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The New Bioweapons Peril: A case to revisit the Biological Weapons Convention

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Abstract

There is no evidence to suggest that SARS-CoV-2 was a biological agent. However, the ensuing pandemic has driven home the potential dangers of weaponised biological material, especially pathogens. Heightening the concerns about bioweapons is the growing ubiquity of gene editing tools like the CRISPR-Cas-9 system that enable both state and non-state actors to produce biological agents for various purposes. While these dangers are being recognised, this paper goes beyond highlighting the peril, to examining the drivers and constraints on bioweapons use, the ways in which bioweapons may be employed, and the trade-offs involved in mounting such attacks. Furthermore, the paper proposes concrete steps that can be taken in a renewed Biological Weapons Convention (BWC) to reduce the risk of bioweapons attacks. Earlier attempts at strengthening the treaty have focused on increasing verification. However, this has failed because states seek to protect their biotech industries from espionage and harassment. Instead of focusing on traditional verification, this paper proposes the creation of a scientific board under the BWC, that will monitor sensitive emerging technologies in the field, set standards for safety and reporting, and create an epidemiological database. To help deter attacks, it recommends ways to improve the response to disease outbreaks and impose penalties on perpetrators.

Keywords: SARS-Cov-2, Biological Weapons Convention, CRISPR, Arms Control, Bioterrorism

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Pathogens pose an unprecedented danger to humankind. It has taken a devastating pandemic to demonstrate the threat that pathogens pose to lives, societies, and economies around the world. The heated debate about the origins of SARS-CoV-2 and allegations of 'gain of function' research may serve to draw attention to the dangers that biological agents can pose. While the origin of SARS-CoV-2 remains mired in debate, the suspicions that it may have been artificially modified highlights how technological developments like gene editing potentially create new avenues for the use of biological agents.

Even amidst the pandemic and the months leading up to the outbreak of SARS-CoV-2 in December 2019, there was a steady stream of incidents involving biological agents.

The first category of incidents involved non-state actors. In the United States in September 2020, letters containing Ricin, a lethal biotoxin were sent to the White House and law enforcement agencies in the state of Texas (Benner 2020). A year earlier, in October 2019, Indonesian police recovered 310 grams of rosary pea seeds, the main ingredient in the lethal biotoxin Abrin, during a raid of a cell of the terrorist outfit Jamaah Ansharud Daulah (Arianti 2019). In another incident involving Ricin, in 2018, German police in Cologne arrested a Tunisian man for trying to build a biological weapon using the biotoxin (The Local 2018). These incidents have two things in common: one, the attackers used biotoxins and not communicable pathogens, and two, the attackers' plans were foiled. If neither of those holds true in a future incident, the outcomes could be very different.

The second category of incidents is laboratory accidents. In September 2019, there was an explosion at a facility in Russia that was storing biological agents including smallpox (Roth 2019). A month earlier, Fort Detrick, the top US biodefence laboratory, halted its work on dangerous pathogens over safety concerns (Wyatt 2019).

These lab incidents highlight the challenge of ensuring high safety standards needed to conduct research on pathogens. They also suggest that labs with less-than-perfect safety records could be vulnerable to leaks involving human malice. The incidents are not just limited to accidents within laboratories: in an unrelated incident, a lone shooter critically wounded two before driving to Fort Detrick. The shooter was stopped by lethal force after driving 800 metres inside the base (Cramer, Diaz and Murphy 2021).

Finally, there are incidents or developments involving emerging technologies that could be weaponised in the future. For instance, in 2018, researchers flagged the 'Insect Allies' programme run by the US Defense Advanced Research Projections Agency (DARPA). The programme sought to use insects to disseminate desired chromosome modifications to agricultural crops. However, the researchers warned that the programme could be "widely perceived as an effort to develop biological agents for hostile purposes" (Reeves et al 2018, 35-37).

Similarly, in 2011 virologists genetically engineered an H5N1 influenza strain that was easily transmissible among ferrets, which respond to flu in a manner similar to humans. By one of the researcher's own admission, it was "probably one of the most dangerous viruses you can make" (Enserink 2011).

