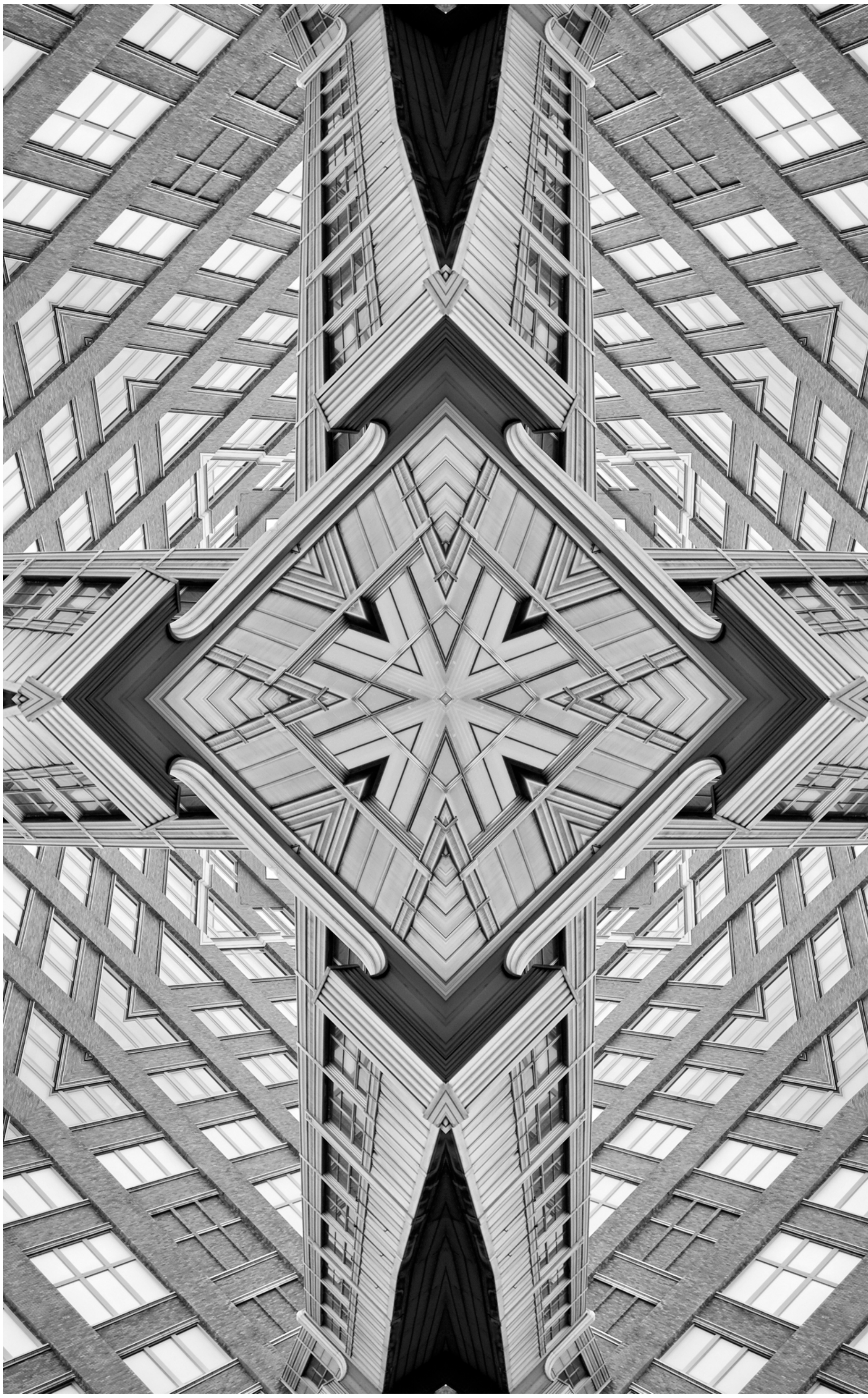
Issue Brief

ISSUE NO. 603
JANUARY 2023



Reevaluating Bioweapons Amid Global Political Fragility

Shambhavi Naik

Abstract

Unstable political systems, ineffectual international organisations, and unprecedented technological advancements have created a global environment that can enable the development and deployment of bioweapons. New-age bioweapons could be used for more than just as weapons of mass destruction. This necessitates a new approach to mitigate risks by staying apace with technological development. India must take a leadership position at the Biological Weapons Convention while strengthening internal surveillance and healthcare systems to ensure its biosecurity. Investments in emerging technologies will be crucial to deter biosecurity threats.

