Disincentivizing Bioweapons

Theory & Policy Approaches

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NTI | bio

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About the Nuclear Threat Initiative

The Nuclear Threat Initiative is a nonprofit, nonpartisan global security organization focused on reducing nuclear, biological, and emerging technology threats imperiling humanity.

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Contents

Introduction

By Nathan A. Paxton and Jaime M. Yassif

Although development and use of biological weapons has been prohibited under the Biological Weapons Convention (BWC) since 1975, the world continues to face significant risks that such weapons could be deliberately used or accidentally released, with catastrophic global consequences. The special dual-use nature of much of modern bioscience and the BWC's lack of monitoring and enforcement mechanisms have made it very difficult to know what activities occur in the world's countries and whether the activities are for legitimate or illegitimate purposes.

Over the course of more than a century, there has been clear evidence that countries have developed bioweapons or created bioweapons programs, but it has been exceedingly difficult to identify known or probable bioweapons developers with certainty. The most comprehensive, unclassified, peer-reviewed study concluded that since 1915, 44 countries have been suspected of pursuing bioweapons. Of these 44, it is likely that 18 never had a bioweapons program, three only considered developing such a program, and 23 had or likely had a bioweapons program at some point.[1] Even though most of the latter countries abandoned their programs by the time they signed on to the BWC, some BWC States-Parties continue to suspect one other of developing bioweapons or at least bioweapons-relevant capabilities.

Given the significant financial resources available to many states, along with the dual-use nature of bioscience research and development today, preventing states from gaining bioweapons capabilities through controls on materials or knowledge will likely prove challenging. That is why this essay collection focuses on understanding and shaping incentives.

To address the urgent risks posed by biological weapons, disincentivizing states from developing bioweapons is crucial, and the discussion around how to do that is underdeveloped. While the analogous literature on nuclear weapons disincentives and deterrence is broad and deep—with engagement from think tanks, policymakers, and academic researchers—there is limited rigorous discourse on making bioweapons development unattractive. To address this challenge, NTI | bio seeks to support a cross-disciplinary *epistemic community,* which political scientist Peter Haas defined as "a network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain."[2]

This essay collection is designed to encourage the exploration and identification of potential solutions to disincentivize states from developing or using biological weapons. Policy solutions to problems such as bioweapons proliferation do not develop in isolation, and a failure to think deeply and analytically about complex challenges can prevent the emergence of effective solutions. Establishing a strong community with the time and resources to examine the range of current and future threats and develop forward-leaning solutions is critical.

The goal of this collection is to bridge theory and practical policy-relevant approaches to develop new approaches to invigorate international efforts to reduce biological threats. This essay collection represents an introductory effort to kick-start better bioweapons research and policy. While we do not expect to create an epistemic community solely based on this collection, we hope it will advance that goal.

Content of This Collection

NTI commissioned this collection of essays from leading thinkers and practitioners in biosecurity, national security, international affairs, and diplomacy. We asked the writers to think through tactics and opportunities to disincentivize bioweapons development and use in the context of strengthening the norms of the Biological Weapons Convention and the more general anti-bioweapons regime and to consider the international context for disincentivizing bioweapons. This collection follows a workshop that NTI convened in November 2023 to begin a discussion with thought leaders and policymakers about effective ways to disincentivize bioweapons use by states. The collection is organized into three sections:

Section 1:
A Tactical Framework to Shape Intention and Disincentivize State Biological Weapon Development and Use

Section 2:
Disincentivization Challenges That Require Further Attention

Section 3:
Potential Tools and Narratives for Dissuasion and Deterrence

Section 1: A Tactical Framework to Shape Intention and Disincentivize State Biological Weapon Development and Use

The first set of essays contains the tactical framework for shaping state intention that structured our discussion at the November 2023 workshop, as well as critiques and extensions of that framework.

Jaime M. Yassif, Shayna Korol, and Angela Kane's article from *Health Security* (reprinted in this volume) delineates a three-tactic strategy to shape a state's cost–benefit analysis of whether to pursue bioweapons. They argue that enhanced transparency, more robust attribution capability, and better-defined accountability will assist international regimes to prevent bioweapons proliferation.

Clarisse Bertherat, Jaroslav Krasny, Louison Mazeaud, and James Revill consider the specific role of transparency. They argue that transparency is a necessary but not sufficient measure for reducing biological arms-racing tendencies. Transparency can contribute to greater confidence that states are abiding by their BWC commitments and therefore strengthen that component of the anti-bioweapons regime. Exploring alternative approaches to transparency, they consider what further aspects of transparency measures would disincentivize bioweapons.

Gregory Lewis, in thinking through the challenges of attribution, similarly finds transparency necessary but not sufficient to support a better regime of anti-proliferation. Focusing specifically on attribution of "deliberate misuse," Lewis teases out how attribution might be used as a (partial) deterrent strategy to discourage a "crime" that (as the BWC defines it) is "repugnant to the conscience of mankind."[3]

Amanda Moodie Muldowney examines the unique challenges of "penalizing" those who violate the biological weapons regime and norm. Drawing specifically on a seminal nuclear theory of detection, Moodie Muldowney notes that attribution poses real costs for violator, victim, and the international community and it will likely take long, concerted, and deliberate action to put an accountability regime with real force into place. Moodie Muldowney considers several options, within and alongside the existing anti-bioweapons regime.

Section 2: Disincentivization Challenges That Require Further Attention

Inspired by the transparency, attribution, and accountability framework in the first section, the second set of essays addresses a set of disincentivization challenges that exist prior to and outside the initial framework. Drawing on philosophy, political science, and international affairs, these authors follow St. Thomas Aquinas's advice to "always distinguish"—that is, the authors work to clarify the concepts and ideas we use to discuss bioweapons in service of making clearer what can or cannot be known and done to halt bioweapons acquisition.

Sonia Ben Ouagrham-Gormley questions the idea of "deterrence by denial." The world cannot disincentivize international actors by trying to persuade would-be malcontents that their work would be futile because of good biodefense. Ben Ouagrham-Gormley notes that bioweapons defense is generally weak. Combining weak defense with a primary policy of deterrence by denial may have the opposite of the intended effect, incentivizing states and terror groups to go after these weapons. She instead proposes more focus on the adverse cost-to-benefit of trying to obtain these weapons.

Drawing on recently published research, Michelle Bentley argues for much greater focus on the "taboo" norm against biological weapons. Bentley advances the idea that international policymakers have largely ignored norms as an important component of an anti-bioweapons regime. Centering the taboo within the regime would allow for measures that "recognize, formalize, and codify" the real repulsion that these weapons invoke in human beings, and she offers suggestions for the specific types of policy that might accomplish this centering.

Nathan A. Paxton takes on the question of "intent." If one goal of this epistemic community is disincentivizing proliferation, it would help to understand what drives a state's intent to get bioweapons. The bioweapons community lacks a grounded understanding of why states pursue—or do not pursue—this class of weapons, and the community has not developed very effective means by which to discern a state's intent. Drawing on a recent model from nuclear proliferation policy, Paxton encourages bioweapons thinkers to consider how revealed bioweapons strategy may derive from intent and provide a guide to that intent.

Tristan A. Volpe thinks through the dual-use dilemma and the prospects for international cooperation to manage biological arms control. Employing original research, Volpe finds that—like several other technologies—biotechnology is highly integrated within the civilian and military economies, and it is also hard to distinguish military from civilian uses of this technology. This falls in a "dead zone" for verifiable international cooperation, and so Volpe draws lessons for bioweapons from alternative arms control for other dead-zone technologies.

Alex John London addresses the conceptual ambiguity in describing artificial intelligence (AI) systems as possessing or demonstrating "emergent abilities." Many have claimed that AI systems show signs of capabilities that could produce new threats, which would be strategically destabilizing. London explores these claims through a precise and thoughtful elaboration of what "revolutionary leaps in cognition" could consist of. This precision will help policymakers better understand the implications of new technology that could facilitate bioweapons proliferation and perhaps lead to better balancing of decisions that "impact the rights and well-being of large numbers of people."

Section 3: Potential Tools and Narratives for Dissuasion and Deterrence

The third section of the collection turns to applied responses. In the section's sole essay, Emma J. Curran and Nir Eyal outline a "simple tool" for disincentivizing bioweapons. They argue that pathogens with enhanced pandemic potential (PEPP) are so transmissible and uncontrollable as to have no utility as an offensive or deterrent weapon. They consider objections but ultimately conclude that PEPP weapons have no upside, only risk.

Conclusion

This collection of essays presents a broad range of ideas. Whether readers agree or disagree with what they find here, we invite them to engage with these ideas through further writing and analysis or by crafting policy initiatives. By producing, organizing, and structuring new thinking about present and future approaches to disincentivize the development, acquisition, and use of biological weapons by states, the collection aims to provide a foundational resource for the development of a bioweapons epistemic community. Although short, the collection will, we hope, be mighty and contribute to making the world safer from the threat of state-sponsored bioweapons and their consequences.

Endnotes

[1] W. Seth Carus, "A Century of Biological-Weapons Programs (1915–2015): Reviewing the Evidence," *Nonproliferation Review* 24, no. 1–2 (January 2, 2017): 142, doi.org/10.1080/10736700.2017.1385765.

[2] Peter M. Haas, "Introduction: Epistemic Communities and International Policy Coordination," *International Organization* 46, no. 1 (1992): 3, doi.org/10.1017/S0020818300001442.

[3] "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction," opened for signature April 10, 1972, United Nations Office for Disarmament Affairs Treaty Database, https://treaties.unoda.org/t/bwc.

Section 1:
A Tactical Framework to Shape Intention and Disincentivize State Biological Weapon Development and Use

Guarding Against Catastrophic Biological Risks: Preventing State Biological Weapon Development and Use by Shaping Intentions

Jaime M. Yassif, Shayna Korol, and Angela Kane

Summary

This essay outlines three key elements to effectively shape intentions and disincentivize bioweapons development and use by state actors: enhancing transparency, improving attribution, and fostering accountability for violating the global norm against bioweapons development and use. The COVID-19 pandemic underscored global vulnerabilities to high-consequence biological events, revealing an alarming lack of preparedness for such crises. As the risk of biological threats escalates, a robust strategy for prevention, early detection, and rapid response to GCBR-scale events, as well as preventing the development and use of biological weapons by states and nonstate actors, is crucial.

Nonstate actors, driven by apocalyptic ideologies, can be thwarted by limiting their access to necessary resources and expertise. However, states, with their substantial resources and capabilities, pose a more complex challenge. Effective strategies must make bioweapons development economically and politically untenable by enhancing transparency, strengthening attribution, and building accountability measures. The current global biosecurity architecture, including the under-resourced Biological and Toxin Weapons Convention, needs significant strengthening. By addressing the gaps and fostering international cooperation, we can disincentivize bioweapons development and ensure a safer future, mitigating the threats posed by potential GCBRs.

Background

The devastating impact of COVID-19 has highlighted global vulnerabilities to high-consequence biological events. The international community was woefully unprepared for a pandemic that has led to millions of deaths and trillions of dollars in economic losses, and has upended daily life. However, notwithstanding the severe damage caused by COVID-19, it should be viewed as a warning shot.[1] It will not be the last pandemic humanity faces, and the next high-consequence biological event could be as destructive or substantially worse.

We define global catastrophic biological risks (GCBRs) as biological events of tremendous scale that could cause severe damage to human civilization, potentially jeopardizing its long-term survival.[2] The Johns Hopkins Center for Health Security has also developed a working definition of GCBRs,[3] and this term is part of a broader discussion about global catastrophic risks that could arise from a variety of sources, including nuclear war, anthropogenic climate change, and advanced artificial intelligence that has not been sufficiently safeguarded.[4, 5] GCBRs could be caused by a naturally emerging infectious disease outbreak, an accidental release of a pathogen, or a deliberate attack. Naturally emerging infectious disease outbreaks that can grow into pandemics are likely to increase in frequency due to urbanization, globalization, and environmental degradation, and the world faces an increasing risk of high-consequence biological events resulting from accidental or deliberate misuse of the tools of modern bioscience and biotechnology.[6-8] Not all outbreaks or global pandemics will grow to the scale of a GCBR as we define it in this article and as others have defined global catastrophic risks more broadly, because the threshold for this type of event is extremely high.

Although COVID-19 does not rise to the level of a GCBR-scale event, it has demonstrated that a biological event can have a devastating global impact, and it should serve as a warning to global leaders that the world needs much more robust protections against high-consequence biological events that could emerge in the future and be substantially worse.

In our view, human-caused biological events involving the accidental or deliberate misuse of an engineered pathogen are more likely to lead to a GCBR-scale event than a naturally emerging pandemic.[9] Scientists have the capacity to deliberately or inadvertently engineer pathogens that are more virulent and transmissible than what nature creates by chance, and the upper limit of damage that could be caused by a human-engineered biological event is unknown.[10-12] Prevention, early detection, and rapid response are all crucial for guarding against GCBR-scale events. However, in this article, we focus on effective strategies for preventing biological events that could become GCBRs, specifically by disincentivizing development and use of biological weapons by states and other powerful actors.

Work to prevent the development and use of biological weapons is crucial. While biotechnology advances offer tremendous potential benefits—including improvements in public health, economic development, and climate change—rapidly advancing capabilities to manipulate biological systems are also making it easier to engineer increasingly sophisticated biological weapons.[5, 13] These advances are making it possible for a wider range of actors to exploit biology to cause catastrophic harm. Unfortunately, the devastation caused by COVID-19 may have exacerbated this vulnerability by making biological weapons more attractive as a means to achieve political, economic, or other more radical objectives.[14]

Two types of actors could pose important risks to bioweapons development and use: states and nonstate actors. Any effective strategy for countering these risks will ultimately need to reduce the likelihood that an actor will have both the capability and intention to develop and/or use a biological weapon that could cause a GCBR-scale event.

To prevent the development and use of biological weapons by nonstate actors, the most effective strategy is to constrain their capabilities to cause catastrophic harm. Nonstate actors are not typically motivated by the same rational economic, political, and military goals that incentivize states, and they may have an apocalyptic vision aligned with using biological weapons to cause global catastrophic harm. Lawrence Kerr has noted that “at one point in time, there were 3,000 named apocalyptic groups around the world,” including terrorists “solely interested in annihilation of humans.”[15] It is fair to assume that some of these groups would readily use biology to cause globally catastrophic harm if given the opportunity.[16] Aum Shinrikyo is an example of an apocalyptic cult that pursued the development of chemical and biological weapons, making several attempts to carry out large-scale biological attacks in Japan in the 1990s; fortunately they were unsuccessful.[17] Importantly, nonstate actors usually lack the resources of states, especially in terms of trained personnel and financial assets, which makes it feasible to constrain their capabilities by denying them access to materials, equipment, and the technical expertise needed to develop or acquire biological weapons. This strategy can be achieved by safeguarding the tools of modern bioscience and biotechnology to prevent their exploitation by malicious actors.[18-21]

In contrast, many nation states have substantial financial resources at their disposal and access to trained personnel, which makes it extremely difficult and perhaps even impossible to constrain their capabilities to develop and use powerful biological weapons. In our view, a much more effective strategy for preventing the development and use of biological weapons by states is to make the potential costs of bioweapons development unacceptably high and to diminish any perceived benefits.[9] Although some states may see potential tactical or strategic benefits of developing biological weapons—or even using them in some cases—they generally have rational political, economic, and military objectives that would not be well served by deliberately causing a GCBR. Nevertheless, bioweapons development can have unintended consequences—including accidental release of a highly transmissible, deadly biological agent—and any attempt at targeted bioweapons use could result in a much larger and more widespread biological event than intended.[22] For these reasons, we contend that state biological weapons programs can and should be countered with well-designed incentive structures.[23] Designing and building such structures is the focus of this article.

States, Biological Weapons, and GCBRs

To develop effective disincentives for bioweapons development or use, it is important to first understand the range of possible motives for states to consider such weapons. First, misperceptions or suspicions regarding other countries' bioscience capabilities and intentions, exacerbated by a lack of transparency, can drive arms-racing dynamics. Second, states may decide that bioweapons are potentially useful for tactical purposes—for example, to carry out a covert, plausibly deniable economic attack, or if they believe they could carry out a targeted attack that did not impact their own population or that of their allies.[24, 25] Third, states may be interested in bioweapons as a strategic weapon for deterrence, potentially as a more accessible and affordable option than developing nuclear weapons.[26] These tactical and strategic incentives could grow over time as geopolitical tensions continue to escalate between the United States, China, and Russia—and as relationships among regional powers face growing strains.[22] Additionally, even if political leadership does not set bioweapons development as a goal, bureaucratic forces and perverse incentives within large government organizations can drive development.[27] Advances in science and technology that make it easier to engineer living systems could influence all of these considerations and shape states' cost–benefit analyses regarding the potential utility of bioweapons. Addressing the risk is not a hypothetical challenge, as there is evidence that several states currently possess bioweapons programs,[28] and many more have the latent capability to pursue such programs if they choose to do so.

Gaps in the Current Biosecurity Architecture

The need to guard against state bioweapons programs is crucial and growing, for the reasons previously outlined, but the global biosecurity architecture lacks adequate mechanisms and resources to disincentivize and deter the development and use of these weapons. First, while the Biological and Toxin Weapons Convention (BWC) is essential for upholding the norm against the development and use of biological weapons, it is woefully underresourced. With an annual budget of US$1.5 million, the BWC lacks the financial resources to fulfill its mandate to effectively prohibit "the development, production, acquisition, transfer, stockpiling and use of biological and toxin weapons."[29, 30] Importantly, unlike the Chemical Weapons Convention and the Nuclear Non-Proliferation Treaty,[31] the BWC lacks an associated operational organization[32] and currently has only an Implementation Support Unit with three full-time staff members.[33]

The BWC also lacks adequate transparency measures to assess and assure compliance. While it has Confidence Building Measures (CBMs), established in 1986 and designed to increase transparency,[34] the tool is insufficient to reduce suspicions about other nations' dual-use bioscience research and development activities. In addition to suffering from a low participation rate, the CBM form itself is outdated and inappropriate for today's advanced global bioscience and biotechnology research and development enterprise. Furthermore, there is no defined process for follow-up or assessment of the information shared by states. Many experts also have lamented the absence of a BWC verification regime.[14, 35] Although there is no consensus within the biosecurity community that verification is practically achievable, our view is that more robust transparency measures that far exceed the scope of CBMs are needed. Without such measures, substantial gaps in the BWC will remain.

Although the global biosecurity architecture includes additional mechanisms outside of the BWC—such as UN Security Council Resolution 1540,[36] the Australia Group,[37] and the 1925 Geneva Protocol[38]—none of these address the gaps outlined in this section. UN Security Council Resolution 1540 is primarily a tool for states to prevent weapons of mass destruction terrorism, including bioterrorism; the Australia Group export control regime is primarily a means of constraining capabilities, which as previously discussed, is a weak measure for preventing bioweapons development by states; and the provisions of the Geneva Protocol, which bans the use of biological weapons, have effectively been incorporated into the BWC.[29]

Addressing key gaps in the global biosecurity architecture will be difficult, especially in the current geopolitical environment, because of the consensus-based decisionmaking approach currently used by BWC states parties that enables a single state to derail constructive dialogue and progress. To close gaps within the BWC and across the broader biosecurity architecture, new and innovative approaches that build stronger systems around the BWC and establish legitimacy through a variety of channels will be necessary.

A New Approach to Strengthening International Capabilities to Prevent Biological Weapons Development and Use

To address the gaps previously discussed, we outline an agenda that revolves around effectively shaping the cost–benefit calculation of states to make biological weapons an unattractive option. We envision 3 key elements of a new strategy to shape state intentions: (1) enhanced transparency and BWC compliance assurance, (2) more robust capabilities to assess and attribute the origins of biological events, and (3) a well-defined system of accountability for BWC violations.

ENHANCING TRANSPARENCY

Transparency is critical for reducing the potential appeal of bioweapons development. Effective transparency measures can help avoid misperceptions and unwarranted suspicions regarding other nations' bioscience and biotechnology activities, which could otherwise drive arms-racing dynamics. Enhanced transparency measures can provide greater assurances regarding BWC compliance, and in rare instances, such measures may be able to detect violations of the BWC.[39]

At present, CBMs are the primary official transparency measure under the BWC, and there are near-term opportunities to incrementally improve them. These opportunities include updating CBM forms to make them more rigorous and appropriate for modern bioscience and biotechnology, equipping the BWC Implementation Support Unit with resources to analyze the content of CBM submissions, and providing training for countries to prepare CBMs to increase the participation rate, which is barely above 50%.[40] However, while helpful, such reforms would constitute incremental progress where more fundamental transformation is needed.

There is currently a political opening to discuss a more ambitious approach to building robust transparency measures, due in part to a statement by the US delegation at the 2021 BWC Meeting of States Parties. Ambassador Bonnie Jenkins, who delivered the statement, argued that the upcoming BWC Review Conference "should establish a new expert working group to examine possible measures to strengthen implementation of the Convention, increase transparency, and enhance assurance of compliance."[41] This statement led to renewed discussions about potentially viable approaches to BWC verification—an issue that did not have broad support across states parties since negotiations on a verification protocol fell apart in 2001, and which was previously opposed by the United States.[42] The subsequent 2022 BWC Review Conference successfully established a working group that will discuss measures on confidence building and transparency and measures on compliance and verification.[43] Recent efforts to explore new approaches to verification include a report on the topic by the United Nations Institute for Disarmament Research, a Wilton Park workshop cohosted by the iGEM Foundation, and the 2022 Next Generation for Biosecurity Competition on the topic.[44-46] Innovative thinking from a new generation of experts is crucial for advancing meaningful approaches to transparency and exploring the possibility of BWC verification, and these efforts represent a promising step in this direction.

It is important to acknowledge uncertainty as to whether a full verification regime for the BWC is technically feasible. A key issue is that bioscience research is deeply dual use, so even with intrusive inspections that reveal important details about the pathogens facilities are working with, such information will not necessarily be sufficient to determine whether bioweapons development is underway.[47]

Even if full verification of compliance is not achievable, introducing "enhanced transparency measures"[48]—including many of the same components of a verification regime but without the high confidence assessments of compliance or lack thereof—would strengthen the BWC. One potentially promising approach is to build on existing voluntary peer review visits, in which a number of governments have conducted site visits to each other's facilities to bolster transparency.[49, 50] Institutions could be encouraged to voluntarily undergo more detailed assessments to demonstrate BWC compliance; incentives could include priority regulatory review, special access to funding, and reduced insurance premiums, among other options.[45]

In addition to efforts by governments, enhanced transparency measures can involve a broader range of stakeholders, drawing on expertise from the biotechnology industry and the academic research community. Ongoing scientific and technological advances continue to transform what is possible for both onsite and offsite assessments of bioscience research facility activities. Leaders from industry, academia, and civil society have an opportunity to develop and run pilot projects on enhanced transparency measures to explore what is possible with the goal of validating a range of new approaches for conducting assessments of bioscience research facilities. A crucial part of these pilot projects will be to find ways to conduct rigorous onsite and offsite assessments while protecting the intellectual property of industry and academic research facilities.

STRENGTHENING ATTRIBUTION

Attribution is another crucial pillar in disincentivizing bioweapons use. States must believe that there is a considerable chance they will be caught if they use or accidentally release biological weapons. To accomplish this, the international community needs stronger capabilities to assess the origins of high-consequence biological events.

This includes strengthening existing mechanisms, especially the United Nations Secretary-General's Mechanism (UNSGM) for Investigation of Alleged Use of Chemical and Biological Weapons.[51] The mechanism is not a standing investigative body, but it relies on a roster of qualified experts, laboratories, and expert consultants nominated by member states who can be called upon to support a UNSGM investigation under short notice. Although the UNSGM is not part of the BWC, it plays an important role in supporting and strengthening it. It is welcome news that the operational capabilities of the UNSGM to investigate bioweapons allegations have continued to advance, but there is still room for improvement. To start with, the UNSGM needs substantially more financial resources to be truly effective.[52, 53] It is currently supported through voluntary, in-kind contributions by a group of member states known as the "Friends of the UNSGM," but it could benefit from a wider range of supporters, including contributions from an expanded roster of UN member states as well as philanthropic donors.

In addition to strengthening the UNSGM, it will also be important to fill gaps. As evidenced by early challenges with discerning COVID-19 origins, current international mechanisms are insufficient to discern the source of ambiguous biological events. The UNSGM has the mandate to investigate allegations of deliberate bioweapons use, but the bar for triggering an investigation is high; it can only be triggered by the secretary-general in response to the request of a member state.[54] In practice, a high standard of evidence is needed to credibly make this type of claim and for the secretary-general to follow through by launching the UNSGM. To date, the UNSGM has been activated 3 times to investigate allegations of chemical weapons use,[55] but it has never been activated to investigate alleged bioweapons use.

In most cases, the World Health Organization would provide the initial international response to a biological event and would be the first organization collecting information on the ground. Although the World Health Organization has authority under the International Health Regulations (2005) to respond to biological events regardless of origin, its key operational strength, and the comfort zone of its member states, is its ability to assess and respond to naturally emerging infectious disease outbreaks. It is unclear how far the World Health Organization would be willing or able to go in assessing the origins of accidents or biological weapons attacks. These limitations mean that investigating high-consequence biological events of unknown origin falls between current mechanisms.[56]

To fill this gap, the Nuclear Threat Initiative proposed a new Joint Assessment Mechanism for discerning the source of high-consequence biological events of unknown origin that would build on existing capabilities and mechanisms with the aim of creating an integrated UN approach to assessing pandemic origins.[57] It would not be part of the BWC but could strengthen the broader biosecurity architecture that supports it. The proposed Joint Assessment Mechanism would be based within the UN secretary-general s office and established under their authority. It would include a standing capability with a small team responsible for integrating and analyzing data on an ongoing basis, and the ability to rapidly launch an assessment when triggered by the UN secretary-general.

