
Biological Warfare: An Emerging Threat of the Future

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Abstract

We are living in a geo-politically transforming world, forcing nations to persistently engage in cooperation, competition, cooperation and even conflict. While the potential global threat and disastrous consequences of biological warfare was known to domain and few security experts, this threat has come to the forefront and greater scrutiny ever since the outbreak of the COVID-19 pandemic. The mind-boggling numbers of human fatalities and casualties, its spiralling and continuing destructive potential (evolving mutations), along with consequences to global economy and way of life has clearly illustrated that the biological threat can be even more devastating than nuclear, because they can persist, propagate and spread through a population globally. Unfortunately, the existing agreements/conventions specially the Biological Warfare Convention (BWC), signed and ratified almost universally (183 nations), is widely acknowledged, but lacks compliance monitoring and verification mechanisms- making it far from effective in controlling biological weapons (BW). In this perspective, the paper examines the emerging threat of biological warfare and the implications it holds for the world at large and India in particular.

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Introduction

“We must come together to prevent, detect, and fight every kind of biological danger whether it is a pandemic like H1N1, a terrorist threat, or a treatable disease”.

—Barack Obama, United Nations General Assembly (2011)¹

An emerging multi-polar world, rise of nationalism and authoritarianism, shift to bilateralism from multilateralism, aggressive hegemonistic China along with Russia and some like-minded nations trying to re-shape the global geopolitical landscape, declining relevance of deterrence of major powers, omnipresent media, increasing digitisation coupled with rapid technological advancements in all fields have created a turbulent, unstable international security environment where all nations are persistently engaged in 24x7 competition, confrontation (occasionally cooperation) and if national interests dictate even conflict. The very concept of security has changed into a multi-domain configuration from the traditional historical and military threat. While the potential global threat and disastrous consequences of biological weapons (BW) were known to domain and few security experts, this threat has come to the forefront and greater scrutiny ever since the outbreak of the COVID-19 pandemic. The mind-boggling numbers of human fatalities and casualties, its spiralling and continuing destructive potential (evolving mutations), along with consequences to global economy and way of life has clearly illustrated that the biological threat can be even more devastating than nuclear, because they can persist, propagate and spread through a population globally.² Advancements in biotechnology and genetic engineering have made it easier for nations and unfortunately terrorist groups (even lone-wolf operators) to have relatively easy access to bio-weapons and create bio-warfare capabilities. India with its troubled unscrupulous neighbourhood, large and diverse population, fairly condensed living clusters, needs to

conduct both proactive and reactive actions against the threat of BW. As a regional power, with a modern diverse pharmaceutical industry, India can contribute substantially, and be a global leader in the fight against BW.

The article aims to provide an overview of the understanding of BW, its brief historical background and instances of use, existing protocols and agreements and its tenuous efficacy, and examines the emerging global threat and its scope, along with an overview of COVID-19 in relation to BW. In addition, the paper also highlights the Indian stance, and its capabilities to become the ‘game changer’ nation in the fight against BW, and concludes by making global recommendations and actions against BW.

Key Definitions and Characteristics

- *Biological Warfare*: Merriam Webster defines it as warfare involving the use of biological weapons; Wikipedia also annotates it as germ warfare which is the use of biological toxins or infectious agents such as bacteria, viruses, insects, and fungi with the intent to kill or incapacitate humans, animals or plants as an act of war.
- *Biological Weapons*: Also termed as biological threat agents, or biological weapon agents (BWA) which are living organisms or replicating entities (viruses which are not universally considered ‘alive’). Entomological (insect) warfare is a subtype of BW. The World Health Organisation (WHO) describes biological weapons as “microorganisms like virus, bacteria, fungi, or other toxins that are produced and released deliberately to cause disease and death in humans, animals or plants”.³
- *Bioterrorism*: It is terrorism that involves the intentional release or dissemination of biological weapon agents (BWA). The success of bioterroristic attempts is defined by the measure of societal disruption and panic, and not necessarily by the sheer number of casualties. Thus, making only a few individuals ill by the use of crude methods may be sufficient, as long as it creates the impact that is aimed for.⁴