Others have sought to reconstruct once-prevalent viruses. In 2002, researchers claimed they had synthetically created the entire polio virus (Naik 2019) and around the same time, scientists at the

Centers for Disease Control and Prevention recreated the virus that caused the 1918-19 influenza pandemic. (CDC 2019)

None of this is to suggest that such research should not be conducted or that all such research is equally dangerous. It is simply meant to highlight the small but non-negligible risk that this sort of work carries from the perspectives of both accidents and from malice.

I The Resurgent Bioweapons Threat

The attempts at bioterrorism, the emergence of new biotech capabilities, and the increase in security competition between states, all illustrate how new technological and political contexts have increased the salience of the bioweapons threat.

These threats are likely to grow as technological developments lower the barriers to developing biological weapons. For example, gene editing tools like CRISPR (clustered regularly interspaced short palindromic repeats), reduce the costs and time required to edit genomes and modify pathogens. Present international agreements are ill-equipped to deal with these new challenges.

In the decades following the Second World War, states formally agreed to abstain from using biowarfare. Under the Biological Weapons Convention (BWC), which entered into force in 1975, 182 states pledged not to use bioweapons, (a re-affirmation of the 1925 Geneva Protocol) and also committed themselves to destroying their existing stockpiles to prevent proliferation of the technology.

This did not mean all states actually shut down their bioweapons programmes. While many states have been accused of maintaining bioweapons programmes, the most compelling evidence comes from the Soviet Union, which ran the world's largest bioweapons programme since 1972. This included both legitimate research into biodefence – for example, working on vaccines against potential enemy bioweapons – as well as stockpiling pathogens in contravention of the BWC. (Leitenberg, Zilinskas 2012) In 1979, a leak of anthrax at a bioweapons facility in the town of Sverdlovsk led to at least 60 deaths, in an incident covered up by Soviet authorities. (Hoffman 2011, 1-6)

At least one state is believed to have actually used bioweapons: the now-extinct white minority regime in Rhodesia (present Zimbabwe) is thought to have used anthrax against local cattle, which eventually infected some humans as well. (Cross 2017)

There have also been occasional incidents triggered by non-state actors. The Japanese cult Aum Shinrikyo unsuccessfully tried to use bioweapons before turning to Sarin gas. (Bleek 2011) Members of the Rajneeshee group in the United States used Salmonella to inflict disease in citizens of Oregon. (Homeland Security Digital Library n.d.) In 2001, letters containing anthrax were sent to several prominent citizens in the US, killing five and leaving another 17 ill. (Cross 2019)

What's common to these incidents is that they were generally contained. That may not always be the case. In the 2016 Worldwide Threat Assessment of the US Intelligence Community, Director of National Intelligence, James Clapper observed that the proliferation of affordable genome editing tools meant that their "deliberate or unintentional misuse might lead to far-reaching economic and national security implications." (Clapper 2016, 9) In November 2018, Wilton Park, an executive

agency of the UK's Foreign Office, reported findings based on interactions with 42 senior policy leaders and scientific and technical experts. More than three-fourth of the participants agreed that advances in biotechnology had lowered barriers to acquire bioweapons and could facilitate the production of more selective and controllable bioweapons that could challenge the current taboo against their use. (Wilton Park 2018)

Gene editing technologies, such as Zinc Finger Nucleases, Transcription Activator-like Effector Nucleases, and CRISPR change two fundamental characteristics associated with bioweapons. One, instead of being unpredictable and unreliable, advances in scientific knowledge could transform biological agents into reliable and targetable weapons, especially for states.

Two, the spread of scientific knowledge could tempt both states and non-state actors to experiment with bioweapons. For non-state actors, this option could prove especially attractive if international controls on conventional light weapons and explosives become stricter.

Finally, in addition to the bioweapons themselves, there are the means of delivery. Small, remotely piloted aircraft like drones offer attackers the means to mount 'stand-off' attacks and effectively spread aerosolised pathogens. Besides specific technologies, there's also the fact of greater global travel and exchange. International passenger traffic has increased from about 200 million passengers in 1980 to 1.9 billion passengers in 2019, just before the pandemic. (International Energy Agency n.d.) Since some biological agents are easy to smuggle or can be carried on human hosts, this presents an important vector through which biological weapons attacks can be mounted.

II The Lures and Pitfalls of Biological Weapons

Both states and non-state actors could use biological weapons. How they use them depends on their incentives. For states, we postulate three broad considerations: attributability, effectiveness, and downsides.