This proposal is part of a broader discussion about ambitious proposals to restructure the international biosecurity architecture. Ambassador Ahmet Üzümcü, former director-general of the Organisation for the Prohibition of Chemical Weapons, put forward a proposal to establish the International Biotech Organization. The International Biotech Organization's core mission would be to "rapidly deploy its technical experts to simultaneously identify the pathogen behind an emerging outbreak while providing public health measures and medical advice to the local authorities on the ground." The independent organization would engage both public and private stakeholders in the biotechnology industry and scientific and philanthropic communities, and would address pathogens that may be accidental, deliberate, or natural in origin.[58]

If these types of mechanisms had existed in 2019 or 2020, some of the difficulties in identifying COVID-19's origins and mitigating its effects might have been avoided.[20] Stronger tools for attribution can have profound implications for international security: For example, determining that a high-consequence biological event is naturally occurring can allay suspicions about BWC violations. Stronger tools for attribution may deter powerful actors from developing and using biological weapons by increasing the likelihood that they would get caught in the act.[59]

BUILDING AN ACCOUNTABILITY SYSTEM

In addition to believing that they are likely to be caught if they develop or use biological weapons, for deterrence to be effective, states must also believe that they will be held accountable. Yet, there is currently no defined international mechanism for accountability in the event of bioweapons development or use.

Failures of accountability following well-documented chemical weapons use have undermined norms enshrined in the Chemical Weapons Convention and illustrate the substantial challenge that the BWC would face if presented with an analogous situation. For example, the mandate of the Organization for the Prohibition of Chemical Weapons-UN Joint Investigative Mechanism, which was created by the UN Security Council to identify and hold accountable those responsible for chemical weapons attacks in Syria, lapsed when Russia voted against renewing its mandate.[31, 60] Additional examples include the use of the Novichok nerve agent in an assassination attempt of Sergei Skripal in Salisbury, England, and to poison Russian opposition leader Alexei Navalny. In both cases, Russia denied responsibility, and the perpetrators have not been brought to justice.[61-63] North Korean leader Kim Jong Un's estranged half-brother Kim Jong Nam was assassinated with the chemical warfare agent VX in Malaysia; North Korea denied responsibility for the attack, and charges against the suspects were dropped.[64, 65]

To avoid erosion of the norm against bioweapons development, it will be essential to establish a clearly defined accountability system for any BWC violations that may arise. Under the UN system and multilateral treaties that rely on consensus, attempts to hold states accountable often become politicized discussions that depend on the geopolitical status and relationships of the state in question. This is a challenge without a clear or easy solution, and policymakers need to explore accountability approaches that cannot be voted down by a single state or powerful coalition. The international community can employ a broad set of tools, including economic sanctions, political pressure and isolation, and in the most extreme cases, military action. Proportionality will be important in deploying these responses, and it would be valuable to lay out a road map for which types of responses are warranted under a range of circumstances.

The biosecurity community can learn from analogous efforts to demand accountability for chemical weapons development and use. For example, at least 27 countries expelled Russian diplomats in the wake of the Salisbury Novichok poisonings. Such international, coalition-based responses send a firm message about the importance of respecting global norms against illicit use of unconventional weapons.[66] In the event of a BWC violation, states parties should coordinate their responses as much as possible to demonstrate shared political will and a united front in demanding accountability. To make this type of response possible, individual countries need to be willing to take action in the face of bioweapons development or use.[22]

The international community must adopt a zero-tolerance policy in response to confirmed cases of biological weapons development or use. To operationalize this, one promising approach could be to develop a biosecurity analogue to the International Partnership Against Impunity for the Use of Chemical Weapons. This intergovernmental initiative, composed of 40 states and the European Union, supports multilateral action to hold perpetrators accountable by compiling and sharing information on those involved in chemical weapons use.[67, 68]

Conclusion

The world is vulnerable to GCBRs, and those risks are growing over time. New approaches to disincentivize states from developing or using bioweapons have the potential to be highly effective and are crucial for strengthening global biosecurity and preventing GCBRs. The COVID-19 pandemic has highlighted our shared vulnerabilities and provided an important reminder of the urgent need to strengthen our defenses against global biological catastrophes. At the same time, growing geopolitical tensions, accompanied by increasingly aggressive disinformation campaigns and false allegations regarding biological weapons, put the BWC and the broader global biosecurity architecture under strain. We must leverage the opportunity to tackle the challenges of enhancing transparency, improving attribution, and fostering accountability for violating the global norm against bioweapons development and use. If the biosecurity and broader international community can come together to develop robust measures for ensuring BWC compliance, we can create a safer, more sustainable future for generations to come.

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Endnotes

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The Role and Limits of Transparency Measures in Disincentivizing Biological Weapons

Clarisse Bertherat, Jaroslav Krasny, Louison Mazeaud, and James Revill

Summary

This essay focuses on the role of transparency in the disincentivization of biological weapons. The central argument is that transparency is unlikely as a stand-alone tool to disincentivize biological weapons programs. However, in combination with other measures, greater transparency in biological research activities can reduce biological arms-racing tendencies and build confidence in the 1972 Biological Weapons Convention. The essay begins with an overview of different forms and directions of transparency. It draws from historical drivers of past biological weapons programs to look at what role transparency measures could theoretically play in disincentivizing biological weapons and bolstering biological disarmament. The article then turns to assess how transparency has operated in the biological weapons regime, taking into consideration the role and limitations of Confidence-Building Measures among other measures, including peer reviews. Finally, the essay explores alternative approaches to generating transparency in the biological weapons regime, including open-source data and methods as a means of forcing greater transparency in biological research and development activities. It concludes by looking at what else is needed for transparency to disincentivize biological weapons.

Types and Directions of Transparency

Transparency, in the context of arms control and disarmament, can be understood as the voluntary release of information, often as part of a multilaterally agreed process. However, greater transparency can also be achieved through involuntary processes. In both cases, transparency can help provide greater confidence in the intentions of an actor, and the term has emerged as somewhat of a feel-good buzzword in international politics. However, the concept can take many different forms, operate in different directions, and provide variable levels of confidence in intent.

In terms of forms, in some cases, transparency can result from *politically binding agreements*, as is the case of the 1972 Biological Weapons Convention (BWC) Confidence-Building Measures (CBMs); in other cases, such as the Chemical Weapons Convention (CWC) declaration regime, transparency is generated through a *legally binding agreement*. However, there are also cases where transparency can be demanded by one state or collective of states of another state (*coercive transparency*).[1] Finally, transparency can also be achieved through *non-voluntary "passive" approaches*, wherein public "information is acquired by the observing actor—independent of the observed actor's cooperation."[2]

Transparency can also have different orientations. States can be transparent to one another, to international organizations, to wider publics, or to some combination of the above. Civil society actors can also provide information that increases the transparency in the activities of a state or entity, in some cases irrespective of whether the entity in question provides consent.

Transparency and Biological Weapons Programs

Transparency can be important in the establishment and maintenance of agreements designed to prevent the development, production, stockpiling, or use of weapons of mass destruction. As Podvig notes, transparency is a basic condition for disarmament and "creates predictability and minimizes the opportunities for misunderstanding and overreaction."[3] Conversely, a lack of transparency or ambiguity in the activities of adversarial states can lead to concerns over such states' development of clandestine weapons designed to gain some form of military advantage. In worst-case scenarios, such concerns can stimulate research on and the development of proscribed weapons or even arms-racing dynamics.

This is particularly challenging in the case of biological weapons, which depend fundamentally on dual-use materials, equipment, and knowledge widely used around the globe for peaceful purposes. This dual-use challenge makes understanding the intent behind the use of biological materials, equipment, and knowledge more important. Transparency measures can provide information to build a better understanding of intent and guard against worst-case assumptions.

Scholarship on the history of biological weapons programs has shown how (frequently incomplete) information on biological activities in an adversarial state has generated concerns over that state's hostile exploitation of dual-use materials, equipment, and knowledge that stimulated adversarial interest in developing in-kind capacity to respond. For example, an albeit patchy knowledge of World War I German anti-animal sabotage programs certainly appears to have had a significant impact on the evolution of biological warfare and stirred interest among several other states in the development of offensive bioweapons programs during the interwar period.[4]

Additionally, Dando et al. identified one factor in the initiation of bioweapons programs as "intelligence (threat analysis) that suggests that potential adversaries are involved in biological weapons programs (even if they are not),"[5] and Guillemin noted that "one frequent justification for developing strategic biological weapons was the suspicion that an aggressive enemy had already armed itself with similar weapons."[6]

Transparency and the Biological Weapons Convention

In the context of the 1972 BWC, the only formal mechanism for generating transparency is through politically binding CBM forms completed by states parties. The concept of CBMs emerged from the Second Review Conference in 1986 as a means "to prevent or reduce the occurrence of ambiguities, doubts, and suspicions, and in order to improve international cooperation in the field of peaceful biological activities."[7] Subsequently, BWC CBMs evolved through an ad hoc expert meeting and successive review conferences, which have sought to review and refine a series of CBM forms for BWC states parties to complete, along with a mechanism for submission and distribution. Currently, BWC CBMs consist of six forms covering, among other topics, national biological defense research and development, outbreaks of infectious diseases, and past activities in offensive or defensive biological research.

Although a useful source of information on some of the relevant activities of BWC States Parties, the current BWC CBM regime remains limited for several reasons. First, despite an increase in the number of states submitting CBMs, participation is still lacking. The BWC Implementation Support Unit (ISU) indicated in December 2023 that "47 [states parties] have never submitted a CBM report, and several [states parties] participate irregularly" and just over 50% of states parties "have exchanged CBMs in the last few years." Second, the information submitted in the summary form is "sometimes incomplete, unclear or does not corroborate with information in the attached CBM forms."[8] Third, yet of greater concern, is that there is no established system through which the content of a CBM is regularly assessed and any potential ambiguities clarified.

To augment the CBM process in the BWC, several states have explored voluntary transparency initiatives or peer review-type processes, which were originally proposed by France in 2011. Several countries have subsequently organized peer review-type activities involving 35 countries from across regional groups. An illustrative list of examples of the participants and topics of select peer review exercises is contained in Table 1.

TABLE 1: ILLUSTRATIVE EXAMPLES OF PEER REVIEW INITIATIVES

Convening Country	Participants	Topic(s)
France[9] *December 4–6, 2013*	International experts and representatives of French governmental and non-governmental organizations	National biosafety and biosecurity system, national export control system, and awareness-raising policies
Benelux states[10] *June and November 2015*	National experts from Belgium, the Netherlands, and Luxembourg	Confidence-Building Measures in the three countries
Germany[11] *August 2–4, 2016*	20 international experts from a range of countries along with German officials	Assessment of several aspects of the Bundeswehr Institute of Microbiology
Morocco[12] *May 9–11, 2017*	Approximately 60 experts, including 16 international experts and a range of Moroccan national experts	National implementation of the Biological Weapons Convention, including pathogen management measures
Georgia[13] *November 14–15, 2018*	19 experts and diplomats, along with representatives from international and regional entities and academia	Assessment of aspects of the Richard Lugar Center for Public Health Research
Kyrgyz Republic[14] *August 16–18, 2022*	28 representatives from national entities, plus experts from five states parties and several international organizations	National Legal Framework, Biosafety and Biosecurity, and International Cooperation and Assistance[15]

Such peer review initiatives (and several other voluntary transparency initiatives), at which external experts are invited to review selected elements of national implementation, can serve as a flexible tool that can improve transparency in the BWC and share good practices in selected areas of BWC implementation, thereby contributing to strengthening the treaty.[16] Moreover, as pointed out by Morocco, undertaking a peer review process and opening a system up to public scrutiny is an important act that demonstrates a state's "commitment to transparency and confidence building within the framework of the BWC."[17]

However, there are limitations to peer review mechanisms in disincentivizing biological weapons development. Peer review initiatives are voluntary, and states can select the reviewers and both the areas *and* the depth of scrutiny. As such, there can be no expectation of reciprocity in transparency. In the current geostrategic climate, there is limited scope for systematizing any form of peer review process multilaterally, which is seen by some BWC states parties as a distraction from the pursuit of verification mechanisms.

"Enhancing" Transparency and Trust in Disarmament Regimes

In the wider arms control and disarmament landscape, several tools could be applied to generate greater transparency and disincentivize weapons development. A selection of illustrative examples of transparency-generating tools—both politically and legally binding—is outlined in Table 2.

TABLE 2: ILLUSTRATIVE EXAMPLES OF OTHER TRANSPARENCY-GENERATING TOOLS

Transparency Tool	Overview
Transparency-related visits	Visits were discussed as part of the BWC protocol negotiations, wherein some states argued that such visits could demonstrate transparency and open channels of communication and contact.[18] Furthermore, some voluntary transparency initiatives have employed confidence-building visits, in which a state invites external actors to scrutinize a national facility.[19]
Baseline information exchanges	Baseline information exchanges, similar to Confidence-Building Measures, could be used to share data on facilities. For example, parties to the Conventional Armed Forces in Europe Treaty are legally obliged to provide detailed baseline information listing numbers, location, and technical data about systems and facilities.[20]
Declarations	Chemical Weapons Convention states parties are legally obligated to submit different forms of declarations covering, among other things, past chemical weapons programs and CW production facilities.[21] In a similar fashion, UN Security Council Resolution 1540 also calls on states to submit national reports on steps to implement 1540, strongly encouraging them to compile national measures to prohibit and prevent the spread of biological weapons to nonstate actors.
Scientific collaboration	International scientific collaboration and science diplomacy can serve as a vehicle to enhance transparency and build trust between scientific communities.[22] In the case of the nuclear community, Lowenthal argued that science diplomacy provided "an alternative channel for international communication through the discussion of scientific aspects of international issues."[23]
Laboratory twinning	Laboratory twinning is not designed to generate transparency per se; however, it can build capacity and research networks, and there have been several laboratory twinning initiatives incorporated into some disarmament regimes. The Organisation for the Prohibition of Chemical Weapons, for example, has developed a laboratory twinning initiative.[24]

PASSIVE FORMS OF TRANSPARENCY: OPEN-SOURCE INTELLIGENCE

Beyond the politically and legally binding forms of transparency outlined here, there are also passive forms of transparency, including mechanisms whereby transparency can be generated involuntarily without the active engagement of the state. This includes the use of open-source information and data, which can be collected and analyzed independently.

For the purposes of this essay, open source is defined as "information obtained lawfully from publicly available sources and not derived from classified sources."[25] Open-source data can include images, videos, news articles, trade data, and satellite imagery that is accessible through unrestricted retrieval of data, data purchase, or registration and access. There are numerous tools that can be used to build transparency—for example:

- The scientific literature can be scanned for indicators of research trends in certain institutions. Scholarly literature can reveal increased interest in a specific scientific topic associated with a particular phase in the development of a bioweapon.
- Corporate profiling can help analysts better understand a biotech company's structure, activities, cash flow, or logistics, such as a surge in purchases or inquiries about specialized equipment.
- Social media content provides a wealth of information that, when properly analyzed, can help paint a picture of specific activities in an institution. This could include the posting of images that may unwittingly point to a specific piece of equipment or other indicator of possible weapons research.
- Event monitoring could help contextualize fragmentary information collected from the aforementioned sources. Examples include current security and political developments, as well as political or military statements.

- Location monitoring of facilities involved in biological research or development could help in the triangulation of biological research activity to a particular geographical point or region.
- Disease outbreak surveillance using public sources can detect and locate unexpected or suspicious disease outbreaks.

Collectively, these types of tools can build a better picture of activities within a state or facility and partially readdress the challenge of incomplete or imperfect information. However, none of these tools on their own is likely to provide conclusive proof of biological weapons development. Moreover, open-source intelligence (OSINT) methods face several obstacles: The scientific literature is vast, and analysts could be overwhelmed by the sheer number of publications; corporate data may be unreliable and difficult to verify through OSINT in all countries; social media monitoring is prone to privacy concerns; and disease outbreak monitoring may include false positives.

Several elements are necessary to effectively use open-source methods and data. First, robust methods for data collection and analysis are required, including analytical methods that are able to overcome subjective bias in data interpretation. These methods, which are widely used by the OSINT community, include data visualization, link analysis, clustering and classification algorithms, natural language processing, and sentiment analysis. To ensure objectivity, it is crucial to employ several methods. Second, the application of robust methods in an international context requires significant and sustainable human and financial resources. Third, for any system to have legitimacy in the multilateral context, it would need to be tested and validated by states, potentially drawing on existing experience and methodologies developed by other actors. Fourth, it requires a geographically representative set of experts trained in the relevant analytical methods and capable of bringing different cultural and language expertise to the table.

TRANSPARENCY AND TRUST

The process of generating transparency, irrespective of the type or orientation of transparency, can involve the collection of objective data through objective technical processes. However, the generation of transparency is also a social process and involves human factors, particularly in the process of interpreting data.

Consideration of the human factor in enhancing transparency is important in two respects. First, as Bowen et al. remarked in relation to nuclear verification, "the human factor, and perceptions of intentions in particular, adds an element of subjectivity that has considerable potential to distort judgments and conclusions."[26] For example, in the interpretation of open-source information, open-source practitioners need to be aware of their own biases and approach any particular issue without a predetermined conclusion or without "seeking" information on noncompliance. Several methods may help reduce, or even prevent, a possible personal bias of OSINT analysts; such methods include but are not limited to blind analysis, cross-verification, the use of standardized procedures (including checklists and guidelines), and, of course, training and regular reflection throughout the process.

Second, the human factor also points to the importance of the relationships between sources and recipients of transparency and the extent to which these actors trust one another. Indeed, trust plays an important role in any transparency process—for example, indicators of biological weapons programs coming from western nongovernmental organizations using open-source data are unlikely to be trusted by states in an adversarial relationship with western countries. This points not only to the importance of generating transparency mechanisms but also to building trust through dialogue and collaboration, including international scientific collaboration, which "can build trust between States Parties, an important aspect of maintaining an effective treaty regime."[27]

After Transparency, What?

Transparency about biological research activities within a state can be important and can play a role in disincentivizing bioweapons development. However, transparency mechanisms as a stand-alone tool will always be limited in the absence of two additional elements. First, there should be channels to consult and clarify information and, where necessary, procedures to resolve outstanding concerns in a manner that is as far as possible insulated from political exploitation. Such channels are important in a highly politicized environment, where selected data points generated through transparency mechanisms can be misinterpreted as part of a mis- or disinformation campaign—a challenge that is becoming more acute with the rise of disinformation efforts generated by artificial intelligence (AI).

Second, there should be mechanisms to investigate allegations of biological weapons development and (where required) impose coercive transparency measures to build a comprehensive assessment of alleged programs—as was the case with the investigation of Iraq's biological weapons programs—and enforce prohibitions on biological weapons development and use. There is a range of possible approaches to restoring compliance, from "naming and shaming" to sanctions imposed by the United Nations (UN) Security Council to collective or unilateral action.[28] Unfortunately, many of the mechanisms to respond to allegations of biological weapons development are under considerable pressure in the current geopolitical environment. For example, the UN Security Council remains divided on many issues, which complicates enforcement of prohibitions and renders other collective or unilateral approaches challenging in the currently strained geopolitical environment.

Reflections

Transparency can play an important role in disincentivizing the development of biological weapons, particularly when operating in combination with other mechanisms. Through the BWC, the current system of CBMs—which remains the only formal transparency mechanism in the treaty—offers some insight into relevant activities of states parties. However, the effectiveness of CBMs is hampered by limited participation, incomplete submissions, and a lack of a follow-up mechanism.

Other voluntary transparency initiatives, such as peer review processes, although valuable, have limitations in terms of the depth and scope of the transparency generated. However, this does not prevent like-minded groups of states collectively agreeing to the parameters and focus for a series of peer review initiatives, including visits to facilities. Such a step could further advance transparency as well as build an understanding of the advantages and disadvantages of such visits.

To address the current deficit, other tools could be explored with a view to enhancing transparency and ultimately disincentivizing biological weapons development and use, including the establishment of mechanisms for science diplomacy as well as the generation of passive transparency through exploitation of new open-source tools. To maximize the value of these transparency-generating tools, such initiatives must be coupled with the activation of channels for clarifying information generated through transparency, as well as measures to investigate and enforce the BWC.

Setting up such a system requires considerable resources, as well as technical, logistic, and political support to build teams of experts able to respond rapidly. However, such a mechanism, which has been raised in the BWC working group discussions on compliance and verification, would go some length to address the difficulties with incomplete transparency and further serve to disincentivize the development and use of biological weapons.

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Endnotes

[1] This coercive model of transparency is evident in Resolution 687, which decided that Iraq shall unconditionally accept, under international supervision, the destruction, removal, or rendering harmless of its weapons of mass destruction. See UNSC, Resolution 687, United Nations 1991.

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Attribution as Deterrence for Biological Weapons

Gregory Lewis

Summary

Some future biological outbreaks may not originate from nature but rather from human mistake or malice. Attribution is the task of discovering which humans or institutions are responsible for accidental or deliberate outbreaks. Although attribution in contexts of accidental misuse is valuable, I focus here on attribution of deliberate misuse—through the development or use of biological weapons—because it is a more pressing and more complex problem. Call this "biological weapons attribution."

Effective bioweapons attribution serves a number of purposes: Identifying the perpetrator of an attack may give insight into their motivation and capability and so inform early responses (e.g., whether subsequent attacks are likely, and if so their likely targets), bioweapons attribution is necessary (but not sufficient) to bring perpetrators to justice and render them incapable of causing further harm, and a fuller understanding of what happened may bring some comfort to victims of these crimes against humanity.

This essay primarily discusses a valuable role for bioweapons attribution: as a means of deterrence. Similar to how an increased likelihood of getting caught may discourage those contemplating a crime, revealing who used weapons deemed "repugnant to the conscience of mankind" may discourage those contemplating a bioweapons attack in the first place. Effective bioweapons attribution could therefore prevent bioweapons use and dissuade bioweapons pursuit, and so help keep the world free from biological warfare.

This is much easier said than done. I talk about the complications of bioweapons attribution as an effective bioweapons deterrent.

Bioweapons Attribution: What Is It Good For?

States may seek bioweapons capability when they believe (rightly or wrongly, rationally or otherwise) that it offers an attractive addition to their pre-existing portfolio of violence. They may contemplate use of this capability in situations which they believe (again, rightly or wrongly, rationally or otherwise) favor bioweapons versus other means available to them.

One feature of bioweapons that may make it attractive to pursue or deploy is the prospect for covert use: to conduct attacks without suffering the consequences of responsibility or retaliation. The gap between appearance and actuality required is scenario dependent. Complete concealment and compelling misdirection may be necessary for a scheme in which a state provokes conflict between two of its rivals by falsely flagging its attack on one as an attack by the other. Barely plausible deniability may suffice to avoid international sanctions escalating into military intervention for a state conducting biological warfare against its own citizens.

Effective bioweapons attribution makes these prospects less appealing by increasing the risk of the attacker's attempted deception being revealed. This has two benefits. In terms of use, bioweapons attribution provides "deterrence by denial" for covert bioweapons attacks: Rational attackers, aware they could or would be discovered, would not conduct attacks which are only worthwhile to their interests if their role perpetrating them must remain hidden. In terms of pursuit, bioweapons attribution, by denying the potential of covert use, makes bioweapons capability less attractive and so dissuades states from bioweapons development in the first place.

WHEN COULD ATTRIBUTION DETER OR DISSUADE?

The deterrence of attribution is limited to covert use; attribution poses no danger to attackers willing to admit responsibility themselves.[1] Thus, its value as a deterrent is circumscribed to how often such covert uses are contemplated and how important such prospects are in making bioweapons attractive to pursue.

That biological weapons are both universally outlawed and widely taboo may mean attackers are more reluctant to be held responsible for an act of biological warfare than for a missile strike or a cyberattack. Thus, in addition to archetypally "clandestine" applications (for example, sabotage, assassination, and other "gray zone" interventions), a state may desire at least some degree of secrecy for bioweapons attacks in contexts in which it would not seek if it were using conventional weaponry—a state may openly declare war yet hide its participation in war crimes. If secrecy is a prevalent need for bioweapons use, then bioweapons attribution may be a broadly applicable deterrent.

Nonetheless, attribution cannot deter, dissuade, or deny *overt* bioweapons use, and such uses (and developing the means for such uses) may still be desirable. One such proposed motivation for state bioweapons pursuit is to acquire a "poor man's atomic bomb" as a means of strategic deterrence inferior to, but easier to obtain than, nuclear weapons.[2] Although secrecy may be desirable while this capability is being developed, possession of the mature capability needs to be credibly communicated: You cannot deter adversaries with a weapon they do not believe you possess.[3] For overt bioweapons attacks in the context of strategic deterrence or tactical desperation, attribution is largely irrelevant.

Attribution is also largely irrelevant to *ostentatious* use, where the value of the attack to the attacker is enhanced by them being identified as responsible. Terrorist attacks typically have this property. Individual terrorists conducting an attack may have little interest in evading capture or in their continued survival; terrorist groups tend to be eager to make their responsibility for an attack and their motivation for launching it plain. State actors could be similarly incentivized. Whether a state is issuing a challenge to the existing international order, expressing hatred or contempt toward the intended victims, intimidating future targets, or demonstrating that it is erratic or its leader a "madman," use of bioweapons—a means deemed morally abhorrent and outlawed internationally—may credibly underline the message that the attacker's violence is intended to send.[4]

DETERRENCE FOR QUASI-RATIONAL, QUASI-UNITARY ACTORS

State behavior is not always wisely calculated and can arise from misjudgment, misperception, non- or irrationality, or factional bargaining. Bioweapons attribution—which would effectively deter intended-to-be-covert attacks from the rational, unitary, strategic actors contemplated in rational deterrence theory—may be less effective directed at real states that demonstrate fewer of those qualities.[5] Even if a state *should* be deterred from developing or using bioweapons, it might do it anyway.