Attribution: Shambhavi Naik, "Reevaluating Bioweapons Amid Global Political Fragility," *ORF Issue Brief No. 603*, January 2023, Observer Research Foundation.

Introduction

Genetic material provides the fundamental building blocks for most physical characteristics. The colour of human eyes, the length of a grain of rice, and the horns of the cattle are all governed by genes. Recently, the importance of genes in influencing the infectivity of pathogens has been highlighted by the rapid spread of Sars-CoV-2, the infectious agent causing COVID-19. Sars-CoV-2 differs from other coronaviruses in a few genetic regions, conferring on it the ability to interact strongly with the human ACE2 receptor.[1] This strong interaction, among other factors, facilitated the rapid spread of COVID-19 worldwide. Further changes in the genetic material of emerging variants have led to subsequent waves of COVID-19.[2] Conversely, the study of Sars-CoV-2 genes have resulted in rapid diagnostic kits and created avenues to engineer successful vaccines that could target its infection.

The role of genes in a human's daily life does not need any emphasis. Techniques such as polymerase chain reaction, cloning, Sanger sequencing, and next-generation sequencing have provided the ability to read, edit, and synthesise genetic material. The functions of genes in health and disease can be unraveled using these techniques. For instance, one can now conclusively demonstrate that certain mutations can increase cancer risk or cause congenital diseases such as thalassemia. By understanding the interactions of proteins that genes encode, humans can create vaccines against infectious diseases. Using computational biology, scientists can predict potential mutations in new variants and be prepared with vaccines before the variants manifest. Scientists use gene editing technologies such as Zinc Finger Nucleases and Transcription Activator-Like Effector Nucleases to edit genes and study their impact on microorganisms. Newer technologies, such as Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR), have extended this capacity to edit human cells with unprecedented precision.

The last few decades have conferred onto humans the tremendous power of altering the very fundamental blocks of biology. This power can be used for alleviating disease, but can also be used to design newer biological weapons, leading to new diseases. COVID-19 has shown the devastation—of life and

Introduction

economy—that new diseases, whatever their origin, can cause. In addition, COVID-19 has also demonstrated the weak nature of key multinational agencies, such as the World Health Organization (WHO), in quickly responding to an emerging threat. In this backdrop, the current turmoil in international relations and political instability across various countries have created an environment that could facilitate the development and deployment of bioweapons. This combined biotechnological progress and fragile political systems warrant a serious study of bioweapons, how they may be potentially used, and how India can protect against this emerging threat.

> "The last few decades have conferred onto humans the power of altering the very fundamental blocks of biology. This power can be used for alleviating disease, but similarly can also be used to design newer biological weapons, leading to new diseases."

New-Age Biowarfare: Setting the Stage

The conversation around biowarfare has thus far mostly been limited to the use of biological weapons as a weapon of mass destruction. In this context, bioweapons are banned by the Biological Weapons Convention (BWC), a multilateral arms control measure in force since 1975.[3] The fear of bioweapons stems from the resulting uncontrolled spread of disease, unlike the relatively more limited fallouts of other weapons. State actors, including the US, that once experimented with creating bioweapons, are wary of a rival stealing these technologies. This fear was so apparent that, in a first in the arms control and disarmament sphere, countries agreed to disband their existing bioweapons programme and destroy any stockpiles. While the treaty can be said to be a major victory for international diplomacy, the lack of a verification mechanism means that there is no real way to check if all signatory countries continue to adhere to its provisions.[4] Further, even the investigation of a potential bioweapon attack can only be started upon a country's request and routed through the United Nations Security Council, rendering the BWC toothless. However, the lack of any major incident involving bioweapons has lulled the international community into ignoring the bioweapons threat and the weaknesses in the BWC. Despite serious attempts, including a verification mechanism within the BWC has failed. Unlike the Chemicals Weapons Convention (CWC), the BWC lacks a scientific board that can advise it on emerging technologies that could impact bioweapons. Even more importantly, the BWC is poorly funded, with the implementation support unit only having three employees as compared with the CWC's 500 or so employees.[5,6] While the lack of use of bioweapons in the interim is promising, it is important to remember that new-age bioweapons may overcome some of the challenges associated with acquiring and using traditional bioweapons.