Attribution: The challenge of attribution is generally referred to in the context of either terrorist or cyber attacks.

A study of state-backed terrorism by Keir Lieber and Daryl Press examined 18,328 terrorist attacks from 1998 to 2008 and found that the perpetrators were identified 42 percent of the time. (Lieber and Press 2013, 89) Furthermore, they examined attacks against NATO states, Australia, Japan, and Israel during the period that killed 10 or more people and found that attribution was made in 36 out of 37 cases. (Lieber and Press 2013, 90) Given that attribution was most likely when both state capacity and fatalities were high, they conclude that states are unlikely to sponsor nuclear terrorism against a major power given the likelihood of attribution and subsequent retaliation. (Lieber and Press 2013, 103-104)

There persists a robust debate about what constitutes attribution in the cyber. (Rid and Buchanan 2015) Thomas Rid and Ben Buchanan argue that "Matching an offender to an offence is an exercise in minimising uncertainty". (Rid and Buchanan 2015, 4) This probabilistic conclusion is reached by building a composite picture using information and insights gleaned at both the technical and political levels. While there are no reliable statistics available on successful attribution of cyber attacks,

Rid and Buchanan offer an important insight into how attribution can occur beyond the forensic level.

What are the implications for a state considering the use of biological agents? There are factors that make it easier for a target state to successfully attribute a bioweapons attack. Unlike with an explosive attack, there is typically no physical destruction involved. This means evidence such as CCTV footage and eyewitness statements could potentially help investigators trace the origins of a bioweapons attack.

On the other hand, depending on the pathogen used, lag time could complicate efforts to track down a plausible patient zero. This is especially so if attackers release biological agents at multiple locations, as a redundancy measure or to complicate contact tracing. Depending on the pathogen used, it may take the target state some time to recognise the possibility that it was attacked, if such a determination is made at all.

Further, it is difficult to attribute the origin of a bioweapon which is biologically close to a naturally occurring pathogen. This is best demonstrated by the controversy surrounding the origin of SARS-CoV-2. Attribution is also likely to be complicated in the near future because of rising antimicrobial resistance. It may be impossible to determine if pathogens that are resistant to vaccines and treatments are natural mutations or have been artificially modified.

However, even with these ambiguities, the attacking state runs several other risks that could lead to attribution. Prior intelligence could help the target state intercept the attacking state's human agents along with the biological agents in their possession. Biological agents could be intercepted during routine stops at airports. Remotely piloted vehicles spraying aerosolised agents could be brought down or crash due to malfunctions.

Since we have no proven cases of a transnational attack using biological agents (not counting biotoxins) since 1945, there is no empirical evidence available to gauge the risks that an attacking state runs. This uncertainty, combined with normative factors may explain why states have hesitated to use bioweapons.

Effectiveness: Biological agents do not generally make for effective tactical weapons. Given lag times, uncertainty about the speed of spread, and the perils of blowback, they cannot be timed effectively as with conventional military operations. One possible exception to this is infecting the crews of enemy naval vessels prior to the onset of a crisis or conflict. However, the difficulties in actually carrying out such an attack are considerable.

Bioweapons could be potentially far more effective as strategic weapons, meant to disrupt economies and societies, sap morale, and divert resources from other priorities. The potential for ambiguity about the causes or origins of an outbreak are an added incentive.

However, for bioweapons to have strategic effect, they must be able to cause the intended damage reliably. For this to happen, the bioweapon must be effective at both causing the intended disease and spreading it.

While creating effective pathogens has been made easier by the availability of gene editing tools, this efficacy may have to be mediated by the need to ensure effective spread. For example, a

communicable pathogen directed at humans will spread more easily if those infected can remain asymptomatic for a period of time and yet transmit the disease to others.

Attackers may also need to make trade-offs between lethality and effective spread. A less-lethal or non-lethal communicable disease may spread more easily, while a deadly disease in which patients show distinct symptoms, may be more easily contained.

This creates dilemmas for both state and non-state actors. States may be content to achieve economic disruption in an adversary (less-lethal diseases may also be more difficult to trace and attribute). However, a state using less-lethal but highly communicable pathogens risks blowback on its own citizens or the citizens of friendly states.

