Concerned?—the Biological Weapons Threat, the Biological Weapons Convention, and the Future

Abstract: The current discourse on the threat from biological "threats" conflates concerns over future pandemics, accidental laboratory leaks, and the threat of deliberate biological weapons use. This conflation bundles apples with oranges, along with sets of policy proposals purportedly designed to address potentially global catastrophic biological risks in their totality. This approach is misguided in that it ignores the reality of biological risks, especially the threat of biological weapons. Historically, few States have pursued the development of biological weapons. In most of these cases, State BW programs were short-lived and unsophisticated. Actual use of BW is very rare with most examples of State BW use limited to use by intelligence services in assassinations and attempted assassinations. Rather than conflating potential BW risks, each deserves to be recognized as having different characteristics requiring different responses. This argument is not to negate the reality of biological risks but to highlight the need for realistic, focused, and tailored assessments and responses for very real and potentially catastrophic threats.

Keywords: biological weapon; biosecurity; biodefense; bioterrorism; Biological Weapons Convention; biotechnology; assassination

In April 2022, US Secretary of State Anthony Blinken on the 50th anniversary of the Biological and Toxin Weapons Convention (BWC), Stated that in the wake of COVID-19, "We must recognize that other biological risks are growing and take action to address them. We face not only an increased threat of naturally occurring diseases but also the potential for laboratory accidents and the intentional misuse of life sciences and biotechnology."[1] Inarguably fine words and noble sentiments, but what does it mean in practical terms? Blinken here is echoing thoughts currently holding sway among some non-governmental organizations, yet the near-term, concrete steps he called for are modest, incremental ones. Do they address a fundamental flaw in the BWC or is there even a fundamental flaw in the Convention? What is the reality behind the biological threat?

Since COVID-19, discussions about biological threats (a combination of pandemic response, biosecurity, and BW)[2][3] have resurrected old canards and suggested expensive and politically challenging responses to this set of different problems,[4] which may or may not surface. In stoking fears of biological threats and the dangers potentially unleashed by a dramatic revolution in the life sciences, some are pushing for the adoption of new programs and significant budget increases point to COVID-19 not only as a harbinger for the next pandemic but of something that could be much worse[5]—including existential risk to the future of humanity. This shrill approach—much like the bioterrorism scare of the first decade of the 2000s—is not rooted in an empirical understanding of biological risks or the multifactorial constraints that limit the risks of deliberate pathogen releases.

Is There a BW Threat Today?

Yes, undoubtedly BW programs exist and they pose a threat. This question was explored in greater depth elsewhere,[6] but in short, BW use most likely will take the form of State use of BW in assassinations or small-scale special forces operations, if at all. The terrorist interest in BW seems to have declined following al-Qa'ida's loss of safe havens and ISIS's loss of its "caliphate." Time will tell if the Taliban's resumption of control in Afghanistan (a possible safe haven for BW development and production) will lead to a renewed terrorist interest in BW. As discussed below, the BW threat from apocalyptic or millenarian religious movements should not be ignored. Although none of these groups have been currently identified as having either the intent or capabilities to use BW to cause harm, some of these groups have or can evolve to have ideologies of a world-ending "cosmic war."[7] We have already seen this "evolution" in the case of Aum Shinrikyo.

The BW threat is defined by intent. Capability absent intent is irrelevant, although the discovery of new capabilities could spur intent. The era of mass-casualty or battlefield BW use is gone. The current BW threat appears confined to assassinations and small-scale use for now. The terrorist threat is diminished, but not eliminated. Advances in the life sciences promise enormous benefits in improving the quality and longevity of human life. They also possess inherent risks. So far, these risks are not reality but could be so soon. We need to be mindful of the potential dangers and prepare accordingly.