Risk factors for state bioweapons pursuit may also be indicators for impaired state rationality: Autocratic governments (particularly personalist dictatorships) may be more defiant of customary international law, more vulnerable to errors of judgment in their leadership, and more prone to factionalism.[6] Bioweapons programs, typically conducted in strict secrecy after the advent of the Biological Weapons Convention (BWC), degrade expected rationality regarding whether to pursue (or use) bioweapons still further. These factors do not render such states undeterrable, but they do make deterrence by attribution unreliable.

ASSESSMENT: HOW PROMISING IS BIOWEAPONS ATTRIBUTION?

The short answer to virtually all policy questions is "maybe, but it depends." A more elaborate answer illustrates what things it depends on, suggests the issue is complicated, but maybe ventures some qualitative terms to give a rough impression. In that spirit, attribution holds promise to *substantially* deter state bioweapons activity, although its impact is *significantly* attenuated by the challenges previously discussed.

Although more detailed, a more elaborate and attenuated answer is not much more informative: It is not clear how much promise is needed to be "substantial" or whether my value of "substantial" is the same as yours. Yet the exact value of how promising (or how challenging) bioweapons attribution is key to how it should be prioritized. Bioweapons are not the only threat to global peace and security, deterrence is not the only way to address the bioweapons threat, and bioweapons attribution is not the only means of deterrence.

I offer this assessment. I think effective bioweapons attribution would reduce future expected worldwide bioweapons activity by somewhere between 10% and 25%. I speculate that roughly half the impetus for bioweapons pursuit is the capability of a covert attack, and at best half of this incentive could be eliminated by effective attribution. Further, I believe that other interventions likely have a greater effect than bioweapons attribution: Better intelligence efforts to reveal ongoing clandestine programs have an advantage that they can, unlike attribution, deter states that wish to covertly pursue overt capabilities. Nonetheless, the anticipated effect of bioweapons attribution is large enough for it to add a useful increment.[7]

Complications in Effective Deterrence

Even if there is potential for bioweapons attribution to provide a useful increment of deterrence, achieving this potential is fraught. I outline what I see as the three main complexities.

EFFECTORS OF ATTRIBUTION

Attribution is necessary but seldom sufficient for effective deterrence: It indicates who warrants punishment for an attack, but if the attacker leaders expect the punishment to be mild, they calculate the attack is still worthwhile to make. Bioweapons attribution's effect is therefore modulated by the credibility of the links between attribution and retaliation.

These links in turn depend on the victim, the perpetrator, and the retaliatory measures intended. At one extreme, the United States has entered into armed conflicts for avowedly counter-proliferation objectives[8] and has issued veiled threats of possible nuclear retaliation if its forces were attacked with chemical or biological weapons in the 1990–1991 Gulf War.[9] U.S. capabilities for severe unilateral retaliation mean that bioweapons attribution sufficient to convince the United States who its attacker was (even if the United States is unable or unwilling to disclose the evidence underlying this determination to third parties) deters covert bioweapons attacks against it.

Those with weaker capabilities may have to appeal to third parties to intervene on their behalf, whether they be particular allies, the broad international community, international legal mechanisms, or the court of public opinion. These mechanisms are not perfectly reliable, and eroding norms (particularly regarding recent chemical weapons use),[10] rising disinformation, and increasing multipolarity deteriorate them further. This both reduces the effectiveness of bioweapons attribution as a deterrent and raises the bar on the quality and transparency of evidence needed for a given attribution to be sufficiently credible.

Optimal Play in Games of Strategic Deception

Deterrence relies on the subjective perceptions of the adversary rather than the objective capability to deter: It does not matter how good you really are but how good they think you are. Issues of credibility and deception are therefore rife: State X typically would wish to correctly evaluate its opponents and therefore know when acting against them is advantageous despite whatever retaliation they could inflict in turn. At the same time, it would hope to successfully trick opponents into believing that acting against X's interests would be much more dangerous than it truly would be.

Given mutual awareness of these incentives, strategies are often complex.[11] A broad capability might be clearly and credibly demonstrated, while the precise details of its performance remain secret; willingness to use it (and in which circumstances) are often kept deliberately ambiguous.[12]

In terms of bioweapons attribution, these issues emerge in how coy one should be about one's bioweapons attribution capability. Besides the risk that greater disclosure could leak sources and methods to an adversary, greater disclosure provides a fuller picture of overall performance to potential adversaries to gauge their risk of discovery of a covert biological attack and inform their calculations as to when this risk may be worth taking.

Optimal strategy for signaling bioweapons attribution capability to rational adversaries likely mirrors those seen with nuclear deterrence: some balance of credible demonstrations and strategic ambiguity. As discussed earlier, less rational adversaries may be more or less susceptible to deterrence than—by the lights of their own strategic interests—they should be. Irrationally deterrable adversaries may offer opportunities for exploitative strategies, such as posturing attribution capabilities that a rational adversary would not find credible.

ADAPTATION, STABLE ADVANTAGE, AND DETERRENCE BY DIFFICULTY

Adversaries may not acquiesce to capabilities contrary to their interests but instead work to mitigate or overcome their effect on them. A state possessing or pursuing a capability to conduct covert bioweapons attacks that becomes aware its opponents possess means to likely attribute such attacks to it may respond by adapting its bioweapons to evade or misdirect these means—rather than accepting that its bioweapons capability is obsolete and shuttering its program. These cat-and-mouse games of measure and countermeasure are commonplace. Yet even if attribution countermeasures are feasible, attribution may still inflict deterrence on potential bioweapons attackers.

First, the cat or the mouse may have a stable advantage in its game thanks to physics or economics.[13] Perhaps with increasing technical mastery for both parties, the sea becomes increasingly transparent, no matter the efforts of submarines to remain hidden.[14] Although a cheap drone is easily destroyed by an interceptor missile, its expense entails a shot exchange problem: Unsuccessful drone attacks still trade favorably against the greater resources the defender has to expend against them.[15] Although the point where the stable advantages lying between, for example, bioweapons forensics and counter-forensics remains unclear, it is plausible that for some fields of technological competition, the defenders enjoy a stable advantage.

Second, even if the playing field of attribution is level—or even if it is slanted to the attacker—the adaptations the attacker is obliged to make to avoid attribution are still costly to them. Developing and deploying bioweapons that can evade a given attribution capability imposes additional costs and design constraints. These adaptations may force compromises among attribution evasion and destructive capability, readiness, or other aspects of the attacker's bioweapons capability. Obliging potential attackers to make these adaptations may be a desirable defensive strategy, even if the "trade ratio" between attacker and defender investment is unfavorable to the latter.[16]

Third, adaptation is more fraught when it is not clear which adaptations are required. Ambiguity over bioweapons attribution performance complicates attacker calculation: An attack they are confident would defeat publicly disclosed means of bioweapons attribution may fail compared with further capabilities the target has kept secret.[17] Uncertainty about what level (or even which features) of counter-attribution performance is required, and the residual fear that one's assessment could be mistaken can enhance deterrence.

In the technological and intelligence competition between attribution and counter-attribution, the defender is not guaranteed to emerge victorious. However, even if they cannot achieve "deterrence by denial," defenders obliging attackers to compete with them in these domains would achieve "deterrence by difficulty." Even if the attacker can win these competitions, doing so increases their cost of doing business and could dissuade them from pursuing bioweapons as a cost-effective means of clandestine violence.

Conclusion

Deterrence, as succinctly put by *Dr. Strangelove*, "is the art of producing, in the mind of the enemy, the fear to attack."[18] Insofar as states seek biological weapons for covert attacks, bioweapons attribution produces a fear of discovery that can deter states. This deterrence is not sufficient alone to make bioweapons unthinkable, nor is it straightforward to effect, but it could make a valuable contribution to global biosecurity.

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Endnotes

[1] Although this also comes in degrees: An attacker might be reconciled to being held responsible but still find a small chance their attack is not attributed to them, an "added bonus" which could tip the scales on decisions that are finely poised (for example, whether to use bioweapons versus conventional weapons for a given attack).

[2] I leave further discussion of whether bioweapons could be an effective strategic deterrent, and which—if any—historical bioweapons programs had this as their primary objective, to the prior literature: Michael C. Horowitz and Neil Narang, "Poor Man's Atomic Bomb? Exploring the Relationship between 'Weapons of Mass Destruction,'" *Journal of Conflict Resolution* 58, no. 3 (2014), 509–35, doi.org/10.1177/0022002713509049; Gregory D. Koblentz, *Living Weapons: Biological Warfare and International Security* (Cornell University Press, 2009).

[3] Credible communication need not be a straightforward declaration. The Israeli nuclear arsenal is a credible deterrent because its existence is widely believed, even if it is not openly admitted.

[4] Russian assassination attempts with chemical weapons may be one example. A Soviet-designed nerve agent is one of the worst options Russia could select for the purpose of avoiding suspicion in their assassination attempts. However, credibly signaling involvement despite officially denying responsibility may serve Russian objectives to challenge western countries or to intimidate other dissidents or defectors (Maria Snegovaya, "Why Did Russia Poison One of Its Ex-Spies in Britain?," *Washington Post*, March 20, 2018, www.washingtonpost.com/news/monkey-cage/wp/2018/03/20/why-did-russia-poison-one-of-its-ex-spies-in-britain; Mitch Prothero, "Why Putin Deliberately Uses Novichok to Poison His Enemies, Even Though It Often Fails to Kill Them," *Business Insider*, September 3, 2020, www.businessinsider.com/why-russia-uses-novichok-poison-putin-enemies-2020-9).

[5] Another problem to contemplate is that the secrecy under which bioweapons programs have been conducted (particularly in the post-BWC era) limits available evidence to understand what motivates states to commence bioweapons programs: Any ongoing program will not be admitted, and those who decided to launch programs in the past (particularly after the advent of the BWC) have many reasons not to carefully preserve evidence or reliably recount their participation in a crime against humanity. This complicates efforts to predict what is likely to motivate current-day or near-future potential bio-weaponeers. Not understanding how they understand biological warfare impedes deterrence: The messaging and capabilities that could dissuade a state looking to bioweapons as a "poor [person's] nuke" may differ from those looking to such weapons for a better (conventional) payload, a last-resort tool to suppress rebellion, or whatever else.

[6] One plausible example of this is Project Coast, the chemical and biological weapons program of apartheid South Africa. Although it produced limited quantities of agents used in assassination, it fell very short of intended program goals and entertained technically implausible biological weapons (for example, attempts to develop racially specific lethal agents and sterilizing vaccines) (Jerome Amir Singh, "Project Coast: Eugenics in Apartheid South Africa," *Endeavour 32*, no. 1 (2008): 5–9, www.sciencedirect.com/science/article/abs/pii/S0160932708000057) and was subject to large amounts of fraud (Chandré Gould and Peter Folb, "Project Coast: Apartheid's Chemical and Biological Warfare Programme," UNIDIR, Geneva, 2002, unidir.org/files/publication/pdfs/project-coast-apartheid-s-chemical-and-biological-warfare-programme-296.pdf). A program with these stigmata of poor state oversight and control may be less likely to cease operations, even when the governing state is appropriately deterred.

[7] There are a couple of additional side benefits: Efforts toward better bioweapons attribution (for example, advances in machine learning to attribute the likely engineer of genetically modified organisms) have limited dual-use risk or offensive purpose compared to other biodefence activities (Gregory Lewis et al., "The Biosecurity Benefits of Genetic Engineering Attribution," *Nature Communications* 11, art. no. 6294 (2020), doi.org/10.1038/s41467-020-19149-2).

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[9] Barry R. Schneider, "Deterrence and Saddam Hussein: Lessons from the 1990–1991 Gulf War," Counterproliferation Papers, Future Warfare Series, Number 47, Defense Technical Information Center, 2009, apps.dtic.mil/sti/citations/ADA518900.

[10] Julia Masterson, "Reinforcing the Global Norm against Chemical Weapons Use," Arms Control Association, February 18, 2021, www.armscontrol.org/policy-white-papers/2021-02/reinforcing-global-norm-against-chemical-weapons-use.

[11] For example, a "pure" strategy of always credibly demonstrating your deterrents eliminates the possibility of bluffing: adversaries can reliably infer one lacks a deterrent whenever a credible demonstration has not been made. A mixed strategy makes this inference unreliable. A statement such as, "We posture to have a deterrent. Some of the time, we are bluffing. Of the times we are telling the truth, some of the time we do not make a credible demonstration even though we could," prevents easy exploitation. An adversary cannot safely call the bluff of undemonstrated capabilities: There is a risk it proves to be a real capability its possessor declined to demonstrate—rather than an illusory one it pretended to possess.

[12] This is common in nuclear posture: Most possessor states do not forswear first use, and (modulo commitments not to use against or threaten states compliant with the Non-Proliferation Treaty) are ambiguous about which precise circumstances they would consider it. The United Kingdom is candid in its use of ambiguity as an intentional strategy:

> [W]e will remain deliberately ambiguous about precisely when, how and at what scale we would contemplate the use of nuclear weapons. Given the changing security and technological environment, we will extend this long-standing policy of deliberate ambiguity and no longer give public figures for our operational stockpile, deployed warhead or deployed missile numbers. This ambiguity complicates the calculations of potential aggressors, reduces the risk of deliberate nuclear use by those seeking a first-strike advantage, and contributes to strategic stability (U.K. Ministry of Defence, "Integrated Review of Security, Defence, Development and Foreign Policy 2021: Nuclear Deterrent," www.gov.uk/guidance/integrated-review-of-security-defence-development-and-foreign-policy-2021-nuclear-deterrent).

[13] Ben Garfinkel and Allan Dafoe, "How Does the Offense-Defense Balance Scale?," *Journal of Strategic Studies* 42, no. 6 (2019): 736–63, doi.org/10.1080/01402390.2019.1631810.

[14] Roger Bradbury et al., "Transparent Oceans? The Coming SSBN Counter-Detection Task May Be Insuperable," ANU National Security College, 2020, nsc.crawford.anu.edu.au/publication/16666/transparent-oceans-coming-ssbn-counter-detection-task-may-be-insuperable.

[15] Bloomberg, "How Drones Are Revolutionizing the Economics of War," April 18, 2024, www.bloomberg.com/news/videos/2024-04-18/how-drones-are-revolutionizing-the-economics-of-war.

[16] A similar pattern can be observed in disrupting organized terrorist groups (Blake Mobley, *Terrorism and Counterintelligence: How Terrorist Groups Elude Detection*, Columbia University Press, 2012). These groups often adapt to increasing security service activity against them with their own counterintelligence efforts (for example, increased compartmentation, tighter centralization, increased training for terrorist operatives). Although these efforts may be effective at preserving operational security, their additional burdens and propensity to increase mistrust between members substantially encumber operational tempo. Even if these counterintelligence measures are cheaper than the intelligence efforts they resist, state services may be glad to inflict these additional costs on them.

[17] A related dilemma is the potential that a covert attack that successfully defeats the bioweapons attribution capabilities of the present is successfully attributed by better attribution capabilities in the future. Attackers may be uncomfortable with the uncertain timeline of their secrecy and doubt their ability to "future proof" their bioweapons against technological advances in bioweapons attribution.

[18] *Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb*, directed by Stanley Kubrick (Columbia Pictures,1963).

After Bioweapons—What? Accountability for Development and Use of Biological Weapons

Amanda Moodie Muldowney

Summary

Accountability for biological weapons development or use is critically important, as it can both dissuade the user from continuing its activities and deter other states that might be inclined to follow a similar path. However, penalizing violators of the biological weapons norm carries some unique challenges: It is difficult to determine an appropriately proportional response, and the victim of this violation may be reluctant to admit what has happened. The menu of options for dealing with noncompliance includes public denunciation, sanctions, military action, or action from the United Nations Security Council. In addition, recent experiences in the chemical weapons realm may offer alternative approaches for accountability, such as prosecution using universal jurisdiction principles or international criminal tribunals. Although these options are not mutually exclusive and can be used in combination, they are also likely to be lengthy processes, so the international community must recognize that accountability cannot happen overnight.

Introduction

Attribution for biological weapons development and use has made significant strides in recent years through improvement of forensic capabilities and international efforts to strengthen the United Nations Secretary-General's Mechanism (UNSGM). While knowing who is responsible for a biological weapon incident can be helpful even if the perpetrators are not made to answer for their actions, holding the developers or users of biological weapons to account is nevertheless an important goal. Doing so can discourage the violator from continuing to pursue the same action in the future or deter others from carrying out similar activities. Attribution alone is not sufficient for this: Even with effective mechanisms to do so, being able to assign responsibility for biological weapons development or use will not necessarily be sufficient to dissuade state actors from these behaviors; they must also believe that such attribution will result in consequences, and that the cost of biological weapons development or use will outweigh any perceived benefit or gains from these activities. If a state believes that there will be consequences for any such development or use, and it perceives those consequences as unacceptably high, it may be less likely to take those actions.

Accountability: Why It Matters and Why It Presents a Challenge

In his seminal 1961 *Foreign Affairs* article, Fred Iklé, who later became the director of the U.S. Arms Control and Disarmament Agency, posed the question, "After Detection—What?"[1] Iklé suggested that the international community had been overly focused on how to detect violations of arms control agreements and that more discussion of the consequences of violations after detection could be beneficial in ensuring that arms control agreements remain effective.[2] Although the article appeared more than a decade before the Biological and Toxin Weapons Convention (BWC) entered into force, many of Iklé's arguments are prescient and contain implications for accountability for biological weapons use today.

The idea that the use or development of weapons of mass destruction should bear a cost, and that levying penalties against those who pursue such activities may dissuade others from following a similar path, is the fundamental principle underlying deterrence. In the nuclear realm, nuclear-armed adversaries must confront the possibility that an attack would be met with a retaliatory nuclear strike, creating an incentive to avoid conflict.[3] In the biological space, however, accountability presents some unique challenges—and not just because retaliation in kind is off the table as an option for punishment, given the treaty commitments and moral stance of the United States and other countries against the development or use of biological weapons.

To deter would-be biological weapon users, any threats of punishment must be perceived as credible. Short of the overwhelmingly destructive capability of nuclear weapons attacks, it can be difficult to determine what punishment an adversary might perceive as sufficiently costly to outweigh the potential benefits of biological weapons use. At the same time, the unique normative language around biological weapons (such as their characterization in the Preamble of the BWC as "repugnant to the conscience of mankind") may also make it difficult for states to determine what an appropriately proportional response to their use would be. It may also be difficult for adversaries to identify what options might be on the table: There are relatively few cases of overt violations of the norm against biological weapons development and use because most countries do not have declaratory policies about how they would respond to such incidents. Would-be biological weapons users must make their best guess about what penalty might result from their violation of the norm, based on what they have observed in other contexts and what they have come to believe about the importance of this particular norm. This could well lead to dangerous miscalculations.

Adversaries who develop or use biological weapons will also do everything in their power to avoid punishment; they will use all the military, economic, or diplomatic tools at their disposal to exert pressure on other states *not* to levy consequences. Disinformation campaigns can be a powerful tool, and Iklé's article is impressive in its foresight of the dissemination of disinformation about biological and chemical weapons in coordinated campaigns in the 21st century. Iklé observes that the violator can "frustrate the international inspection system and prevent it from reaching an official finding,"[4] "blame the other side for having violated the agreement first and thus confuse the issue,"[5] "accuse the other side of fabricating the evidence as a pretext for breaking the agreement or covering up some other misdeed,"[6] or "assert that the agreement is obsolete and denounce it unilaterally."[7] Russia has used all of these tactics against the United States in its efforts to spread disinformation at meetings of the BWC and the Organisation for the Prohibition of Chemical Weapons over the past decade, and particularly in the wake of Russia's 2022 invasion of Ukraine. By denying the facts or distorting the narrative, adversaries can convince others in the international system not to take retaliatory action to uphold the norm against biological weapons and to justify their indecision by claiming that it is impossible to know the truth of the situation.

In addition, Iklé points out that a country experiencing a violation of an arms control agreement—in this case, a country that has been the victim of a biological weapons attack or that has experienced consequences from another country's development of biological weapons—may have a difficult time retaliating. Domestic public opinion may be against any sort of response, and other political considerations could take precedence over retaliation for biological weapons development or use. A victim country might be reluctant for many reasons to admit that it has experienced a biological weapons attack. For example, such an admission could demonstrate weaknesses in the country's defense or public health systems that it might not want to have revealed to the international community. Alternatively, a state party to the BWC might be concerned that invoking the Convention would limit its ability to take charge of the response or decision-making processes, and that it might be forced to cede control to other actors;[8] it is also possible that the state party might hope to avoid exacerbating tensions that could lead to a potentially bloody and expensive conflict.

Options for Accountability

For the reasons outlined above, it will be challenging for states to hold others to account for biological weapons development or use. What might accountability measures actually look like? The menu of options for dealing with noncompliance has historically been limited; it might include public denunciation, sanctions, military action, or requesting action from the United Nations Security Council (which could include United Nations [UN] sanctions, resolutions, or multilateral military efforts). However, other options for accountability should also be considered.

PUBLIC DENUNCIATION

With regard to public denunciation, Iklé was skeptical that "world opinion" would result in negative consequences for the violator or deter others from pursuing a similar path. He wrote, "Speeches or resolutions in the United Nations, or critical editorials in the world press, are not likely to hurt him [the violator] very much. One reason world opinion is so impotent is that its memory is so short. If the world's reaction cannot be translated immediately into substantive political or military changes damaging to the violator, it will lose all force."[9] In other words, emphasizing the abhorrent nature of the activity is not sufficient; it must be clear that there are consequences. Some of those consequences, Iklé argues, could be damaging for the violator, such as stronger opposing alliances, but simply garnering negative reactions or even losing prestige or influence is unlikely to have a dissuasive effect.

SANCTIONS

Iklé was also rather dismissive of sanctions, arguing that political and economic sanctions are unlikely to prove effective without being coupled with military action. Yet sanctions have often been the response of choice to bring noncompliant states back in line with arms control treaties or punish states for violations. As one international group of experts notes, this may well be because "they are virtually the only option for exerting influence on noncooperative states between merely declaratory responses and military action, or threat of action."[10] To be sure, the record of sanctions in compelling behavior change is mixed at best. In an example unrelated to arms control, sanctions put in place after Russia's invasion of Ukraine have limited Russia's capabilities, but they have not halted Russia's aggression. It is therefore difficult to gauge whether the sanctions have sent the desired message—namely, that violations of international norms will result in coalition responses that could be costly to Russia or other violators in the long term.[11]

Nevertheless, given the ease with which sanctions can be imposed and the extent to which policymakers tend to rely on them as a tool of compellence, it would be unwise to dismiss them out of hand. Since Iklé's article first appeared, a large body of literature has been produced on when and how to apply sanctions to have the greatest effect. Scholars who have explored case studies of sanctions have found, for example, that sanctions are more effective when the recipient states have a clear understanding of what they need to do to have the restrictions lifted and that multilateral support can play a key role in ensuring that sanctions are as strong as possible.[12] These findings have rarely been taken into account in the shaping of sanctions policy; nevertheless, empirical research on the impact of sanctions continues to enhance understanding of how to increase their effectiveness as a policy tool. Policymakers should consider how to incorporate these findings and the resultant recommendations into future sanctions policy if they want to continue to use sanctions as a tool to compel certain behavior.

Action by the United Nations Security Council

States can, of course, refer cases of biological weapons development or use to the United Nations Security Council; Article VI of the BWC provides states parties with the right to request that the Security Council investigate alleged breaches of the Convention. Similar to other arms control treaties, the BWC places the UN Security Council as the primary authority on compliance disputes. However, it does not specify what actions the Security Council may take to hold violators accountable, other than conducting investigations.

Recent developments have shown the limitations of the Security Council when it comes to accountability for the use of weapons of mass destruction: For example, Russia has repeatedly vetoed attempts to condemn or sanction the Assad regime in Syria for its chemical weapons attacks against Syrian civilians or refer it to the International Criminal Court. Similarly, in November 2022, Russia lodged a complaint with the Security Council under Article VI of the BWC, alleging that the United States and Ukraine were in violation of the BWC, in an attempt to distract from its own illegal and unjustifiable invasion of Ukraine. Russia's proposed resolution failed, but its efforts created an unfortunate precedent wherein a BWC member state attempted to use the provisions on noncompliance for purely political reasons. There is good reason to believe that if a future allegation of biological weapons development or use involved one of the five permanent members of the Security Council or a close ally of one, the council would be unable to reach agreement to conduct an investigation, let alone apply multilateral sanctions or use armed force. It is difficult to identify a solution for this dysfunction; prospects for reforming the Security Council, either by enlarging it to include additional permanent members to make it more representative, or by changing its veto provisions or other voting rules, appear dim.[13]

Despite these problems, however, the Security Council remains the final arbiter regarding the consequences of noncompliance. Although Russia's vetoes of any action against Syria for its chemical weapons use—as well as its attempts to misuse the council as a platform for disinformation to justify its invasion of Ukraine—provide illustrative examples of the limits of the Security Council's authority, most states will likely still prefer to deal with compliance concerns through the council. This preference is likely due in part to the Security Council's multilateral nature, which provides an additional degree of legitimacy, and in part to the fact that it is the mechanism prescribed by most arms control treaties and enshrined under international law.

The Security Council remains a vital platform for diplomacy; it is still a forum where states can work together, share information about intentions, seek to influence each other, and advance ideas about peace and security, including about the importance of the norm against biological weapons. Even if the council is unable to take action on future development or use of biological weapons, it is important to continue to seek ways to improve its functionality and ensure that it can take appropriate action in the event of a future allegation, if only because it is the sole avenue for accountability mentioned by name in the BWC and as such will remain the only acceptable approach for some states.