- *Bio-crime*: Bio-crime implies the use of a biological agent to kill or make ill a single individual or small group of individuals, motivated by revenge or the desire for monetary gain by extortion, rather than by political, ideological, religious or other beliefs.
- *Agro-terrorism*: Bioterrorism used to cause significant economic losses by infecting livestock or crops, or contaminating buildings. Modern agribusiness is vulnerable to anti-agricultural attacks by terrorists, and such attacks can seriously damage the economy as well as consumer confidence. The destructive activity using BW is called ‘agro-bioterrorism’ and is subtype of agro-terrorism.⁵ Outbreaks of diseases such as foot and mouth disease, rinderpest,⁶ and Newcastle disease⁷ lead to loss of the nation’s disease-free status and subsequent bans on the export of animals, meat, and derived products, causing significant economic losses.⁸ Although not an attack, the foot and mouth disease outbreak in the UK in 2001 directly affected the private and public sectors, with an estimated loss of € 8 billion.⁹ The clean-up of various buildings involved after the 2001 anthrax letters cost the US government \$320 million.¹⁰ Although this kind of agro-terrorism has not yet occurred, the threat should be taken seriously, given the impact that it may have.
- *Genetic Engineering*:¹¹ Genetic engineering is the process of human intervention to transfer functional genes (DNA) between two biological organisms. In the BW/BT context, it is the manipulation of genes to create new pathogenic characteristics (increased survivability, infectivity, virulence, drug resistance, etc). Organisms with altered characteristics are the “next generation” biological weapons.

BWA: Characteristics and Suitability & Impact of Biotechnology

Biological weapons are characterised by low visibility, high potency, substantial accessibility and relatively easy delivery. BWA are

unconventional weapons that can be delivered by unconventional means like aerosol sprays [most effective and most probable to be used including by terrorists, because of their particle size (1-5 μm) due to which they are most efficiently delivered to their target (air sacs of lung)], food and water contamination, conventional explosive munitions or by covert injections. Because of their concealed delivery, easy transportation and difficult identification, they are readily adaptable for terrorist operations or to gain political advantages. The requirements for a biological attack are obtaining a pathogenic organism or toxin to multiply in such a way that the agent retains its viability and attributes, are amenable to enter a human being in sufficient quantities to cause disease. Thus, a vial containing an organism, even if it is pathogenic, does not constitute a biological weapon. The Aum Shinrikyo¹² attack shows that, unless the technological hurdles are successfully overcome, the outcome will be 'a dud'. Hopefully, the uncertainty in the outcome will act as a deterrent for terrorists, and be a reason for them to use more conventional weapons.

There exists an array of organisms, which may be more or less suited for this purpose. The traditional BWA of both the US and former Soviet biological weapon programmes were chosen for this task after a long and careful selection process that narrowed the long list of potentials down to a few. The agents selected were considered to be suited for causing mass casualties because they were found to share a number of characteristics,¹³ namely; high morbidity, and potentially highly lethal; highly infectious or high toxicity (low ID 50 or ICt50); suited for mass production and storage until delivery without loss of pathogenic potential; suited for wide-area delivery, and hardy enough to withstand the delivery process; relatively stable in the environment after dissemination for a period long enough to infect humans; suitable for having the potential as a BWA improved by genetic engineering and weaponisation processes. Terrorists, naturally may not be so fussy for example, no long-term storage or mass delivery requirements, providing more options of BW. For a list of potential

BWA, early symptoms/prodrome, clinical syndrome and diagnostic assay, examples of BT and trends in agents; use endnotes links.¹⁴

The detection of such an attack requires recognition of the clinical syndromes associated with various BWA. Diagnosis can be made on clinical grounds and on investigations. Protective measures can be taken against BWAs. These should be implemented early (if a warning is received) or later (once suspicion of agent use is made). After the confirmation of diagnosis emergency medical treatment and decontamination are performed in rapid sequence. Patients are then evacuated and specific therapy is given according to the agent involved. Appropriate emergency department and hospital response could significantly limit the morbidity and mortality of BWA.