The Historical Record

The possibility that existential biological risks may arise from the deliberate, intentional use of biological weapons in an attack is not borne out by the history of BW use. States and even terrorist groups are rational actors (although their decisionmaking processes and rationales may be opaque to us); none are known to have sought to use BW in a globally cataclysmic attack. As Seth Carus has written, "The growth in BW's lethality was not matched by increased use. Indeed, evidence of the widespread use of biological agents is known since 1945. A very few small-scale attacks, amounting to biological sabotage, have taken place, but none of those exploited the new dissemination technologies developed by the United States and the Soviet Union."[8]

Claims that States are looking to unleash BW to cause an extinction event have no empirical basis.[9] Assertions that COVID-19 has awakened State and terrorist interest in BW are counterfactual.[10] The intentions of these actors are focused on achieving specific goals, whether religious, political, or social. The use of BW is unlikely to achieve those goals, given its uncontrollable, unpredictable, and indiscriminate nature. The global spread and extensive, widescale harm resulting from COVID-19 has only reinforced the negative perception of BW. Idiosyncratic actors, such as lone wolves, apocalyptic religious groups, or radical environmental extremists may be incentivized toward BW because of COVID-19, but none of these actors have been identified, and none may exist.

Assertions that misperceptions and suspicions may result in an "arms race" fueling State interest in BW while some States would seek BW for strategic deterrence in an anarchic global order lacking in transparency and characterized by heightened threat perceptions and mistrust.[11] Another argument is that internal bureaucratic pressures may lead to unauthorized BW development by rogue government agencies outside the political control of national leaders. All of these assertions are fallacious. First, an arms race involves two or more States seeking to negate a known or perceived weapons advantage by the other either by developing a larger

number of weapons, more advanced weapons, or defensive capabilities. Second, the perception that a lack of international transparency in the life sciences—especially in high-containment biolaboratories—and the absence of a verification mechanism in the Biological Weapons Convention (BWC) will fuel a BW arms race is not supported by the historical record. The lack of transparency and the absence of a BWC verification regime are long-standing, yet the number of States suspected of pursuing BW has decreased, not increased.

Historically few States pursued BW development, and of the small number that did, those efforts rarely lasted more than a few years. In general, most State BW programs—excluding those of the Soviet Union and the United States—were small and unsophisticated[12] Militaries rarely integrated BW into their planning as evidenced by the rarity in which BW was included in doctrine or training. Cases of BW use by militaries are almost nonexistent. Apart from the few States that perceived a strategic or tactical military utility in these weapons, States historically sought to possess BW to retaliate in kind. Development of military BW capabilities as a deterrent ceased to be viable with the advent of nuclear weapons. Saddam Hussain's development of BW as a deterrent against attack was an illusion.[13] Retaliation-in-kind has been abandoned and other weapons systems now have replaced BW in the retaliatory mission. Advanced conventional munitions are far more effective in the retaliatory role, and until 2022 the US still retained the nuclear option to retaliate against CBW use by an adversary as a "hedge, if in the national interest.[14]

The use of BW by States has been largely limited to the employment of toxins in assassinations by intelligence services. Although the use of toxins in assassinations or attempted assassinations is rare (the use of CW agents being relatively more common), several cases are documented including cases involving ricin, botulinum toxin, cardiac glycosides, and curare. As the norm against assassinations has largely collapsed, the normative barriers prohibiting BW use in assassinations likely are significantly weakened. BW use in assassinations likely will become more common, although most incidents will remain undetected. The prevailing goal of BW use in assassination will be for the deaths to be attributed to natural causes. They will be silent deaths. As one recent study published by a research organization within the French Ministry of Defense described it, the goal is "pas vu, pas pris,"—the concept that illegality is acceptable on the part of the intelligence services as long as the act is undetected.[15]

Technology and the Life Science Revolution

Arguments that the relative ease and inexpensive nature of BW have made BW attractive[1617] are unfounded. Of course, game-changing revolutions in the life sciences, data sciences ("big data"), and artificial intelligence are on the horizon, if not manifesting themselves today. Information hazards likewise raise concerns[18] scientists conducting cutting-edge life science research could uncover means of causing global catastrophic biological risks. Concerns of information hazards are often linked to gene sequencing, editing, and synthesis, as well as gain-of-function research which could result in novel dangerous pathogens.[19] All these, however, have to be balanced with the very real benefit they promise for many with life-threatening or chronically debilitating health conditions. The Statement that "accidental or deliberate misuse of an engineered pathogen is more likely to lead to a catastrophic-scale event …"[20] is baseless on its face. Hyperbolic handwaving and scaremongering do not do science or the future of the human race any good.

