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Deterring Biological Warfare in the Indo-Pacific✢

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|ABSTRACT|

The COVID-19 pandemic exposed vulnerabilities to threats posed by human pathogens in societies around the world, including in the United States and US partners in the Indo-Pacific region. Aiming to bring the pandemic to an end, the members of the Quad, Australia, India, Japan, and the United States, vowed to increase cooperation on COVID-19 vaccine access and bolster health security in the region. The Biden administration also emphasized reducing the risk of future biological catastrophes in its March 2021 Interim National Security Strategic Guidance. Considering this renewed emphasis on health security, this paper will examine how deterrence concepts can be applied to reduce the risk of biological warfare to the United States and partner countries in the Indo-Pacific. As part of this broader question, this paper will analyze whether new strategic coalitions, namely the Quad, can use deterrence collectively to strengthen health security, and it will focus on deterring potential biological warfare threats posed by two state actors: China and North Korea. This paper will review existing literature on deterring biological warfare, current strategic thinking on health security and deterring biological warfare, and then project that thinking to the emerging biological warfare threat environment.

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Ⅰ. Introduction

The COVID-19 pandemic has renewed interest in biological warfare, both in the potential for actors to conduct biological warfare and in preventing biological warfare. This paper will examine how deterrence theory can be applied to dissuade actors from conducting biological warfare. In particular, this paper will analyze how the United States and partners in the Indo-Pacific region can deter biological warfare threats from China and North Korea. This paper argues that the potential broad range of effects that biological warfare could produce means that no single model of deterrence can be applied to deterring biological threats. Further, existing US extended deterrence commitments, developing partnerships and coalitions like the Quad, and potential indiscriminate nature of biological agents requires the United States to develop deterrence strategies in close coordination with allies and partners in the Indo-Pacific region.

This paper will proceed as follows. The next section gives an overview of current and future biological warfare threats, and then section III looks at what is publicly known about Chinese and North Korean biological warfare capabilities. Section IV summarizes general deterrence theory and then reviews the literature on deterring biological warfare. Next, section V analyzes how the United States and partners in the Indo-Pacific can utilize deterrence theory to prevent biological warfare by China and North Korea. Finally, section VI offers concluding remarks.

Ⅱ. Current and Future Biological Warfare Threats

The use of biological agents in warfare has a long history in international affairs, and some scholars in the 20th century dubbed biological weapons as a "poor man's atomic weapon" due to their relative ease and low cost of production and potential to cause mass casualties. For example, the release of a highly lethal biological agent, such as anthrax spores, could lead to the deaths of up to millions of people in urban areas. Yet, the historical record shows that biological weapons have had limited utility in creating tactical or strategic advantage due to several challenges in weaponizing and delivering biological agents to their intended target.

Francisco Galamas described some of the challenges regarding the use of existing biological agents in warfare, particularly considering using biological weapons for strategic effect. It should be noted that his analysis is reflective of weaponizing naturally existing pathogens. Galamas wrote that natural pathogens produce uncertain and unreliable effects due to invisibility, delay, and uncertainty of dissemination.[1] On invisibility, effective biological agents need to be 1 to 5 microns in size, which renders them invisible to the human eye, and biological weapons do not destroy physical infrastructure. Thus, the weapons and their effects are not immediately visible to the target. Regarding delay, the timing of the effects of biological weapons depends on the incubation period of the pathogen used, which could be hours, days, or even weeks.

Finally, the conditions of delivering biological weapons can greatly impact the effectiveness of the attack. The effectiveness of biological agents can be reduced by weather conditions, such as

1) Francisco Galamas, "Biological Weapons, Nuclear Weapons and Deterrence: The Biotechnology Revolution," *Comparative Strategy*, Vol. 27, No. 4 (2008), p. 316.

temperature, rain, sunlight, humidity, and wind, and biological agents could be destroyed by the mode of delivery, such as a ballistic missile. Moreover, the target population can take medical countermeasures, such as administering antidotes or vaccines, to render a biological weapons attack ineffective.[2)]

Another challenge related to delivery is blowback, which refers to a biological agent, like a virus, spreading to also affect the attacker. The SARS-CoV-2 virus that causes COVID-19 is an example of the type of pathogen that could be a poor agent for biological warfare due to the difficulties in controlling the spread of the virus, and SARS-CoV-2 being novel means that populations around the world were vulnerable to infection, severe illness, and death. Panelists at an October 2020 conference at Lawrence Livermore National Laboratory concluded that the COVID-19 pandemic has "created disincentives for states to develop pathogens as offensive biological weapons," and even countries that have not experienced as many infections of deaths as the United States, such as China and North Korea, have been negatively affected by the pandemic. Thus, countries "are unlikely to pursue the weaponization of a novel pathogen because of the potential for blowback."[3)]

Even for existing, highly lethal pathogens, the example given above about using anthrax spores to attack urban populations should be tempered with the consideration that the actual effects of such an attack would be highly dependent on the weather conditions at the time of attack, the method of delivery, and the health conditions of the target population. This means that an attacker would risk violating an international norm against the use

2) Galamas (2008), p. 316.

3) L. J. Borja, A. Campbell, M. Kirschke-Schwartz, B. Radzinsky, and B. Williams, *Workshop Summary – Rethinking US Biosecurity Strategy for the Decade Ahead* (Livermore, CA: Lawrence Livermore National Laboratory, 2020), p. 7.

of biological weapons for uncertain strategic or tactical effect. By contrast, other kinetic weapon systems, particularly nuclear weapons, can produce highly visible, immediate, and reliable effects on target populations.

However, many scholars and analysts now point to advances in biotechnology in recent decades to warn of ways that attackers could overcome these challenges to produce and deliver effective biological weapons. While SARS-CoV-2 may not be an ideal biological agent for use in warfare, the ongoing COVID-19 pandemic also has exposed weaknesses in many countries' public health systems, including in the United States, and some argue that adversaries could be motivated to use biological weapons in light of this. A review of biotechnology advances, with an emphasis on genetic weapons, is necessary to help determine how deterrence can be used to reduce the threat of these advances.

In 2018, the National Academies of Sciences, Engineering, and Medicine identified three areas of developing biotechnology as most concerning: recreating known pathogenic viruses, making existing bacteria more dangerous, and making harmful biochemicals via in situ synthesis.[4] All of these categories involve some sort of genetic manipulation, either editing or synthesis, and potentially can produce biological agents that address the weaponization challenges discussed above. Yelena Biberman wrote that these biotechnologies also are enabled by recent advances in genetic sequencing technologies, bioinformatics, and artificial intelligence that has led to rapid growth in genomic data generation, with China leading the world in genetic sequencing.[5]

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4) Yelena Biberman, "The Technologies and International Politics of Genetic Warfare," *Strategic Studies Quarterly*, Vol. 15, No. 3 (2021), p. 7.

5) Biberman (2021), p. 9.