For non-state actors seeking to create a mass casualty event, lethality is paramount, but effective spread of the disease may require multiple attacks or aerosolised release. The sole non-state actor known to have attempted aerosolized release was Aum Shirnikyo, which failed at the task of creating an aerosolised version of anthrax. (Danzig and Hosford 2012) On the other hand, open air tests carried out by the Soviet Union using the smallpox virus were highly effective, and even resulted in multiple unintended deaths. (Leitenberg and Zilinskas 2012, 121-134)

Future attackers will also benefit from new technologies that make dispersion of a pathogen easier. Small-sized remotely piloted vehicles may be effective at this role. The ability of such vehicles to be launched from anywhere and evade detection makes them attractive to both state and non-state actors. While the payload on small RPVs will be low, it is possible for attackers to mount multiple attacks on different locations to ensure the spread of a pathogen. RPVs could be used in heavily populated urban centres, which increases the likelihood of both disease spread and the detection of the RPVs. Such vehicles could also be used more discreetly to attack crops and livestock. Attacks of this nature would likely be favoured by states that want to disrupt an enemy's economy.

Downsides: Any actor deploying bioweapons must take into account the risks involved. This risk is a product of the likelihood of successful attribution and the impact of such attribution on the power or the survival of the attacker.

For non-state actors with an apocalyptic bent, attribution may be desirable. Such organisations may either embrace their own extinction as a necessary step to achieve higher goals, or place trust in their decentralised structure to limit damage. Overground non-state actors may choose to risk mounting less-lethal attacks as well. They can seek to limit damage using a combination of misinformation (alleging government conspiracies or claiming that the other side attacked first) and plausible deniability (attributing the attacks to 'rogue elements' or 'lone wolves' within the organisation that have since been purged).

Non-state actors seeking to create an independent state of their own may be less likely to carry out bioweapons attacks. Research shows that such organisations often portray themselves as following the laws of armed combat and international law more generally. To achieve their war aim, separatists often "signal their capacity and willingness to be good citizens of the international community to which they seek admission." (Fazal 2017, 71) This means they have fewer invectives to mount biological attacks.

The first state to mount a significant bioweapons attack must bear the risk of suffering high costs. Any use of bioweapons (other than targeted use of biotoxins) would be a major violation of norms

established for nearly a century and other states could seek to punish the attacking state in an attempt to re-establish these norms.

However, states are capable of gradually weakening the norms associated with bioweapons. This is most likely to happen through low-grade, perhaps non-lethal attacks, that are difficult to attribute. The ubiquity of conspiracy theories and misinformation, as well as the habit of states to blame adversaries for natural phenomena, foster an environment in which states can get away with a minor bioweapons attack. If such attacks are nevertheless followed by a series of mutual retaliations, norms against the use of bioweapons could weaken considerably.

III How Biological Weapons Could be Used

Table 1: Motivations for bioweapons use

	STATE	NON-STATE ACTORS
Reasons to develop biological weapons	○ Targeted weapons that can be used for limited strategic effect ○ No need for stockpile, fairly easy to recreate ○ Difficult to track	○ Lower cost of development ○ Relative ease of procurement ○ Justified by occurrence of diseases in religious texts ○ Can create fear in target populace ○ Difficult to track
Reasons not to develop biological weapons	○ Reputational, economic, and military costs incurred if successful attribution is made ○ Other weapons may be more effective or suitable to the state's requirements	○ Maintain reputation, avoid international isolation if successful attribution is made
Kind of biological weapons	○ State actors would focus on developing bioweapons that are difficult to attribute and can used to achieve limited political goals	○ Non-state actors are likely to focus on developing bioweapons that maximise casualties

We envision five scenarios in which new-age bioweapons could be used.

One, states could use non-communicable pathogens as assassination tools. In 1978, Bulgaria's secret service killed the dissident Georgi Markov in London with the bio-toxin Ricin (Nehring 2017). Russian assassins have allegedly used radioactive isotopes and nerve agents in more recent attacks. However, biotoxins that are difficult to treat but do not risk wider infection provide another alternative in the future (Groll 2018).

Two, non-state actors will seek to produce and deploy biological weapons. Religious cults in particular seem to have an affinity for such weapons – as the attacks by Aum Shinrikyo and

Rajneeshee attest. For apocalyptic terrorists, bioweapons are attractive not only because they are a relatively easy way to inflict mass death but because diseases carry with them the connotations of divine retribution.