- *Classification of BWA:* The biological warfare agents can be classified as:¹⁵
 - Bacteria: Anthrax, Plague, Brucellosis, Cholera, Clostridium perf toxin, Staph enterotoxin B, Melioidosis, Tularemia
 - Virus: Congo Crimen Hemorrhagic Fever, Ebola, Hemorrhagic Fever, Small Pox, Rift Valley Fever, Venezuelan Equine Encephalitis
 - Fungus: Trichothecene Mycotoxin
 - Rickettsia: Q Fever
 - Miscellaneous: Saxitoxin (derived from paralytic shellfish), Ricin (cytotoxin derived from castor bean mesh)

- *Environmental Detection:* Only recently, detection systems for BWA has been introduced in a few countries, including India. Methods being developed and constantly updated are Biological Integrated Detection System (BIDS),¹⁶ which is a multi-component system that provides monitoring, sampling detection and presumptive identification. BIDS is vehicle/helicopter (short- and long-range using UV and laser to scan area of interest to detect agents). These technologies use components that automatically determine the count/size of particle, determine if

particles are living organisms, classify some basic cell characteristics for identification. Portal Shield System and Joint Biological Point Detection system are also being developed which consists of network of biological and chemical point detectors, air sample device with audible alarms linked to computer/communication control systems.

- *Biotechnology and Biological warfare:*¹⁷ Biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet. The biological process of micro-organisms has been used for more than 6,000 years to make useful food products such as bread and cheese as also to preserve dairy products. The term was originally used to explain the commercial use of living organisms. However, with an increase in information on deoxyribonucleic acid (DNA) and with the creation of recombinant DNA technology, all activities associated with gene manipulations or genetic engineering have been included in the domains of biotechnology. Biotechnology apart from its use of healing the world, also enhances energy and food production. On the flip side, the progress of biotechnology has made BW more effective.¹⁸ As genetic engineering can boost horizontal gene transfer which is to transfer genes to unrelated species, it may be used to create new pathogenic bacteria and antibiotic resistance among pathogens. According to WHO reports there are at least 30 new diseases including AIDS, Ebola and Hepatitis C which have emerged over the last 30 years. Genes for antibiotic resistance are also believed to have spread horizontally. Such microbes are the cause of concern because infections with these and other similar strains will not respond to known treatments and therefore accidental or intentional release of such genetically engineered organisms into the environment may be disastrous. The whole world is now aware of the dreaded mutations of the coronavirus, causing intense worry amongst governments, epidemiologists and biotechnologists.

Historical Background: Post-WW II & Instances of use of Biological Weapons

The history of biological weapons is difficult to assess because of a number of confounding factors. These include difficulties in verification of alleged or attempted biological attacks, the use of allegations of biological attacks for propaganda purposes, the paucity of pertinent microbiological or epidemiological data and the incidence of naturally occurring endemic or epidemic diseases during hostilities.¹⁹

Biological warfare is as old as civilisation. The history of warfare and the history of disease are unquestionably interwoven. Throughout the history of warfare, disease and non-battle injury have accounted for more deaths and loss of combat capability than from actual battle in war itself.²⁰ To cite few examples: Scythian archers are said to have infected their arrows by dipping them in decomposing bodies or in blood mixed with manure as far back as 400 BC; while in 190 BC, Hannibal is said to have won the battle of Eurymedan by firing earthen vessels full of venomous snakes into the enemy ships; in 18th century AD, British forces distributed smallpox infected blankets to native Americans to create transmission of disease.²¹ While other examples include: Germans developing anthrax, glanders, cholera and a wheat fungus for use as biological weapons in the First World War; in 1940s and 1950s, the US and Britain continued research on various offensive biological weapons like anthrax and botulinum toxin and also continued to the 1960s; in 1970s, USSR and allies were suspected of having used yellow rain (trichothecene mycotoxins) during campaigns in Cambodia and Afghanistan, which caused alimentary toxic aleukia (ATA) in civilians.²² Since the 1980s, terrorist organisations have become users of biological agents. The most frequent bioterrorism episodes have involved contamination of food and water. For example, in September 1984, international contamination of restaurant salad bars in Oregon by followers of Bhagwan Rajneesh infected 751 persons with Salmonella

typhimurium.²³ Recently, in a short span of time, that is from September to November 2001, 23 cases of bioterrorism occurred in the US which mostly involved, postal workers, where letters contaminated with anthrax were handled or opened.