As early as 2000, the UK's Royal Society convened a distinguished group of scientists and scholars to examine the BW threat. In their report, they highlighted several areas of concern, namely "First, there is fear of the unknown effects of new agents that might be produced by genetic manipulation. Second, the production of BW is relatively cheap and easily concealed under the cover of peaceful activities (e.g., in pharmaceutical plants), so the weapons could become attractive to those nations with low budgets seeking a counter to nuclear weapons. …Given the relevant technology, they are simple to produce in small quantity."[21] These same predictions have been repeated countless times in countless publications ever since, and nowhere is there a sign of fruition[22]. A BW effort, by either a State or non-State actor, requires intent. Intent is linked to utility. Does the State or non-State actor view BW as having utility? Capability alone is insufficient. Yet determining intent almost certainly is the most difficult element of the BW program to discern. No one is a mind reader with 100 percent clarity into the thought processes of decision-makers. Even then national leaders change their minds. What was true regarding their intent one day may not be true the next.

So, to a central question in this debate, does the revolution in the life sciences mean that the risk of bioweapons has increased?[23] Arguments that advances in bioengineering, big data, and artificial intelligence raise the risks of intentional misuse by lower barriers. Undoubtedly a revolution in the life sciences is underway as is the increasing speed of horizontal and vertical proliferation of discoveries and capabilities often referred to as the "democratization of science." A persistent message is "These advances could give malicious actors greater access to scientific knowledge and capabilities to create deadly biological agents, potentially manufacturing the next pandemic."[24] The common argument is that lower barriers mean that the necessary science and technology now or soon will be accessible to a much larger number of people, some of whom may have harmful intent. An increase in capabilities, however, is not causally related to increased intent. Nor does an increase in capabilities at lower levels of expertise equate to an increase in the number of malicious actors. Here we are confronted with a logical fallacy. Because more people can do does not mean that more people will. This limitation on intent negates fears that lower technical barriers will incentivize the intentional development of the next pandemic. Envisioning that anyone, except for possibly an apocalyptic movement, would have an interest in intentionally unleashing a catastrophic pandemic is difficult. The scale and scope as well as the uncontrollable nature of a pandemic is itself a powerful disincentive.

The most likely exploiters of the advances in the life sciences are national BW programs, of which few nations are suspected, yet none have acknowledged—or likely ever will—their pursuit of BW. Lessons from previous State BW programs have shown that development, production, and stockpiling BW were challenging with complex obstacles to be overcome at all stages. The complexity surrounding BW comes from the fact that BW involves by definition living organisms with their specific requirements for viability. Few States possessed large-scale BW programs that lasted more than a decade or two. Issues as to why most State programs only pursued BW for short periods before abandoning them have not been thoroughly explored. Also worthy of exploration is the possible role of tacit knowledge in obstructing BW development.[25]

Little is known about any currently suspected State BW program. What we do know is limited to the public Statement of the US Department of State's annual arms control and disarmament compliance reports and occasional press accounts and journal articles. The Chinese military is thought to be actively looking at military applications of biotechnologies, mostly for cognitive control. As one Chinese military officer pointed out "Military biotechnology has not yet become

an instrument of military power. …We cannot use and control it at our will. Progress is still needed in supporting areas such as military information technologies and material science. Even so, the increased pace of development of modern biotechnology tells us that the day on which we will begin to make full military use of its advantages is not too far off."[26]

Terrorist Interest in BW

Following the 1995 sarin attacks in the Tokyo subway system by Aum Shinrikyo and even more so after the 2001 anthrax letter mailings, concerns of possible terrorist use of BW rose considerably, and enormous sums were funneled into preventing terrorist BW use and mitigating any consequences. Of the known terrorist groups interested in BW, only one, the Rajneeshees, managed to conduct a successful BW attack.[272829]

Arguably, an apocalyptic group bent on bringing about its vision of the end times might seek BW for use in an extinction-level attack, but no such group has been identified. Jamie Yassif and her coauthors cite a Statement by Larry Kerr[30] that 3,000 apocalyptic groups exist and some are solely interested in exterminating humanity.[31] Kerr is far from an expert on the subject; experts on the intersection of CBW and apocalyptic groups such as Jeffrey Bale have found that a potentially very small number of yet-unidentified apocalyptic/millenarianist religious movements with specific characteristics could pose a BW threat.[32] Although the number of these groups likely is higher than Kerr's number, none are known to be solely interested in bringing humanity to extinction. Their rationales are far more complex. Of the very few groups (ex: Aum Shinrikyo, the Rajneeshees, and Colonia Dignidad) pursuing BW agents in the past, none conceived of BW use to annihilate humanity.