Indeed, since the treaty was signed in 1975, the nature of warfare and the technologies to engineer biological weapons have changed. New-age technologies are changing both the kind of biological weapons that can be used and the delivery mechanisms to deploy these. The use of biological weapons can be covert, with attribution to a particular source obscured by limits of scientific detection and political mechanisms. This may make biological weapons appealing to state or non-state actors interested in subverting a rival authority without necessarily having to engage in a full-blown military intervention. Thus, the theatres where biowarfare could be engaged may differ from the traditional battlefield.

In addition, bioweapons may confer the advantage of selective destruction of agriculture or animal livestock. A state or non-state actor who wishes to use biowarfare might not be interested in directly killing human populations. Instead, they may target agriculture or animal husbandry, leading to starvation, heavy economic losses, or the artificial creation of dependence on a provider country. Such selective destruction cannot be achieved using other means of warfare. The emergence of new diseases, the changed patterns of predator movements and the unpredictable nature of agricultural outputs driven by climate change and globalisation can obfuscate any investigation of an unusual biological event. Thus, new-age bioweapons bred to cause economic devastation without directly hurting human populations are a category that needs to be assessed.

Moreover, new technologies are being developed to deliver gene editing components into humans for medical purposes. Delivery mechanisms, such as genetically modified viruses, do not cause any harm and carry medical payloads that can cause the necessary gene edits inside a human body. Such *in vivo* delivery mechanisms are envisioned to revolutionise medical therapy for diseases of genetic origin, such as certain cancers, thalassemia, and haemophilia. However, these same medical tools could also be used to carry malicious payloads. These mechanisms could, in effect, ease delivery, which remains one of the major challenges of deploying bioweapons. As the technologies improve—which they will and must for medical purposes—we will see further simplification of the delivery of gene editing components.

Finally, the experience with COVID-19 has demonstrated the difficulties in identifying the origins of novel diseases. Notwithstanding the nature of the virus' origin, the first WHO investigation into the origin happened only after the World Health Assembly passed a motion in May 2020. Subsequent investigations by various institutions have come under criticism for the conflict of interests of the investigators.[7] The controversies fuelled by these delayed and opaque investigations on social media has led to the spread of further misinformation. The fallout of the political games surrounding the scientific investigation is that we are no closer to understanding the virus's origin and identifying ways to prevent a pandemic of this scale from breaking out again.

Thus, the advantages of using novel technologies such as gene editing coupled with the quagmire created by weak multinational institutions means that a cleverly designed bioweapons attack may never be identified. On a global stage, where war-related state actions are often met with economic sanctions or other consequences, biowarfare may provide an interesting avenue to even state actors, who seem to have been averse to their use. Below are some new approaches in which bioweapons might be used.

- **Targeting individuals for attack**

The use of bioweapons for personal attacks is not novel. The 1978 assassination of Bulgarian dissident Georgi Markov using a ricin pellet fired from an umbrella brought attention to the use of this biotoxin.[8] In 2020, letters containing Ricin were sent to the US White House and various law enforcement agencies in Texas.[9] Ricin has also been recovered from individuals in Indonesia and Germany. Ricin, which is banned under both the BWC and CWC, has been used for limited attacks but does not offer any avenue for personalisation. However, with new technologies and a better understanding of human biology, it may become possible to design new-age bioweapons that can be tailored for a specific human target.