MILITARY ACTIONS

A final option identified by Iklé for responding to arms control noncompliance is military measures. These, again, must be seen by the violator as credible threats, and they must inflict sufficient costs such that the violator is convinced that violating the norm would not be worthwhile. It is not an option for BWC states parties to respond in kind to biological weapons use, given both their treaty obligations to refrain from biological weapons possession or use and the fact that most maintain an ethical stance against the use of biological weapons. It is therefore difficult to know what sort of nonbiological military response would be seen as both proportional and credible. Iklé suggests some ideas for ensuring that an arms control violation is met with a prompt and strong response. For example, he argues that the U.S. Congress or other legislatures could adopt legislation enabling quick action by their president or prime minister, or special committees could take on the responsibility of mobilizing legislative support to respond to breaches of a treaty.[14]

The military dimension of the compliance discussion has become more complicated since Iklé's article appeared, particularly in light of developments in the health security space over the past five years. The COVID-19 response created an opportunity for the U.S. Department of Defense to reposture itself to fight and win in the face of biothreats and to examine its role in addressing future threats, as seen in the 2022 Biodefense Posture

Review. As part of this process, the Department of Defense has worked to enhance early warning, speed up responses, and improve coordination across the various components of the department that are responsible for biodefense issues, along with increasing investment and collaboration.[15] Such developments are not limited to the United States: Countries around the world have begun to incorporate ideas of "health security" into their military planning and explore how their military can respond not just to deliberate biological events but also to naturally occurring outbreaks.

At the same time, the expansion of the nonkinetic battlespace might create additional targets that go well beyond what Iklé might have envisioned in his discussion of the "limited conflict" that could result if deterrence fails. Rather than resorting to physical force, militaries can now respond to biological weapon use with cyber warfare, electronic warfare, or information operations; alternatively, they can use these tools in coordination with traditional kinetic approaches to carry out more targeted conventional attacks. Consequently, the world is potentially in a very different position in 2024 than it was in 1961 with regard to the willingness of militaries to respond to bioweapons events and the options available for how they do so.

LEGAL OPTIONS

There may be additional options for responding to biological weapons development or use that were not on the table 10 years ago, much less six decades ago. For example, to pursue legal accountability for the use of chemical weapons in Syria, several countries have explored the use of universal jurisdiction, a long-standing but rarely employed legal principle that allows states to investigate and prosecute crimes committed outside their territory without regard to the nationality of the victims or the perpetrators.[16] Germany, France, and Sweden have filed cases against members of the Syrian regime, including Syrian president Bashar al-Assad, for using chemical weapons against civilians.[17] It is possible that, in the event of development or use of biological weapons, some states might use the same legal principle to authorize prosecutions of the responsible individuals; the prospect of such legal accountability might deter some individuals from going down that path.

In November 2023, a group of Syrian civil society activists issued a declaration calling on states to establish an international tribunal to prosecute the use of chemical weapons.[18] The tribunal would be established by a multilateral treaty signed by states from around the world and allow the states to collectively prosecute crimes that they otherwise might pursue individually using extraterritorial jurisdiction. The activists promoting the initiative suggest that the tribunal could be set up initially with six to eight participating states, with a view to further broadening its membership after its establishment, based on past tribunals and their consultations with experts.[19] Such collective legal approaches could create added legitimacy beyond processes initiated by individual states and would demonstrate to would-be perpetrators that they would be held accountable.

These examples in the chemical weapons space draw on established precedents from international humanitarian law. The groups focused on countering bioweapons threats historically have not done much to engage with humanitarian and war crimes communities. However, those seeking accountability for possible biological weapons use should consider collaborating with experts in these fields to identify additional potential pathways that may be available to create legal accountability for individuals who choose to assist a state in the development or use of biological weapons, including heads of state and others responsible for the decision to carry out these activities.

Conclusion

It is important to keep in mind that all these options—from possible military measures to international tribunals to Security Council resolutions—can take time. Even sanctions, which are popular among states in part because they can be implemented quickly, are unlikely to have an immediate effect on a violator's behavior, let alone immediately deter others from following a similar path. It is unrealistic and unwise to expect that accountability can be enforced right away or to consider such immediacy a requirement for the norm against biological weapons to remain intact.

The measures described in this chapter do not necessarily need to be used in isolation; indeed, the most effective approach to combating biological weapons development or use and deterring other would-be users is one that combines various measures for accountability. Such a "Swiss cheese" model will help to ensure that the burden of upholding the norm against biological weapons does not fall too heavily on any one state or group of states. It is the responsibility of the entire global community to ensure that biological weapons continue to be viewed as abhorrent and that their use remains unthinkable. A demonstrated willingness to take action against anyone who develops or uses such weapons and to hold them to account is vitally important for the continuation of this norm.

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Section 2: Disincentivization Challenges That Require Further Attention

Two Competing Bioweapons Nonproliferation Policies: Deterrence by Denial and Dissuasion

Sonia Ben Ouagrham-Gormley

Summary

Over the past few years, analysts have promoted the idea that a policy of deterrence by denial could help deter bioweapons use because building strong defenses against bioweapons will convince potential users of their futility. In this paper, I argue that a biodeterrence by denial policy can instead have a proliferating effect because (1) the conditions for building strong defenses against bioweapons are not present today and (2) claiming readiness for a bioattack when defenses are weak can invite states and terrorist groups to develop those weapons. This essay offers an alternative policy of bioweapons dissuasion, which aims to exploit the current challenges of bioweapons development to convince would-be proliferators that the cost–benefit ratio is not in favor of bioweapons development. The essay also evaluates the extent to which new technologies such as artificial intelligence can or cannot support bioweapons development.

The terrorist attacks of 2001 and the anthrax letters that followed have moved the bioweapons threat to the top of government policy focus and made it a part of collective concern. After abating a little, the sense of vulnerability to biothreats has been reawakened by the recent COVID-19 pandemic, which showed that in spite of two decades of work on a biodefense strategy, the United States was still struggling to respond to a public health emergency. For many analysts, these challenges will make the development of bioweapons all the more appealing to states and terrorist groups, and they argue that the best policy to prepare for such an eventuality is to adopt a strategy of deterrence by denial: Mounting strong defenses against the use of bioweapons, they claim, will make the use of such weapons less appealing to enemies.

The argument seems logical, but it has three major weaknesses. First, it assumes that there are no inherent challenges in bioweapons development and that states and terrorist groups just need to gather the will and the ingredients to succeed in developing working biological weapons. Second, it ignores an important lesson from the COVID-19 pandemic: that defending against a bioagent is not only costly but also technologically, organizationally, and logistically extremely challenging, even with international mobilization to combat the pandemic. Third, claiming to stand ready for a bioweapons attack may promote proliferation because an adversary can misinterpret U.S. biodefense activities for bioweapons work.

The alternative to biodeterrence by denial that I have been promoting for over a decade is a policy of biodissuasion. Biodissuasion rests on the principle that the barriers to entry to bioweapons are much greater than the proponents of deterrence by denial make it out to be and, therefore, reinforcing these barriers to entry would yield greater benefits at a much lower cost. This policy is not without challenges because it requires systematic and coordinated action from the whole of government. But it carries the potential of reinforcing the biological weapons nonproliferation regime and norms against bioweapons development and use. In this paper I will start by highlighting the distinction between deterrence by denial and dissuasion. Then I will identify the weaknesses of deterrence by denial as applied to biological weapons and then explain why biodissuasion is a better alternative.

Distinctions between Deterrence by Denial and Dissuasion

Deterrence is a concept borrowed from nuclear weapons strategy and aims to convince an enemy not to use an existing nuclear capability. Deterrence works either by threatening the adversary with massive retaliation in response to a first strike—"deterrence by punishment"—or by convincing the adversary that a first strike would not succeed because it would be countered by a strong defensive capability and followed by a massive retaliation—"deterrence by denial." Therefore, while deterrence by punishment relies on offensive capabilities, deterrence by denial focuses on offense *and* defense. Owing to this dual purpose, deterrence by denial is both very costly and a much more challenging strategy technologically because it requires the development of precise weapons capable, for example, of intercepting incoming ballistic missiles reliably—an objective that has not been fully achieved yet, even in the United States.[1]

In contrast, dissuasion aims to convince an enemy not to develop a threatening capability in the first place, by demonstrating that the barriers to entry are so daunting that the cost of developing these weapons would be much greater than the expected benefit. This is achieved primarily through political and diplomatic means, which do not incur the high cost of uncertain and challenging technological developments.

Deterrence by denial and deterrence by dissuasion therefore differ in their focus: While the former is based on the premise that the threatening weapon system already exists and needs to be countered, the latter aims to nip it in the bud and prevent its emergence in the first place.

Deterrence by Denial as Applied to Biological Weapons

Proponents of biodeterrence by denial base their argument on a widely shared belief that the threat already exists—that is, that countries and nonstate actors already have or intend to develop such weapons and that bioweapons are easy to produce because of their dual-use nature and the accessibility of their technologies. Additionally, the argument goes, the emergence of new biotechnologies and artificial intelligence (AI) tools facilitates the process because of their de-skilling effect. It follows that the use of bioweapons is inevitable—hence, the need to focus on developing defense capabilities that will deter an attack.[2] This argument is faulty on three major fronts—the greatest being that it assumes that the implementation of a biodeterrence by denial strategy is entirely in the hands of the government.

MOTIVATIONS AND ACCESS TO TECHNOLOGIES ARE POOR PREDICTORS OF ACTUAL CAPABILITY

First, there is no evidence that countries or terrorist groups have achieved a bioweapons capability. Most current assessments are based on assumptions about a country's or group's intent or motivations, often erroneously equating access to biotechnologies or existence of a bioindustry to a bioweapon's infrastructure. But as history shows, motivators are poor predictors of the actual capability of a state to produce a working weapon because they are often based on inaccurate assumptions.

For example, the creation of a U.S. bioweapons program during World War II was in part motivated by the fear that Germany might introduce such weapons in the conflict. Allied intelligence reports estimated that because Germany had many skilled biologists, it surely had a bioweapons program, and as Germany was approaching a "strategic crisis" in 1944, the country's leadership, the reports claimed, would likely order loading bioweapons in V-1 missiles for use against Europe.[3] In reality, Germany never produced biological weapons because Hitler had banned their development and use. Hitler's position did not change in spite of signs that the country was losing the war and despite German scientists' continued warnings that the Allies were working on such weapons.[4] Therefore, the creation of the U.S. bioweapons program was based on inaccurate assessments of an enemy's motivation and intent. The U.S. program continued after World War II because of the emergence of another threat: that of the Soviet bioweapons program. But in this case too, U.S. intelligence assessments of the Soviet program were largely inaccurate, vacillating over the years between underestimating and overestimating the program's achievements.

Similar to the German example cited, U.S. assessments of Iraq's biological weapons program and its achievements were vastly inaccurate, culminating in the 2003 U.S.-led invasion of Iraq. Much of the George W. Bush administration's justification for the invasion was based on information provided by an Iraqi defector code-named Curveball, who claimed that Iraq had developed mobile bioweapons labs that could evade United Nations (UN) inspections. Soon after the invasion, it became clear that such labs had never existed and that Iraq's bioweapons infrastructure had been effectively destroyed by 1996 under a UN resolution. Even before the invasion, part of the intelligence community had questioned the reliability of Curveball's allegations.[5] There were undoubtably political motivations behind the U.S. government's and part of the intelligence community's willingness to ignore evidence pointing to the absence of a bioweapons program, in favor of information provided by an unreliable source.[6] But like the assessment of World War II Germany's bioweapons capabilities, the Iraqi example shows that mistaken estimates made based on perceived motivations of an enemy, coupled with a sense of vulnerability, resulted in costly policies.

Bioterrorism threat assessments have followed similar patterns. After the attacks of September 11, 2001, orchestrated by the terrorist group al Qaeda, much concern was raised about the existence of al Qaeda's bioweapons program. Multiple press accounts and U.S. and foreign government officials stated that al Qaeda had attempted to acquire bioagents, had tested some of them on animals, and had developed delivery mechanisms, among other claims.[7] In reality, al Qaeda's interest in bioweapons did not go beyond the exploratory phase and never resulted in the actual creation of a research laboratory or any kind of bioweapons development.

Even when a country or group has a clear intent to produce bioweapons and takes steps to acquire the technology and material, the outcome is rarely commensurate to the resources poured into that effort. For example, Iraq's bioweapons program that spanned a period of two decades—from 1974 to 1996—achieved meager results, in spite of benefiting from the country's vast financial resources, access to material and technologies, and willing or unwitting technical support from many countries. The Iraqis managed to produce large quantities of liquid anthrax and botulinum toxins but failed to effectively weaponize those agents. That failure was due to multiple factors, including the lack of expertise, a program organization that prevented the creation and effective use of bioweapons-specific knowledge, and a political leadership that intruded in technical decisions.[8] For example, while Iraq had acquired fermenters for large-scale production, it was unable to scale up production until the late 1980s, when a fermentation expert joined the program.[9] Similarly, the Iraqi program had acquired equipment to dry liquid bioagents—drying is essential for dissemination—but it did not have a drying expert, thus resulting in its inability to produce a dry form of the agents it manufactured. Iraq also did not have weaponization experts within its program. Weaponization was handled by the chemical weapons program and consisted in loading liquid biological agents into bombs originally developed for chemical weapons delivery. Because dissemination of the agents was to occur upon impact, the explosion would have destroyed most of the agents, rendering the weapons ineffective.[10]

Terrorist group Aum Shinrikyo was also highly motivated to produce and use bioweapons in support of its apocalyptic beliefs, and the members worked at it for six years—from 1990 to 1995. The group also had substantial financial assets and access to biotechnologies and material and had among its members individuals with scientific and biology backgrounds. The group's activities were also protected from police scrutiny because of Aum Shinrikyo's status as a religious organization. Yet the group failed at every stage of bioweapons development from research, development, and production to weaponization and dissemination.[11] The causes of the group's failure are very similar to those that confronted the Iraqi program: lack of expertise in the various stages of bioweapons development, a leadership that interfered with scientific decisions, and a program plagued by the demands of covertness.[12]

These examples demonstrate that identification of an enemy's intent or motivations is difficult to make, and even when there is indeed clear intent to develop a bioweapon, the country or group does not necessarily have the ability to bring the project to fruition. In reality, the analysis of past state and terrorist programs demonstrates that bioweapons development is not conditioned by access to technologies but by the acquisition of expertise required to manipulate fragile bioagents (whether viruses, bacteria, or toxins). That is because such bioagents are sensitive to their environmental and handling conditions, making them unpredictable throughout the various stages of development (research, production, testing, and weaponization) and use as weapons. In fact, most countries and terrorist groups that have engaged in bioweapons development have failed to develop a working weapon, and those that succeeded—the United States and the Soviet Union—have not achieved results commensurate to the resources invested in their programs.[13]

Many have argued that the emergence of new biotechnologies and new scientific techniques such as the gene editing tool CRISPR could be leveraged by untrained individuals to sidestep some of the hurdles caused by their lack of expertise. Additionally, the recent spread of AI tools such as large language models (LLMs) is believed to further reduce the need for expertise because they allow easier access to scientific information and can even offer tutorials on how to perform an experiment.[14] What this argument fails to recognize is that although new technologies can indeed automate or facilitate some stages of an experiment, they do not eliminate the need for expertise because new technologies create new problems that require their users to have sufficient knowledge to (1) recognize the problem, (2) understand the source of the problem, and (3) find ways to solve the issue.

Solving problems caused by new technologies often necessitates the intervention of outside experts, underscoring the communal aspect of science.[15] For example, when scientific kits do not produce the intended results, scientists typically call on experts inside and outside their institutions to identify the source of and find solutions to the problems they face. Similarly, LLMs might provide easier access to information, but data that can be codified and transferred via tangible means (publications, text, drawings, video, etc.) is generally incomplete: It does not include the tacit skills or know-how that are required to use written information effectively and adapt it to a new environment. More important, the focus on access to technology and data ignores the important fact that the development of bioweapons (or any weapons system, for that matter) is not simply the result of access to the proper "ingredients" but the product of a unique socio-technical environment in which expertise and knowledge are created by unique combinations of people, work organization, and management. The reproducibility crisis in science illustrates this challenge: Many experiments cannot be reproduced, even by individuals with the appropriate expertise and technology, often because they do not have the same skills as the original authors, or they operate in a different environment where minute changes in material or equipment can affect results.[16]

REQUIREMENTS OF ROBUST AND CREDIBLE DEFENSE NOT PRESENT

Second, to be credible, biodeterrence by denial would require at least five key conditions:

1. An effective biosurveillance system capable of detecting and characterizing threat agents rapidly
2. A public health system capable of responding to a long-term emergency
3. A pharmaceutical industry capable of developing medical countermeasures swiftly and agile enough to adapt to the specific threat agent(s) used in an attack

4. An effective system of communication and coordination at all levels of government to ensure accurate messaging and logistic support for organizing the response and distributing countermeasures

5. Buy-in from the general public

The COVID-19 pandemic demonstrated vividly that these conditions are lacking, particularly but not exclusively in the United States. Indeed, the detection and characterization of the virus were slow, the response was delayed and decentralized, messaging by the Centers for Disease Control and Prevention (CDC) and the U.S. Food and Drug Administration (FDA) was changing and confusing, the public health system was overwhelmed quickly, and the provision of adequate protective equipment and distribution of diagnostics and vaccines when they became available were disorganized.[17] Although the development of a vaccine took place at record speed, much of the characterization of the virus that served as a basis for the development of a vaccine was the result of an international effort.[18] Such cooperation is not guaranteed in the event of an adversarial attack, particularly if the enemy took care to create a coalition against its target.

The spread of Russian disinformation about the origins of COVID-19 and unproven cures for the disease has demonstrated how an adversary can take advantage of internal political divisions to further weaken response to a biothreat.[19] The disorganized U.S. response and foreign disinformation caused many U.S. residents to distrust government experts, refusing to implement suggested countermeasures (vaccine, masks, distancing). Some state authorities, such as in Florida, made it a point to disregard CDC guidelines, thus allowing the virus to spread further and acquire genetic mutations that made it more contagious. Political opposition and resistance to vaccination are nothing new in the United States, but in the context of biodeterrence by denial, they demonstrate that the implementation of such a strategy would require the U.S. government to get the buy-in of the entire population and political elite, which the COVID-19 pandemic showed is far from guaranteed.

This point is worth emphasizing: In the nuclear field, the implementation of deterrence by denial is entirely dependent on government and, more specifically, the Department of Defense. In a biodeterrence by denial strategy, multiple actors must contribute—from federal agencies to state and local governments and the general population—creating multiple failure points that can be exploited by the enemy. Further, the United States still does not have a reliable biosurveillance system capable of swiftly detecting threat agents; the BioWatch network of sensors, established in the aftermath of the 9/11 events, still faces the same challenges today as in its early years after two decades of development, including persistent false alarms and the need to manually remove filters to take them for analysis in a lab.[20]

Many of these challenges are reminiscent of the weaknesses in the preparedness and response system revealed by the 2001 anthrax letters.[21] A similarly slow and uncoordinated response to the current H5N1 bird flu that is spreading among dairy cows in the United States can be observed today, with insufficient testing of herds, limited supply of tests, uncertainty about how the virus is spreading, limited sharing of information between agencies, and lack of clear guidance to the public on the safety of milk in grocery stores.[22] Preparedness is also wanting: Although government officials indicated that 125 million doses of the bird flu vaccine could be manufactured within 130 days if needed, those doses would not be sufficient for the whole population in the event of a fast spread of the virus because the vaccine requires two shots.[23]

Such a slow response in the context of a virus that is well characterized clearly indicates that the United States is not ready to mount a strong and convincing defense against a biological attack. In spite of the many changes and improvements made since 2001, the country still struggles to respond swiftly and effectively to natural events. These challenges could be multiplied if the attack involves one or several unknown agents specifically designed for harm.

RISKS OF A DETERRENCE BY DENIAL STRATEGY

Finally, a biodeterrence by denial strategy carries the risk of promoting bioweapons proliferation because messaging readiness for such an attack and creating preparedness and response infrastructure and mechanisms for such an eventuality could be misconstrued as bioweapons development. As noted earlier, identifying an enemy's intent to develop bioweapons is made difficult by the dual-use nature of biotechnologies. Because the United States has repeatedly misinterpreted other countries' intentions, other countries can view U.S. biodefense efforts with a suspicious eye, particularly if those efforts are entrusted to the Pentagon and leverage Department of Defense assets overseas, as proponents of biodeterrence by denial propose.[24]

Some countries, such as Russia, would likely intentionally distort U.S. activities to spread disinformation, as they did during the COVID-19 pandemic, and as demonstrated by their decade-long disinformation campaign claiming that U.S. biosurveillance and biodefense cooperation with former Soviet states under the Cooperative Threat Reduction (CTR) program is a cover for bioweapons development.[25] Although such claims have been systematically debunked, they have and continue to spread extensively, notably through U.S. media and government representatives as well as foreign governments.[26] Further engaging CTR-funded laboratories in Georgia, Ukraine, Asia, or Africa in a biodeterrence by denial strategy run by the Pentagon will only provide more fodder to the disinformation campaigns of Russia and other hostile countries.

Misinterpretation of U.S. intent, whether erroneous or as part of a disinformation campaign, also carries the risk of further weakening the Biological Weapons Convention (BWC). Since starting a war with Ukraine, Russia has intensified its onslaught on the BWC, using the treaty and the UN as forums to further spread disinformation about alleged bioweapons activities by the United States, notably by invoking Articles V and VI of the BWC to formally discuss Russian allegations.[27] Russia found few supporters during these discussions, but the systematic and intensive push of false information can create more confusion about U.S. activities and provoke questions about the value of the BWC; both would benefit Russia's objectives.

This does not mean, however, that the United States and other countries should not improve preparedness and response to biothreats. These are necessary steps as demonstrated by the recurrent outbreaks of the past couple decades. But any improvements in detection, characterization of bioagents, and response should be conducted in the context of improving health infrastructure for the general public and should be managed by a civilian agency. A disease outbreak, whether of natural or human-made origin, will be first detected and handled by the public health system. Therefore, improving public health detection and response will necessarily contribute to defending against a potential bioattack. Additionally, a program under the control of a civilian agency, such as the U.S. Department of Health and Human Services, is less likely to raise the same suspicions as a program under the control of the Pentagon, even if it is targeted by foreign disinformation.

Dissuasion as a Better Alternative

The concept of dissuasion is more readily applicable to bioweapons not only because such weapons have been banned under the BWC but also because bioweapons developments have been and remain a difficult proposition. Therefore, focusing on strengthening and publicizing the barriers to entry would yield more solid and sustained results.

KNOWLEDGE AS THE KEY BARRIER TO ENTRY

What is missed in the biodeterrence-by-denial argument is that the barrier to entry to bioweapons development is not at the front end of the process—that is, with access to technologies and material as in the nuclear weapons field—but is further down the development process, during the knowledge acquisition phase. Because bioagents are living organisms that mutate and are sensitive to their environmental and handling conditions, their behavior is unpredictable throughout all stages of development, from research and development to production to testing and weaponization—and during use as weapons. Therefore, learning to manipulate fragile agents and create the proper conditions to maintain their lethal characteristics at each stage of the bioweapon's life cycle is the key barrier to entry in the field.

That specific expertise is acquired, not through books and scientific documents, but via hands-on experience, which may take years, even with previous civilian expertise in the study of the agents concerned. For example, when scientists at the former Soviet bioweapons facility Vector were asked to develop a production process for the Soviet smallpox weapon, they were initially unable to do it even though their staff included experienced virologists from the local university, including the director of the facility, who was a smallpox expert. It was only after receiving on-site support and training from the scientists who originally designed the weapon at the Zagorsk facility that they were able to produce the agent successfully. Even with expert support, however, it took them five years to achieve positive results. This was due to a variety of challenges, including the need for Vector scientists to learn and practice the techniques and processes that are specific to bioweapons work. Another major challenge was to adapt the original protocol that was developed for small-quantity bioreactors and come up with a new formulation that could withstand the stiff requirements of scaling up. After four years of development, the new production process developed at Vector produced only smaller quantities of the virus than the more traditional process of growing the smallpox virus in chicken eggs.[28]

The learning curve in the U.S. bioweapons program was much longer: The program was originally populated with large numbers of scientists from major universities and laboratories, but none of them had prior bioweapons expertise, and, according to former U.S. bioweapons scientists, it took them about 20 years, from 1942 to 1965, to learn how to work with the various agents they experimented with (the program was shut down in 1969).[29]

Additionally, each stage of a bioweapon's development requires different types of expertise and the involvement of teams of individuals representing different scientific and engineering disciplines. These individuals need to be organized and managed in specific ways to allow for the effective use of their expertise, ensure the creation and transfer of new knowledge within a team and program, and allow the identification and resolution of problems rapidly. Organization and management have been serious roadblocks to bioweapons development in most past state and terrorist programs because the need to maintain a covert program usually leads to the adoption of an organizational and managerial style that prevents the creation, use, and transfer of knowledge. Simply put, the need for covertness leads to the adoption of a fragmented and compartmentalized organization and management, with a high level of secrecy that creates barriers to direct interaction and exchange of information among people, teams, and facilities constituting a program. As a result, knowledge—when created—remains confined to its authors, limiting its passage from one stage to the next and preventing the timely identification and resolution of problems, thus leading to project delays and failures.[30]

Production, scale-up, and weaponization are particularly difficult stages of bioweapons development because they create changes in an agent's environmental conditions, exposing it to contamination or changes in properties that affect its efficiency as a weapon. For example, the U.S. program routinely faced issues of batch contamination during production and scale-up that were never fully resolved. U.S. scientists also found that the botulinum toxin they developed as a weapon lost its toxicity during aerosolization, thus precluding its use as a weapon.

In short, because they rely on fragile living organisms that are difficult to control and remain unpredictable through all stages of development and use as weapons, bioweapons programs have generally been unsuccessful. Even the U.S. and Soviet programs, the only two that have been able to produce working bioweapons, have not been fully successful: The U.S. program, which lasted 27 years and cost an estimated $700 million, produced only a small arsenal of bombs—but no missile that could deliver them. The Soviet program, which lasted about 60 years and cost billions of dollars, was able to weaponize classical agents but failed to develop new engineered pathogens—a task that was the focus of its last 20 years—and failed to develop ballistic missile warheads capable of protecting the agents from the shock of a ballistic missile reentry.