During the period of its "caliphate," ISIS likely had some (perhaps short-lived) interest in developing BW, but their BW effort almost certainly was eclipsed by their relative success in producing CW agents and rudimentary munitions. What remained of ISIS's interest in BW after the caliphate collapsed, was limited to encouraging followers in the West to dabble with toxins, such as ricin.[33] As for al-Qa'ida's anthrax program, with the US invasion of Afghanistan in 2002 and the arrest of Khalid Sheikh Mohammed in March 2003, what modest interest al-Qa'ida had in BW likely evaporated.[34] The takeaway from this is that the BW threat from politico-religious terrorists has largely been aspirational and often focused on the use of readily available toxins in limited attacks than pathogens for use in a mass casualty attack.[35]

Deterring Nations or Non-State Actors from Deliberating Causing Harm

Proposals aiming to "disincentivizing development and use of biological weapons by States and other powerful actors,"[36] are misdirected, largely because they fail to understand the nature of the BW threat, especially foreign perceptions that BW lacks military utility in inter-State conflict. With near universal accession to the BWC, countries have publicly disavowed the use of BW. Militaries around the globe have abandoned the concept of BW utility in a strategic sense, and almost all militaries likewise see no tactical utility in BW use. BW is inherently unreliable, uncontrollable, and indiscriminate. All these factors effectively dissuade militaries from an interest in BW. No nation is known to have a military doctrine that involves battlefield BW use, nor of having military units trained, equipped, and capable of battlefield-scale BW deployment. As Filippa Lentzos commented "It [BW] has always been seen as an ungentlemanly weapon. It's never an element of your arsenal that you are proud to display. It's always an underhand thing."[37]

Likewise, pursuing BW as a deterrent is equally nonsensical. Possessing a BW capability as a deterrent requires that the possessor message possession to potential adversaries, in effect announcing that the possessor violates the norms prohibiting CBW and opening the door to international condemnation. Possession of BW in the context of strategic "ambiguity" is not a strong deterrent in the face of far more effective deterrents—cyber warfare, automated weapons systems, and advanced conventional weapons. BW as a capability to retaliate-in-kind is an outdated notion rejected today worldwide. Today, deterrence against adversarial CBW use against the US, its allies, or partners is assigned to US conventional weapons. Establishing a robust system of detection and medical countermeasures is not an effective deterrent.[38] Classic deterrence theory is founded on credible responses to WMD use.[39] Effective countermeasures, however, can reduce the threat of BW use by lessening their effect—thus reducing the utility of BW. This is not deterrence, yet can still be useful.

Is the Biological Weapons Convention Up to the Task?

To clarify a key point, the BWC does not explicitly address BW use; it outlaws the production, possession, and transfer of biological agents including toxins "types and in quantities that have no justification for prophylactic, protective or other peaceful purposes."[40] The 1925 Geneva Protocol outlaws the use of poison gas but also adds a ban on the use of biological weapons in international armed conflict,[41] yet many States took reservations to the Protocol, allowing them to use CBW in retaliation. Of course, the BWC's prohibition on possession can be seen as a prohibition on use. Hard for a State to use BW without first possessing BW, yet the prohibition on use is not explicitly stated in the BWC.

Some have argued[4243] that the current geopolitical situation combined with a revolution in the life sciences is straining the BWC? as never before. Yet the BWC has nearly universal acceptance. Virtually every country on the globe has accepted the BWC prohibitions and adopted the underlying prohibitive norms. One would expect that if the BWC was under such tremendous strain, States would be abandoning the BWC or rejecting its underlying norms. This is not the case, and contrary claims are hyperbolic on their face.