Genetic editing can be used to make existing pathogens more virulent and more appealing as a potential biological weapon, but as discussed above, there are natural pathogens that are quite virulent. The main challenges with biological warfare are more associated with effectively and selectively delivering the pathogen to the target and producing intended effects rapidly. Advanced biotechnology can produce pathogens that are more resistant to environmental and delivery system conditions, such as ultraviolet radiation and temperature and pressure variations.[6] Other genetic manipulations can make bacteria that are resistant to known antibiotics or viruses that are able to get around current vaccinations or seem invisible to the immune system altogether.[7] These types of biological agents would significantly reduce the utility of medial countermeasures and provide the attacker with a more reliable weapon.

Medical countermeasures also could be defeated by hybrid biological agents. Such agents using genetic manipulation also can create new biological agents by combining the genes of different pathogens to synthesize new hybrid biological agents.[8] The numerous potential hybrid agents that could be produced would make developing medical countermeasures against each hybrid agent very difficult.

Genetic manipulation also has the potential to create precise biological agents that can target a particular individual, group of people, or even crops and farm animals. So-called genetic weapons could be engineered to target certain genetic characteristics found in individuals or groups of people, especially populations with

6) Galamas (2008), p. 318.
7) Galamas (2008), p. 319.
8) Galamas (2008), p. 320.

relatively less genetic diversity. After such a genetic agent is ingested, the agent would only activate and cause adverse effects if the person has the genetic characteristics that the agent targets. Genetic sequencing for targeted individuals or groups would be necessary, but existing databases of genetic information and environmental sampling could be used to sequence the target population and engineer precise genetic weapons.[9] Domesticated crops and farm animals could be even more vulnerable to genetic weapons due to the selective breeding that reduces their genetic diversity.

Stealth viruses also could be developed that enter and infect human cells "while remaining dormant for indeterminate periods of time without provoking disease. The virus could later be activated by an internal or external signal and produce illness in infected individuals."[10] Such a virus could be used to gain coercive bargaining leverage through the threat of activating it. However, it would seem that the attacker would have to make further manipulations to ensure that the stealth virus would not also come back and infect their population, thus causing illness at home when activated.

Potential technology for delivering new biological agents also is under development. Pathogens could be connected to nano-carriers to help permeate cell membranes and the blood-brain barrier. This could reduce the amount of agent required to produce the desired effect due to increased effectiveness of infecting targeted populations. Small unmanned aerial vehicles (UAVs) also could be designed to deliver biological agents precisely and effectively.

Taken together, Biberman summarized these advances in bio-technology. "By combining nanotechnology, computational power, and synthetic biology with AI and robotics, one can imagine a future

9) Biberman (2021), pp. 13-16.

10) Galamas (2008), pp. 320-321.

involving various types of robots, drones, or satellites that could manufacture and deliver 'smart germs' anywhere in real time."[11] While this section reviewed the possibilities for future biological warfare to come to this troubling conclusion, the next section will look at what China and North Korea are known to have in terms of biological warfare capability.

Ⅲ. Chinese and North Korean Biological Warfare Capabilities

China and North Korea acceded to the Biological Weapons Convention (BWC) in 1984 and 1987, respectively.[12] In Article I of the BWC, parties to the treaty commit to never "develop, produce, stockpile or otherwise acquire or retain: (a) microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes; (b) weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict."[13] Article II commits parties to "destroy, or to divert to peaceful purposes… all agents, toxins, weapons, equipment and means of delivery specified in Article I" within nine months of access to the treaty.[14] The BWC

11) Biberman (2021), p. 16.

12) Arms Control Association, "Biological Weapons Convention Signatories and States-Parties," https://www.armscontrol.org/factsheets/bwcsig (Accessed May 3, 2022).

13) United Nations Office for Disarmament Affairs, "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction," https://treaties.unoda.org/t/bwc (Accessed May 3, 2022).

14) United Nations Office for Disarmament Affairs.

allows parties to conduct biological research and development for defensive and peaceful purposes.

Despite their status as parties to the BWC, the US government has raised suspicions that China and North Korea are not in full compliance with their commitments under the treaty. The US Department of State's 2021 Adherence to and Compliance With Arms Control, Nonproliferation, and Disarmament Agreements and Commitments report listed China, Iran, North Korea, and Russia as states possibly not in compliance with the BWC. The report assesses that China and North Korea may not be in compliance with their Article I and Article II obligations. This section will summarize the assessments made by the US government and other open source reporting available on Chinese and North Korean biological warfare capabilities.

1. China's Biological Warfare Capability

Regarding China, the US Department of State's 2021 report cites two concerns. First, the report assesses that toxin research and development at Chinese military medical institutions has dual-use applications, including as potential biological weapons. Second, the report states that China possessed an offensive biological weapons program from the early 1950s to at least the 1980s, but there is insufficient information available to determine if that program was abandoned in accordance with Article II of the BWC. The report assesses that North Korea has had an offensive biological weapons program since the 1960s, which puts Pyongyang in violation of Article I and Article II of the BWC.[15)]

15) US Department of State, "2021 Adherence to and Compliance With Arms Control, Nonproliferation, and Disarmament Agreements and Commitments," https://www.

The unclassified version of the report provides little details on what particular biological warfare capabilities either China or North Korea may possess or are developing. Before acceding to the BWC, the report claims China probably weaponized ricin, botulinum toxins, and the causative agents of anthrax, cholera, plague, and tularemia, and the research with dual-use applications being conducted at military medical institutions is characterized as "identifying, testing and characterizing diverse families of potent toxins."[16] The report provides fewer details on North Korea. It says Pyongyang has developed biological weapons agents and "probably can produce sufficient quantities of biological agents for military purposes."[17] China and North Korea have officially denied having offensive biological warfare programs, and given the secretive and dual-use nature of biological research and development, there is little other information available in the open source literature that describes either country's potential offensive biological warfare capability.

The US Department of Defense (DOD) publishes an unclassified report on China's military annually, and recent reports imply only that China has a latent biological warfare capability and intent. In 2019, the DOD report stated that China's "biotechnology infrastructure is sufficient to produce some biological agents or toxins on a large scale" and that China probably has the capability to weaponize and deliver biological agents.[18] The 2020 report only states China's

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state.gov/2021-adherence-to-and-compliance-with-arms-control-nonproliferation-and-disarmament-agreements-and-commitments/ (Accessed May 3, 2022).

16) US Department of State (2021).

17) US Department of State (2021).