China is so far the only nation (officially) whose people have suffered biological weapons attack attacks during the war, using plague, anthrax and syphilis. Prior to and during the Second World War, the Japanese Army established highly secret but extensive programmes of bacteriological warfare throughout China. The “secret of the secrets” in these “factories of death,” such as the now-infamous Unit 731, was the barbaric experiments conducted by Japanese doctors and scientists upon thousands of living human beings, mostly Chinese nationals. In addition, biological weapons were deployed against both military and civilian targets in at least a dozen “large-scale field tests” throughout China. Hundreds of thousands of civilians died or suffered horribly from these human-made plagues.²⁴ After the Second World War, and with the Cold War looming, the US authorities made a secret deal with Japanese perpetrators, granting them immunity from war crimes prosecution. The purpose was to monopolize the scientific data gained through inhuman human experimentation so as to advance the United States’ own BW programme.²⁵ While the Soviet Union tried to publicise internationally the overwhelming evidence from the Khabarovsk trial in the late 1940s, the public in the West was ignorant of Japan’s BW crimes until the late 1980s or 1990s mainly because the U.S. authorities dismissed the trial as a “communist propaganda”.²⁶ For the sake or in the name of national interest and national security, the US government trampled justice and morality underfoot and engaged in what the English common law tradition defines as ‘complicity after the fact’. The US government has never issued a public statement on its cover-up of Japan’s wartime medical atrocities, let alone a public apology.²⁷

Protocols and Agreements: Failed Treaty?

In response to the horrors of the First World War, including the use of chemical weapons, the 1925 Geneva Protocol was created to ban the use of biological and chemical weapons,²⁸ currently signed by 65 of 121 states, which prohibits the development, production and use in war of biological and chemical weapons.

The WHO identified the threat of biological and chemical warfare officially in the midst of the Vietnam War and Cold War, after UN resolution 2162B (XXI) was adopted in 1967, condemning all actions contrary to the Geneva protocol. This resulted in 1970 WHO report ‘Health aspects of Chemical and Biological weapons’, updated in 2004 into WHO guidance ‘Public health response to biological and chemical weapons’.²⁹ This WHO document focuses on detecting and responding to unusual disease outbreaks. Important recommendations are standardized surveillance and the provision of adequate healthcare in cases of such emergencies. In 1969, President Richard Nixon issued an executive order unilaterally and unconditionally ending America’s bioweapons program, and all US stockpiles were destroyed by 1972 (not verified).

*The Biological Weapons Convention.*³⁰ The BWC formally known as “The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons (BCTW)” prohibits the development, production, acquisition, transfer, stockpiling and use of biological and toxin weapons. It is the first multilateral disarmament treaty banning an entire category of weapons of mass destruction (WMD). The BWC is a key element in the international community’s efforts to address WMD proliferation and it has established a strong norm against biological weapons. The Convention has reached almost universal membership with 183 states-parties, including Palestine, and four signatories (Egypt, Haiti, Somalia, and Syria). Ten states have neither signed nor ratified the BWC (Chad, Comoros, Djibouti, Eritrea, Israel, Kiribati, Micronesia, Namibia, South Sudan and Tuvalu).

As widely acknowledged, the BWC, like many other international declarations and agreements, lacks compliance monitoring and verification mechanisms so that it is far from effective in controlling biological armament. Also, the convention does not specifically define which agents or toxins are prohibited, and what quantities would go beyond the justification. As on date, 16 countries plus Taiwan (which includes all five UNSC members) are currently suspected of having biological weapons programs: Canada, China, Cuba, France, Germany, Iran, Iraq, Israel, Japan, Libya, North Korea, Russia, South Africa, Syria, the United Kingdom and the United States.