Can the BWC keep up with changes in the life sciences, big data, and artificial intelligence? At its outset, the BWC was envisioned as an agreement to prohibit States Parties from the development, production, and stockpiling of BW. Now with the near-universal acceptance of the BWC and fewer than a handful of possible compliance concerns put forward by the United States,[44] the BWC arguably is withstanding the test of time. As originally conceived the BWC did NOT aim to constrain non-State actors or criminals from obtaining BW, nor did it seek to impose biosecurity measures to prevent accidental pathogen releases from laboratories or impose guidelines on scientists.

The BWC is holding up as the embodiment of a norm constraining States from developing, producing, and stockpiling biological weapons. Violations of the norms—or concerns over compliance by a very small number of nations—do not weaken the norm or the BWC. State responses—or rather, a lack of response to violations—would signal a weakening of the norm.[45]

What Does it Mean to Strengthen the BWC?

To strengthen the BWC, Secretary Blinken called for some incremental steps, including increasing resources for international assistance and cooperation, establishing an S&T review mechanism, and creating a new expert study group to look at ways to strengthen the BWC.[46] At

the BWC's Ninth Review Conference, the State Parties adopted these proposals as well as increased the size of the BWC staff from three people to four. Budget issues continue to plague the BWC and constrain its activities. Yet none of these issues lessens the importance of the BWC as the embodiment of the norm or the ability of the BWC to gather States Parties to regularly discuss BW-related issues.

Does BWC "strengthening" imply a need for a verification protocol? In her 2022 address before the BWC's Ninth Review Conference, US Ambassador Bonnie Jenkins Stated, "We also need to explore what measures – yes, including possible verification measures – might be effective in today's context."[47] In the past, a verification protocol has been a contentious issue and the current political climate does not portend well for the adoption of verification measures. One author, Garrett Ehinger, suggested that perhaps verification should begin with monitoring innocuous "dual-use industries like breweries or cheese-making facilities. A way to do this could be requiring signatories to report domestic traffic to those industries, and submit to randomized visitations to a pre-specified number of the lowest-trafficked locations per unit area to verify BWC report accuracy."[48] Assuming that Ehringer is well-intentioned, even if hopelessly misguided, the proposal to conduct BWC verification for every brewery or cheese producer seems wholly unfeasible, given the enormous regulatory and reporting burdens on businesses that almost certainly are not involved in BW production. As US Ambassador to the BWC Ken Ward recently stated, "You don't want to create false confidence in a verification regime." He goes on to State, "You have to be clear: What can we verify? What can we not verify? And we're never going to be able to verify on a daily basis, if every biological facility in the world doing good things instead of bad things. It's impossible to know."[49]

Implicit in calls to strengthen the BWC is an intention to raise the BWC as a priority among the States Parties. Historically, most States Parties have shown little concern over the threat of BW, and the low priority given the threat is reflected in the meager budget allocated for the BWC functions.[50] That most States Parties likely see no utility in BW and do not see themselves threatened by BW likely contributes to the lower emphasis placed on the BWC and its activities.

Whatever is done to strengthen the BWC will have to pass two tests. Is the proposal politically acceptable and is it technically feasible? Political acceptability likely will be the higher hurdle to overcome. A host of issues—internal and external to the BWC—have polarized the political climate. Consensus on whether to adopt any major proposal will be difficult. Modest, incremental proposals likely will be more palatable.

Is the BW Norm "Unraveling?"

With the public rejection of BW by nearly every nation and virtual universal acceptance that BW use is repugnant,[51] the BW norm remains unchallenged. Even those nations suspected by the US of having BW programs, all including North Korea, have disavowed BW activities. None of the States Parties, even Russia or China, have shown the least interest in abandoning the BWC. Using public declarations of support for the norm and the BWC as measures, the BW norm is strong and faces no overt challenge. Assertions that the BW norm is under attack seem unfounded.