The advances in sequencing technology have significantly reduced the cost of sequencing. The first human genome sequencing effort took 13 years (1990-2003) and cost about US$1 billion, but it currently costs anywhere between US$300 to US$1000, with prices expected to reduce further soon.[10,11] Further, the ability to sequence from smaller amounts of starting materials or ancient samples has also improved. Consequently, genetic sequencing for both medical and non-medical purposes has mushroomed. Genetic sequencing can inform on health, risk of disease, and even ancestry of individuals. In research, genetic sequencing is useful in characterising genes and unravelling their functions.

As our knowledge of the human body improves, we may be able to target individual weaknesses in our biology. It may even become possible to target individuals using their genes.[12] Getting deoxyribose nucleic acid (DNA) for sequencing genes is easy—DNA can be obtained from fingerprints, saliva, or other bodily matter. Even building potential DNA sequences using DNA obtained from samples of close relatives is becoming possible. Finally, various countries, including India, are moving to create forensic and medical DNA databases, and private companies such as 23andMe and Ancestry.com are building databases that could act as repositories of DNA.

Given this context, tailored weapons to target individuals may become a convenient option for an interested State or non-State actor. For example, genome sequencing may reveal an individual has a higher risk of a particular disease. Then CRISPR-based tools may be created to cause further mutations to increase this risk or expedite disease causation. Such designer diseases may remain untraceable and may be treated as normal disease progression, allowing the perpetrating party to remain anonymous.

- **Targeting population subgroups**

Building on the premise of tailored weapons, it is likely that weapons meant to target particular population subgroups based on ethnicity may be designed. Ethnic groups, particularly those that practice endogamy, may carry common genetic signatures. These signatures can be used as a targeting mechanism for bioweapons. A hypothetical scenario can be as follows: a delivery vector, such as a virus, is created to deliver a lethal genetic payload. The switch to turn on the transcription of this payload is engineered to respond to the unique signature present in the ethnic group. A more plausible scenario is the development of new diseases that can be used to target populations while the perpetrator develops vaccines or antidotes to protect their forces and people.

- **Targeting agriculture**

Agriculture is an easy target for bioweapons, with the ripple effect likely to be felt worldwide. Over the past few decades, changes in predator patterns have been observed. In 2020, for example, swarms of desert locusts damaged crops across multiple states in India. Some of these regions have not seen locusts' swarms since the 1970s. Such changes are to be expected and can be attributed to climate change.[13] However, the obscurity provided by climate change can also cloak any deliberate effort at sabotaging agriculture.

The US Defense Advanced Research Projections Agency runs a programme called 'Insect Allies' to use insects to deliver genetically modified viruses to plantations. These viruses will then genetically modify the target plants. This programme aims to respond to any emerging threats to agricultural produce quickly. As noble as that goal is, any technology developed to deliver beneficial payloads can be usurped to deliver harmful payloads. Questions have been raised about the relative utility of this programme, and it remains to be seen how scientists can ensure that the system is not misused.[14]

Similarly, scientists are also working on a molecular technique called 'gene drives'. Gene drives is a system that circumvents the natural method of an offspring inheriting genes from either parent through a random choice. Gene drives introduce a new gene in insects, which is always inherited by the offspring and future generations. Such systems are being developed to combat vector-borne diseases such as malaria and dengue. However, this system could also be used to deliver a toxin or pathogens to a target population, sparking fears of it becoming a tool for biowarfare.[15]

Should These Technologies be Banned?

Emerging technologies based on natural processes such as CRISPR and gene drives give humans unprecedented control over our genetic foundations. There is no point denying that this control could be used to achieve malicious outcomes. However, there are tremendous benefits to allowing these technologies to blossom. The lowest hanging fruit is the alleviation of human disease and suffering, particularly those diseases of genetic origin. Other benefits include improvement of agricultural outputs, conservation of endangered species and increased human productivity. The risk of bioweapon engineering is relatively low compared to the thousands of laboratories involved in performing research on the beneficial applications of gene editing. Hence, the spread of these technologies needs to be promoted so that their beneficial applications continue to prosper. Though these technologies are becoming rapidly available, there is still expertise and infrastructure requirements for successfully building a bioweapon using gene editing. At the same time, these technologies need to be regulated to prevent their use for malicious purposes.