Three, states or warring factions may choose to deploy bioweapons during civil wars and insurgencies. Repressive states may use biological agents against inconvenient minorities or even populations under mass incarceration (while inoculating their own personnel). Indeed, bioweapons may be used in a manner depressingly familiar through history: against besieged cities. In 1346, the Mongols infamously catapulted diseased corpses into the fortified city of Caffa (modern Feodosia in Crimea), infecting the city's defenders with the Black Death (Riedel 2004).

If the more recent sieges of Aleppo and Ghouta in Syria are any indication of how future civil wars will unfold, besiegers will have powerful incentives to engage in biological warfare. Cities under siege will be short of the medical supplies and personnel needed to properly diagnose and treat illnesses. The circumstances of a civil war will also preclude investigation into the perpetrators. For example, during the Syrian civil war, inspection teams from the Organisation for the Prohibition of Chemical Weapons (OPCW) and the World Health Organization (WHO) came under fire from small arms and mortars (Bidwell and Bhatt 2016, 8-9). The inspectors were also limited in their mandate to simply determining whether or not an attack had occurred; they could not work to determine which party had carried out attacks (Bidwell and Bhatt 2016). In the event of a biological attack in similar circumstances, investigators may not have the remit to identify a patient zero or have access to detailed health records. While investigators may be able to obtain samples of a pathogen, this may not provide enough information to identify the attacker.

Four, states may mount calibrated 'less-lethal' attacks on other states that limit escalatory options. We can imagine a designer pathogen unleashed on US military bases in the Middle East or North-East Asia. Such an attack may cause few or no fatalities but could create enough disruption to seriously hamper any planned military operations or exercises.

States can also mount less-lethal attacks against farms and livestock of an adversary to create economic and social disruption. Such attacks may directly kill no humans and may be impossible to attribute, while causing panic, creating pretexts for other states to impose trade restrictions on agricultural goods from the target state, and causing economic loss. There is even a precedent for such attacks in Rhodesia's use of anthrax to target both rebels and their livestock. Evidence for the Rhodesian bioweapons programme remains murky even today and has become clearer only decades after the conflict (Cross 2017).

Less-lethal attacks of this kind pose a deterrence problem for states without bioweapons. In 1970, US President Richard Nixon rationalised his decision to give up bioweapons by saying "If somebody uses germs on us, we'll nuke 'em" (Safire 1995). India's nuclear no-first-use nuclear doctrine similarly makes an exception for "major" biological and chemical weapons attacks (Ministry of External Affairs 2003). However, the nuclear option isn't credible against lower order attacks. This is especially so if the attacking state is itself a nuclear power that also wields a panoply of other conventional and chemical weapons as well, as North Korea does. In such circumstances the target states would have to take recourse to non-kinetic measures like sanctions or cyber-attacks. Any effective multilateral sanctions regime against a state using bioweapons presumes strong norms against their use. If these

norms were to be diluted, such less lethal biowarfare aimed at economies could become as common as present-day cyberattacks.

Five and finally, states or regimes facing imminent extinction at the hands of internal or external enemies may choose to unleash all the deadly pathogens in their arsenal, with potentially devastating consequences.

IV The Need to Revisit the BWC

Despite the expanding threats, bioweapons have not been accorded the serious attention bestowed on nuclear or chemical weapons. This is quite obvious from a comparison of the composition of the BWC with its equivalent treaty – the Chemical Weapons Convention (CWC). The CWC headquartered in The Hague has approximately 500 employees. On the other hand, the BWC Implementation Support Unit consists of only three people.

The absence of a verification instrument is a recurring criticism of the BWC. It has been long recognised that lack of verification renders the treaty toothless and ineffective. The CWC, on the other hand has a verification mechanism that allows international inspectors to scrutinise chemical plants of interest, based on a pre-agreed classification of chemicals recommended by CWC's scientific advisory board (Tucker n.d.).

The case for a similar inspection mode for bioweapons has been actively challenged. There are significant differences between the dual-purpose uses of chemicals and biological entities. For one, biological agents that can feed into bioweapons or for peaceful purposes may be difficult to differentiate. Bioweapons may also be required in smaller quantities than chemical weapons, since they contain the unique characteristics of self-proliferation in the host/outside environment. Thus, while chemical facilities can be easily inspected on the basis of quantities of hazardous chemicals they store, biological facilities cannot be assessed using the same metric.