18) Defense Intelligence Agency, "China Military Power 2019: Modernizing a Force to Fight and Win," https://www.dia.mil/Portals/110/Images/News/Military_Powers_Publications/China_Military_Power_FINAL_5MB_20190103.pdf (Accessed May 3, 2022), pp. 39-40.

intention to rapidly develop strategic science and technology sectors, including biotechnology, and gain competitive advantages through research on "majorly influential disruptive technologies."[19] The 2021 report adds that available "information on studies conducted at PRC military medical institutions has included information that discusses identifying, testing, and characterizing diverse families of potent toxins with dual-use applications."[20] The US Air Force also reportedly simulated a future war that began with a Chinese biological weapon attack, which indicates that DOD believes China is or will be capable of conducting biological warfare.[21]

Other sources indicate growing interest among China's military leadership in the application of biotechnology to future warfare. Elsa Kania wrote that writings and statements by military and defense officials in China increasingly view biology as a new realm in warfare that could change the character of future conflict. Much of this writing seems to be concerned with applying biotechnology to help People's Liberation Army (PLA) personnel and weapon systems achieve and maintain superiority in conflict, not necessarily with developing biological weapons for attacking adversary militaries or populations. But Kania also notes that some Chinese researchers have expressed interest in a new concept of biological deterrence that is enabled by biotechnology, particularly ethnic-specific

19) Office of the Secretary of Defense, "Military and Security Developments Involving the People's Republic of China 2020," https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF (Accessed May 3, 2022), p. 145.

20) Office of the Secretary of Defense, "Military and Security Developments Involving the People's Republic of China 2021," https://media.defense.gov/2021/Nov/03/2002885874/-1/-1/0/2021-CMPR-FINAL.PDF (Accessed May 24, 2022), p. 95.

21) James Kitfield, "'We're going to lose fast': U.S. Air Force held a war game that started with a Chinese biological attack," *Yahoo! News*, March 11, 2021, https://www.yahoo.com/now/were-going-to-lose-fast-us-air-force-held-a-war-game-that-started-with-a-chinese-biological-attack-170003936.html (Accessed May 24, 2022).

genetic weapons. One Chinese researcher wrote that due to "'the high lethality, low cost and diverse means of genetic attack, it will have a profound impact on future wars' in ways that could increase the destructiveness of warfare'…As a result, the outcome of war may no longer determined by the destruction of combat, but rather there could be further blurring of the boundaries between peace and warfare."[22)]

Kania then detailed Chinese researchers' advancements in genetic editing technology, such as CRISPR, which has potential dual-use applications for peaceful and military purposes. Combined with China's strategy of military-civil fusion that, in part, seeks to apply innovations from the private sector to the military, this is an example of the US Department of State's concerns with potential dual-use biological research in China and the difficulty with verifying the peaceful or military nature of the research.

Again, this is not proof of an active offensive biological warfare program in China but latent capability that could be militarized if Chinese leadership decides to do so. Miles Pomper and Richard Pilch emphasized this point by writing that "there is no indication in the open-source domain – including statements from Chinese leadership, state media reports, government budgetary allocations, and scientific publications or lack thereof – that China maintains an offensive BW program, despite access to the necessary building blocks."[23)] The openly available literature and reporting seems to agree that China has the potential capability to develop biological weapons, perhaps more potential than most other countries, but Beijing's intentions

22) Elsa B. Kania, "Minds at War: China's Pursuit of Military Advantage through Cognitive Science and Biotechnology," *Prism*, Vol. 8, No. 3 (2020), pp. 91-92.

23) Miles Pomper and Richard Pilch, "Asia-Pacific Perspective on Biological Weapons and Nuclear Deterrence in the Pandemic Era," *Journal for Peace and Nuclear Disarmament*, Vol. 4, No. S1 (2021), p. 352.

behind its biotechnology development and any plans for potential use of biological weapons are harder to discern.

2. North Korea's Biological Warfare Capability

Regarding North Korea, US government and other open source information provides an even less clear picture of North Korea's current or potential future capabilities. By the US Department of State's own admission, insight into North Korea's biological warfare capabilities is fragmented, but Pyongyang may view biological weapons as able to counter US and South Korea conventional military superiority.[24] The US government has assessed since at least the late 1980s that North Korea operates an offensive biological warfare program, and from at least the late 1990s, various US government agencies have assessed that North Korea could produce biological warfare agents, such as anthrax, cholera, and plague, and weaponize such agents for delivery with conventional munitions.[25]

South Korean government reporting on North Korea's suspected offensive biological warfare program has offered more details in the past, but more recent reports offer less details. The 2018 Defense White Paper released by South Korea's Ministry of National Defense states only that there are indications that North Korea can produce various types of biological agents, such as anthrax, smallpox, and pests.[26]

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24) US Department of State (2021).

25) Elisa Harris, "North Korea and Biological Weapons: Assessing the Evidence," https://www.stimson.org/2020/north-korea-and-biological-weapons-assessing-the-evidence/ (Accessed May 3, 2022).

26) Republic of Korea Ministry of National Defense, "2018 Defense White Paper," https://www.mnd.go.kr/mnd_book/DefenseWhitePaper/2018/final(eng)/index.html (Accessed May 3, 2022), p. 34.

Bruce Bennett referred to this South Korean government reporting, Russian intelligence reports from the 1990s, and North Korean defector reporting from the 2000s as evidence of North Korean biological weapons development in testimony to the US House of Representatives in 2013.[27] Bennett listed over 20 biological agents that Pyongyang could be developing, particularly citing anthrax, cholera, plague, and smallpox.[28] Bennett added that North Korean special forces could be used to deliver biological agents, and he believed that those agents would likely be delivered as an aerosol that would be dispersed and carried by the wind.[29]

More recent press reporting has noted that some North Korean defectors have been found to have anthrax[30] and smallpox[31] antibodies in their systems. This indicates that those individuals were either vaccinated against those pathogens or were exposed some way, such as through human experimentation. Neither anthrax nor smallpox are known to be major health concerns in North Korea, which leads some to speculate on how and why some defectors have those antibodies. It could be a result of a defensive biological program, or there could be more malicious intent behind it.

Combined with US intelligence reporting, this led some analysts to make strong statements on North Korea's biological warfare capabilities and intentions. Anthony Cordesman said that Pyongyang

27) Bruce W. Bennett. *The Challenge of North Korean Biological Weapons* (Santa Monica, CA: RAND Corporation, 2013), pp. 2-3.

28) Bennett (2013), pp. 4-5.

29) Bennett (2013), pp. 4, 6.

30) John M. Donnelly, "The Other North Korean Threat: Chemical and Biological Weapons," *Roll Call,* June 12, 2018, https://rollcall.com/2018/06/12/the-other-north-korean-threat-chemical-and-biological-weapons/ (Accessed May 24, 2022).

31) Emily Baumgaertner and William J. Broad, "North Korea's Less-Known Military Threat: Biological Weapons," *The New York Times,* January 15, 2019, https://www.nytimes.com/2019/01/15/science/north-korea-biological-weapons.html (Accessed May 24, 2022).