Several analysts have speculated that the socio-technical challenges that have characterized bioweapons development in past state and terrorist programs could be erased by the advent of AI tools that could not only reduce the need for expertise but also deliver how-to guides, allowing faster bioweapons developments with limited resources. But, as indicated earlier, LLMs provide only information—they do not confer their user's practical laboratory expertise. A lot of the laboratory expertise is composed of visual or sensorial cues that are difficult to translate in written or spoken language and would not be found in LLM libraries. For example, the synthesis of the polio virus that took place in 2002 hinged on a seemingly simple and straightforward technique that consisted of crushing bovine cells in a Dounce homogenizer to produce the cell extract necessary to grow the virus. Yet the technique is devilishly difficult to master: Push too hard and the cells are destroyed; push too gently and the cells are not crushed enough. Thus, scientists at the Stony Brook laboratory who conducted the synthesis had to learn to apply the right amount of pressure to crush the cells and allow the experiment to proceed further. Some became masters at the technique, while others struggled. To improve their chances, some of them had to get a custom-made Dounce homogenizer because commercially available instruments did not perform sufficiently well.[31]

Additionally, scientists often use language that is vague and can be understood only through extensive experimentation. For example, when a scientist says that the cells "look happy," he or she probably means that the cells have reached a state that is appropriate for the experiment under way. But "happy" means different things in different contexts, and that's not something that LLMs can capture. Furthermore, scientific experiments require the use of a variety of material (reagents, water, etc.) that have changing properties, and this variability can introduce failure points in an experiment. For example, the pH of the water can change from one location to the next, or the reagents may have different properties depending on the supplier, thus introducing variables that can make reproducibility impossible, even by scientists previously successful in conducting an experiment. Thus, if LLMs do accelerate access to information, they do not provide all of the details because they cannot be expressed or quantified, nor do LLMs allow easier or faster acquisition of hands-on lab expertise.

Some experts have also pointed to biological design tools (BDTs) as a potential way of overcoming the socio-technical challenges of bioweapons development. BDTs are specialized AI tools trained on biological data and can help, for example, design new proteins or confer new biological functions to existing proteins. However, BDTs require specialized knowledge to use them effectively in an experiment. Additionally, the data provided by BDTs needs to be validated in the laboratory, making it challenging for non-experts to use these tools for good or bad.[32]

LEVERAGING THE CHALLENGES OF BIOWEAPONS DEVELOPMENTS

For too long, the dominant narrative about biological weapons has been one of reducing these weapons to the acquisition of their main ingredients and emphasizing their ease of production and value for an adversary in light of the continued vulnerability to biothreats. Since the mid-1980s, assessments by the intelligence community have portrayed bioweapons development as fast and straightforward, particularly with the advent of new biotechnologies.[33] These claims have been repeated over the years by U.S. and foreign government officials, as well as the media and biosecurity experts, to the point that they are rarely questioned.

Apart from grossly mischaracterizing the threat, this narrative poses the risk of making bioweapons attractive to potential enemies. It is known, for example, that al Qaeda considered bioweapons precisely because of this narrative. A memo written in 1999 by al Qaeda deputy head Ayman al-Zawahiri stated: "[T]he enemy drew our attention to them by repeatedly expressing concerns that they can be produced simply with easily available materials … [and that] defense against such weapons is very difficult, particularly if large quantities are used."[34]

This narrative also masks important truths about bioweapons developments and prevents the adoption of policies that would more effectively reduce proliferation. Past state and terrorist bioweapons programs show that such developments are protracted and costly, and seldom result in working weapons because the challenge of working with fragile and unpredictable agents requires difficult-to-acquire expertise. Therefore, it is important to start developing truly dissuasive policies that leverage these challenges.

CHANGING THE NARRATIVE WHILE COUNTERING RUSSIAN DISINFORMATION

First, it is important to change the current narrative from one positing easy-to-produce weapons to one that highlights the multiple barriers to bioweapons development. The fragility and unpredictability of bioagents create a natural barrier that cannot be overcome without the acquisition of the appropriate expertise. That expertise, which constitutes a stiff barrier to entry in the field, is not acquired through scientific documents but via prolonged, hands-on experience, requiring the involvement of a community of experts who have knowledge adapted to the agents under study and the skills to maintain their properties throughout all stages of development and weaponization. This knowledge is not easily acquired and may require decades of work, as demonstrated by the U.S bioweapons program, or might not pan out at all, as shown in the case of terrorist group Aum Shinrikyo.

Further, the use of that expertise is conditioned by the organizational and managerial conditions of a program, which constitute an important barrier to success even when proper expertise is available. Because bioweapons development has to be covert to prevent detection, the organizational and managerial demands of covertness (fragmentation, compartmentalization, high security) are inconsistent with the needs for knowledge creation and use (openness, direct interaction, unfettered exchanges). Finally, a major barrier to bioweapons development is that the weapons remain uncertain and unpredictable when used; for example, bioagents are sensitive to UV light, and weather patterns and varying landscape can limit their dispersion and reduce their efficiency.

This new narrative about the challenges of bioweapons development should be part of a government policy of dissuasion and systematically conveyed by government officials. This is particularly important in a context of Russian disinformation. Russia has indeed seized on the dominant narrative to promote its false claims about U.S. activities, notably that the United States and Ukraine were developing ethnic bioweapons and super soldiers to be used against Russia. However nonsensical they might be, these claims have spread, and they risk taking hold when it is claimed that bioweapons are easy to produce and that everything is possible with new technologies. Therefore, an essential element of countering Russian disinformation is also to counter the false narrative about the ease of production of biological weapons.

REINFORCING THE BWC

One of the unsung qualities of international nonproliferation treaties is their disruptive power. Regular inspection, or the threat of inspection, leads proliferating countries to stop their activities, move them to another location, and possibly destroy some of the material produced. Such moves in the biological field are particularly damaging; because bioagents are so fragile, changing their environment can destroy them. Such disruptions during challenging stages, such as production and scale-up, can effectively disrupt a program and prevent progress. More important, some knowledge might be lost during the disruption, making it harder for the project to resume where it stopped.

Unlike the Non-Proliferation Treaty and the Chemical Weapons Convention, the BWC still does not have a verification mechanism. The 2001 BWC protocol was rejected by the United States partly because, in the view of the then-Bush administration, the BWC could not be verified because of the dual-use nature of biotechnologies. What they failed to understand is that even an imperfect verification mechanism can be effective as a result of its disruptive effect. Therefore, it is important to renew discussions about adopting a verification mechanism for the BWC that includes even very imperfect inspections.

Conclusion

The challenges of bioweapons development observed through the analysis of past state and terrorist programs are hardly a thing of the past as some analysts have claimed—simply because the key material used in bioweapons development is still the same: living microorganisms that have unpredictable behavior throughout the research and development process. As a result, the key barrier to entry in the bioweapons field remains the acquisition of bioweapons-specific expertise that occurs only through years of experimentation. Therefore, it is important to capitalize on this barrier to discourage countries or terrorists groups to engage in bioweapons development.

The strategy of bioweapons dissuasion proposed in this essay can achieve that goal. In contrast, a bioweapons deterrence by denial strategy is more likely to invite more countries or groups into the bioweapons club because it reinforces the prevailing narrative that bioweapons are easy to produce. The argument that new technologies have a de-skilling effect and may help accelerate or facilitate bioweapons developments by untrained individuals is not supported by empirical studies. These studies have shown that new technologies—even if they do automate or facilitate some tasks—also create new problems that require their users to develop new expertise to use them effectively.

Additionally, new technologies do not solve all problems that may arise at different stages of a bioweapon's life cycle. Therefore, any discussion about the role of new technologies in weapons development needs to be supported by rigorous analysis of what new technologies can and cannot do, what aspect or stage of weapons development are they likely to help, and to what degree that changes the bio-proliferation equation. This, too, should be part of a dissuasion policy to effectively curb the appeal of bioweapons development.

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The Biological Weapons Taboo: A "New" Focus for Arms Control

Michelle Bentley

Summary

International policymakers and analysts state that norms are a necessary and vital means of biological arms control. Yet this statement is an ideal that is not reflected in reality. The anti-bioweapons regime is built primarily around measures that seek to change the strategic environment by ensuring biological aggression cannot be enacted or convincing actors that biowarfare is not in their strategic interests, a state of affairs termed here as "strategic restraint." These strategic measures do not preclude the idea that arms control should also stigmatize biowarfare as a form of "normative restraint." Yet norms have not been made a priority in bioweapons control and are reduced to a secondary by-product of strategic restraint.

This chapter engages with a specific norm—the biological weapons taboo—to both highlight and challenge the way the regime ignores norms. The chapter outlines the taboo to demonstrate why actors are normatively averse to bioweapons and why new arms control measures that directly reflect and seek to strengthen this aversion can radically improve biowarfare prevention. The chapter argues that policymakers must (1) fully understand the taboo as the basis of a new arms control framework and (2) introduce measures that recognize, formalize, and codify the taboo as an international value and standard of behavior. The chapter shows what this approach would mean in practice and the types of policy needed not only to enact the taboo (as the basis of more effective arms control) but also to place the taboo at the very center of the regime within its own right.

Introduction

This chapter calls for a radical rethinking of norms in biowarfare arms control;[1] in particular, the norm of the biological weapons taboo. International policymakers and analysts state that norms should comprise an integral aspect of biological arms control. Yet this statement is not reflected in the reality of the anti-bioweapons regime. Biological arms control instead centers on strategic denial and persuasion, termed here "strategic restraint." Policy is principally aimed at ensuring that biological aggression cannot be enacted or at convincing actors that biowarfare is not in their strategic interests, through policies such as investigation mechanisms.

Strategic restraint measures do not preclude the idea that arms control could—and should—*also* stigmatize biowarfare as a form of "normative restraint." Yet this chapter argues that norms are not given sufficient attention. Adopting an almost entirely strategic and technical focus, international policymakers fail to make use of another powerful set of disincentives regarding bioweapons. Moreover, to the extent that the bioweapons regime does consider norms, they are seen only as a secondary by-product of strategic restraint. International actors view norms as a nice addition to the regime, but norms are not constructed as a priority, or even a core focus, for arms control. Norms have been reduced to a rhetorical flourish—an issue lauded as vital in public but rarely associated with any substantial consideration in terms of actual policy measures.

This chapter not only highlights how the biological arms control regime ignores norms but also demonstrates what that regime is missing out on when it does so. The chapter argues that policymakers' halfhearted engagement with norms is mistaken. In doing so, the chapter specifically addresses the norm of the biological weapons taboo. The taboo is the idea that biowarfare is so abhorrent and immoral that actors will not use or even possess bioweapons. The chapter outlines the taboo to show why actors are normatively antipathetic to biowarfare and to explore how far the taboo can and should be capitalized on as a tool in disincentivizing the acquisition, production, or use of bioweapons.

Although this argument does not reject strategic restraint as a valid and necessary means of arms control, policymakers need to rethink and re-engage with the taboo to promote new measures that fully understand, recognize, and centralize the taboo within arms control; enforce the stigmatization of biowarfare as an intrinsic wrong; codify the taboo; ingrain the taboo within language/rhetoric; formally address the humanitarian aspects of biowarfare; and normalize the taboo as a core value and standard of behavior within the regime as well as in international politics more generally. Only when policy actors make the taboo what they say it should be—a priority—can the regime hope to halt "one of the most pressing security issues of the twenty-first century."[2]

The Biological Weapons Taboo

Weapons of mass destruction (WMD)—typically understood as nuclear, biological, chemical, and radiological armaments—are set apart from conventional weapons, defined by the United Nations (UN) as weapons that are not WMD.[3] The line between WMD and conventional warfare is problematic and not always clear: Conventional arms also cause extreme destruction, and there is no consensus on which exact criteria differentiate WMD (leading to different weapons being included in the classification at different times).[4] Yet the UN definition reflects how WMD are seen as distinct.

This distinction is further manifested in the taboos associated with WMD. A taboo is characterized by three features: disgust, stigmatization, and fetishization.[5] What is taboo is repellent (disgust), whereby this emotional response translates into the subject's social and political rejection (stigmatization), and the subject is prioritized and reified as an exceptional concern (fetishization). It is then not simply the case that WMD are different but that these armaments are seen as uniquely odious and immoral—to the extent that actors will not use or even possess them. In cases where actors do pursue WMD, they may go to extraordinary lengths, because of the taboo, to hide their arsenals and are widely condemned if those arsenals are revealed.

Nuclear, biological, chemical, and radiological armaments are very different weapons from one another, and the precise nature of the taboos relating to each do differ. Even so, the same general model of taboo applies. This model can be applied to biowarfare to identify a biological weapons taboo and understand why actors are normatively averse to bio-violence. In terms of disgust, the idea that disease is repulsive is self-evident. This disgust is seen as distinct from that felt toward other (particularly conventional) forms of violence, whereby disease is an inversion of the healthy body, the anthesis of medical care, invisible and stealthy (and when disease becomes visible, takes the form of often horrific physical symptoms), invasive to and internalizing harm within the body, and indiscriminate on a mass scale.[6] The unique disgust associated with biowarfare is magnified in relation to contagious biological agents, where contagion can replicate destruction in a way that conventional warfare and even other WMD cannot.[7]

Because biowarfare creates distinctive forms of disgust, it is also distinctively stigmatized. Stigmatization is the identification, discrimination, and rejection of what is deemed abnormal, as a form of social control.[8] By recognizing biological arms as different/abnormal compared with other weapons, biowarfare is understood as a major violation of appropriate actor behavior and must be prohibited. Stigmatization is mutually reinforced by the fetishized construction of biowarfare as an exceptional and priority threat. Bioweapons are not "just another weapon." Disease comprises "one of the most fundamental factors in human affairs,"[9] which then makes biowarfare a stand-out concern that can "arouse a *peculiar degree* of ire and passion [emphasis added]."[10] Fetishization is also evident in the UN definition of WMD. The definition was designed not only to recognize WMD as distinct (stigmatization) but also to establish the threat as more dangerous and important than conventional warfare.[11]

The Taboo as Arms Control

The taboo's influence on international behavior is contested. Realist scholars—who would generally acknowledge a state's self-interest and survival above all other considerations—argue that the taboo is, at best, only a secondary and minor influence compared with more strategic factors. As part of this argument, some analysts assert that bioweapons lack military utility; for example, contagious agents are deemed unusable because of their uncontrollable capacity to spread, including to the attackers themselves.[12] In trying to understand why actors would not use bioweapons, therefore, this is interpreted not as an issue of normative feeling but simply as a fact that bioweapons cannot do what actors want them to do. Yet other analysts do identify utility, arguing that bioweapons offer a military advantage as highly potent and accessible weapons.[13] Yet if bioweapons *are* effective weapons—or at least if their lack of utility is questionable—then this lack cannot explain nonuse and there must be another reason at play. This reason is identified here as the taboo. There is extensive historical evidence that the taboo influences actors.[14] For example, the 1972 Biological Weapons Convention (BWC) has been explained as a self-interested diplomatic solution. States that had renounced, or did not have capacity for, biowarfare wanted to strategically deny this option to others.[15] Yet James Leonard, U.S. ambassador to the United Nations, explicitly said that the United States negotiated the BWC to "get a norm [opposing biowarfare] on the books."[16] Moreover, the BWC employs taboo language, calling biowarfare "repugnant to the conscience of mankind."[17]

The BWC demonstrates not only the taboo's influence but also that the taboo is recognized as an effective means of arms control. This chapter seeks to drive home this point by asking a devil's advocate question: Would the taboo alone stop biowarfare? If the taboo is upheld, then no actor would sanction or use these weapons. There would be no desire toward biowarfare to control. Arms control would then not even need other means of prevention, per strategic restraint. Logic suggests that if the taboo were established to a sufficient level, then the arms control regime could dispense with other measures. Surely the taboo constitutes a more effective approach than trying to control the consequences of actor motivation through strategic means because the motivation is always there to resurface. Strategic restraint is firefighting; the taboo puts out the fire.

This statement is provocative—and it is meant to be. This argument is not a practical suggestion but a thought exercise designed to highlight what the taboo offers to arms control and, moreover, to then challenge how arms control is currently conducted. If the taboo can, even only theoretically, resolve the arms control issue, then why is it not taken more seriously? Of course, relying on norms to shape actor behavior is considered idealistic—even naïve. Realists argue that the impulse to actor self-interest already mentioned will mean that taboos are easily broken and so cannot constitute a reliable basis for arms control. Yet calls for a more robust arms control regime suggest that strategic restraint is also not dependable—either in the sense that strategic restraint has not been or cannot be perfectly implemented or is not intrinsically effective. Despite this criticism, the regime still seeks to capitalize on the potential that strategic restraint seems to offer. Why not adopt the same attitude toward the taboo and capitalize on its potential as well?

A New Focus for Arms Control

The biological arms control regime acknowledges the taboo's potential to preclude biowarfare. Yet this acknowledgment is not fully reflected in practice. A good example is the excellent analysis of future arms control efforts by Jaime M. Yassif, Shayna Korol, and Angela Kane. The authors recognize the BWC's significance in "upholding the norm against the development and use of biological weapons."[18] This statement implies that the taboo is vital to successful prevention. Yet the solutions discussed within the study focus solely on strategic restraint. The authors do state that these solutions—connected to improved transparency, attribution, and accountability—contribute to norm reinforcement.[19] This is true. Any measure precluding biowarfare will promote the idea that biowarfare is a prohibitive wrong. Yet the more interesting aspect of this analysis *is that the taboo is not directly addressed or prioritized*. The study replicates the problem with the existing arms control framework: The taboo is only tacitly recognized as significant and is limited to a secondary by-product of strategic restraint.

Policymakers must be more serious about the taboo. First, this will require them to truly understand the taboo. When policy actors and analysts talk of norms, they tend to reduce the taboo to a general idea that biowarfare is simply "bad." Yet the stated description of the taboo reveals that it is a complex and multifaceted concept issue—incorporating diverse factors including disgust and the means of social rejection—which is more than an abstract claim that biowarfare is wrong. Policymakers must fully understand the normative dynamics underpinning actor aversion to biowarfare, and this will then generate an entirely new set of practical questions for policy. If disgust is acknowledged as a major aspect of aversion, how does the regime exacerbate this disgust—specifically, the unique disgust associated with disease—to make biowarfare less strategic and less thinkable? How should policies play up the perceived abnormality of disease to strengthen the stigmatization that can stop biowarfare from happening? How can the regime bolster fetishization to make actors believe that biowarfare is not just wrong but an excessive wrong that can never be tolerated? Simply put, it is not enough to state that biowarfare is "bad" and expect that to be sufficient. Policymakers must engage deeply with the detailed motivations behind the taboo and establish this understanding as a new framework for arms control. Critically, this framework must also accept that the taboo cannot fully derive from strategic restraint alone. The taboo must be a focus within its own right.

Second, there must be targeted policies that implement this new framework. In terms of what this would look like in practice, policymakers should start by turning to the 2017 Treaty on the Prohibition of Nuclear Weapons (TPNW), which bans the use, possession, testing, and transfer of nuclear weapons. This treaty is explicitly designed to stigmatize nuclear weapons and strengthen the respective taboo on nuclear armaments as a primary means of control.[20] The treaty demonstrates the importance of prioritizing taboos *as* arms control and the types of policies that can enact this contribution. Building on this approach, the biological arms control regime can then introduce comparable measures that go beyond strategic restraint to

- promote a full understanding of the taboo through policymaker education (workshops, conferences, information materials)
- actively recognize and centralize the taboo (mission statements, policies built explicitly on the taboo as a core aim)
- promote stigmatization (policies that communicate biowarfare as an intrinsic wrong as opposed to a strategic miscalculation)
- codify the taboo within core agreed documents (the BWC is a good start but is insufficient alone to uphold the taboo as a core aim)
- employ language or rhetoric that communicates the taboo's ideals *as* ideals (the BWC's reference to repugnance is another good starting point, but an expanded regime requires stronger and more widely employed language or rhetoric)
- formally recognize the humanitarian implications of biowarfare (similar to the TPNW)
- normalize the taboo as a core international value and standard of international behavior (public statements, sanctioning those who do not comply)

Conclusion

This analysis is a call to arms for the biological weapons taboo: a wake-up call as to what normative restraint can contribute to biowarfare prevention. The taboo provides a comprehensive understanding as to why actors oppose biowarfare, outside of a strategic calculation framework. Within that understanding lies a new policy framework that directly engages with and strengthens actor aversion as the means of more-effective arms control. Critics may state that the taboo *is* recognized within the regime. As this chapter notes, however, that is not enough. Policymakers must realize that they are not living up to their own statements concerning the taboo's importance. To address this, international actors must rethink the very framework of arms control in line with the taboo and, on this basis, introduce new measures that support, strengthen, and implement the taboo. This new approach must not simply seek to derive the taboo from strategic restraint but enforce the taboo as a means of arms control within its own right.

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Endnotes

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[15] Jack Beard, "The Shortcomings of Indeterminacy in Arms Control Regimes: The Case of the Biological Weapons Convention," *American Journal of International Law* 101, no. 2 (2007): 271–321.

[16] James Leonard, "The BWC after the Protocol: Previewing the Review Conference," *Arms Control Today* 31, no. 10 (2001): 14.

[17] Convention of the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, 1972, disarmament.unoda.org/biological-weapons. [Author's note: This chapter recognizes that "mankind" is a gendered term that should be rejected.]

[18] Jaime M. Yassif, Shayna Korol, and Angela Kane, "Guarding against Catastrophic Biological Risks: Preventing State Biological Weapon Development and Use by Shaping Intentions," *Health Security* 21, no. 4 (2023): 260.

[19] Yassif, Korol, and Kane, "Guarding," 262, 263.

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Prospects for Assessing State Intent to Proliferate Biological Weapons

Nathan A. Paxton

Summary

Action to disincentivize states from acquiring bioweapons assumes a prior belief of knowing and being able to alter intent for such arms. This essay identifies several questions and lines of analysis that require examination as a more coherent body of explanations and policy to prevent bioweapons acquisition and use is developed. It examines the complexities of understanding and influencing state motivations to develop biological weapons, highlighting the lack of comprehensive studies on their proliferation compared to nuclear proliferation, and argues that technical or observational data alone is insufficient to grasp state intent. The essay challenges a potential bioweapons epistemic community to think hard about how bioweapons might fit into a state's strategic goals, as well as whether bioweapons provide unique capabilities. Drawing from previous work on nuclear weapons, this essay argues that focusing on how a state might pursue a nuclear weapon would improve understanding of bioweapons proliferation. The means and process of bioweapons procurement could offer subtle clues regarding a state's ultimate strategic goal. The essay encourages future work to think through how a state's bioweapons pursuit flows more explicitly from its strategic goals and environment. Finally, the essay summarizes policy and research questions that could guide bioweapons analysts to create a more coherent foundation for an epistemic community and for greater security against this class of arms.

Introduction

The goal of this project and essay collection is to identify and socialize ways by which the international community might disincentivize states from acquiring or using biological weapons. To do that task requires an idea of the reasons that states might want to obtain this category of weapons, then altering that intent. While there is deep and long-standing literature that attempts to address several problems of nuclear proliferation, the attention to bioweapons proliferation has received comparatively little attention.

The potential proliferation of bioweapons poses a hard epistemological question to the life and social sciences that cannot rely on technical or observational data alone. (Even so, as W. Seth Carus has pointed out, even the data that does exist are scant and selective: "Currently, it is difficult to answer even basic questions about the extent and character of [bioweapons] proliferation. … There is no generally accepted list of past or current [bioweapons] programs. …There is little detailed information available about most [bioweapons] programs, and reliable histories of specific programs are rare."[1])

This hard question lies in the dual-use nature of bioscience research and its derivative technologies. These technologies may either help or harm human populations, and the technology itself is neutral with respect to the intent of the actor using it.

Disincentivizing bioweapons requires altering the intent of a country to obtain them. Doing this requires an assessment of that intent, which is a tricky problem for both social science and natural science. At present, the best that one might be able to do is identify possible intentions, alter those factors—and then hope.

A lack of theory, data, and applications impedes making better sense of what is observed. In this essay, I outline three considerations that might yield understanding of the motivations behind and means for proliferation:

1. Why do some states choose to pursue bioweapons, while others forgo proliferation?
2. How accurately and in what time frame can a state's intent to proliferate bioweapons be known?
3. How does knowing the path states might follow to develop a bioweapon help to understand state intent and offer options for disincentivizing proliferation?

This essay briefly describes research and policy development agendas that could help to disincentivize the proliferation of these weapons. First, I discuss the question of intent—whether states want to pursue this class of weapons—particularly in preference to other types of weapons. I also consider the question of whether it is possible to accurately and in real time correctly perceive or assess a state's intent with respect to bioweapons proliferation. Second, drawing on recent scholarship, I look at specific bioweapons proliferation strategies a state pursues and how to understand what might help to dissuade states.

Intent

Participants in the workshop that inspired this collection of essays described a state's intent with respect to bioweapons as a function, inclusively, of its incentives and its capabilities.[2] The workshop regarded the state's incentives as deriving (somewhat exogenously) from an individual state's domestic politics, the international strategic environment, and from any perceived net advantages of bioweapons per se.[3]

In terms of capabilities, the workshop focused on the scientific, engineering, and military–industrial expertise required for usable bioweapons. An epistemic community around bioweapons that deepens academic understanding and policy development can move beyond this simplified understanding of intent and develop understanding that is more in line with the causal complexity in strategic studies and in defense ministries' planning. The present lack of a bioweapons epistemic community hinders the development of better, more nuanced ideas of why states would want to possess these weapons.

Current thinking points out that intent is subsidiary to a state's larger goals for its place in international affairs.[4] To put it simply, states that intend to pursue bioweapons are (probably) not pursuing these weapons simply to have them. The bioweapons serve a larger goal of the state. A state's pursuit of security, prestige, bureaucratic autonomy, regime stability, or electoral success could all affect the state's offensive and defensive goals, which in turn affect the specific intent to obtain bioweapons.[5] As a state's goals change, one should expect that the intent for bioweapons also changes.