Despite these challenges, the BWC member states have previously attempted to devise a verification protocol. The latest of these attempts was the convening of an ad-hoc committee known as the VEREX group in 1991 by the Third Review Conference. Even in the backdrop of this attempt, US Ambassador Ronald Lehman, Director of the Arms Control and Disarmament Agency, stated that:

> "The BTWC could not be verified effectively because biological production facilities are dual-use and lack distinctive "signatures";
> A negotiated regime could not be sufficiently intrusive to detect clandestine facilities, generating false confidence that a country was in compliance when in fact it was not;
> and highly intrusive inspections by multinational teams could expose both government and commercial facilities to foreign espionage. In particular, the loss of valuable trade secrets could weaken the competitive edge of the US biotechnology and pharmaceutical industries" (Office of Technology Assessment 1991, 74).

This was not surprising – the US had always maintained that a bioweapons treaty was non-verifiable (Foreign Relations of the United States 1951). This was, however, in opposition to other

countries. In 1999, the European Union reiterated its demand to establish a verification regime (Roberts 2003, 30).

After much deliberation the VEREX group suggested 21 confidence-building measures to strengthen the implementation of the BWC including mandatory declaration of facilities, random transparency checks and investigations into suspect sites. However, after years of debate, in 2001 this verification mechanism was found to be unacceptable to the US, which believed its benefits did not outweigh its risks. Reasons for American obduracy included the uncertainty of differentiating and identifying a bioweapon from a naturally occurring agent, especially in the absence of any overt traits like gene manipulation and the risks to biodefence preparations and the dual purpose nature of biological agents (Roberts 2003, 30-31). This last reason is of particular importance to the US which has a prolific biotechnology industry, supported by research and development companies. There is considerable fear that the provisions of BWC can be misused for espionage by foreign entities on original research being carried out in these research units. As a consequence, there has been no serious attempt to revive the need for a verification protocol; however, recently Chinese Ambassador for Disarmament Affairs Li Song called for the relaunching of the verification protocol negotiations (CGTN 2021).

Even the voluntary confidence-building measures which require member parties to voluntarily exchange information on vaccine production plants, biodefence programs, and unusual disease outbreaks have seen little active participation. From 1987 to 1995, only 70 of the then 139 member states of the BWC submitted data declarations, and only 11 took part in all rounds of the information exchange (Tucker 2002).

While the absence of any significant state-driven biowarfare incident may have led to this neglect, the arrival of new dual-use technologies such as synthetic biology and genome editing have exposed gaps in the international regulatory architecture that need to be filled to prevent the proliferation of bioweapons.

Given these changes, the BWC is likely going to be insufficient to prevent the proliferation of bioweapons. The convention is structured around states and there is scant provision to tackle the threat of non-state actors indulging in biowarfare. Furthermore, the failure of signatories to arrive at a verification mechanism has rendered it toothless. Notably, Israel has not signed the convention and so their bioweapons status is open to speculation.

The convention itself is underfunded. Much of the 2018 December Review Conference was devoted to finalising a mechanism to continue funding the meagre implementation support unit. However, higher funding alone will not overcome the shortcomings of the BWC. Fewer than 15% of participants in the Wilton Park study felt greater resources alone would be sufficient to address the risks posed by high consequence bioweapons.

It is thus necessary not only to strengthen the BWC but to reimagine it to adapt to the expanded theatre of bioweapon use. It is important to recognise the possibility of non-state actors abusing biological agents as weapons of mass destruction. A non-state actor aiming to cause maximum damage using limited resources could produce an imperfectly engineered or manipulated biological entity that is nevertheless capable of having catastrophic effects. In this sense, containing the spread of the biological agent in the territory of one state-party and subsequently placing liability of response on

one state-party might be insufficient. Instead, a global approach to curtailing and responding to the threat of biowarfare is more prudent.

V A New Biological Weapons Treaty:

We propose a renewed treaty between state parties that is represented by scientific and diplomatic personnel from signatory parties. The current treaty only has diplomatic representation, but lacks the scientific board that is a feature of the Chemical Weapons Convention (CWC). The overarching mandate for the treaty would remain the prevention of a biological weapons attack. There are three steps in biowarfare that need to be addressed. First, reducing the proliferation of agents and associated weaponisation technologies. Second, detecting and swiftly containing a biological outbreak. Third, the identifying biological outbreak as a bioweapons attack and the perpetrating party and institutionalising a sanctioning structure.