Potent and Immediate Global Threat

The employment of BWA is not limited to war alone, but can occur at any time, at any place and by anyone. They can be employed as WMD. The use of BWA has far-reaching consequences and can result in fear and panic in a population, whether under attack or being threatened to gain political advantages in political activities. The stress associated with a biological attack could create high numbers of acute and potentially chronic psychiatric casualties.³¹ Talking of potential threat, the most dreaded example is the great influenza pandemic during World War I that killed 20 million people or more worldwide in 1918.³² Although this was a naturally occurring event, what if a country could create a biological agent that could yield the same catastrophic loss of life on the enemy? That, in essence, is the potential effect of applying genetic engineering for biological warfare or bioterrorism. In this century, it is widely predicted that advances in biology and biotechnology will revolutionize society and life as we know it. At the same time, the “black biology”³³ of biotechnology which can be used to create biological weapons, will be one of the gravest threats we will face. Black biology is a shadowy science in which microorganisms are genetically engineered for the sole purpose of creating novel weapons of terror. Biophysicist Steven Block a

professor of biological sciences and applied physics at Stanford says, “The idea that anybody can brew this stuff in their garage vastly overstates the case, but any technology that can be used to insert genes into DNA can be used for either good or bad”.³⁴ When ‘cloning’ and ‘designer genes’ are routine buzzwords; in November 2018, Chinese scientist *He Jiankui* of the Southern University of Science and Technology in Shenzhen, China, declared that he used the gene-editing technique CRISPR-Cas9 to create genetically modified human babies,³⁵ anything is possible, and it is become increasingly difficult to discern fact from fiction.

- *Emerging Technologies and Governance Mechanisms*: Advances in three specific emerging technologies; additive manufacturing (AM) or 3D printing, artificial intelligence (AI), and robotics,³⁶ could facilitate, each in their own way, the development or production of biological weapons and their delivery systems. This could be by enabling the automation of developmental or production steps that previously required manual manipulation or analysis by a human. They could also provide new possibilities for BW use and increase the exposure of digitised biological data and operating parameters to cyberattacks. All three technologies are difficult to control, not least due to their dual-use nature, their digitisation, and the fact that they are mainly developed by the civilian and private sectors. However, the impact of these technologies on the engineering of biological weapons and their delivery systems should not be exaggerated, as the expertise required to exploit these technologies for the purpose of developing and producing biological weapons remains significant and continues to pose a barrier to most actors.

What is indeed worrying is that nearly two dozen conventional biological agents including smallpox, anthrax, Ebola and typhus plus an unknown number of genetically engineered organisms are still maintained by many countries including the big three (US, Russia and China which though a late starter is a very quick learner)³⁷ and if falls

in wrong hands like terrorists, could be unleashed on an unsuspecting public and cause a global pandemic. We are still a long way from eradicating (if ever) the COVID-19 pandemic. The US and other developed countries should be doing more to prevent the spread of biological weaponry, which undoubtedly are a serious threat to peace in the twenty-first century.³⁸ Because of increasing technological innovation and sophistication of equipment, and the proliferation of knowledge through the internet across the world, equipment has become cheaper, smaller, and easier to operate, and methods have become easier to execute, bringing the focus to terrorist threat who certainly won't follow Geneva Convention or BWT. Driven by their hunger for power and dominion, states and terrorist groups may feel increasingly tempted to access and exercise such super-biological means of destruction. The spread of conspiracy theories reflects a series of longstanding and damaging trends in the geopolitical domain, which include deep mistrust, animosities, the power of ideologies such as nationalism, and the sacrifice of truth in propaganda campaigns. Alarming, the safety of the scientific laboratories where the most dangerous pathogens are researched (and sometimes created) has long been a sword of Damocles hanging over humankind.

