.[20] India was among a handful of nations that had the expertise to manufacture a vaccine indigenously. India not only manufactured it but also distributed it free or at very low cost to its own citizens and to many other countries that beared the brunt of COVID-19. It was self-reliant on that front. Many private companies with government support had a very crucial role to play. This paves a whole new dimension for tackling any such disease in the future.[21] India started the COVID-19 vaccination program in January 2021. If history is any gauge, this was actually very less time to develop and distribute an effective vaccine after standard clinical trials. The state governments played a very crucial role in the storage and distribution of the vaccine and the effective implementation of the vaccination program. India has had a very successful implementation of vaccination programs in the past. That experience and infrastructure with trained personnel play a huge role in the implementation of the COVID-19 vaccination.[22]

For the vaccine to be acceptable, it has to undergo stringent trials for efficacy, safety, etc. A robust clinical trial hub is the bare minimum essential to do this. Recently, India has become a reliable and attractive hub for clinical trials. That allowed for fast-paced clinical trials for vaccines, which could be available to the public in nearly record time. That experience will come in handy in the event of future uncertainties.[23] Drug treatments like antibiotics, anti-fungals, and anti-helminthics have a key and major role in the management of bacterial, fungal, or parasitic infections. However, it is very limited to viral infections, as antiviral treatment is available for only a few viruses. During the peak of the COVID-19 pandemic, a lot of drugs were tried or studied for efficacy in patients, but they were met with very limited success.[24] Hence, it is an area of active focus and research for the development of antivirals for future pandemics due to EIDs and REIDs.[25] The development of monoclonal antibodies is also a promising premise to look into. During the COVID-19 pandemic, many of them were in use with variable results, but certainly it is an area to look into, especially with the paucity of antiviral agents.[26]

CONCLUSION

The infectious agents are here to stay with us. Just that, we need to be more vigilant with them and always anticipate their presence. With improvements in innovation and technology, dealing with these agents can be more pragmatic, multi-pronged, and reliable. Prevention and quicker diagnosis are cornerstones to tackling these agents. Emerging and reemerging infectious infections are here to stay. In a country that is as diverse as ours, progressing, and entering new niches as we are unsettled and hungry, it is inevitable that we do not get these exotic infections that have the capacity to explode. The balance has to be maintained between all domains of health. We should not let all the lessons learned during COVID-19 time go forgotten, and we should build upon that.

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