What India can do to Improve Biosecurity

Over the past decades, multiple disease outbreaks have happened in India's neighbourhood. The second COVID-19 wave demonstrated how ill-prepared India's health system is to face an emerging disease.

A national policy governing the supply chains of biological products, access to biological reagents, and ethical training of researchers will help promote biosafety and legitimate uses of emerging technologies. This can prevent laboratory accidents and leakages of biological material that could be used as a basis to create biological weapons. However, if a biosecurity risk is comprehended, its origin as a bioweapon or a natural occurrence is a secondary question. The primary challenge is to detect the threat early and limit its spread. In this context, India needs to take four steps to prevent and prepare for a possible biosecurity risk.

- **Set up a biosecurity threat identification system**

There is a need to set up a surveillance hub to identify emerging threats to India's biosecurity.[16] This hub can support India's intelligence agencies and work with the appropriate ministries to ensure the country is prepared to tackle any risks or threats. The surveillance hub should incorporate digital monitoring systems to monitor digital content related to biological events. This information would be analysed by a team of agricultural experts, public health professionals, statisticians, epidemiologists, and analysts trained in strategic studies. Finally, trained officers could acquire field samples for further analysis if required. Such a system would be essential for India to remain ahead of emerging threats.

- **Universal healthcare**

Any threat to human biosecurity can be encountered with a robust healthcare system. This includes access to primary healthcare, testing facilities, and research on designing new vaccines and medicines. All biosecurity threats—whether a bioweapon or natural pathogen—qualify as a threat if they can cause serious damage to human life. A responsive healthcare system, geared to detect, respond, and communicate on health threats, would reduce the threat to India.

What India can do to Improve Biosecurity

- **Renegotiating BWC**

COVID-19 has shown that biosecurity cannot be the concern of any one nation. Similarly, India cannot tackle bioweapons on its own. Hence, it needs to take a leadership position at the BWC and negotiate a treaty more appropriate for the new technologies.[17] In this regard, India has recently reiterated its call for negotiating a verification protocol for BWC.[18] The BWC immediately requires substantial funding sources and a scientific board capable of advising the Convention on emerging threats. The board could also prescribe a common minimum programme for biosafety policies and healthcare responses. The Convention should create a threat matrix for emerging technological applications and pathogens and design proportionate evasive measures. Further, the Convention should consider actively monitoring unusual disease patterns and maintain a database of evolving pathogen genetics.

- **Fund more gene editing research**

While this may seem counterintuitive, the best biodefence against an engineered pathogen may be understanding its pathogenicity and designing vaccines or therapies. Gene editing may play a critical role in both characterising the pathogen quickly and even creating therapies. However, for this to happen, India needs to actively fund gene editing research so that the expertise and infrastructure are available locally. For example, if a new plant pathogen is destroying rice plants, gene editing may be able to deliver an antidote to protect the plants quickly.

> "A national policy governing the supply chains of biological products, access to biological reagents, and ethical training of researchers will help promote biosafety and legitimate uses of emerging technologies."

Conclusion

Bioweapons have long been considered uncontrollable weapons of mass destruction, resulting in them being shunned by the international community. However, new technologies and a fragile international political scenario have created a situation where targetable bioweapons may be created and used without attribution. This situation warrants a revisit of the BWC and how the world views bioweapons. Stricter regulation, global cooperation, and better healthcare and agricultural practices are a must to prevent any untoward event.

(This brief was first published in the GP-ORF Series 'Future Warfare and Technologies: Issues and Strategies'.)