The balance between offense and defense "dominance" also affects a state's goals. Under the "security dilemma" (where an increase in the provision for security of one state decreases the security of others) there are two questions a state has to ask about any weapon a potential adversary might come to possess: Can one meaningfully *distinguish* between offensive and defensive uses of the weapon, and does the weapon *favor* offensive or defensive uses?[6] According to Koblentz, bioweapons fall into the worst possible category on these terms. First, the outside observer has a hard time distinguishing whether a biotechnology product is for civilian or military use or for offensive or defensive purposes. Second, bioweapons favor offensive use because they rely on many diverse agents, are comparatively potent, and are difficult to defend against.[7]

A better consideration is needed about some of the shibboleths associated with bioweapons. For example, biological weapons are often characterized as "poor man's nuclear weapons," implying that bioweapons proliferators *really* want nuclear weapons instead and that this pursuit is particularly likely for low- and middle-income countries. Are bioweapons truly substitutable in this manner? Empirical attempts to answer such a question are mixed but may slightly favor the view that bioweapons are not efficient or desirable second-best options. Horowitz and Narang express a conventional approach to the nuclear–biological substitution logic. They find that chemical and biological weapons may be substitutable for nuclear weapons at early stages in the development of weapons of mass destruction, but once countries obtain nuclear weapons, they "appear much less likely to initiate pursuit of biological weapons and even chemical weapons."[8]

Ben Ouagrham-Gormley argues that success in bioweapons development is quite costly and expensive and that it usually does not reach its intended objectives.[9] Poor Toulabi argues that serious methodological flaws, poorly defined concepts and data coding, and credulity about sources for claims of bioweapons programming have led to significant overestimation of the existence of bioweapons programs.[10] Carus points out that most biological weapons programs in the period from 1915 through 2015 were small, tactical, and unsophisticated—only the United States and the Soviet Union had programs that could reasonably be described as "poor man's atomic bombs."[11]

How a state perceives that biological weapons might help it achieve policy or strategic goals bears better empirical examination so that policymakers can more effectively shape the tools of diplomacy and deterrence to counter their spread. Analogous questions from the nuclear and chemical realms offer better scholarly and policy engagement. Sagan, for example, posits that there are three primary reasons that states pursue nuclear weapons: (1) to increase security versus external threats, (2) to further domestic political and bureaucratic interests, and (3) to augment a state's international prestige.[12] This is not to say that no analysis has occurred: Ben Ouagrham-Gormley examined the external threat dimension of the problem; Koblentz provided insight on how the Syrian, Iraqi, and South African regimes pursued biological weapons development to counter internal security threats; and Bentley's focus on the "taboo" of biological weapons addresses the anti-prestige of these weapons. Even so, there is more ground to plow here, particularly in how these research insights might be translated to policy.[13]

Finally, there is the consideration of whether and how biological weapons alter the costs of engaging with the state that possesses them. Many people in the community of experts appear to believe bioweapons are "offense dominant"—that is, they provide a significant positive advantage to the state that uses them as part of an attack and could not be easily overcome either by the attacked state or indeed the global community.[14] Others perceive bioweapons as relatively defense dominant.[15] Further, defense policymakers often state that bioweapons have no military utility.[16] What is not available are data and analysis to help make sense of the true strategic and tactical dominance that a bioweapon does or does not bring—or at least data on what states thought about dominance in cases where states may have pursued or possessed bioweapons. Policymakers need more empirics and fewer thought experiments so that they can begin to design better institutions and arrangements for disincentivizing the acquisition or use of bioweapons.

Assessing Intent

Assessing a state's intent in real time is hard and may not be possible with great accuracy. Intent assessment is subject to inherent positional and heuristic biases. Although there is at least one analysis of U.S. intelligence regarding the intent of the USSR, Iraq, Libya, and Cuba,[17] more extensive empirical analysis of a larger universe of cases would be a helpful contribution toward developing data for a bioweapons epistemic community.

Social scientists who study the development and discernment of intent are divided on the question of whether outside observers can accurately figure out what another state wants to do based on the state's observable policy actions and possible military capabilities. One difference lies in whether the analyst gives primacy to capabilities or behavior in assessing intent.[18] Some analysts argue that a state's observable behavior signals what it wants. For example, a state that joins a binding international institution or withdraws from a collective security agreement engages in behavior that indicates its intent regarding its foreign policy. Critics of the behavior-based view note that states may use their behavior to obscure or deceive, and thus would require further analysis to determine a second order of intent. With respect to bioweapons, Koblentz argues that states very much work to obscure their intentions.[19] In this issue area, behavioral cues are not useless for intent discernment, but they likely have limited use.

On the other hand, different analysts argue that state capabilities—particularly the increased ability to make war—provide a better gauge of offensive intent[20]—that is, rather than what a state has done or is doing, a focus on capability points to the future and a maximal model of behavior, particularly if the country in question is seen as an adversary. This view argues that a state that *can* take some action should be regarded as demonstrating some degree of intent to fulfill that ability. This analysis breaks down in the context of dual-use technology such as biotechnology, where virtually any component or advance could be intended for entirely harmless or harmful use.[21] In both cases—behavior observation and capabilities assessment—the assessment of intent relies on the observer's *belief* about a state's goals.

Intent assessment also seems difficult to accomplish in relatively real time. For weapons and military programs, states must rely heavily on intelligence gathering and analysis capabilities, whether open source or classified. While post hoc analyses that identify possible signals of an unusual outbreak may someday prove useful as indicators of developing or ongoing events, this "new" indicator would require cross-validation with other sources of intelligence: "Biological weapons are a notoriously difficult target for intelligence agencies. … [T]he intelligence community's analyses of national and non-state [bioweapons] programs often rely on assumptions of potential agents and delivery systems unsupported by data. This is in large part because traditional collection methods such as imagery and signal intelligence are poorly suited to collecting useful information on biological threats and the community is not properly configured to monitor the large volume of [bioweapons]-relevant information available from open sources."[22] Even with the growth of computing power, tools, and algorithms, human sources are the most useful for parsing out whether actions and capabilities have bad intent behind them—even though human sources are "unreliable" and "difficult to corroborate."[23]

Finally, intent—because its assessment depends heavily upon beliefs—depends on *who* is doing the assessing. The intelligence community that *collects* data and presents it to policymakers who *decide what to do* based on that data often come to different conclusions about intent when using different indicators. Intelligence agencies often have their greatest expertise in military matters, so they tend to prioritize "military indicators over other types of indicators in their analysis of intentions."[24] Intelligence agencies may have the capability to monitor open-source information relevant to biological weapons proliferation, but those agencies may not prioritize or take seriously such information. Decision-makers, on the other hand, appear to place priority on "personal insights" about adversarial decision-makers and "vivid" and costly signals that other leaders give off or send. Decision-makers also complain that intelligence can lack political insight.[25]

Even if knowing a state's intent regarding bioweapons is a very difficult endeavor with a large degree of uncertainty and bias, it is worth continuing to try. Much of current discussion focuses on *whether* a state might try to get a biological weapon. The inverse question might also be addressed: Why do states not pursue these weapons? Bentley has offered one analysis,[26] and more work in this vein remains to be done. An alternative approach might look at proliferation strategy—*how* a state goes about acquiring these weapons—as another entry into understanding state intent.

Proliferation Strategy

One route for looking at intent has not been widely examined, in part because theory around bioweapons proliferation remains underdeveloped, especially compared to nuclear or more general strategic scholarship. There is a tendency to assume that all potential bioweapons proliferators will follow the same pathway to acquiring a bioweapon and that potential proliferators also seek to complete the whole process of developing a bioweapon.

Narang's recent work on differing strategies of nuclear proliferation provides an approach for thinking through the potential similarities and differences with bioweapons proliferation. In the bioweapons context (as with nuclear), the leaders of states capable of developing some form of bioweapon likely ask themselves two questions: whether to "fully weaponize" that capability, and what conditions would cause the state to implement full weaponization. If the state does not choose to fully weaponize, then it must choose some interim point along the path to full bioweapons development that satisfies its present needs while also preserving its options for future security.[27]

Of the main strategies that Narang outlines—"sprinting," "hedging" (with a number of variants), "hiding," and "sheltered pursuit"—hedging and hiding are likely the most applicable to the bioweapons realm at present.[28] As a strategy, *hedging* pursues "a bomb option, laying the groundwork for weaponization in the future under some set of strategic decisions." The hedging state does not say yes or no to pursuing a weapon—it says "maybe. … A hedger often develops capabilities that contribute to a peaceful nuclear energy program but would be valuable for a weapons program."[29] Nuclear hedgers may stop at many points along the path to full weaponization. For example, they might pursue materials production but avoid work on military applications of such production. Hedgers further down the path might work to gain better domestic control of the materials needed. They might also more openly militarize and weaponize applicable technologies. Even further down the road, one would expect to see a state develop organizational routines for weapons management and bring together the necessary elements of a weapon while not assembling them.

In pursuit of bioweapons, hedging may be harder to define. Hedging is a conscious strategy to develop dual-use technology for possible future weaponization, and there is no evidence that any state has pursued the strategy as Narang describes it.[30] To better develop this epistemic community, one useful task would be to articulate whether hedging exists in the case of bioweapons and what such a hedging strategy looks like. For example, a state military or security apparatus may use methods to keep abreast of civilian and private-sector activity that it might weaponize rather than actively intervene in developing dual-use technology. In other words, the military partially outsources hedging activity.

Because of the dual-use dilemma, for example, biological research programs may produce materials or techniques that are indistinguishable vis-à-vis their military or nonmilitary use (as Volpe points out elsewhere in this collection). In such a case, the outside observer may not be able to assess hedging based on actions early on the path toward a fully realized bioweapon. Bioweapons development and production (as Ben Ouagrham-Gormley points out in this collection) has many steps beyond the dual-use, indistinguishable, basic, or translational bioscience. Of the several steps involved in producing an agent for bioweaponization,[31] the further down the road of weaponization that a state goes, the less the dual-use ambiguity may apply, and the more obvious the proliferation strategy may become. Further development of a theory and evidence of possible bioweapons proliferation strategies would help clarify the existence, role, and signatures of bioweapons hedging.

Hiding strategies pursue weapons "in a fashion that privileges secrecy over speed."[32] Many appear to assume that potential bioweapons proliferators pursue hiding strategies (and, as noted, existing research seems to support that bioweapons are pursued and used covertly). Although not unreasonable, given both the existence of the Biological Weapons Convention (which entirely outlaws this class of weapons) and the "taboo" against bioweapons (which Bentley discusses elsewhere in this collection),[33] this assumption bears examining. Because the earlier stages of potential bioweapons development might look indistinguishable from nonmilitary biotechnology research and development, it could be easy to mistake one strategy of proliferation for another.

Better strategic theoretical development would offer more distinction as to which actions align with which proliferation strategy. Better theory may also help provide more traction on the deeper question of what *is* known and what *can* be known more generally about a state's intent.

Why does the strategy of proliferation matter so much? Narang's model of nuclear proliferation argues that the choice of which weapons to develop and how to go about getting them grows out of the strategic environment that a state faces: "The choice of technology flows from the strategy of proliferation."[34] Trying to alter intent by seeking to constrain the diffusion of technology or material fails to address the overall strategic environment that drives intent.

States, compared with nonstate actors such as terrorist groups, probably have an easier time marshaling the necessary resources to develop bioweapons.[35] How states go about pursuing those weapons could dictate the technologies they pursue. Available technology does not set a strategy of whether and how to get bioweapons. States pursue and create technology for bioweapons because it suits their strategic goals. To constrain the intent to get a bioweapon, the larger strategic environment for the pursuing state must be altered. Attention should be paid not only to *whether* a state wants bioweapons but *how* it is going about acquiring them, for the means potentially can indicate *why* a state might want a bioweapon.

Conclusion

I have raised several open questions that would help further develop a knowledge and practices (epistemic) community aimed at disincentivizing bioweapons proliferation. Sets of incentives structure intent, and strategies drive technological choices. From the perspective of assessing intent, the following are a minimal set of the questions raised that need answers if there will be more systematic policy and more rigorous analysis:

- How do bioweapons fit into a state's goals for its place in the international system?
- To what extent do perceptions about the resource efficiency of bioweapons drive proliferation? If bioweapons are not "the poor man's nukes," then what other tactical or strategic goals drive proliferation?
- How does the relative indistinguishability of dual-use technology affect the calculation of a state's intent? How can this challenge be better addressed?

Another consideration is whether states pursue a variety of proliferation strategies and what those strategies reveal about the state's intent to entirely follow through on creating and even using a bioweapon:

- What strategies do bioweapons proliferators follow in their pursuit? How do the proliferation strategies chosen fit into a grand strategy or lower-level military doctrine and tactics?
- What observable actions align with which bioweapons proliferation strategies? What would help separate entirely peaceful biomedical research from a more deliberate strategy of weaponization?
- How might altering a state's larger international strategic environment affect its desire to acquire a bioweapon?

At present, insufficient understanding exists about the full set of reasons that states might want to obtain bioweapons, and this impedes the ability to alter the set of desires and calculations that drive proliferation. More attention to strategy and less relative focus on technology may be key to increasing the ability to prevent countries from making these weapons more common.

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Endnotes

[1] W. Seth Carus, "A Century of Biological-Weapons Programs (1915–2015): Reviewing the Evidence," *The Nonproliferation Review* 24, no. 1–2 (January 2, 2017): 129, doi.org/10.1080/10736700.2017.1385765.

[2] Other factors might further affect the state's intent, so this is a list of necessary inputs. We did not consider whether they were sufficient to describe the formation of a state's bioweapons intent.

[3] The supposed net utility of bioweapons may be limited to cases when they may be used covertly and at small scale, such as in "sabotage or assassination operations." While biotech advances might increase such utility, it is hard to predict how the "shape and dimension" of those advances could translate to warfare (Glenn Cross, "Wrestling with Imponderables: Assessing Perceptions of Biological-Weapons Utility," *The Nonproliferation Review* 27, no. 4–6 [September 1, 2020]: 24, doi.org/10.1080/10736700.2020.1858621).

[4] Keren Yarhi-Milo, "In the Eye of the Beholder: How Leaders and Intelligence Communities Assess the Intentions of Adversaries," *International Security* 38, no. 1 (July 1, 2013): 7–51, doi.org/10.1162/ISEC_a_00128; Sebastian Rosato, "The Inscrutable Intentions of Great Powers," *International Security* 39, no. 3 (2014): 48–88.

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[10] Biejan Poor Toulabi, "The Myth of the 'Poor Man's Atomic Bomb': Knowledge, Method, and Ideology in the Study of Chemical, Biological, and Nuclear Weapons," *Journal of Global Security Studies* 8, no. 1 (March 1, 2023): 1, 10, doi.org/10.1093/jogss/ogac037.

[11] Carus, "A Century of Biological-Weapons Programs," 152.

[12] Scott D. Sagan, "Why Do States Build Nuclear Weapons?: Three Models in Search of a Bomb," *International Security* 21, no. 3 (1996): 54–86, doi.org/10.2307/2539273.

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[14] See Anders Sandberg and Cassidy Nelson, "Who Should We Fear More: Biohackers, Disgruntled Postdocs, or Bad Governments? A Simple Risk Chain Model of Biorisk," *Health Security* 18, no. 3 (June 2020): 155–63, doi.org/10.1089/hs.2019.0115, for one example of a thought experiment along these lines; Koblentz, *Living Weapons: Biological Warfare and International Security*, 22 ff.

[15] Michael Montague, "Towards a Grand Unified Threat Model of Biotechnology," preprint, September 12, 2023, philsci-archive.pitt.edu/22539.

[16] Edward M. Spiers, *A History of Chemical and Biological Weapons* (Reaktion Books, 2010), 66, 69; Bentley, *The Biological Weapons Taboo*, 3.

[17] Koblentz, *Living Weapons: Biological Warfare and International Security*, chap. 4, esp. 198–99.

[18] Yarhi-Milo, "In the Eye of the Beholder," 8.

[19] Koblentz, *Living Weapons: Biological Warfare and International Security*, 142.

[20] Jervis, "Cooperation under the Security Dilemma"; Rosato, "The Inscrutable Intentions of Great Powers," 71.

[21] Consider, for example, botulinum toxin (Botox). In the United States, this is a federally regulated "select agent," like ricin, anthrax bacteria (*Bacillus anthracis*), or Ebola virus. The United States produces it in vast quantities each year, primarily for cosmetic and medical purposes. What should an adversary make of this behavior and capability? The answer likely comes down more to prior beliefs about U.S. security goals and how botulinum-based weapons might serve those. Similarly, Botox production in Iran likely faces scrutiny from U.S. observers, even as Iran is also a major destination for cosmetic procedures.

[22] Koblentz, *Living Weapons: Biological Warfare and International Security*, 142–43.

[23] Koblentz, *Living Weapons: Biological Warfare and International Security*, 142–43.

[24] Yarhi-Milo, "In the Eye of the Beholder," 48.

[25] Yarhi-Milo, "In the Eye of the Beholder," 47, 49.

[26] Bentley, *The Biological Weapons Taboo*.

[27] Vipin Narang, *Seeking the Bomb: Strategies of Nuclear Proliferation* (Princeton University Press, 2022), 16.

[28] Sprinting is an "open and determined" race to develop the weapon in question "as quickly as possible." "Sheltered pursuit" occurs under the "tolerance and protection" of a major power. As Narang describes them, neither appears to describe the present situation with bioweapons (Narang, 21–22).

[29] Narang, *Seeking the Bomb*, 17.

[30] I thank Greg Koblentz for this point about a conscious strategy.

[31] The Nuclear Threat Initiative identifies the following:

1. Choose an agent.
2. Acquire an agent.
3. Acquire a production method.
4. Stabilize the agent.
5. Concentrate the agent.
6. Choose a delivery method.
7. Field test.
8. Mass produce.
9. Stockpile and mobilize weapons.

See Nuclear Threat Initiative, "How Biological Weapons Work," Nuclear Threat Initiative, 2016, tutorials.nti.org/biological-weapons-nonproliferation/how-biological-weapons-work.

[32] Narang, *Seeking the Bomb*, 23.

[33] Bentley, *The Biological Weapons Taboo*.

[34] Narang, *Seeking the Bomb*, 26.

[35] Jaime M. Yassif, Shayna Korol, and Angela Kane, “Guarding against Catastrophic Biological Risks: Preventing State Biological Weapon Development and Use by Shaping Intentions,” *Health Security* 21, no. 4 (August 2023): 259, doi.org/10.1089/hs.2022.0145.

Biotechnology and the Dead Zone for Managing Dual-Use Dilemmas

Tristan A. Volpe

Summary

What role does the overlap between civilian and military activities in the life sciences play in thwarting arms control over biological weapons? States have used international institutions to control many dual-use capabilities, from nuclear reactors to aircraft and rockets. But efforts to manage the military uses of biotechnology in this manner—including with the Biological Weapons Convention (BWC)—have consistently fallen short. Recent research from Jane Vaynman and me reveals why this is the case. We specify how variation in the two dimensions of dual-use nature of technology can enable or block arms control agreements. This essay first summarizes the results from our research, focusing on how the dual-use dilemma has varied across all weapons technologies available to states over the past 150 years. The second part focuses on why it is so difficult to curtail biological weapons with international institutions. Biotechnology falls in a "dead zone" for arms control, where daunting detection and security risks kill the prospects for verifiable cooperation. The conclusion draws lessons for disincentivizing the development of bioweapons from alternative arms control efforts over other technologies in the dead zone, notably taking smaller slices and establishing behavioral norms.

Introduction

The dual-use nature of biotechnology has long vexed the life sciences. The problem is that many public health and biomedical research endeavors are difficult to distinguish from malicious military activities. This duality creates a tension between needing to advance biomedical research while also preventing the development of biological weapons. Yet the life sciences do not suffer this dilemma alone, as all technology is dual use to some degree. Even lethal warships, attack drones, and missiles have peaceful cousins in the civilian economy. States have used international institutions to control some of these capabilities, from nuclear reactors to aircraft and rockets. But efforts to manage the military uses of biotechnology in this manner—including with the BWC—have consistently fallen short. What role does this dual-use overlap between civilian and military activities play in thwarting arms control over biological weapons? How does this feature of biotechnology compare to other technologies? And what lessons can be drawn to disincentivize the development and use of bioweapons?

In a new study of how technology shapes the prospects for arms control, Jane Vaynman and I shed some light on these issues.[1] We find that the dual-use nature of technology can enable or block arms control agreements. In the first part of this essay, I summarize the results from our research, focusing on how the dual-use dilemma has varied across all weapons technologies available to states over the past 150 years. The second part builds on this foundation to pinpoint why it is so difficult to manage biotechnology with international institutions—it falls squarely in what we term the "dead zone" for arms control, where daunting detection and security risks kill the prospects for verifiable cooperation. I conclude by drawing lessons for disincentivizing the development of bioweapons from alternative behavioral and informal efforts to manage other weapons in this dead zone.

How the Dual-Use Dilemma Varies across Technology

All technology has both civilian and military applications. The life sciences embody this trait, but they are hardly unique. The dual-use nature of technology cuts across almost every weapon system, from aircraft and space systems to nuclear fission and hypersonic vehicles. This foundational feature often makes it hard to limit military competition. Recent research reveals why this is the case.

Vaynman and Volpe's study argues that the dual-use features of technology matter because they shape the tension between detection and disclosure at the heart of arms control: Agreements must provide enough information to detect violations—but not so much that they disclose deeper security vulnerabilities.[2] The framework therefore characterizes technology along two dual-use dimensions: the *ease of distinguishing* military from civilian uses and the *degree of integration* within military enterprises and the civilian economy. As these attributes vary, so do prospects for cooperation.

Distinguishability drives the level of monitoring needed to detect violations. When a weapon is indistinguishable from its civilian counterpart, states must improve detection through intelligence collection or intrusive inspections. But integration sharpens the costs of disclosing this type of information to another state. For highly integrated technology, demonstrating compliance could expose information about other capabilities, increasing the security risks from espionage. In practice, this often takes many intrusive modes of verifying arms control compliance off the menu of acceptable options for states.

The study combines these dual-use variables—distinguishability and integration—to specify four distinct information problems that states face as they try to devise arms control agreements over various technologies.

The first is a *detection constraint*, whereby indistinguishable technology drives up the verification requirements, such as the intrusive inspections used to monitor compliance with the Nuclear Non-Proliferation Treaty (NPT). The key factor here is that the low level of integration dampens the security risks associated with such inspections, thereby making it feasible to construct verification regimes.

The second is a *disclosure constraint*, in which the espionage risks of inspecting highly integrated technology limit the use of intrusive monitoring. However, the detection needs are more modest in this zone because military weapons can be easily distinguished from civilian counterparts, as found in the case of many conventional weapons systems.

The third is an *arms control zone*, where the dual-use nature of technology does not itself vex negotiations. Strategic forces, for example, fall into this space because long-range ballistic missiles are distinguishable from civilian space launch vehicles and exhibit low levels of integration. This lowers the detection requirements while also easing concerns about the security implications of inspections, thereby opening the menu of options for arms control verification.

The final and most severe problem stems from the combination of both detection and disclosure constraints. The study finds that indistinguishable and integrated technology creates a *dead zone* for arms control because it drives up detection requirements while also sharpening the security risks associated with any inspections. Cyber arms control, for example, is often considered infeasible because governments and private actors are justifiably reluctant to allow intrusive inspections of sensitive compute capabilities.

Table 1 summarizes these distinct zones. The study develops a new qualitative dataset that assesses these dimensions and their impact on arms control outcomes across all modern armament technologies available to states over the past 150 years. Key findings are highlighted from each of the four information problems that confronted states as they sought to negotiate limits over different military capabilities, most notably long-range rockets, anti-satellite weapons, the nuclear fuel cycle, and conventional weapons. An online appendix provides full case studies of every technology.[3]

TABLE 1: HOW TECHNOLOGY SHAPES INFORMATION BARRIERS TO ARMS CONTROL

		Distinguishability	
		Low	High
Integration	Low	*Detection Constraint*	*Arms Control Zone*
	High	*Dead Zone*	*Disclosure Constraint*

Why Biotechnology Falls in the Dead Zone for Arms Control

The results help to specify why it has been so difficult to manage the military applications of biotechnology with formal arms control agreements. Unfortunately, biotechnology falls into the dead zone for arms control—it is both extremely indistinguishable and highly integrated. This means the tension between detection and disclosure makes it quite hard to curtail the technology's nefarious uses with international institutions. Indeed, even the design of the BWC—an arms control treaty that bans the development and use of biological weapons—supports this expectation because the BWC suffers from major verification problems.

The life sciences embody one of the most indistinguishable technologies when it comes to differentiating peaceful from military uses. Biotechnology scores similarly to cyber capabilities and space systems along this dimension, as even benign efforts to protect computer networks from attack or clean space debris often look like military activities. Indistinguishability matters because it drives up the level of monitoring that states would need to verify compliance with arms control agreements, such as the BWC or many other potential regimes. Four specific problems loom large here.

First, the small and dual-use nature of biological agents makes it difficult to draw clear distinctions based on their physical properties. Biotechnology has multiple applications in civilian, defensive, and offensive domains. For example, the same biological agent can be useful in peaceful medical procedures, public health research to prevent pandemics, and military weapons.