"has made major strides" in the technical areas needed for producing biological weapons, and Joseph S. Bermudez, Jr. added that North Korean scientists likely have experimented with gene editing.[32] Former DOD official Andrew Weber declared that North Korea's biological warfare program is "advanced, underestimated, and highly lethal," and he said that Pyongyang is "far more likely to use biological weapons than nuclear ones."[33]

Similar to reporting on China's biological warfare capabilities, other analysts urge caution in assessing North Korea's biological warfare program. In a review of public reporting from US and South Korean government agencies, Elisa Harris concluded that North Korea may have once had or still has an offensive biological warfare program, but its current status, scope, and capability are largely uncertain. She finished her analysis by writing, "[n]othing in the official public record to date indicates that North Korea has an advanced BW [biological weapons] program, notwithstanding media reports to the contrary."[34] North Korea also does not have as robust of a civilian biotechnology sector as China, meaning that North Korea's latent biological warfare capability also is more limited.

John Parachini wrote that even if North Korea has samples of smallpox, anthrax, or other biological agents, "weaponizing them is a formidable scientific and engineering challenge."[35] Moreover, Parachini assessed that it would be unlikely that North Korea could develop advanced biological warfare capabilities while also

32) Baumgaertner and Broad (2019).

33) Baumgaertner and Broad (2019).

34) Harris (2020).

35) John Parachini, "Why We Should be Skeptical About Recent Reports on North Korea's Biological Weapons Program," *38 North*, January 30, 2019, https://www.38north.org/2019/01/jparachini013019/ (Accessed May 24, 2022).

developing nuclear weapons and long-range ballistic missiles. Parachini argued that the lack of clear information on North Korea's biological warfare capabilities and intentions presents a conundrum for the United States and partners. He wrote that "it is important not to let attention to North Korea's nuclear weapons obscure the potential dangers CBW capabilities may pose, it is equally important not to overstate those dangers."[36] Being unprepared for a possible North Korean biological warfare threat could lead to disaster, but reacting too hastily may lead to mistaken military action and unintended conflict escalation.

While there is much uncertainty regarding Chinese and North Korean biological warfare capabilities, the United States and partners in the Indo-Pacific region seem concerned enough to feel the need to respond and counter potential biological threats coming from these two countries. Deterring adversaries from acting is preferrable to attempting to defend and respond to attacks, and scholars and practitioners should consider how deterrence concepts could be applied to these potential biological threats. Before discussing how the United States and partners in the Indo-Pacific can employ deterrence in countering potential biological warfare threats from China and North Korea, the next two sections will give an overview of deterrence theory generally and then review existing literature on deterring biological warfare.

36) John Parachini, "North Korea's CBW Program: How to Contend with Imperfectly Understood Capabilities," *Prism*, Vol. 7, No. 3 (2018), p. 92.

Ⅳ. Deterrence Theory and Deterring Biological Warfare

The most common conception of deterrence is termed deterrence by punishment and can be described as dissuading an adversary from taking an action by threatening unacceptable violence in retaliation. Deterrence by punishment was the most dominant conception of deterrence theory that was developed and applied to prevent nuclear war between the United States and the Soviet Union during the Cold War; however, deterrence can be applied more broadly. In addition to deterrence by punishment, Glenn Snyder proposed that deterrence can be achieved by what he called deterrence by denial.

Snyder viewed deterrence as "discouraging the enemy from taking military action by posing for him a prospect of cost and risk outweighing prospective gain."[37] Deterrence by punishment works by increasing the adversary's costs of acting, and deterrence by denial works by decreasing the adversary's gains from acting. Jeffrey Knopf wrote that "denial strategies aim to dissuade a potential attacker by convincing them that the effort will not succeed and they will be denied the benefits they hope to obtain."[38] Writing in terms of cost-benefit analysis and combining deterrence by punishment and deterrence by denial, Joseph Nye defined deterrence as "dissuading someone from doing something by making them believe that the costs to them will exceed their expected benefit."[39]

Nye also added two ways to deter adversary action: deterrence by

37) Glenn Snyder, *Deterrence and Defense: Toward a Theory of National Security* (Princeton, NJ: Princeton University Press, 1961), p. 3.

38) Jeffrey Knopf, "The Fourth Wave in Deterrence Research," *Contemporary Security Policy*, Vol. 31, No. 1 (2010), p. 10.

39) Joseph S. Nye, "Deterrence and Dissuasion in Cyberspace," *International Security*, Vol. 41, No. 3 (2016/17), p. 45.

entanglement and deterrence by norms. Nye defined entanglement as "the existence of various interdependences that make a successful attack simultaneously impose serious costs on the attacker as well as the victim."[40] These interdependences can lead a state to believe that there is more benefit to maintaining the status quo than to upsetting the status quo by attacking, even if the attack is not defended against or there is no fear of retaliation.[41] Nye wrote that deterrence by norms works "by imposing reputational costs that can damage an actor's soft power beyond the value gained from a given attack. Like entanglement, norms can impose costs on an attacker even if the attack is not denied by defense and there is no retaliation."[42]

Both deterrence by entanglement and deterrence by norms could be considered forms of deterrence by punishment, since they both work by increasing the adversary's cost of acting. Yet, these two methods of deterring are important distinctions because they demonstrate that nonmilitary tools can be used to punish and increase the adversary's cost of acting. Deterrence by denial also can work by using nonmilitary tools. This is a particularly important point to keep in mind when considering how to deter nonnuclear threats, such as biological warfare.

Deterrence theory and the four different deterrence methods discussed here can apply to all threats, but there are challenges to applying each of these four deterrence methods to biological threats. The optimal biological warfare deterrence strategy likely will require a combination of these methods, and creative deterrence thinking will be required to apply deterrence theory to preventing biological warfare.

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40) Nye (2016/17), p. 58.
41) Nye (2016/17), pp. 58-61.
42) Nye (2016/17), p. 60.

1. Deterrence and Biological Warfare

Ever since the advent of nuclear weapons in 1945, deterrence has been prevalent in US strategic thinking. Bernard Brodie set the tone for this thinking by writing in 1946 that the United States should commit itself to a strategy of deterrence for the nuclear age. Brodie famously stated, "[t]hus far the chief purpose of our military establishment has been to win wars. From now on its chief purpose must be to avert them. It can have almost no other useful purpose."[43]

Even after the end of the Cold War, deterrence has remained ingrained in the thinking of US strategists. Deterrence concepts have been applied to a wide range of threats facing the United States and allies, and deterrence appears in many US strategic documents and statements. How to deter biological warfare is one of the nonnuclear threats that scholars and practitioners have attempted to address. The literature on deterrence and biological warfare covers both deterring adversarial use of biological weapons and using biological weapons to deter adversaries. This section will focus on reviewing scholarly literature on the former.

First, this review will focus on using deterrence by punishment against biological weapons. The United States ended its offensive biological weapons program in 1969 and ratified the BWC in 1975, and all US allies and partners in the Indo-Pacific relevant to this paper (Australia, India, Japan, and South Korea) ratified or acceded to the BWC by 1987.[44] This means that the United States and allies have given up the right to respond in kind to biological weapons or effectively use biological weapons as a deterrent. Robert Joseph and

43) Bernard Brodie, *The Absolute Weapon: Atomic Power and World Order* (New Haven, CT: Yale University, 1946), p. 62.