Shambhavi Naik *is the Head of Research at Takshashila Institution and is the chairperson of the Advanced Biology programme.*

Endnotes

1 Ana Sandoiu, "Why does SARS-CoV-2 spread so easily?," *Medical News Today*, March 17, 2020, https://www.medicalnewstoday.com/articles/why-does-sars-cov-2-spread-so-easily#Key-receptor-on-human-cells\

2 Rehan M El-Shabasy et al., "Three waves changes, new variant strains, and vaccination effect against COVID-19 pandemic," *International Journal of Biological Macromolecules*, 204 (2022):161-168 https://pubmed.ncbi.nlm.nih.gov/35074332/

3 Arms Control Association, "The Biological Weapons Convention (BWC) At A Glance," https://www.armscontrol.org/factsheets/bwc

4 Jonathan B. Tucker, "Putting Teeth in the Biological Weapons Convention," *Issues in Science and Technology*, XVIII (2002):3 https://issues.org/tucker/.

5 Annual Report of the Implementation Support Unit, Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, 2019, https://documents-dds-ny.un.org/doc/UNDOC/GEN/G19/300/74/PDF/G1930074.pdf?OpenElement

6 Arms Control Association, "The Chemical Weapons Convention (CWC) At A Glance," https://www.armscontrol.org/factsheets/cwcglance

7 Paul D. Thacker, "Covid-19: *Lancet* investigation into origin of pandemic shuts down over bias risk," *BMJ*, 375(2021), https://www.bmj.com/content/375/bmj.n2414

8 Christopher Nehring. "Umbrella or pen? The murder of Georgi Markov. New facts and old questions". *Journal of Intelligence History*, 16(2017):1, 47-58, https://tandfonline.com/action/showCitFormats?doi=10.1080%2F16161262.2016.125824

9 Katie Benner, "Ricin Is Said to Have Been Sent to White House," *New York Times*, September 19, 2020, https://www.nytimes.com/2020/09/19/us/politics/ricin-white-house-postal-service.html

10 GlobalData Healthcare, "Personalised medicine set to surge as gene sequencing costs fall," Pharmaceutical Technology, November 30, 2018, https://www.pharmaceutical-technology.com/comment/genome-sequencing-price-drop/

11 Brandon Colby, "Whole Genome Sequencing Cost," Sequencing Education Center, Sequencing Outsmart Your Genes®, https://sequencing.com/education-center/whole-genome-sequencing/whole-genome-sequencing-cost

12 John Sotos, "There are things worse than death': can a cancer cure lead to brutal bioweapons?" *The Guardian*, July 31, 2017, https://www.theguardian.com/science/2017/jul/31/bioweapons-cancer-moonshot-gene-editing

Endnotes

13 Kabir Agarwal and Shruti Jain, "Climate Change Brings the Worst Locust Attack in Decades to India," *Science The Wire*, May 27, 2020, https://science.thewire.in/environment/locust-attack-india-jaipur-climate-change/

14 RG Reeves et al., "Agricultural research, or a new bioweapon system?," *Science*, 362(2018):6410, 35-37, https://science.sciencemag.org/content/362/6410/35.summary

15 Sharon Begley, "Why the FBI and Pentagon are afraid of this new genetic technology" *STAT*, November 12, 2015, https://www.statnews.com/2015/11/12/gene-drive-bioterror-risk/#:~:text=The%20possibilities%20for%20%E2%80%9Cweaponizing%E2%80%9D%20gene,who%20briefed%20the%20bioweapons%20office

16 Shambhavi Naik and Ruturaj Gowaikar, "A National Epidemic Service for India," Takshashila Institution, 2022, https://takshashila.org.in/research/takshashila-discussion-document-a-national-epidemic-intelligence-service-for-india

17 Shambhavi Naik and Aditya Ramanathan, "The New Bioweapons Peril," *Indian Public Policy Review*, 3(2022):1 https://ippr.in/index.php/ippr/article/view/94

18 India's Explanation of Vote (POST VOTING) Other WMD Cluster- 77th UNGA First Committee, 31 October 2022, UNHQ, New York, https://meaindia.nic.in/cdgeneva/?pdf17006?000

Images used in this paper are from Getty Images/Busà Photography.

OBSERVER RESEARCH FOUNDATION

Ideas . Forums . Leadership . Impact

20, Rouse Avenue Institutional Area,
New Delhi - 110 002, INDIA
Ph. : +91-11-35332000. **Fax :** +91-11-35332005
E-mail: contactus@orfonline.org
Website: www.orfonline.org