Second, the development pathway for offensive weapons heavily overlaps with defensive research and broader commercial biotechnology endeavors. “The capabilities for conducting the research, development, production, and testing of biological weapons are virtually identical to those employed by defensive programs and in legitimate civilian enterprises,” Gregory Koblentz concludes.[4] Most notably, ostensibly peaceful research on infectious diseases can generate knowledge and experience that could be turned into an offensive weapon. For example, scientific efforts to understand naturally occurring disease outbreaks use similar methods to cultivate and experiment with pathogens.[5]

Third, the deployment pattern for biological weapons programs can look like peaceful or defensive medical institutes. The same equipment found in the pharmaceutical industry, for instance, can also be used to produce biological warfare agents. Koblentz points out that this allows “a nation developing biological weapons to hide its activities in civilian institutes that appear to be, or actually are, conducting legitimate pharmaceutical or medical research.”[6] Indeed, it has long been difficult to identify clear biological weapons programs because most efforts were small and hidden amid larger defensive research projects on pathogens.[7] While a few large and sophisticated bioweapons programs had unique signatures—notably pathogen stockpiles and delivery vehicles—it was hard to “distinguish between military and civilian research and between offensive and defensive research," as several studies concluded in the 1960s and 1970s.[8] Remote monitoring of facilities was insufficient to parse out civil or military uses, especially as small-scale equipment emerged in the 1990s that could be used for bioweapons production.[9]

Fourth, the civilian and defensive applications of biotechnology can often be rapidly converted into research on offensive weapons. There are significant challenges associated with the weaponization and delivery of biological weapons.[10] But the underlying "research, development, production, and testing activities used to develop [defensive and offensive] capabilities are similar, if not identical, in many ways," Koblentz argues.[11] This feature shrinks the amount of time needed to transform civilian biotechnology into a military asset.

The difficulty of distinguishing peaceful from malicious uses of biotechnology need not itself kill the prospects for effective arms control. Consider the remarkable success of the 1968 NPT in curtailing the development of nuclear weapons around the globe. The civilian uses of nuclear fuel-cycle capabilities—specifically the capacity to produce fissile material—have long been difficult to distinguish from military weapons development.[12] The indistinguishable nature of nuclear technology drove up the detection needs for verifying peaceful uses under the NPT. This is why intrusive International Atomic Energy Agency (IAEA) inspections of civil nuclear facilities were considered essential for the treaty to be effective. But nuclear technology is also a niche field and tends to be isolated from other activities or infrastructure, often for physical safety and security reasons. This feature—integration—explains in part why states accepted intrusive inspections: They faced modest security risks from information disclosure. IAEA inspections of an atomic energy program would provide little insight into a state's capacity to employ force beyond the nuclear realm. Even total access to civilian nuclear facilities seldom illuminates broader metrics of military power.

By contrast, the problem with modern biotechnology is that it has long been highly integrated within the civilian economy for commercial and defensive public health purposes. The discovery of the DNA structure in 1953 set the scientific foundation for this major expansion, but what mattered for civilian integration was the use of such knowledge to genetically engineer organisms. In 1973, the range and variety of uses for biotechnology exploded as techniques became available to genetically modify living organisms. The Cohen–Boyer recombinant DNA process led to growing commercial interest in genetic engineering. In 1982, the U.S. Food and Drug Administration approved the first genetically engineered drug to treat diabetes. By 2000, more than 125 genetically engineered drugs had been approved. The CRISPR-Cas9 gene editing process further expanded the range of applications and lowered barriers to entry.

The combination of dual-use indistinguishability and high integration pushed biotechnology into the dead zone for effective arms control. Yet states still negotiated constraints in 1968 through 1971, culminating in the BWC of 1972, which banned the development and possession of biological weapons and their delivery systems. But verification was "deliberately omitted from the BWC" because it would have required on-site inspection that promised to be "unacceptably intrusive to the Soviet Union."[13] In addition, the drafters of the agreement recognized that the growing integration of biotechnology within scientific and commercial enterprises around the world would have required prohibitively intrusive inspections to be effective.[14]

The highly integrated nature of biotechnology meant that intrusive inspections of broader defensive and economic activities could have created major security and economic risks. Access to defensive research could be leveraged by an adversary for offensive purposes. Biotechnology companies also closely guarded scientific breakthroughs and trade secrets. Insisting on monitoring, as parties likely should have given the difficulty with distinguishing between civil and military programs, would have likely led to the agreement being rejected because of these security constraints. Perhaps it would have been better to have no treaty at all than to operate under one without verification protocols. But the United States instead opted for "a more unilateral approach" to monitoring compliance, in part because it assessed that others would have few incentives to cheat on the agreement.[15] In reality, the Soviet Union had made a different assessment and redoubled its biological weapons program in ways that were difficult for the United States and other states to detect. Subsequent negotiations to enhance transparency made little progress. An effort to include a verification protocol failed in 2002 for a variety of reasons related to Russian intransigence over its alleged BWC violations and opposition from countries in the global south. Negotiators also argued that the spread of dual-use bio-equipment to "almost every corner of the world" made the BWC unverifiable without intrusive inspections.[16]

What Options Exist for Constraining Competition over Dead Zone Technologies?

Biotechnology is not alone in suffering from such a severe tension between detection needs and security concerns. Many other technologies at the crux of U.S.–China competition today—from space systems and cyber capabilities to artificial intelligence foundation models—fall in the dead zone for arms control. Just like biotechnology, they all share the same indistinguishability feature with nuclear technology, but their relative ubiquity creates severe security risks from inspection. What is to be done with such technologies?

The bad news is that the severe tension between detection and disclosure often dooms the prospects for formal cooperation. Despite numerous efforts to negotiate limits, arms control agreements failed to emerge over almost all technologies in this zone. Even the sole exception—the BWC—has no verification regime, rendering it ineffective as an arms control institution. This option is simply not viable for biotechnology or other capabilities in the dead zone.

Yet some qualified optimism may still be in order. The good news is that the problems identified here do suggest several alternative options for managing the dark side of life sciences in the years ahead.

First, states can attempt to control a narrow slice of the technology that is more distinguishable. An illustrative example comes from efforts to curb the spread of unmanned aerial vehicles (UAVs)—more commonly known as drones—with multilateral export controls. In 1987, states agreed to limit the export of UAVs with specific range and payload features (300 kilometers/500 kilograms) under the new Missile Technology Control Regime (MTCR).[17] The Wassenaar Arrangement Dual-Use List also adopted similar restrictions in 1996. These agreements coordinated export controls and improved information sharing. The upshot is that the high-end military drones in this select category were quite distinguishable. This enabled states to rely on their own unilateral collection methods to verify compliance, thereby sidestepping the security risks from inspecting this ubiquitous technology.

The limitation of this approach is that it covered a shrinking slice of technology as more indistinguishable drones came to dominate the market. In 2012, for example, only 7% of all UAV systems were subject to MTCR controls.[18] This trend has only accelerated, especially given the recent conversion of small, low-end, commercial drones into cheap weapons systems on the battlefields of Ukraine.

Similar efforts have been adopted for the life sciences. In 1985, for instance, a small group of countries established the Australia Group as a multilateral export control regime to regulate the transfer of technology, components, and materials that could be used to manufacture biological and chemical weapons. But much like the MTCR, the informal group merely coordinates information sharing among member states—there are no formal verification measures.

Second, states sometimes find it more viable to focus on managing behaviors rather than limiting capabilities, especially for technologies in the dead zone. This sidesteps the verification and disclosure problems by shifting observation to the effects of actions rather than the development or possession of technology. Recent efforts to dampen the burgeoning arms race over fielding weapons in space illustrate this approach. States have long struggled to establish controls over anti-satellite (ASAT) weapons that could increase the risk of conflict. Multiple attempts to build on the 1967 Outer Space Treaty—which banned the placement of nuclear weapons or other weapons of mass destruction in orbit by curtailing non-nuclear ASAT capabilities—failed during the Cold War.[19] The indistinguishable nature of space technology plagued every ASAT negotiation with a formidable verification problem.[20] At the same time, space technology became highly integrated within both the military and civilian realms, thereby creating severe security risks from disclosing such information via inspections.

Instead of pushing to limit ASAT development and deployment, the United States has recently championed norms—voluntary agreements between various actors—for responsible behavior in space. Washington's efforts have focused on the readily observable effects of kinetic ASAT tests: the creation of debris fields in space from the physical destruction of satellites.[21] Space debris poses a serious threat to satellites that are integral to the global economy, not to mention many modern militaries. There is no dual-use distinguishability problem with sorting out the civil or military origins of debris creation—it is simply observable to any nation with space situational awareness.[22] Establishing an international norm to abstain from destructive ASAT tests thereby seeks to curtail an especially dangerous behavior in space without an actual arms control agreement.

The life sciences may lend themselves to such a behavioral approach. There are long-standing efforts in place to establish norms of appropriate and safe behavior for biomedical research. The obvious downside to this approach is that states can only respond to a violation after the damage is done. But this risk may be tolerable because it sidesteps some of the severe detection and disclosure problems rooted in biotechnology today. Governance efforts to develop international institutions should consider this alternative when the dual-use nature of technology renders traditional arms control agreements unverifiable.

Conclusion

Norms that shape behavior in a meaningful manner are difficult to establish in world politics. But three next steps could help norms related to appropriate uses of biotechnology become broadly accepted. First, the United States should redouble its efforts to lead the international conversation on standards and practices that all actors should adopt. This top-down approach enables the development of clear and consistent guidelines for responsible behavior in this field. It also offers the opportunity to establish the consequences for violations, such as exclusion from prestigious international forums and consortiums that offer members tangible benefits.

Second, governments should also continue to focus on national-level efforts to build legislation and safety regulations with industry partners. This bottom-up process provides greater flexibility for individual actors to tailor regulatory frameworks and define best practices. Domestic legal instruments help codify standards and can be scaled up and harmonized at the international level. Private actors may be more willing to work with their respective governments here to protect intellectual property and economic advantages.

Finally, the global architecture for attributing the employment of biological weapons must be considerably strengthened in the years ahead. For a behavioral norm to be widely adopted, all actors must know when it has been violated. In the space domain, key nations maintain the sophisticated infrastructure to identify and then attribute debris-creating events to specific actors. By contrast, public doubts about the origins of recent viral pandemics illustrate the need for credible mechanisms to differentiate biological weapons attacks from naturally occurring disease outbreaks. Governments may also be reluctant to disclose national intelligence that compromises sources and methods.[23] The upshot is that international organizations—notably the World Health Organization and the United Nations Secretary-General's Mechanism for Investigation of Alleged Use of Chemical and Biological Weapons—can play a key role in providing neutral information. Additional support would help enhance the ability of these institutions to provide global attribution capabilities.[24]

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The views in this article are the author's own and do not reflect those of the U.S. Department of Defense or the U.S. government.

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"Emergent Abilities," AI, and Biosecurity: Conceptual Ambiguity, Stability, and Policy

Alex John London

Summary

Recent claims that artificial intelligence (AI) systems demonstrate "emergent abilities" have fueled excitement but also fear grounded in the prospect that such systems may enable a wider range of parties to make unprecedented advances in areas that include the development of chemical or biological weapons. Ambiguity surrounding the term "emergent abilities" has added avoidable uncertainty to a topic that has the potential to destabilize the strategic landscape, including the perception of key parties about the viability of nonproliferation efforts. To avert these problems in the future, scientists, developers, policymakers, and other parties should take credible steps to strengthen the health of the scientific ecosystem around AI.

Introduction

Recent advances in AI, specifically generative AI, which includes generative pretrained models or large language models (LLMs), have captured the public imagination and set off alarm bells among the many parties interested in security. At the epicenter of this concern are claims that with increases in the scale of compute, volume of training data, and number of parameters, predictable gains in performance[1] have been accompanied by powerful and surprising, emergent abilities.[2] These range from the ability to plan,[3] to reason about causal relationships,[4] and most surprising of all, to demonstrate "sparks of [artificial general intelligence] AGI," or early signs that these systems are on the verge of constituting artificial general intelligence.[5] At the extreme, such claims conjure fears that generative AI will turn on humanity like *The Terminator*'s Skynet, *War Games*'s WOPR, *2001: A Space Odyssey's* HAL-9000, or Marvel Comics' Ultron. But they also engender slightly less fanciful worries that powerful new capabilities might enable a wider range of players, from rogue states or malevolent organizations to highly motivated individuals, to more easily, quickly, or cheaply develop biological weapons, including new agents with enhanced lethality.[6]

If technological advances that are relatively easy to access truly can produce revolutionary new threat capabilities for a wider array of parties, strategic equilibria can be destabilizing. If actors believe that they can strengthen their position by acquiring these new capabilities, efforts at nonproliferation can be undermined. Even if it is not clear that such technological advances have materialized, sufficiently credible uncertainty about technologically assisted threat capability can create a destabilizing environment in which actors feel compelled to act, either to strengthen their strategic position or to mitigate risks that might compromise their current position. As a result, and as illustrated below, uncertainty about the capabilities of new AI systems can reach beyond commercial interests to impact the larger strategic landscape—the way actors represent the basic features that frame decision problems related to security.

Conceptual ambiguities have exacerbated the challenge of crafting evidence-based policy, and those ambiguities have sown confusion, obscured the nature of stakeholder disagreements, and fostered an atmosphere of hype. To better navigate such challenges—including the potential development of bioweapons though the assistance of AI systems—key stakeholders should take steps to strengthen the health of the scientific ecosystem surrounding AI.

Conceptual Ambiguities around "Emergence" and "Ability"

The one ability that LLMs do possess is the one for which they have been designed and trained—to predict the next token given a set of tokens presented in the form of a prompt. (A token is a set of letters, often a pair or a triple.) It is genuinely stunning that systems trained to build complex statistical relationships among tokens in incomprehensibly large training sets can produce coherent text that is often relevant to the prompt and sometimes surprisingly useful. This facility with language has led researchers to inquire about what other abilities these systems might possess. It is in this context that researchers have claimed to identify emergent abilities. Unfortunately, both terms in this phrase are ambiguous—and this ambiguity has important implications for risk and for judgments of safety and reliability.

Consider first what might be meant by something being emergent or emerging at some level of complexity. "Emergent" may have two distinct meanings here. Epistemic matters relate to the nature of knowledge and how knowledge is validated. The *epistemic sense* of emergent refers to the difficulty in predicting, at one level of complexity, what a system might be able to do at some higher level of complexity.[7] Ontology refers to the nature of being or existence. The *ontological sense* of emergent refers to something new coming into existence, to the birth of a new ability.[8]

Now consider what might be meant by some new "ability." This term might refer to the *task* that a system can be used to perform or to the internal *capacities* by virtue of which it is able to perform some tasks. The disambiguated combinations of these views (two meanings of "emergent" and two of "ability") are summarized in Table 1 and numbered for ease of reference.

To understand the extent of the ambiguity in these terms, consider now the extent of diversity in the disambiguated views this phrase can express.

TABLE 1: AMBIGUITIES IN THE CONCEPT OF "EMERGENT ABILITIES"

		Ambiguities in the notion of ability	
		Task related	Capacity related
Ambiguities in the notion of emergence	Epistemic	1. The mundane claim that as scale increases, one may not know how model performance will increase on new tasks.	3. The deeper uncertainty about whether increases in scale will result in models with surprising new internal capabilities (uncertainty about whether models will develop unexpected capacities that will enable them to perform tasks that humans currently cannot).
	Ontological	2. The more mundane claim that internal capacities remain the same but the surprising claim that predicting the next token can be a useful approach to performing a much wider range of tasks than initially thought.	4. The amazing claim that, at some new scale, systems develop new internal capacities in virtue of which they can better perform established tasks or perform a wider range of new tasks. Necessary for artificial general intelligence and a presupposition of many surprising claims about internal representations.

Dangerous Ambiguity: Evolution or Revolution?

Expressions that fall into Boxes 2 and 4 in Table 1 make statements about how to understand what generative AI can do and how it does that. To use slogans, Box 2 sees generative AI as a largely evolutionary progress, while Box 4 treats it as a revolutionary leap.

When talk of emergent abilities falls into Box 2, it asserts the claim that with increases in scale and complexity, a system that predicts the next token can be used to perform a wider range of tasks than simply producing or predicting the next token. These assertions are likely to be somewhat measured when it comes to claims about the reliability or robustness of these systems since outputs are generated from complex statistical relationships among tokens without the assertion that such systems are learning the underlying structure of some domain or developing some novel cognitive ability.

Figure 1A illustrates the underlying process that generates such results. Those who hold this view are likely to regard these systems as "stochastic parrots."[9] The utility of a stochastic parrot depends on preserving correlations among syntactic relationships derived from the data fed into the model that those models use to associate inputs with correct or useful outputs. From this perspective, the capabilities of these systems, while impressive, are limited to compressing and making available information that is already contained in the training data—they repackage the portions of the Internet on which they have been trained.[10] A reasonable expectation in the possible state of the world described by Box 2 in Table 1 and Figure 1A is that confabulations (so-called hallucinations) are likely to be endemic to such systems since they combine tokens without tracking the underlying logical or causal structure of the world.[11]

In contrast, Box 4 in Table 1 contains assertions that, at some new scale, LLMs develop new internal capabilities—the ability to reason and plan, for example—in virtue of which they can perform better on established tasks or perform a much wider range of tasks. Such views are illustrated in Figure

1B. Some of the most sensational claims about LLMs reside in this box because they imply that designing a system to predict the next token can, with sufficient complexity, give rise to internal representations that constitute a revolutionary leap in cognition. If such systems form an internal representation of the structure of some domain—such as biochemistry—that allows them to reason and plan, then they might be able to solve problems that go far beyond the simple application of prior patterns derived from the training data. This includes discovering new cures or new toxins or pathogens that are currently beyond human reach. Similarly, the hope—or concern, if an actor's motives are malign—is that by tuning these models to rely more heavily on new capabilities, fabrications or hallucinations might be eliminated, and these systems might become more reliable and robust.

Risk, Uncertainty, and the Strategic Landscape

Ambiguities about the claim being expressed by the phrase "emergent abilities" have major implications for how to think about the strategic landscape. These features include the states of the world that actors regard as feasible—all the things that might happen, from natural disasters and pandemics to terrorist attacks and other acts of aggression (and whether this should include the novel actions of a new AI). They also include the set of acts actors might take to avert, mitigate, or respond to various threats.

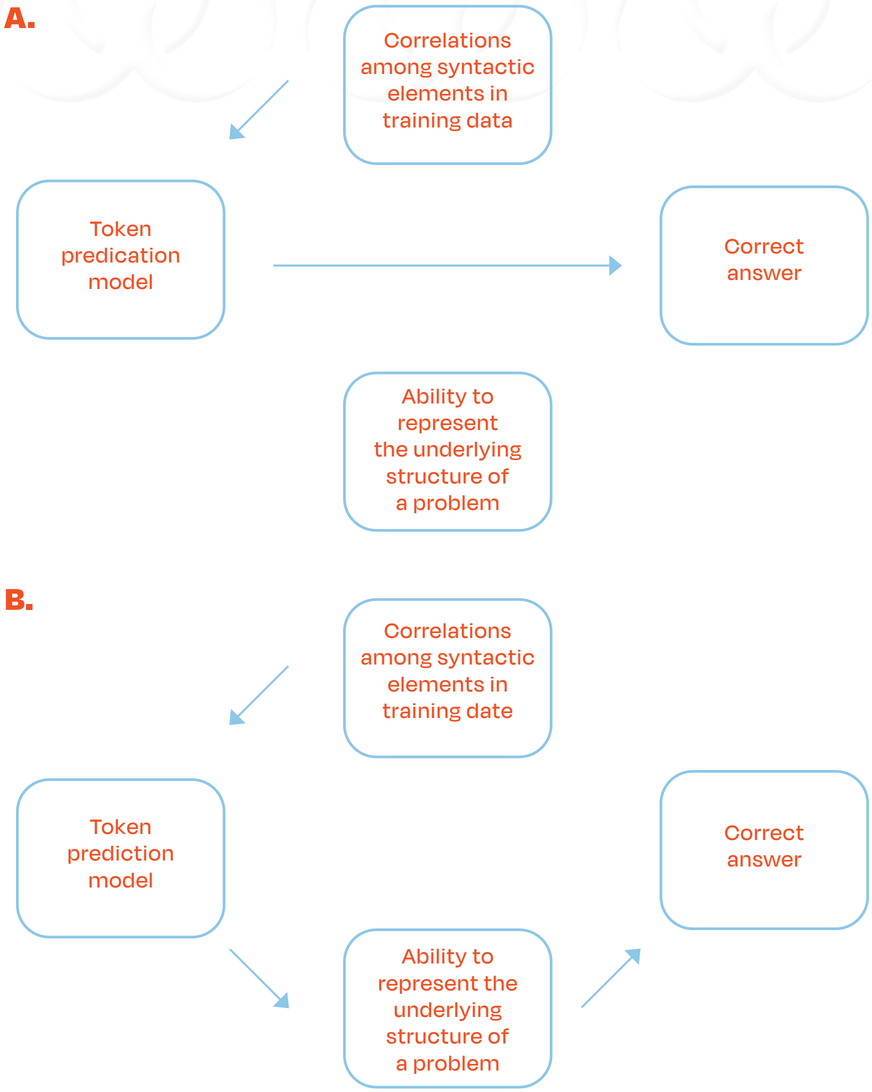

Figure 1: Directed acyclic graphs (DAGs) representing the difference between (A) models that produce the correct answer merely through correlations between syntactic elements in their training data and syntactic features of the correct answer and (B) models that develop new internal representations that allow them to produce the correct answer by exercising some new capability. DAG A corresponds to Box 2 in Table 1; DAG B corresponds to Box 4 in Table 1.

When talk of emergent abilities falls within Box 2 in Table 1/Figure 1A, it represents evolutionary progress. It may pose practical challenges for interested parties, but the uncertainty it generates falls into Box 1 in Table 1. Managing this kind of uncertainty constitutes a problem of decision-making under risk because the states of the world that are feasible and the set of acts that are available are largely stable. This is the kind of uncertainty with which strategic actors must routinely grapple. In contrast, developments captured by Box 4 in Table 1/Figure 1B entail the kind of uncertainty expressed in Box 2. This uncertainty represents a substantive alteration to the strategic landscape. The reason is that systems that develop new internal capacities might be able to do things that are qualitatively new. In particular, emergent abilities of this type might not simply enable systems to do things that had been envisioned by being assigned a low probability (the kind of uncertainty represented in Box 1).

Instead, they might enable abilities that are unexpected in the sense that actors had not thought to consider them when envisioning the states of the world that might arise or when enumerating the set of acts they should consider. This is sometimes called "Knightian uncertainty," where the decision-maker is unsure about which states of the world to entertain, let alone what probability to assign to them.[12] For example, is there a need to contemplate and prepare for events in which systems with new internal capacities develop biological weapons of a type that humans have yet to envision and use some novel mechanism to deliver them in a way that produces an outcome not contemplated? Without a well-defined partition over qualitatively new and unexpected events, it is difficult to assign coherent probabilities to each state.

A common reaction to uncertainty of this kind is to move away from standard approaches to decision-making under risk, in which potential harms and benefits are multiplied by their probability of occurring, and permissible acts are those that produce a ratio of expected benefit and harm that is "reasonable" in some sense. Instead, with Knightian uncertainty, some actors will gravitate toward approaches that are more precautionary and loss averse in that they give priority to averting outcomes that would be extremely bad, no matter how likely those outcomes are to occur.[13] When actors are unsure about the type of challenge they face—whether updating prior assessment or having to imagine wholly different worlds—these ambiguities can change not only how stakeholders think about novel technologies and their possible impacts but the decision rule they use to reason about risk and uncertainty—and thus the trade-offs between security and liberty that they view as reasonable.[14]

Equivocation, Instability, and Policy

The difficulty of formulating coherent and ethically sound security policy is exacerbated when implicit conceptual confusion leads different agents to radically different representations of the strategic landscape. The realistic possibility that parties who see LLMs as capable of supercharging chemical or biological weapons programs will view nonproliferation efforts as infeasible or view states that develop LLMs as violating prohibitions on chemical or biological weapons programs, which can have a destabilizing effect. As a consequence, states looking to reinforce nonproliferation efforts may contemplate, among other steps, restrictions on AI work that violate the rights and liberties of individuals or groups.

A healthy scientific ecosystem is a bulwark against such uncertainty. The health of the scientific ecosystem is facilitated by three elements. The first is drawing clear conceptual lines between unambiguous views that are well-differentiated alternatives. The goal here is to ensure that the various properties of systems associated with each view can be carefully articulated so that various claims about utility and hypotheses about the emergence of novel capacities can be differentiated. An ecosystem in which ambiguous claims frustrate the ability of interested parties to efficiently differentiate relevant alternatives in terms that can be empirically tested is unhealthy.

Second is a process that promotes rigorous, expeditious, and efficient testing designed to identify which of these claims are supported by evidence. Efforts to evaluate systems under conditions that control for confounding, and thereby that distinguish between the states of affairs depicted in Figure

1A versus B, should be central to this work. Third is a credible system of incentives that reward engaging in this process of rigorous testing and peer evaluation before claims about the abilities of systems are widely publicized. Central to this process should be credible efforts to reduce conflicts of interest that arise when the parties who profit from the sale of a system are also producing the research that outlines system capabilities, potential benefits, and shortcomings.

In contrast, early studies that purport to substantiate claims from Box 4 without carefully distinguishing and controlling for mechanisms for model performance that fall within Box 2 exacerbate uncertainty and perpetuate the prospect of inflated expectations. Once public attention has been captured and expectations framed, the buzz created by inflated claims, whether of benefit or danger, overshadows and threatens to drown out the more measured findings of carefully controlled investigations. As one example, the claim that LLMs have developed the capacity to plan is central to the hopes of AGI optimists and the fears of AGI pessimists who trace out alternatively utopian and dystopian visions of the future. In a series of studies, Subbarao Kambhampati and colleagues[15] evaluated the planning capabilities of generative AI models in a way that differentiates task performance based on recall or pattern recognition between syntactic elements in the prompt and syntactic elements in the training data (Box 2 and Figure 1A) from the capacity to represent and reason about the underlying structure of a planning problem (Box 4 and Figure 1B). When the syntactic elements used to refer to items in a planning problem are altered, but the structure of the problem remains unchanged, LLM performance effectively disappears. Similar findings have been reported in studies that examine causal reasoning,[16] theory of mind,[17] and the more general claim that novel capabilities emerge suddenly at new scales.[18]

As a result, it is unsurprising that early reports that generative AI models might be used to develop novel chemical or biological agents have been tempered by recent findings that such models offer marginal advantages when compared to the baseline of using information already present on the Internet.[19] Improving the health of the scientific ecosystem around AI cannot eliminate uncertainty that attends new scientific advances, but it can help stakeholders reduce avoidable uncertainty that arises from conceptual ambiguity.