44) Arms Control Association (2021).

John Reichart wrote that the United States "is limited to conventional and nuclear response options and must think about the interrelationship of these two capabilities so that they work together to strengthen deterrence."[45]

On that interrelationship, Joseph and Reichart wrote that "nuclear weapons are likely to play a central role in deterring…large-scale… biological weapons use…against the United States and our coalition partners, and especially against the US homeland."[46] They argue that nuclear threats may be most credible in deterring biological warfare against urban population centers, and even at lower levels of conflict, the United States may use nuclear threats as a "disproportionate response" to biological warfare against US forces or coalition partners in order to enhance deterrence. Thus, they argue that US nuclear weapons could enforce a norm against any use of biological weapons, from small-scale tactical use to large-scale strategic use, but also acknowledge that nuclear threats against lower levels of conflict may not be credible.

Victor Utgoff listed other arguments for using nuclear weapons to retaliate against biological weapons attacks. First, public rage and a strong desire for vengeance could pressure US leaders to employ a nuclear response. Second, military leaders could push for nuclear retaliation if they felt that biological weapons effects had caused a military imbalance or that only nuclear weapons could practically destroy an adversary's biological warfare capability. Third, an ally that was attacked with biological weapons could call for the United States to respond with nuclear weapons. Finally, the international

45) Robert G. Joseph and John F. Reichart, *Deterrence and Defense in a Nuclear, Biological, and Chemical Environment* (Washington, D.C.: National Defense University Press, 1999), p. 18.

46) Joseph and Reichart (1999), p. 19.

legal principle of belligerent reprisal could be used to justify using nuclear weapons to respond to a biological attack.[47]

The 2018 Nuclear Posture Review (NPR) also alludes to possibly using the US nuclear arsenal to deter biological warfare. The NPR describes the need for the US nuclear posture to be able to hedge against future uncertainties, and the "proliferation of highly-lethal biological weapons" is given as an example of a technological uncertainty that needs to be hedged against.[48] The NPR also lists nonnuclear strategic threats as "chemical, biological, cyber, and large-scale conventional aggression,"[49] and declaratory policy in the NPR on nuclear use gives a role for US nuclear weapons to deter nonnuclear strategic threats.

> The United States would only consider the employment of nuclear weapons in extreme circumstances to defend the vital interests of the United States, its allies, and partners. Extreme circumstances could include significant non-nuclear strategic attacks. Significant non-nuclear strategic attacks include, but are not limited to, attacks on the US, allied, or partner civilian population or infrastructure, and attacks on US or allied nuclear forces, their command and control, or warning and attack assessment capabilities.[50]

Proponents of this ambiguous policy claim that "because the United States has foresworn the option of retaliating in kind, nuclear

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47) Victor A. Utgoff, *Occasional Paper No. 36: Nuclear Weapons and the Deterrence of Biological and Chemical Warfare* (Washington, DC: The Henry L. Stimson Center, 1997), pp. 7-9.

48) US Department of Defense, "2018 Nuclear Posture Review," https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF (Accessed May 3, 2022), p. 14.

49) US Department of Defense (2018), p. 38.

50) US Department of Defense (2018), p. 21.

weapons threats are the only strong deterrent preventing so-called rogue nations from using their…biological arsenals."[51] Scott Sagan countered that this "calculated ambiguity" doctrine creates a "commitment trap" that increases the likelihood that the United States will use nuclear weapons in future military conflicts.[52] Sagan made the following argument of how this commitment trap increases the chance of a US nuclear retaliation.

> …threats to use nuclear weapons in response to a chemical or biological attack are credible, because if CW [chemical weapons] or BW [biological weapons] are used despite such threats, the US president would feel compelled to retaliate with nuclear weapons to maintain his or her international and domestic reputation for honoring commitments. The increase in the probability of US nuclear retaliation is both the deterrent benefit of current doctrine and its gravest potential cost.[53]

Sagan made this argument after analyzing US statements intended to deter Iraq from using chemical weapons during Desert Shield and Desert Storm in the early 1990s. Despite strong statements of severe punishments if Iraq used chemical weapons, later revelations showed that then US president George HW Bush did not intend to use nuclear weapons in case of Iraqi chemical weapon use. Sagan wrote that this historical record only increases the commitment trap's pressure on future US presidents to use nuclear weapons in response to biological or chemical attack on US or allied interests.

While not specific to deterring with US nuclear weapons, a related

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51) Scott D. Sagan, "The Commitment Trap: Why the United States Should Not Use Nuclear Threats to Deter Biological and Chemical Weapons Attacks," *International Security*, Vol. 24, No. 4 (2000), p. 85.

52) Sagan (2000), p. 86.

53) Sagan (2000), p. 87.

critique of deterrence by punishment using military means came from Knopf and coauthors Wyn Bowen and Matthew Moran after analyzing the US response to Syrian use of chemical weapons from 2012 to 2013. They argued that the United States and partners rely too much on a "resolve plus bombs" formula to deter adversaries. This formula emphasizes "the need to communicate the resolve to use force if threats went unheeded and assumed that if force was used it would involve airpower."[54] They made three main critiques of this formula. First, this views credibility as all-or-nothing, instead of a matter of degree. Second, this formula measures costs only in terms of physical destruction and ignores the domestic context that influences the adversary's calculations. Third, regimes resorting to the use of chemical weapons may already feel threatened and vulnerable to collapse, which makes assuring the adversary that punishment will not come if the adversary complies with the deterrent demand particularly important.[55]

Other countries, namely Israel, also have considered the deterrent effect that their nuclear arsenals have on biological warfare. Avner Cohen wrote that after the Gulf War in the early 1990s, "many Israelis believe that the opaque nuclear deterrent was effective in deterring Saddam's use of non-conventional weapons."[56] However, Cohen responds that there are other explanations for why Iraq did not use biological weapons against Israel and that Israel's nuclear weapons would only be used if national survival is at risk, which did not appear to be the case during the Gulf War.[57] Israel's ambiguous nuclear

54) Wyn Bowen, Jeffrey W. Knopf, and Matthew Moran, "The Obama Administration and Syrian Chemical Weapons: Deterrence, Compellence, and the Limits of the 'Resolve plus Bombs' Formula," *Security Studies*, Vol. 29, No. 5 (2020), pp. 799-800.

55) Bowen, Knopf, and Moran (2020), p. 800.

56) Avner Cohen, "Israel and Chemical/Biological Weapons: History, Deterrence, and Arms Control," *The Nonproliferation Review*, Vol. 8, No. 3 (2001), p. 43.

capability obviously is much different than the US nuclear posture, but strategists and scholars in both countries question the value in using nuclear weapons to deter biological warfare.