The Scientific Board

Unlike the CWC, the current BWC does not have a permanent scientific board that can keep itself apprised of technology changes and thus recommend operational standards for using the various technologies. It is, therefore, crucial that any new treaty have an established scientific board which periodically reports on any incidents and threats associated with emerging technologies. The board should consist of scientists and clinicians from the signatory countries as well as representatives from the World Health Organisation (WHO) and Global Health Security Agenda (GHSA). The scientific board should have the powers to invite representatives from other governmental and non-governmental organisations to investigate outbreak events or leakage incidents in signatory and non-signatory countries.

Categorisation of Emerging Technologies and Applications

In addition to periodic reporting, the scientific board could also establish and maintain an updated list of sensitive technology applications and agents, based on their amenability to manipulation, ease of use, and possible threat to human and environmental health. For example, gene editing is the underlying technology in both somatic gene editing and gene drive studies. However, the use of a malicious gene drive can cause much greater damage than the malicious use of somatic gene editing. Thus, a prioritsation of technologies would help create regulations to accordingly govern them.

Access to healthcare and general standard of living of citizens should also be considered when prioritising disease-causing agents. Diseases which may be considered relatively harmless in places such as the US, may wreak havoc in other parts of the world which have weak primary healthcare networks. For example, much of the dialogue in the US is centered around a potential outbreak of Ebola or anthrax on US soil; but in case of India, a simple outbreak of pandemic flu or vaccine-resistant measles could be disastrous.

The two categorisations based on risks of technology and agent would help arrive at a risk index for the use of a particular combination technology and an agent. It is important to note that a

particular technology or agent by itself might not be harmful, but the application of the technology on a specific agent might yield a hazardous product. It is therefore prudent to assess hazard levels based on the final product, not on the technology of agent by itself. For example, the use of gene editing in the flu virus could result in a potentially dangerous pathogen. However, the simple maintenance of E. coli in routine culture is unlikely to pose any hazard, as long as appropriate biosafety measures are followed. Thus, the risk index, and associated precautionary measures, will be higher for gene editing in flu as compared with maintenance of E. coli cultures. The comprehensive list of technologies and agents – categorised by their risk level – would help individual countries decide on countermeasures to prevent their proliferation and respond to any incident.

The Common Minimum Programme

To prevent proliferation of technologies that may be abused for weaponisation, the Scientific Board could agree to a common minimum program that prescribes practices for laboratories using those techniques/agents.

These practices could include courses on ethics, material management practices, personal protection practices and safe disposal practices. Further, institutions should be encouraged to maintain a management unit to ensure that these practices are followed and mechanisms put in place for reporting any non-compliance. The recent incidents in the US and Russia at facilities housing biological agents reveal the inability of existing measures to curb leakages and highlights the need for implementing a more stringent programme. The lab leak theory of SARS-CoV-2 also hinges on the research on a pathogen being carried out in a less-equipped laboratory facility.

A key concern of established accreditation standards such as Good Lab Practices (GLP) or International Organization for Standardization (ISO) is the high cost associated with their implementation. This increases barriers for their adoption and discourages smaller organisations including startups and small businesses in lower income countries from adopting them. The degree of standards and compliance required to be followed by institutions could be tiered according to scale and risk index of the operation. For example, research on gene drives which could be potentially misused to transfer malicious cargo across large swathes of a target population should be subject to more scrutiny than normal somatic gene editing.

The common minimum program should address the least number of regulations laboratories need to set up to use the various technologies. Individual countries could then supplement the list based on their internal requirements.

Creating an Epidemiologic Database

Numerous infections – both existing and emerging – currently remain unidentified. Further, pathogens keep on evolving and it is difficult to establish if a new pathogen has arisen from a natural event or as a result of human deliberation. Thus, it is important to track pathogen evolution and geographic location as an aid to understand how diseases spread and if a certain event may be a result of intentional human intervention. In consultation with WHO and GHSA, this treaty should form a database of disease patterns across geographies and communities. The treaty could also take measures to set up a repository of naturally found pathogens and document genetic changes found in

them over time. Such a database could be used to analyse changes in pathogens and determine if any intentional changes have been made.