Strengthening the health of the scientific ecosystem surrounding AI is critical for ensuring that research in this area produces information on which a wide range of decision-makers can rely when making decisions that can impact the rights and well-being of large numbers of people.[20] Because Knightian uncertainty can destabilize strategic equilibria, practices that minimize the perception of such uncertainty when this perception is avoidable help to avert circumstances in which actors might feel compelled to defect from nonproliferation efforts. They also help ensure that public perception, stakeholder attention, social resources, and security efforts are not captured by parties who might benefit from inflated perceptions regarding the abilities of novel technologies.

Conclusion

The challenge of balancing security with the freedoms that define open societies is complicated by advances in technology. These complications stem from uncertainty around the disruptions that will flow from innovation as well as the challenges that new approaches can pose to old concepts. Conceptual clarity is essential to the ability of stakeholders in the scientific ecosystem to expeditiously articulate and efficiently address pivotal scientific questions, to maintain a realistic sense of the strategic landscape, to mitigate the dangers of hype, and to foster the creation of timely, evidence-based policy.

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Section 3:
Potential Tools and Narratives for Dissuasion and Deterrence

Simple Tool for Disincentivizing the Worst Pandemic Bioweapons

Emma J. Curran and Nir Eyal

Summary

This essay proposes a simple way to incentivize states not to develop pathogens with enhanced pandemic potential (PEPPs) as bioweapons: to tip all state actors that all of them stand to lose from developing such highly lethal, highly transmissible bioweapons. Being highly transmissible, a PEPP used as a weapon could easily spread, infecting a state's own citizens and leaders. Therefore, no state concerned for its own citizens or leaders can afford to use a PEPP weapon, even having developed or acquired it. We then show that when this is commonly known between states, having PEPPs provides no useful deterrent to a state, and there is no point getting into an arms race. Developing and stockpiling PEPP weapons gives states no gain, only risk. We end by assessing three objections to our thesis.

Introduction

The destructive power of some future biological weapons, or bioweapons, could dwarf that of most traditional weapons, of past bioweapons, and of natural pandemics. Although there currently might be a lack of know-how, scientists in the future could probably program PEPPs[1] for high transmissibility, immune evasion, and lethality, alongside other traits that would make their accidental or deliberate release a potential catastrophe for a species.[2] This makes the prevention of the development and use of such future bioweapons more urgent than that of traditional bioweapons such as anthrax and perhaps even natural pandemic pathogens (Ebola, for example). Engineered bioweapons could be the worst weapons humanity has created.

Jaime M. Yassif, Shayna Korol, and Angela Kane helpfully distinguish ways to disincentivize state and individual actors from developing PEPPs.[3] Their pioneering discussion of disincentivizing state actors puts forth three ways to decrease state intentions to develop bioweapons: enhancing transparency, strengthening attribution, and building an accountability system. But those researchers readily admit that these solutions are imperfect. Unlike nuclear weapons—whose barriers to production are located at "the front end of the development process"[4]—the production of synthetic bioweapons, and to some degree, some PEPP bioweapons, does not require rare materials and could take place largely out of sight.

In this essay, we discuss a potential complementary means to reduce state motivation to produce PEPPs. Our focus is specifically on the worst bioweapons—future PEPPs that will be maximally transmissible, immune evasive, and lethal, and thus pose a global catastrophic biological risk (GCBR).[5] This means our proposal for disincentivizing the production of weaponized PEPPs is surprisingly simple. One could simply inform all states about the following: They stand to gain very little and to risk a lot from developing PEPPs. The core reason is that deploying the worst PEPPs as bioweapons would jeopardize the health of a state's own leaders and citizens precisely because these pathogens are so transmissible and difficult to control: Even if released in an enemy state on the other side of the planet, such PEPPs would usually spread to their own citizens and their leaders. This knowledge might be propagated through routine messaging from international organizations such as the World Health Organization (WHO) and major national agencies through a series of international meetings and country visits, through a video campaign, or through publications in medical, natural science, or policy journals. Further options are conceivable.

This essay analyzes the implications of this observation for the incentives of state agents to develop the worst bioweapons. The following section shows that with PEPPs, the standard incentives for state agents to develop bioweapons do not apply; states would be imprudent to use PEPPs as offensive weapons or deterrents or to develop them out of arms race dynamics. In addition, merely developing and stockpiling PEPP bioweapons comes with nontrivial risk of accidental release and of inspiring copycat operations. So, developing PEPP bioweapons is both pointless and risky for states. Informing them of that point may dissuade the development of this unusually dangerous category of weapons at a low cost. The final section addresses three potential objections to our proposal, concerning *differential risk*, *rationality*, and *redundancy*.

PEPPs and State Motivations

As Yassif, Korol, and Kane note, creating effective disincentives against the development of any bioweapon requires first understanding the motives of states to develop it.[6] A state might develop or procure bioweapons to deploy them as offensive weapons or stock them to deter aggression from other states.[7] Under conditions of mistrust, states may also develop bioweapons if they worry that other states may come to possess bioweapons, leading to an arms race dynamic.[8]

The highly lethal, transmissible, and indiscriminate nature of the worst PEPPs weakens, at least on the face of it, all these incentives for state agents to develop them as a form of bioweaponry. First, consider how the highly transmissible and lethal nature of the worst bioweapons will undermine their usefulness as a strategic weapon. Insofar as a state genuinely wishes to protect the well-being of its citizens, or at least its leaders, understanding that highly transmissible pathogens are likely to infect them too should motivate it not to deploy bioweapons. (In addition, the state's allies are unlikely to sanction the state's use of PEPPs, given allies' concerns for their own health.)[9] Here, highly infectious PEPPs contrast with old-school bioweapons such as anthrax, for example, whose limited transmissibility could keep attackers safe.

Perhaps states may still have incentives to develop PEPP bioweapons as a form of deterrent. For a weapon to function as a deterrent, it is essential that other states believe that the state developing the bioweapon will use the weapon if sufficiently provoked. Yet if other states are aware of a state's prudential reasons not to release PEPPs, then they would not normally believe that their adversaries are likely to release them even if provoked. No state minimally concerned for the health of its citizens or leaders would willingly release highly lethal and transmissible pathogens anywhere. Mutual knowledge of this consideration would remove the entire deterrence advantage of having bioweapons.

Such mutual knowledge would therefore impede a PEPP bioweapons arms race as well. Arms races typically occur because states wish to avoid a situation in which they lack a weapons program that other states have. Yet this situation is only objectionable for a state when it leaves it vulnerable to attacks. When a state knows that other states cannot afford to use their superior PEPP weapons stockpiles, it also knows that it need not build its own program. In short, even if states suspect that other states are developing the worst PEPP bioweapons, they lack the incentives to enter a PEPP bioweapons arms race. And if a state fears that a rogue individual is developing or in possession of a PEPP bioweapon, responding to that threat with its own PEPP threats is pointless. A state cannot afford to use that weapon against the individual—and the individual will know that.

What states *do* gain from developing and possessing PEPPs as weapons is lots of risk. Accidental release is possible,[10] as is the misuse of the technology by adversaries, including terrorist groups. Taken together, this means that, typically, states not only lack reasons to develop PEPPs but they also have significant reasons not to develop them. Strategically and tactically, the costs of PEPP weapons far exceed their benefits. Thus, a likely effective, relatively inexpensive, and readily implementable means of disincentivizing the development of the worst PEPP bioweapons would be to promulgate these calculations to all states.

Replying to Potential Objections

DIFFERENTIAL RISK

The preceding argument rests on the assumption that PEPPs are indiscriminate—that once they are released, being highly infectious and immune evasive, they will probably spread across the world, killing undifferentiated numbers of people across states, including, crucially, the citizens and leaders of the state that released them. This, however, need not always remain the case. Since the inception of the Human Genome Project, some have been concerned that bioweapons may one day be able to target specific subpopulations, such as the genetic groups prevalent in an enemy state only.[11] Because SARS-CoV-2 affected some ethnic groups more than others, some made the unfounded allegation that it was developed to harm mainly non-Chinese racial–ethnic groups.[12]

Furthermore, if states can develop safe and effective vaccines against their pandemic pathogens and widely distribute them to their populations, then they still might have good reason to develop PEPPs. Provided the vaccines are sufficiently efficacious at preventing mortality and morbidity, deploying these bioweapons offensively might allow a state to gain a crucial advantage over their adversaries in times of war. Instead of the PEPP weakening both states equally or similarly, the vaccine would allow a state to significantly weaken its adversaries while its own citizens remain largely protected.

Similarly, even lacking a vaccination program, some states might be less vulnerable to the bioweapon that they wish to make known. Rich countries may note their comparative advantage over poor adversaries in protection against the worst pathogens, for example, with their vastly more developed healthcare, indoor-air sterilization systems, next-generation personal protective equipment, and other relevant anti-pandemic infrastructure. Island nations with limited need for external contact might also feel comparatively safe, as might a regime with unique political ability to impose and afford a very long shutdown. In such cases, releasing a PEPP may seem to provide a state with a military advantage over other states—enough so to undermine the disincentives expounded.

Thankfully, it is not clear that discriminating PEPPs could be developed in the foreseeable future, if ever. It is also far from clear that any state could covertly develop and distribute a vaccine known with high certitude to be extremely efficacious (against mortality and severe morbidity) to its entire population. Even leaving these considerations aside, there is cause to be skeptical about the weight of such concerns about differential risk. Take the example of the vaccine: Even if it is the case that the state can develop a vaccine to protect its citizens in 97% of cases and distribute it to all, its use of a PEPP could still leave a full 3% of its citizens and leaders dead. It would also spell death to the state's trade partners and cultural interlocutors abroad—not just its adversaries. Such a cost may be prohibitive even when it grants a state an advantage over adversaries.

Of course, the response offered here has its limitations. First, it fails if the stakes of losing the war are large enough. Imagine a state struggling to save its population and leadership from complete genocide. Releasing a PEPP to avert that threat might be advantageous when a vaccination caps mortality from the PEPP at 3%. Second, if an extremely efficacious vaccine was developed, one that reduced morbidity to a fraction of a percent, then releasing PEPPs may once again become a plausible offensive option for states. This observation has an odd upshot: As vaccines become more efficacious, they increase the likelihood of global catastrophe from pandemic bioweapons. The surer a state is that it is protected from PEPPs, the *weaker* its leaders' reasons *not* to release them. Beyond a certain level of efficacy, vaccines have dual-use potential.

A REPUTATION FOR "IRRATIONALITY" AND DOOMSDAY MECHANISMS

Might some states still have incentives to develop PEPPs to achieve deterrence? After all, a weapon's efficacy as a deterrent is a function of other states' beliefs regarding the likelihood that that weapon will be used. States that have been historically perceived as unconcerned for the safety of their own citizens and leaders, or as unable to make the cool-headed game-theoretic calculations offered here, might be viewed by their enemies as likely to use PEPPs as bioweapons. As such, their possession of the worst bioweapons would have genuine force as a deterrent, providing an incentive for them to develop and stockpile these weapons.

In a parallel vein, philosopher Derek Parfit tells the story of a burglar who threatens to shoot a homeowner's child unless the homeowner opens her safe.[13] One way for the homeowner to thwart that threat is to take "irrationality pills" which make her act manifestly against her own family's safety interests. The pills might, for example, lead her to say, honestly and hence convincingly, things like "By all means shoot my child—here, please shoot that other child too!" The burglar might conclude that threatening is pointless and leave without the money and without harming anyone. Although Parfit uses the case to demonstrate that it can sometimes be rational for people to render themselves irrational, for the purposes of the argument here, his story can demonstrate something subtly different: that it could sometimes be rational for a state to either *be* or *pretend* to be irrational or at least unconcerned about its own citizens' and leaders' safety.

But the current context is different from the one Parfit's burglar occupies. States lack "irrationality pills." Instead, a trail of past actions is what builds their reputation. And the only way for a state to make other states believe it to be thoroughly indifferent to its own citizens' and leaders' safety, or unable or unwilling to make cool-headed calculations, is by leaving for many years a trail of reckless actions and calculation errors. Leaving such a trail would be very costly for any state to do. It is not something that any existing state, or any except very few, would be willing to do.

One way a state might minimize the cost of this plan is to make randomized or irrational decisions over a small percentage of its decisions, a percentage *just* large enough to make other states fearful of the nontrivial chance it might, in the future, actually release PEPPs despite it being an "own goal" to do so.[14] However, even acting irrationally about the few decisions necessary to convince others that one is sincere is probably very costly. If other states are to believe that a state will release a PEPP at catastrophic personal costs, then they need to have strong evidence that this state is willing to harm its own citizens and leaders massively. Non-rational decisions about trifling choices will not do. The cost of providing strong evidence of acting massively non-rationally is, unsurprisingly, extremely high.

The only way for a state to develop biodeterrence without the very costly development of such a reputation is by tying the weapon to a "doomsday" mechanism. A state known to be rational and responsive to its own citizens' and leaders' health interests may nevertheless bind itself to a mechanism that ensures the release of a mutually destructive bioweapon should another state engage in certain aggressions. Mutual knowledge of the deployment of the doomsday mechanism should deter such aggressions, even if its possessor has a reputation for standard rationality.

Nevertheless, doomsday mechanisms risk annihilating their owner upon every false positive alert. This is not something that states lacking error-proof control systems can afford. So, any doomsday mechanism would have to involve the option to stop it. And other states' knowledge of that option would usually bar a state believed to be standardly rational from enhancing its deterrence through the possession of PEPP bioweapons.

REDUNDANCY

This section addresses two concerns that this essay's proposal is redundant. The first is that, given the simplicity of the proposal, states would have already known about it if it worked. Either the proposal fails or, surely, the calculations offered would have long been common knowledge. An answer to this concern is that sometimes obvious things need to be spelled out before they are received. Even if individual states are privately aware of these calculations, they may remain unaware that this is mutual knowledge. The mutual knowledge of these facts further undermines both deterrent and arms race–based reasons to develop PEPPS as bioweapons. Disseminating this information widely ensures that it is mutually known and thus remains important for mitigating catastrophic biological risks.

Another concern about redundancy is that Yassif, Korol, and Kane's three proposed ways to decrease state incentives to develop biological weapons achieve the same goal. Moreover, they may very well dissuade the development of additional forms of biological weapons including, for example, anthrax.

But this essay's proposal has advantages over Yassif, Korol, and Kane's three proposals. It would be typically cheaper and may result in much stronger disincentives. Focused on transparency, attribution, and accountability, their proposals ultimately hang on a state's desire to avoid punishment for the development or use of bioweapons. But any state fully willing to jeopardize the lives of its own leaders and citizens by releasing a very lethal and very communicable pathogen is unlikely to be swayed by threats of international and domestic accountability—surely in terms less harsh than likely death (threatening such punishments may create sufficient disincentives against the development of weaker biological and chemical weapons). In that regard, the relatively inexpensive disincentive proposed here does not only complement but also has advantages over extant proposals.

Conclusion

Simply informing states that using PEPP bioweapons would probably be catastrophic for their own citizens and leaders might be a powerful tool to disincentivize the development of such weapons. For many states, the realization that they cannot afford to use these weapons offensively or defensively would disincentivize their development and procurement. If this is correct, then in nearly all cases in the foreseeable future, sharing a simple insight could inexpensively keep the world safer against state development of the worst bioweapons.

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Endnotes

[1] White House Office of Science and Technology Policy, "United States Government Policy for Oversight of Dual Use Research of Concern and Pathogens with Enhanced Pandemic Potential," May 6, 2024, www.whitehouse.gov/wp-content/uploads/2024/05/USG-Policy-for-Oversight-of-DURC-and-PEPP.pdf.

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[10] Alison Young, *Pandora's Gamble: Lab Leaks, Pandemics, and a World at Risk* (Hachette Group, 2023).

[11] British Medical Association, *Biotechnology, Weapons and Humanity* (Harwood Academic, 1999).

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[13] Derek Parfit, *Reason and Persons* (Oxford University Press, 1987), 12–13.

[14] Thanks to Nathan Paxton for suggesting this possibility.

Appendix

Meeting Report: November 2023 Workshop on Disincentivizing State Bioweapons Development and Use

The risk of a catastrophic biological event caused by a bioweapon continues to grow as a result of rapid advances in technology, increased global capability to create and engineer pathogens that could cause a pandemic, and states' potential interest in biological weapons. Academic and policy literature on disincentivizing states from developing or using bioweapons is underdeveloped.

NTI | bio seeks to develop a cross-disciplinary "thought and practice community" to explore and identify potential solutions to disincentivize states from developing or using biological weapons. Failure to think deeply and analytically about complex challenges like this can prevent the emergence of effective solutions. Establishing a strong community to examine the range of current and future threats and develop forward-leaning solutions is critical. Workshop participants engaged in five sessions centered on questions about what drives state intent to acquire or use bioweapons, three tactics for disincentivizing bioweapon acquisition or use (attribution, accountability, and transparency), and how to shape state intent through international cooperation. Three overarching themes emerged:

1. Discerning state bioweapon intent remains difficult and inexact.
2. An innovative tool kit is required to dissuade or deter.
3. Flexibility and scalable responses are needed.

Measuring Intent: Incentives and Capabilities

The workshop focused partly on exploring concepts and practical approaches to disincentivizing—that is, altering a state's intent—the development, acquisition, or use of bioweapons. Because states are unlikely to articulate *why* they would acquire or use these weapons, it is necessary to look at a state's incentives and capabilities to come to a best assessment about its intent.

INCENTIVES

Workshop participants discussed several categories of incentives that might drive states toward bioweapons. States may see positive incentives from their domestic, social, and political environment; from the international strategic environment; and from the nature of bioweapons vis-à-vis other weapons.

Participants acknowledged that international state behavior links to domestic social, political, and economic factors and characteristics. For example, although participants noted that democratic states almost never engage in war with each other, democracies are likely not exempt from motivations for bioweapons development, particularly if facing a nondemocratic rival.

The discussions also considered how the international political environment affects state incentives and may drive some states to consider this less-acceptable means for balancing against external threats. Some historical examples of state bioweapons acquisition or surrender (including the United States, United Kingdom, Israel, and South Africa) appear to reflect the impact of external threats (as well as internal regime survival).

Finally, participants explored the idea that, owing to advances in biotechnology and life sciences, states might pursue biological weapons as a less costly and substitutable variety of mass destruction weapons, driven by the (possibly incorrect) perception of "ease" and "affordability." This thread overlapped considerably with the discussion of bioweapons development capabilities.

CAPABILITIES

Participants focused on the necessary capabilities for bioweapons development. The discussion underscored the formidable challenges in acquiring the scientific and technical expertise required for bioweapons development; this expertise draws on several disparate scientific disciplines, as well as weapons system engineering and delivery method expertise. Participants explored the challenges in defining bioweapons development thresholds and highlighted those definitions as areas needing further exploration. In other words, are there actions or thresholds that might provide good indicators for detecting bioweapons development? Participants noted the complexity of this issue compared with the nuclear space.

The dual-use nature of biological research complicates considerably the distinction between latent scientific capability and active weaponization. One example raised was gain-of-function research, where enhancing some characteristics of bacteria or viruses could serve purposes ranging from researching countermeasures for future outbreaks to potential bioweapons development.

A Deep Tool Kit for Dissuading, Deterring, and Reinforcing Norms

Possible disincentivizing tools are broad natured and will likely require use in more combinations than in other weapons regimes.

TOOLS AND NARRATIVES FOR DISSUASION AND DETERRENCE

Drawing from existing efforts in bio as well as insights from the nuclear and chemical sectors, participants discussed strategies that make use of innovative tools and narratives.

Innovative Prevention

- Disrupting development programs through export controls, intelligence operations, and the promotion of verification mechanisms.
- Highlighting bioweapon forensic capabilities to serve as a deterrent.
- Collaborating with insurance companies to incentivize responsible behavior through stricter financial liability.
- Maintaining and expanding a narrative about the intricacy and unpredictability of bioweapon development and use.

Evolving Transparency

- Adapting the Biological Weapons Convention's Confidence-Building Measures to better include technological developments and private-sector activity, while complementing voluntary transparency initiatives such as peer reviews and site visits.
- Bettering oversight of national biosafety and biosecurity practices to reduce reckless scientific conduct.

Improving Attribution

- Acknowledging the complexity of the current imbalance in punishing people who speak out or report incidents without offering corresponding rewards or protections.

Multifaceted Accountability

- Developing and implementing economic tools—such as a common agreement to deposit a proportion of state GDP in an international adherence fund—which can exceed the reach of traditional economic sanctions.
- Creating an international legal tribunal specifically for bioweapons, drawing parallels with norms against chemical weapons.
- Introducing the idea of an international body with authority to punish, highlighting the importance of global cooperation.
- Making individual state leaders accountable for bioweapons development, as well as exploring accountability for private companies that provide materials linked to bioweapons.

REINFORCING NORMS

In addition to the technical tool kit for combating bioweapons development and use, the international community can also use and strengthen the norms against their development and use. Technical tools and norms mutually uphold and sustain each other, and it is important not to leave either category to the side. Participants highlighted the importance of strong anti-bioweapons norms to disincentivization, particularly as proliferation prevention tools. Discussion explored how norms and technical enforcement tools might jointly bolster accountability.

Participants acknowledged the challenges in maintaining and reinforcing norms, especially in the face of emerging technologies. Highlighting the role of transparency and accountability, discussions underscored the importance for nations to prioritize domestic policies that align with international norms. This would help foster collective commitment to the prohibition on biological weapons while upholding accountability down to the individual leader level.

The Necessity for Flexibility and Scalable Responses

Responses to the challenge of bioweapons development or use must be flexible and adaptive. As the threat landscape changes, so must disincentivization tactics.

THRESHOLDS FOR ATTRIBUTION AND ACCOUNTABILITY

The thresholds for attribution and accountability action present complex challenges. Participants argued that all violations of norms or prohibitions against bioweapons deserve response from the international community, but response severity needs to be proportionate to the violation. Moreover, because ensuring attribution accuracy is difficult, the accountability regime would need to balance response against the potential misjudgment of an innocent party.

Some dialogue focused on how biosecurity discussions need to mark out clear distinctions for the disincentivization strategies to employ before and after the verified use of a bioweapon.

Augmenting transparency, attribution, or accountability would differ depending on whether the situation is "pre- or post-boom." Transparency and verification offer greater returns pre-boom, while attribution and accountability may offer more benefit in the post-boom period.

Recognizing the need for a nuanced approach, participants emphasized encouraging countries to disclose potential breaches early and foster a culture of transparency. Areas requiring further exploration included potential misattribution risks after a major conflict involving bioweapons and the unconventional nature of bioweapons use in assassinations.

PROPORTIONALITY IN RESPONSE

From idea to inception, there are many steps and increasing demonstrated intent along the path to acquiring bioweapons. Participants agreed that there must be proportional response that scales up as the assessed intent of bioweapons acquisition goes up. Given the accepted heinous nature of bioweapons, participants raised questions about how to implement proportionality effectively.

Historically, there has been a limited menu of options available to hold states accountable, including sanctions, UN Security Council recourse, and military action. Participants emphasized a need for a multifaceted response strategy—combining immediate actions, such as implementing sanctions, with longer-term work like collecting and preserving evidence to construct a comprehensive case for presentation at the International Court of Justice or the UN Secretary-General's Mechanism.

EMERGING TECHNOLOGY AND SCIENTIFIC OVERSIGHT

The dual nature of new biotechnologies both facilitates scientific progress and eases bioweapons development. Transparency efforts vis-à-vis these technological advancements will be increasingly important, especially in subject areas that states could more easily conceal (for example, combining bio with artificial intelligence). The discussion centered on challenges in controlling biosecurity technology, where the dual requirements of disclosing information for violation detection clashed with protecting intellectual property and commercial secrets. Recognizing the tension between revealing enough information for compliance and avoiding excessive disclosure, the discussion drew parallels with restrictive inspections in other domains.

Additionally, participants underscored the critical role of trust in scientific collaboration for effective biosecurity. The conversation shifted to oversight challenges for potentially dangerous research, emphasizing the need to ensure transparency without impeding scientific progress. Concerns were raised about scientists' reluctance to accept oversight and potential restrictions on scientific inquiry. Overall, participants stressed the fostering of trust, transparency, and flexibility in responding to state intentions regarding bioweapons development.

Next Steps Toward Building an Epistemic Community

Meeting participants agreed that this community of knowledge and practice (an epistemic community) for bioweapons disincentivization exists on a small scale at this moment, and there needs to be sustained focus to ensure further discussion. Participants proposed some practical strategies and tactics to move forward:

1. **Publish Collection of Essays:** NTI pledged to publish a collection of essays, capturing ideas from this meeting's participants and other experts in the field.

2. **Convene Additional Meetings:** NTI intends to organize additional meetings on disincentivization. Participants urged that the conversation broaden to include other domains (e.g., autonomous weapons, space policy, cybersecurity, etc.) as potential guides for tackling bioweapons threats and expand to involve more international participants.

3. **Address Academic Concerns and Explore Fellowship Models:** There is a lack of academic focus and resources on bioweapons. Participants contemplated the feasibility of encouraging academics to formulate more comprehensive theories of bioweapons, with a cautionary note against chasing a singular, grand idea. Participants encouraged exploring fellowship models, similar to the Stanton Nuclear Security Fellowship,[1] to incentivize scholars to think through bioweapons issues.

4. **Engage Funders:** Encourage funders to support translational research and involve them in identifying problems that academics can address in the field of bioweapons. By bringing together academics with policy, funders can connect policymakers with experts who can provide solutions.

Endnote

[1] Harvard Kennedy School, Belfer Center for Science and International Affairs, Stanton Nuclear Security Fellowship, www.belfercenter.org/fellowship/stanton-nuclear-security.

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