These critiques show why many scholars turn to other methods to deter biological warfare. The only other form of punishment mentioned often in the literature is to use the norm against biological weapons use codified in the BWC. Many authors have called for strengthening the BWC, particularly for better verification of the treaty's provisions. These authors point to the ability of the BWC to deter both proliferation of biological weapons[58] and use of biological weapons by the great powers.[59] As Nye described, using a multilateral treaty to deter by norms would impose reputational costs on any actor that uses biological weapons.

The more prominent theme in the literature is to use deterrence by denial against biological warfare. Utgoff wrote that defensive measures against biological warfare could reduce the potential damage from such attacks to levels comparable to conventional warfare, thus denying the strategic gain of using biological weapons.[60] Frank Lebeda also wrote of the ability of medical and nonmedical countermeasures to produce a deterrence by denial effect. Lebeda argued that protecting populations from biological warfare could cause an adversary to "dismiss the use of the available threat agent or to use extra resources (time, money, manpower) to weaponize a different one," and by "protecting individuals against the most lethal and readily deployable threat agents, the remaining available

57) Cohen (2001), p. 44.

58) Lynn M. Hansen, "Biological and Toxin Weapons: Arms Control, Stability, and Western Security," *Politics and the Life Sciences*, Vol. 9, No. 1 (1990), p. 51.

59) Utgoff (1997), p. 3.

60) Utgoff (1997), p. 3.

choices may be less toxic, less stable in the environment, and more costly to produce."[61]

While biotechnology has changed significantly since Utgoff and Lebeda published those articles in 1997, scholars and practitioners continue to emphasize deterrence by denial against biological warfare. In 2014, Margaret Kosal wrote that a "strong public health infrastructure is likely to be the key in reducing vulnerability" to biological warfare and would deter an adversary from considering biological weapons attacks.[62] Writing in response to the COVID-19 pandemic, Andrea Howard argued for bolstering deterrence by denial capability by "increasing interagency cooperation, wargaming the resulting plans, and compiling the materials required for their execution."[63] Christine Parthemore and Andy Weber advocated for improving early warning systems, vaccine and therapeutic development, development and deployment of advanced personal protective equipment, and cooperation with allies and partners.[64]

However, the potential limitations of using deterrence by denial also have been pointed out. Lebeda wrote that an adversary "must be convinced that defensive deterrence against biological…threats exists and is effective."[65] This reflects Snyder's earlier writing defining deterrence by denial, where he argued that the defender's

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61) Frank J. Lebeda, "Deterrence of Biological and Chemical Warfare: A Review of Policy Options," *Military Medicine*, Vol. 162, No. 3 (1997), p. 158.

62) Margaret E. Kosal, "A New Role for Public Health in Bioterrorism Deterrence," *Frontiers in Public Health*, Vol. 2 (2014), p. 2.

63) Andrea Howard, "The Pandemic and America's Response to Future Bioweapons," *War On the Rocks*, May 1, 2020, https://warontherocks.com/2020/05/the-pandemic-and-americas-response-to-future-bioweapons/ (Accessed May 3, 2022).

64) Christine Parthemore and Andy Weber, "A Deterrence by Denial Strategy for Addressing Biological Weapons," *War On the Rocks*, September 23, 2021, https://warontherocks.com/2021/09/a-deterrence-by-denial-strategy-for-addressing-biological-weapons/ (Accessed May 3, 2022).

65) Lebeda (1997), p. 158.

capability is the key factor for determining the credibility of a deterrence by denial strategy. In additional to technical capability, Parthemore and Weber added that "a strategy of deterrence by denial will only be credible in the right political environment – one in which Americans and their leaders are united in confronting biological threats."[66] The US public's response to and handling of the COVID-19 pandemic could make an adversary question the credibility of US biological defenses, which would reduce their deterrence by denial effect.

Communicating the effectiveness of any deterrence strategy against biological warfare will be inherently challenged by a "demonstration effect." The current and future biological threats described earlier are largely unproven as deployable, effective weapons. This works for both deterring biological warfare and using biological weapons to deter. While scholars like Biberman argued that genetic weapons do not need to be demonstrated in order to produce a deterrent effect,[67] mere latent capability of no other weapon system, including nuclear weapons, has been proven to produce a deterrent effect.

On the other hand, deterrence by denial against current and future biological threats also has not been demonstrated. Wargaming and exercising defenses against and responses to biological warfare is necessary, but it will be challenging to develop credible defenses against undemonstrated weapon systems. Moreover, demonstrating defenses, including medical countermeasures, may give an adversary information on how to defeat those defenses by adjusting pathogens accordingly.

There is an adage that a country reveals to deter and conceals to attack, but in this case, it is hard for either the defender or the

66) Parthemore and Weber (2021).

67) Biberman (2021), p. 21.

adversary to reveal. Unlike nuclear weapons, the effects of modern weaponized biological agents employed on various real-world targets, such as cities or military assets, is largely undemonstrated. Similarly, defenses against modern weaponized biological agents are largely undemonstrated. Responses to natural biological threats, like the COVID-19 pandemic, provide some information on deterrence by denial capabilities, but an adversary would have to translate this to how those defenses would perform against candidate biological weapons. Whether an adversary would end up being deterred by concluding that the attack would not produce the desired results is uncertain, and uncertainty in those calculations could lead to deterrence failure.

V. Applying Deterrence to Biological Warfare Threats in the Indo-Pacific

Developing strategies to deter China or North Korea from conducting biological warfare against the United States or allies and partners in the Indo-Pacific will be challenging due to the uncertainties and novelties related to modern biological agents described in previous sections. The massively and reliably destructive nature of nuclear weapons make developing deterrence strategies against them arguably more straightforward. The United States aims to deter any attack that produces strategic effect on US or allied territory, and any nuclear use is viewed as strategic in nature. Thus, there is a clear goal of deterring any use of nuclear weapons against US or allied territory. The implementation of a strategy to achieve this deterrence goal can be more complicated, such as whether US conventional

superiority can deter nuclear attack or if only US nuclear weapons can do this.

While modern biological weapons may potentially be able to cause as many casualties as nuclear weapons, biological weapons share more attributes with other emerging technological threats, such as cyber weapons. Biberman describes some of these similarities that present challenges to deterrence strategists.[68)]

- Compared to nuclear weapons, cyber and biological weapons, including genetic weapons, can be produced relatively easily by small teams using common biotechnology equipment in small facilities.
- Biological warfare programs are hard to detect due to their small footprint, lack of unique signatures, and use of inherently dual-use, widely available technologies.
- Like cyber weapons, biological weapons can be modified for varying levels of lethality and destructiveness and can be effective against human and non-human targets, even potentially being able to precisely target certain individuals, groups, animals, or plants.
- Biological warfare and cyber warfare can be conducted covertly and can be difficult to attribute.

With these and other considerations discussed above in mind, the analysis will now apply Nye's four methods of deterrence, punishment, denial, entanglement, and norms, to deterring China or North Korea from conducting biological warfare.

68) Biberman (2021), pp. 18-19.