- *COVID-19 and BW*: Two theories on the origins of COVID-19 have been widely circulating in China and the West respectively, one blaming the United States and the other a highest-level biocontainment laboratory in Wuhan, the initial epicentre of the pandemic. Both theories make claims of biological warfare attempts.³⁹ After reading numerous international articles including those emanating from the USA, according to the available scientific evidence, these claims are groundless. Yet, the fact that the virus is not human-made does not necessarily exclude the possibility that the virus escaped the lab by accident.⁴⁰ This remains an open question; without independent and transparent investigations, it may never be either proven or disproven.

India and BW

India has ratified the BTWC on 15 July 1974, and pledges to abide by its obligations. India has defensive BW capabilities and has conducted research on countering various diseases. India also has an extensive and advanced dual-use pharmaceutical industry. We live in a fairly volatile regional security environment, with disputed land borders, contiguous to a nation with known BW expertise and stocks which has a rogue nation as a client, which makes it imperative that we must stay ahead of the loop of BW and BT.

- *Capabilities and Potential:* New Delhi possesses the scientific capability and infrastructure to launch an offensive BW program, but does not appear to have chosen to do so.⁴¹ In terms of delivery, India also possesses the capability to produce aerosols and has numerous potential delivery systems ranging from crop dusters to sophisticated ballistic missiles. However, no information exists in the public domain suggesting interest by the Indian government in delivery of biological agents by these or any other means.⁴² India has sought to improve its capabilities in biotechnology, largely in a peaceful capacity, and has a well-developed biotechnology infrastructure that utilises well-trained scientists experienced with infectious diseases and numerous pharmaceutical production facilities and bio-containment laboratories (including labs at Biosafety Levels 3 and 4). In October 2002, then Indian President A.P.J. Abdul Kalam asserted that India “will not make biological weapons. It is cruel to human beings ...”.⁴³ Some of India’s facilities are dedicated to developing defensive measures to combat biological attacks, and these same facilities potentially could be repurposed to provide offensive agents as well. India’s biodefense industry is centred at the Defence Research and Development Organisation (DRDO), and its primary lab, is located in Gwalior, Madhya Pradesh.⁴⁴ Studies in toxicology, biochemical pharmacology, and the development of antibodies against several bacterial and viral

agents are done. Additionally, the Indian government has established nuclear, biological, and chemical (NBC) warfare directorates in the armed services, as well as an inter-services coordination committee to monitor the programme. The Indian Army has further established an NBC cell at Army Headquarters to study the effects of NBC warfare. In 2003, the DRDO turned over India's first indigenously produced NBC reconnaissance vehicle to the Indian army. India has made substantial efforts to prepare its military force for a biological attack. However, representatives of the Indian Army's Medical Corps have publicly expressed reservations on the Indian hospitals preparation and adequacy to events arising from BW.⁴⁵ India's Central Industrial Security Force (CISF), originally established to defend heavy industry, transportation hubs, nuclear facilities and the like, has also developed the ability to deploy specially-trained first responders to the scene of a nuclear or biological attack.⁴⁶ In January 2003, the Indian government announced changes in India's nuclear use doctrine and stated that the new posture allows India to "retain the option of retaliating with nuclear weapons" in the event of a major biological or chemical attack against India or Indian forces anywhere.⁴⁷ India has stringent export control regulations outlined in the special chemicals, organisms, materials, equipment, and technologies (SCOMET) guidelines; India's national export product control list that identifies goods, technologies and services subject to dual-use licensing requirements.⁴⁸

- *The Fight against Bioterrorism*: On 3 June 2015, India and the US signed a new 10-year defence framework agreement, which includes provisions to work cooperatively to develop defence capabilities, including "a lightweight protective suit effective in chemical and biological hazard environments".⁴⁹ The Indian government along with friendly nations need to pool their resources and make major investments in the R&D of state-of-the-art devices capable

of instantaneously detecting lethal bacteria and viruses in the environment.⁵⁰

- *Setting up an Institutionalised National and Strategic Body:* Setting up a National and Strategic Body to monitor biological and chemical threats, carry out holistic defensive planning, preparation, procuring equipment, order raising suitable armed forces, paramilitary and NDRF (National Disaster Response Force) units/sub-units and personnel and training them is an absolute imperative in the immediate future. The newly raised SPG (Strategic Planning Group) headed by the NSA would be an appropriate body to oversee the functioning of this new organisation. The body can have a mixed composition of core experts, administrators and security forces representatives from all concerned departments/organisations including ministries and even industry. Execution can be appropriated to the concerned organisations and agencies.