The only mention that the BW norm may be under assault is a 2019 Statement by senior US State Department official Christopher Ford who makes a rather specious argument that because of CW use (in Syria and by Russian and North Korean assassins), then ipso facto the BW norms is in jeopardy. Ford Stated "We live today in a time in which norms against chemical weapons use

are under coordinated international assault: the Syrian regime and ISIS terrorists have both used chemical weaponry repeatedly;… North Korea used the nerve agent VX as a tool of assassination in 2017, and Russia itself employed chemical weaponry in an assassination attempt on British soil last year. Given these grim developments, it is hard to feel much confidence that terrorists and irresponsible governments would show any more restraint with biological weapons if and when they acquire them.[52] When outlining the threat, Ford pointed to instances of CW use adding that States and non-State actors *could* also use BW. CW and BW are not equivalent, not identical, and not interchangeable, so there is no causal link between them. To say that because X has happened, B could happen is a meaningless argument.

What Should be Done?

First, it should be understood that different biological "threats" require different responses. The threat of future pandemics necessitates a different response than the possibility of laboratory accidents or the deliberate use of BW. The clustering of disparate biological threats clouds issues resulting in poorly allocating resources across competing priorities. Each of the biological "threats" needs to be viewed separately. One solution to these "threats" does not exist. The likelihood of a viral pandemic greater in severity than COVID-19 is a given due to globalization, human encroachment on animal habitats, and Anthropocene environmental degradation.[535455] Robust disease surveillance and pandemic preparedness are crucial to mitigate the loss of life as well as economic, social, and political upheaval globally. The resource needs to cope with the next pandemic must be evaluated and allocated apart from other biological "threats." The securitization of public health to address future pandemics is problematic in that it shifts responsibility from the public health community to national security departments. In that sense, securitization is misguided. However, if securitization succeeds in mobilizing a rapid and effective all-of-government response, it has an upside.

Accidental laboratory releases are not security threats in themselves although some—depending on the pathogen—may become public health emergencies. Biosecurity procedures are designed to minimize the likelihood of such accidents, but cannot prevent them from occurring. Accidents have occurred and probably will continue to take place at even the best-managed laboratories. The focus needs to prioritize international biosecurity regulations and cooperation. To date, no regulations exist to oversee international scientific cooperation in the life sciences. This lack of oversight was highlighted by US Director of National Intelligence, Avril Haines, in her 2023 Annual Threat Assessment, which linked "lack of international consensus on biosafety norms" to risks that an emerging or novel pathogen could unleash a devastating pandemic.[56] Although ethical guidelines, such as the Tianjin Biosecurity Guidelines for Codes of Conduct for Scientists, are a positive step toward creating a norm they are aspirational not controlling.[57] Armed conflict also jeopardizes the security of life science and public health laboratories in many parts of the world. Biosecurity and the potential for accidental laboratory releases differ markedly from the other biological "threats" described.

The Role of the Intelligence Community

The Intelligence Community has a major role in detecting, characterizing, and reporting on State and non-State BW efforts. This long-established role is a difficult one, given the dual-use nature of the technologies and know-how involved. It often requires hard, painstaking work and a good deal of luck to fully understand the BW efforts of some States and non-State groups. Luck as a factor in intelligence about biological weapons programs comes when defectors from BW

programs volunteer information. Often defector information provides critical breakthroughs in understanding foreign BW programs. Key examples of this are the 1989 defection of Vladimir Pasechnik and the 1992 defection of Ken Alibek, both of which provided significant revelations about the Soviet BW program.[58]

The work of the US Intelligence Community regarding BW has come under intense criticism at times,[59] but the work is continuing. One critical report concluded that "Biothreat intelligence collection and analysis capabilities are dangerously neglected," claiming "There is a growing need for biothreat intelligence as the barriers to developing biological weapons fall and the range of potential malicious actors expands. New ways to analyze data from social media, trade, published research, and genetic sequences can help us detect potential biothreats before an event occurs."[60] The claim that BW-related intelligence is seriously neglected is unfounded. The report provides no evidence to support the claim. The proposition that analysis of social media, trade publications, journal articles, and genetic sequences will shed light on potential biothreats from presumably clandestine BW programs also is unsupported. Although such costly and labor-intensive efforts may be helpful, they are very unlikely to address the key question of intent.