1. Deterrence by Punishment

Ideally, the United States and partners in the Indo-Pacific will be able to deter any and all use of biological weapons by China or North Korea, but deterrence by punishment alone may not be able to achieve such a lofty goal. Deterring by punishment with military means likely will be more effective at higher levels of biological warfare, and nuclear weapons may only be effective at deterring the highest levels of biological warfare.

Section V discussed arguments for and against using nuclear weapons to deter biological warfare against the United States. Thus far, the United States does not rule out using nuclear weapons to deter biological warfare, and it is possible that allies under the US nuclear umbrella see that there is utility in this policy, too. However, the credibility of nuclear threats, particularly at lower levels of biological warfare, can be questioned, and the history of the nuclear age is filled with examples of nuclear-armed states failing to deter attacks or conflict, although nuclear weapons arguably deterred strategic level conflict between the major powers. This means that the United States and partners must look at other types of punishments and coordinate when and where particular punishments would be threatened to deter biological warfare.

Threatening the use of proportionate kinetic attack against an adversary who conducts a biological weapons attack on the United States or allied populations could be one way to phrase a deterrence by punishment strategy, and kinetic attack could be interpreted to mean either the use of conventional or nuclear weapons. This also could help to convey to China and North Korea that any use of biological weapons, regardless of the actual effects, is unacceptable and will be punished.

However, in addition to typical uncertainties in extended deterrence situations, characteristics of biological weapons complicate deterrence by punishment. Depending on the speed at which the biological agent acts, when would the punishment be meted out? If an agent takes weeks or months to produce mass casualties, will a kinetic response after such a long time from the initial delivery of the biological weapon make a difference to the adversary? Also, can the origin of the attack be conclusively attributed, or do difficulties in biological forensics and plausible deniability on state-sponsorship of the attack make attribution too difficult?

Finally, if the proportionality, timeline, and attribution factors can all be effectively worked out, then what targets in China or North Korea can be held at risk that would reliably deter Beijing or Pyongyang from deciding to conduct biological warfare? Biological weapons facilities may be too small, hardened, or numerous to make threatening to attack them deter the adversary from going forward with the planned attack. Moreover, the adversary may be facing domestic factors that make the expected costs of inaction or the benefits of action seem higher than whatever costs can be imposed by retaliatory kinetic attacks.

Using other instruments of national power, such as diplomacy or economics, to punish will be discussed under deterrence by norms.

2. Deterrence by Denial

All of the difficult questions, particularly those related to the credibility of threats of punishment, related to deterrence by punishment push many scholars and practitioners to advocate for deterrence by denial strategies. In addition, deterrence by denial strategies involve building up solid defenses and good public health

measures that can be useful in responding to natural pathogens or other forms of attack. Applying modern biotechnology to develop medical countermeasures, improving interagency coordination and capabilities through exercises and wargames, and preparing military personnel or the general public to be able to overcome biological warfare are all beneficial to peace time measures to improve resiliency to any type of biological threat.

However, as discussed above, implementing deterrence by denial will be hampered by the demonstration problem. Neither China nor North Korea has a truly demonstrated biological warfare capability, just suspicions of offensive biological warfare programs and projections from dual-use technologies and facilities. For example, it will be hard for the United States and partners in the Indo-Pacific to know what medical countermeasures to prepare for undemonstrated biological warfare capabilities, and then demonstrating effective deterrence by denial capabilities will be equally challenging. Even with strong deterrence by denial capabilities, it may take a few thwarted attempts before an adversary internalizes that a particular threat vector is ineffective, but advanced biotechnology may allow the adversary to quickly develop and deploy new biological agents.

Deterrence by denial alone then could be repeatedly tested and strained to keep up with a determined adversary. A layered approach that focuses more on deterrence by denial at lower levels of biological warfare and more on deterrence by punishment at higher levels of biological warfare may be more robust. At low levels, the adversary may be deterred by thinking that such attacks could be thwarted by denial capabilities and also risk punishing retaliation, and at higher levels, the adversary knows they are risking severe punishing responses.

To make deterrence by denial effective in extended deterrence

situations in the Indo-Pacific, the United States should work with allies and partners on common biodefense and public health standards and capacity building. Relatively weaker denial capabilities in one ally could lead to deterrence failure and resultant casualties, alliance strain, and potential follow-on attacks. The Quad alignment of Australia, India, Japan, and the United States emphasized the need to cooperate on ending the COVID-19 pandemic and improving health security, and such collective action needs to address biological threats beyond the current pandemic.[69)]

While much of the cooperation on COVID-19 has focused on technical aspects, such as vaccine development and distribution, the pandemic has highlighted the importance of the general public's actions in a country's public health system. China or North Korea could work to exploit the social tensions and weaknesses exposed by the pandemic in planning a biological weapons attack. The United States and Indo-Pacific partners, individually and collectively, must reflect on how to improve social resiliency to biological threats in order to bolster deterrence by denial.

3. Deterrence by Entanglement

Nye wrote of deterrence by entanglement in the context of cyber deterrence and argued that countries that are more reliant on cyberspace will be deterred due to the potential blowback that could come from using cyberspace for offensive purposes. The biotechnology sector may not be as connected and entangled as cyberspace, but one could think of industrial relationships and supply chains in the

69) White House, "Quad Leaders' Joint Statement: 'The Spirit of the Quad'," https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/12/quad-leaders-joint-statement-the-spirit-of-the-quad/ (Accessed May 3, 2022).

biotechnology sector that cross borders as a form of entanglement. A country could get cut off from vital biological agents, equipment, or know-how as a result of conducting a biological weapons attack.

While not necessarily Nye's definition of entanglement, a related blowback could be a deployed pathogen affecting the attacking country. A novel pathogen spreading back to the attacking country through unintentional release, international travel or commerce, or even the victimized country intentionally sending the pathogen back are all examples of how an attacking country could be victimized by blowback. An engineered pathogen also could unexpectedly mutate beyond its intended form and become a threat to the attacking country's population, too.

Between China and North Korea, China clearly has more to lose if its biotechnology industry is harmed due to a biological weapons attack by the country's military. North Korea also seems willing to endure relative international isolation, as demonstrated by closing its borders during the COVID-19 pandemic, and has even gone so far as to decline offers of vaccines from the international community. Thus, China may be more susceptible to deterrence by entanglement than North Korea.

As Nye notes about deterrence by entanglement, the attacker can get punished this way even if the attack is not denied or responded to with other punishments. The question then must be how much of a deterrent effect this phenomenon produces and whether it is sufficient to replace other deterrence measures. The United States and partners in the Indo-Pacific may not be willing to rely on deterrence by entanglement but certainly would welcome any extra deterrent effect it may produce.

4. Deterrence by Norms

Nye also wrote that deterrence by norms functions similarly to deterrence by entanglement. The BWC codifies the general international norm against the use of biological warfare, and a country who conducts biological warfare in the future could face significant diplomatic and economic sanctions for such actions. As with entanglement, China likely is more susceptible to being deterred by norms than North Korea, but coming to agreement on norms beyond the current BWC with either country may be challenging.