Global Recommendations for Prevention of BW and BT

Governance of biosafety and biosecurity is long overdue. Such governance should include three key areas; an effective ban on offensive BW programmes; much-improved prevention and preparation for bioterrorism; and more transparency and surveillance of biological research labs (particularly P4 and P3 labs) in which scientists investigate the most dangerous pathogens such as the Ebola virus and the coronavirus. It is, therefore, absolutely necessary and urgent that the international community takes coordinated actions to prevent any human-made pandemic. Astoundingly, there is no international organisation, in the UN system or elsewhere, charged with overseeing biosafety and biosecurity at the global level.⁵¹ Enhancing global oversight of biosafety and biosecurity needs new ethical vision. Any new structure must move beyond the sweeping ideologies like nationalism and the current practices dominated by secrecy, mistrust, and animosities. An ‘each to his own’ global response to COVID-19

shows how indispensable trust is for containing the pandemic, indeed, for any global public health effort, or for reaching a consensus on a more effective BWC. While it may appear unrealistic in this world of *'realpolitik'*, a framework based on ethical values of transparency, trust, and trustworthiness, and the common good of humanity, could well be the only answer. A combination of punitive and incentive-based effort built on human values, and surveillance (horrendous implications for the entire globe, hopefully will rein in rogue nations and terrorist groups), appears to be the way forward.

On 27 March 2020, India urged the comity of nations and the international community to ensure strict compliance of a global treaty banning production of entire range of biological weapons of mass destructions,⁵² highlighting the need for effective response to the challenges posed by new scientific developments in the area. This fresh call to ban biological weapons was made on the occasion of 45th anniversary of the Biological and Toxin Weapons Convention (BTWC) coming into force. To which, India's Ministry of External Affairs also underlined the need for international cooperation on BW, including institutional strengthening of the WHO.

Conclusion

While conspiracy theories on the origins of COVID-19 are probably scientifically groundless, the fear behind them is not. The pandemic has woken up the world to the potent, live and real threat of BW. For the sake of humanity, developing a much more robust global governance of biosafety and biosecurity than currently exists at present is an urgent imperative for the international order. BT or BW is neither something new, nor something that is likely to go away. While the likelihood of a successful bioterrorist attack is not very large, given the technical difficulties and constraints resulting from the need to work in secret, and more probably at the low-technology end of the spectrum than the high-

technology end, however, even if the number of casualties is likely to be limited, the impact of a bioterrorist attack is high, will affect many lives, and is certainly to be costly in direct and indirect ways. Thus, it is best to be prepared to deal with the consequences. Moreover, low cost and easy access to genomic technologies make it feasible for such weapons to be deployed by almost any attacker. Even small alterations are sufficient to create hazardous effects. India is well-poised geo-politically today to lead the charge to ensure a more effective and punitive BCWT. Concurrently India needs to create a national set up to monitor and battle BW. Today the world is at crossroads. On the one hand, modern biology is so promising and curative, on the other immensely destructive. The First World War saw chemical; and the Second World War experienced the mass devastation of nuclear weapons. If mankind is not proactive we should be ready for the Third World War, which could well be 'Biological'.