Advances in scientific understanding of genetics could also create the ability to to develop targeted bioweapons. These might be used to covertly attack individuals or ethnic groups who share a genetic identity. Whether the use of bioweapons for strategically targeting individuals should fall under the remit of the BWC or any new treaty remains debatable. But the use of bioweapons for targeting ethnic populations should be considered on par with their use as weapons of mass destruction. State or non-state actors that mount such attacks can also be subject to the UN's 1948 Genocide Convention.

To mitigate the dangers of such weapons being developed, an international database would help establish patterns of normal and unusual disease outbreaks. Any significant changes in pattern (say affecting more than 1000 individuals over a period of 3 months) could be referred to the alliance for a healthcare response.

Universal Healthcare Response

However, even the strictest regulation will not guarantee the non-proliferation of biological weapons. Thus early detection and containment of biological attacks are of paramount importance. In this regard, strengthening the GHSA to work in complement with the BWC would help countries set up and achieve healthcare targets. For example, countries could agree on a standard time to detect an unusual infectious outbreak – say 72 hours. Countries could then work together, to set up the infrastructure and technology required to achieve this standard, taking into account the constraints of funding and terrain of the host country. Technology transfers, particularly for point-of-care diagnostics which can detect outbreaks quickly, should be prioritised under the alliance, even if this upsets some pharmaceutical companies.

The treaty could facilitate alliances between member countries to work together on relevant problems – for example a subgroup of Australia, Bangladesh, India and Malaysia could work on healthcare responses to the Nipah outbreak. This subgroup could work on improved diagnostics, vaccines and management of Nipah through student exchange, technology and knowledge transfer. Finally, the alliance could also work towards setting up precautionary measures and response guidelines for civilian use in case of a biological outbreak.

Sanctions and Penalties

Currently, there are no outlined penalties for developing bioweapons or for not adhering to established biosafety standards. The new treaty should outline these in the context of state and non-state use of bioweapons. It must also devote serious consideration to the dangers of non-state actors using bioweapons and the challenge of crafting an effective global response to such an event. Currently, the BWC holds states responsible for any bioterrorism activity in their territories. It does not, however, contain a mechanism for a coordinated transnational approach to this threat. Non-state actor-led bioterrorism is a global threat and needs to be addressed as such. Holding individual states responsible would be ineffective in resolving this issue. Thus, instead of drawing state-parties into a treaty wherein they are individually responsible for biological attacks in their own territories, a stronger alliance of countries who want to fight the threat of biological weapons is warranted.

However, enforcing penalties is difficult in the absence of mandatory verification. This has been most ably demonstrated by the COVID-19 experience, where a thorough investigation into possible laboratory origins of the Sars-CoV-2 have been negated by the lack of activation of BWC or UNSC. A mandatory verification mechanism combined with a sanctions regime may have led to the early identification and rectification of any possible compromised standards at the Wuhan Institute of Virology. In the absence of mandatory verification, sanctions and penalties may become limited to overt bioweapons such as biotoxins and genetically manipulated biological entities.

VI Conclusion

The theatre for bioweapons use may no longer be limited to states carrying out mass attacks. Instead, the range of threats has dramatically widened to include use in assassinations, civil wars, targeting ethnic groups, and mass-casualty attacks by non-state actors.

Advances in biotechnology and improved access to scientific knowledge may make bioweapons a feasible option for both states and non-state actors. The BWC is ill-equipped to deal with these threats. A new bioweapons treaty is required to address concerns arising from these new threats. This new treaty would require adequate funding and a scientific advisory board tasked with evaluating emerging technologies. The treaty also needs to take a more proactive role in documenting natural/suspicious outbreaks and use an evidence-based approach to assess outbreaks.

It often takes crises or tragic events to prompt the world's states into taking coordinated action. However, to wait for such an incident to occur to take biological weapons seriously would be a folly. A single incident could threaten the whole world and would not be containable by any sarcophagus. Hence, there is an urgent need to develop clear ways to tackle both the proliferation and fallout of bioweapons. Furthermore, the healthcare standards and infrastructure that need to be set up will not only help ward off biological attacks but will have salutary effects on our ability to prevent and contain natural epidemics that impact the health of the whole world.

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