Should the Intelligence Community become involved in disease surveillance (i.e., pandemic warning or biosecurity at the laboratory level? The answer probably is no. The Intelligence Community has a small DOD element, the National Center for Medical Intelligence, which has as its core mission medical intelligence in support of US military foreign deployments. It collects and analyzes information related to health infrastructure and endemic diseases in a large number of countries related to its mission. Before 2019, global disease surveillance was not strictly within its mandate. The Intelligence Community could perform global disease surveillance, but that function belongs to the WHO and the OIE at the international level as well as the CDC and HHS nationally. Those entities are better positioned and better equipped to undertake a pandemic warning mission than the US Intelligence Community, which is already overtasked with competing priorities.

Conclusion

Claims that with the convergence of artificial intelligence powered by machine learning, a revolution in the life sciences, big data, and other technological innovations will lower barriers to the development of biological weapons and usher in new threats seem exaggerated. The historical record demonstrates that few sophisticated and technologically advanced nations sought to possess biological weapons and even fewer ever attempted their use. The lowering of barriers and the "democratization" of the life sciences is unlikely to be a credible incentive for States to develop BW. The necessary intent is not apparent.

Efforts to dissuade States from BW development and use need to focus on minimizing the utility of BW thereby lessening States' possible interest in BW. Strengthening the norms prohibiting BW development, embodied in the BWC should be prioritized. Steps taken at the Ninth Review Conference of the BWC, including enlarging the BWC staff and creating a science and technology advisory group, are positive steps. Calls to strengthen the norm should not be interpreted as evidence that the norm has weakened or that it is under attack. The near universality of the norm demonstrates that it remains robust. This conclusion is further bolstered by the fact that no nation now admits to having a BW program, and no nation has recently argued against the importance of the BW norm or the BWC. Fears of a biological arms race are unfounded.

The lowering of barriers might incentivize radical apocalyptic or millenarian religious groups, who might be attracted to BW as a weapon in their "cosmic war." However, these groups historically are exceedingly rare, and no such groups have been identified in recent times. As for lone actors, the barriers have not yet fallen to a level that would put BW within easy reach of a novice. Lone actors intent on causing harm likely will be more attracted to conventional modes of kinetic violence, such as guns, explosives, and knives.

Terrorist group interest in BW historically has been small compared to their interest in conventional capabilities or even chemical weapons. Al-Qa'ida, for a short time, had a rudimentary BW effort made up of a handful of people. It produced nothing and ended shortly after the US invasion of Afghanistan. ISIS sought to develop a BW capability, but that too failed, and the group turned those efforts to developing CW. Other groups likely looked at possible BW use, but again nothing came of it. The requisite intent seems lacking.

Conflating the BW threat with other biological "threats," such as naturally occurring pandemics and accidental laboratory releases serves no practical purpose except to muddle these serious issues. No single panacea exists that can address all three "threats." As COVID-19 demonstrated, even a relatively mild pathogenic virus can unleash almost unimaginable horrors on the global population with serious social, political, and economic consequences. As the studies mentioned above have shown, more deadly pandemics are likely to occur more frequently, and a global response is urgently needed. The possibility of laboratory accidents is a constant and they are in no way unusual. Efforts need to be strengthened to ensure to the extent possible that dangerous pathogens do not escape laboratory confinement.

To adequately deal with these three biological "threats," national and international responses and resources must be tailored for each threat separately. Development of national and international pandemic preparedness and response capabilities likely pose the greatest threat to humanity. This threat is almost inescapable, given the increase in emerging pathogens arising from climate change and the degradation of animal habitats. Diplomatic efforts and international public health efforts need to develop equitable, sustainable, and effective capabilities to ensure that emerging pathogens of pandemic potential are identified early and effectively combatted to prevent the spread and mitigate harm. Given that accidental laboratory releases are a perennial problem, laboratory biosafety and biosecurity need to be reinforced and these practices institutionalized internationally through treaties, laws, and regulations. Guidelines are useful as first steps in norm development but ultimately are unenforceable. An international biosafety/biosecurity norm is important. The threat of intentional, deliberate use of BW perhaps is the least concerning. The historical record is clear that most actors whether States or non-State see little utility in BW, given its unpredictable and uncontrollable nature. The lessening of scientific and technical barriers is unlikely to change that perception. Although capabilities might become more advanced, the necessary intent is unlikely to favor BW.

Declaration of Interest Statement

No potential conflict of interest was reported by the author.

Funding

This publication was written with support from an Open Philanthropy grant.

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