There is a norm against the use of biological warfare, but beyond that, agreeing to norms on acceptable biological research and development, on sharing of such information with other countries, and on transparency of domestic biodefense programs will be difficult to establish. The United States and partners could attempt to lead on such issues by taking measures to increase transparency of their biodefense programs and developing collective standards for bioresearch. However, for deterrence by norms to be effective, China should be involved in norms development. North Korea's participation in norms development also could be welcome, but Pyongyang is less likely to want to participate.

But even just the existing norm against biological warfare could be sufficient to produce a deterrent effect in the minds of Chinese and North Korean leaders. The United States and partners in the Indo-Pacific, along with the rest of the international community, should make it clear that either country will face serious loss of reputation and incur diplomatic and economic sanctions for any use of biological weapons, either domestically or internationally. Again, China may have more to lose in such threats compared to North Korea, but China also may be more capable of withstanding such punishments.

5. Layered Deterrence

The US Cyberspace Solarium Commission recommended taking a layered deterrence approach to bolstering deterrence against threats in cyberspace. The Commission urged using a combination of deterrence by denial and deterrence by punishment (using military and nonmilitary tools) to shape behavior, deny benefits, and impose costs on adversaries in cyberspace.[70] A similar approach may be optimal to deter biological warfare against the US and partners in the Indo-Pacific. Such an approach would have to be well coordinated with partners and tailored against the range of potential biological warfare threats posed by China and North Korea.

Section III summarized the uncertainty regarding the potential biological warfare threats posed by China and North Korea, which challenges formulating deterrence strategies. However, speculation regarding possible Chinese use of biological weapons seems to focus on Beijing's anti-access, area denial (A2/AD) strategy.[71] This strategy is at preventing the United States at being able to intervene militarily against China, such as in a conflict between China and Taiwan. Even limited use of biological weapons against US military forces or bases in the Indo-Pacific could give China the time it would need to conduct an amphibious invasion of Taiwan.

A layered deterrence approach to such a threat could include bolstering deterrence by denial by improving the biological defense capabilities of US and allied forces, which would reduce the A2/AD effect of a biological attack. While improving biological defense

70) Cyberspace Solarium Commission, "Report," https://www.solarium.gov/report (Accessed May 24, 2022).

71) Kitfield (2021).

capabilities, Washington could make clear that any use of biological weapons would prompt a US military response against Chinese interests, along with punishing economic and diplomatic sanctions against China. The current war in Ukraine and related economic sanctions against Russia by the United States and allies shows the potential effects of unified economic and diplomatic sanctions against an adversary. Such a threat may be enough to prevent any Chinese use of biological weapons through deterrence by entanglement and by norms.

Speculation on possible North Korean use of biological warfare is broader. Bennett argued that Pyongyang "could use biological agents in isolation, perhaps as an escalated provocation in which it seeks to infect a limited number of people, or it could use biological agents as the leading edge of an invasion of the ROK, hoping for thousands or even more infections to weak the ROK's defense and will to fight."[72] Other analysts propose that North Korea could use biological agents covertly to cause societal panic in South Korea or Japan and disrupt US and allied military operations.[73] Again, improving US and allied biological defense readiness would bolster deterrence by denial against the range of threats proposed here, but a layered deterrence approach against North Korea would be limited by Pyongyang's relative isolation and indifference to norms. Economic sanctions could be employed by the United States and allies, but deterrence by entanglement or by norms likely would not be very effective. In this case, military tools to layer deterrence by punishment with deterrence by denial may become relatively more important.

72) Bennett (2013), p. 4.

73) Donnelly (2018).

VI. Conclusion and Recommendations

Recent advancements in biotechnology and the COVID-19 pandemic have put more focus on thinking of how to prepare for and respond to future biological threats, including potential threats from state actors like China and North Korea. US strategic thinkers often turn to applying deterrence theory to new threats, and deterrence certainly can play a role in preventing biological warfare. Yet, any one model of deterrence, be it by punishment, denial, norms, or entanglement, likely cannot effectively prevent the range of threats biological agents could pose in the future, and combinations of deterrence methods likely will present a more robust deterrence posture against biological warfare. In addition, the United States and partners in the Indo-Pacific must view biological warfare as a common threat and work on coming to agreement on common deterrence strategies.

To better understand how to apply deterrence to prevent biological warfare, a few avenues for future research are recommended. First, how effective is deterrence by denial against biological warfare? In the literature, deterrence by denial is often mentioned for preventing nonnuclear threats, such as those in the conventional, cyberspace, and outer space realms. A more rigorous analysis of the effectiveness of deterrence by denial toward those threats could provide lessons to apply toward deterrence by denial against biological warfare. Second, does a latent biological warfare capability provide some deterrent effect? As discussed in this paper, modern biological warfare capabilities, such as genetic weapons, mostly are undemonstrated in their effects on civilian or military targets, but some scholars argue that the ease of development and production could provide states with a latent deterrent capability. The deterrent effect of latent

nuclear capability has been studied, and this could serve as a starting point for studying the strategic effect a latent biological warfare capability could have. Third, how can the United States and partners in the Indo-Pacific incorporate deterring biological warfare into their existing deterrence strategies? The range of effects that modern biological warfare could produce means this would not be as straightforward as the United States providing its nuclear umbrella to deter nuclear attacks on allies. Some lessons from other areas, such as conventional deterrence, could be drawn and attempted to be applied to deterring biological warfare.

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[국문초록]

인태지역의 생물학전 억제에 대한 연구

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코로나19의 유행으로 미국과 인태지역 미국의 파트너를 포함한 전세계 사회가 인간병원균에 얼마나 취약한 지가 드러났다. 전세계적 유행병의 전멸을 목표로, 호주, 인도, 일본, 미국의 쿼드 회원국들은 코로나19백신 공급에 대한 협력을 강화하고 역내 의료보장을 약속하였다. 또한 바이든 정부는 2021년 3월 발간한 국가안보전략 중간 지침(Interim National Security Strategic Guidance)을 통하여 미래 생물학적 위협을 감소시키기 위한 노력을 강조한 바 있다. 이러한 의료보장 및 안보에 대한 재강조가 이루어지고 있는 가운데, 본 논문은 억제(deterrence) 개념이 미국과 그의 인태 파트너 국가들을 향한 생물학전의 위협을 감소시키는 데에 적용될 수 있는지 살펴본다. 더 나아가, 쿼드와 같은 신생 전략적 연합체가 공동 억제를 통하여 의료보장과 안보를 강화할 수 있는지, 특히 중국과 북한과 같은 국가들로부터 오는 잠재적 생물학전의 위협에 관해 정책 방향을 제시한다. 기존 생물학전 억제에 대한 연구와 현재의 의료보장과 안보에 대한 전략적 고찰을 바탕으로 새로운 위협환경을 예측해 본다.

주제어: 생물학전, 억제, 인태전략, 중국, 북한

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