Notes

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2. Sadanand Pandey (2019), "Are Biological Weapons More Dangerous Than Nuclear Weapons? What Is the Current State Of Biological Weapons Research?", ResearchGate, 21 January 2019. Available online at https://www.researchgate.net/post/Are_Biological_Weapons_More_Dangerous_Than_Nuclear_Weapons_What_Is_The_Current_State_Of_Biological_Weapons_Research, accessed on February 24, 2021.
3. See "Biological Weapons", World Health Organization. Available online at https://www.who.int/health-topics/biological-weapons#tab=tab_1, accessed on January 28, 2021.
4. HJ Jansen et al. (2014), "Biological warfare, bioterrorism, and biocrime", *Clin Microbiol Infect*, Vol. 20, No. 6, June 2014, pp. 488-496. Available online at <https://www.sciencedirect.com/science/article/pii/S1198743X14641732>, accessed on January 28, 2021.
5. Jim Monke (2007), "Agroterrorism: Threats and Preparedness", CRS Report for US Congress, Congressional Research Service, 12 March 2007. Available online at <https://fas.org/sgp/crs/terror/RL32521.pdf>, accessed on February 24, 2021.
6. See "Rinderpest", Science Direct. Available online at <https://www.sciencedirect.com/topics/medicine-and-dentistry/rinderpest>, accessed on February 21, 2021.

7. Newcastle disease (ND) is a highly contagious and often severe disease found worldwide that affects birds including domestic poultry. It is caused by a virus in the family of paramyxoviruses. See, World Organisation for Animal Health. Available online at <https://www.oie.int/en/animal-health-in-the-world/animal-diseases/newcastle-disease/>, accessed on February 21, 2021.
8. Mark Wheelis, et al. (2002), "Biological Attack on Agriculture: Low-Tech, High-Impact Bioterrorism", *Bioscience*, Vol. 52, No. 7, July 2002, pp. 569-576.
9. "The 2001 Outbreak of Foot and Mouth Disease", Report by the Comptroller and Auditor General, HC 939 Session 2001–2002, National Audit Office, London, UK, June 2002. Available online at <https://www.nao.org.uk/wp-content/uploads/2002/06/0102939.pdf>, accessed on January 15, 2021.
10. Ketra Schmitt and Nicholas A. Zacchiak (2012), "Total decontamination cost of the anthrax letter attacks", *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, Vol. 10, No. 1, pp. 98-107.
11. Genetic engineering is the process of using recombinant DNA (rDNA) technology to alter the genetic makeup of an organism. Traditionally, humans have manipulated genomes indirectly by controlling breeding and selecting offspring with desired traits. Genetic engineering involves the direct manipulation of one or more genes. Most often, a gene from another species is added to an organism's genome to give it a desired phenotype. For details see, National Human Genome Research Institute. Available online at <https://www.genome.gov/genetics-glossary/Genetic-Engineering>, accessed on February 5, 2021.
12. HJ Jansen, et al. (2014), "Biological warfare, bioterrorism, and biocrime", *Clin Microbiol Infect*, Vol 20, Issue 6, June 2014, pp. 488-496. As noted by Jansen, et al., in 1995, the Aum Shinrikyo sect disseminated sarin in a coordinated attack on five trains of the Tokyo metro system, in an effort to ultimately start an apocalyptic war, from which the sect was meant to emerge as rulers of Japan and possibly even the world. The attack resulted in 12 deaths and at least 1400 people being injured. An earlier attack in 1994, using sarin in Matsumoto, central Japan, resulted in seven deaths and 200 people being injured. At the time, the cult had several thousand members and assets worth millions of dollars, including a sheep farm in Australia for field testing. Its chemists were able to synthesise sarin and VS nerve agent gases, among other agents, by themselves. Only in 1998 did the authorities learn that the cult had previously tried to attack metropolitan Tokyo with anthrax spores or botulinum toxin on at least eight different occasions in the period 1990–1995. All of these attempts failed, owing to the use of non-pathogenic preparations and technical difficulties in creating an aerosol.
13. Ibid.
14. Reshma Agarwal, et al. (2004), "Biological Warfare -- An Emerging Threat", *Journal of the Association of Physicians of India (JAPI)*, Vol. 52. Available online at <https://www.japi.org/v2f4c4b4/biological-warfare-an-emerging-threat>, accessed on January 31, 2021.
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