Asia-Pacific Perspective on Biological Weapons and Nuclear Deterrence in the Pandemic Era

Richard Pilch and Miles Pomper

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About the Author

Richard Pilch is the Director of Chemical and Biological Weapons Nonproliferation Program at the James Martin Center for Nonproliferation Studies (CNS) of the Middlebury Institute of International Studies. A physician by training, Dr. Pilch has focused on national security issues since 9/11 and the "anthrax letter" attacks of 2001. In 2002, he completed a postdoctoral fellowship in chemical and biological weapons nonproliferation at the James Martin Center for Nonproliferation Studies, after which he spent nearly a decade overseas assessing and addressing biological warfare (BW), bioterrorism, and public health emergencies of international concern, including threats posed by the former Soviet Union's (FSU) legacy offensive BW program. He has performed onsite assessments of every known civilian BW facility in Russia, led multiple threat reduction programs on behalf of the US government, served on over thirty technical panels and advisory boards, and authored more than sixty technical publications and White Papers. He co-edited the definitive Encyclopedia of Bioterrorism Defense (Wiley) with his long-time mentor and former CBWNP Director Dr. Ray Zilinskas in 2005. Dr. Pilch received his MD from the University of Miami Miller School of Medicine and MPH from the Johns Hopkins Bloomberg School of Public Health.

Miles Pomper is a Senior Fellow in the Washington DC office of CNS. He has written dozens of articles, papers, and book chapters on nuclear energy, nuclear nonproliferation, nuclear security, and nuclear arms control. Before joining CNS he served as Editor-in-Chief of Arms Control Today, Previously, he was the lead foreign policy reporter for CQ Weekly and Legi-Slate News

Service, where he covered the full range of national security issues before Congress, and a Foreign Service Officer with the US Information Agency. He holds a master's degree in international affairs from Columbia University and a master's degree in journalism from Northwestern University.

Abstract

This article provides an Asia-Pacific perspective on biological weapons and their relevance to nuclear deterrence in the pandemic era. The entire class of biological weapons is banned by international law; however, biological weapons are generally less costly and less technically challenging to develop than nuclear weapons. Conversely, nuclear weapons are openly possessed by multiple countries in the Asia-Pacific despite their corresponding cost and technical complexity. These two types of weapons of mass destruction – biological and nuclear – do not exist in isolation but in a multifactorial geopolitical environment where the threat and control of one impact that of the other. A third factor that holds the potential to influence this dynamic is the increasing likelihood of natural outbreaks and pandemics. This paper explores potential intersections of biological and nuclear weapons in the pandemic context. First, it describes the threat of biological weapons, including history, threat assessment methodology, and specific threats in the Asia-Pacific region. Next, it reviews options for biological weapons control. Finally, it discusses nuclear deterrence and escalation in the context of both natural and deliberate biological events. It concludes with a summary of key points and recommendations for regional security and stability

Keywords
Biological weapons, nuclear deterrence, pandemic era, Asia-Pacific

Introduction

This article provides an Asia-Pacific perspective on biological weapons and their relevance to nuclear deterrence in the pandemic era. The entire class of biological weapons is banned by international law; however, biological weapons are generally less costly and less technically challenging to develop than nuclear weapons. Conversely, nuclear weapons are openly possessed by multiple countries in the Asia-Pacific despite their corresponding cost and technical complexity. These two types of weapons of mass destruction – biological and nuclear

– do not exist in isolation but in a multifactorial geopolitical environment where the threat and control of one impacts that of the other.

A third factor that holds the potential to influence this dynamic is the increasing likelihood of natural outbreaks and pandemics. The Asia-Pacific has been the source of the majority of recent natural outbreaks with global impact, including SARS (2003), H5N1 and H7N9 influenza, and now COVID-19, a trend that is expected to continue as surging population growth and industrial expansion brings humans into closer contact with novel disease agents and their animal reservoirs. Such natural events might be misinterpreted as deliberate biological attacks or used to mask them, with the potential for nuclear escalation in the balance.

In the following sections, we explore potential intersections of biological and nuclear weapons in the pandemic context. First, we describe the threat of biological weapons, including history, threat assessment methodology, and specific threats in the Asia-Pacific region. Next, we review options for biological weapons control. Finally, we discuss nuclear deterrence and escalation in the context of both natural and deliberate biological events. We conclude with a summary of key points and recommendations for regional security and stability.

Threat

a. Historical Context: 20-21st Century Bioweaponry

The biological warfare (BW) programs of Japan, the United States (US), and Soviet Union/Russian Federation provide a representative timeline of State-level BW activities in the 20-21st century.

Japan. The modern era of BW is rooted in the interwar period but arrived with Japanese BW activities during World War II and the coincident Second Sino-Japanese War.[1] While the US, United Kingdom (UK), and Canada had active BW programs during this timeframe, only the Japanese extensively employed biological weapons against civilian and military populations

[1] For a historical overview of BW, see Seth Carus, "The History of Biological Weapons Use: What We Know and What We Don't," Health Security, vol 13, no 4 (2015).

both in captivity and in the field. In all, the Japanese BW program's experimentation on captives and prisoners of war, conservatively estimated, took over 10,000 lives, while field usage led to the death of as many as several hundred thousands of men, women, and children.[2]

Japan participated in Geneva disarmament discussions in the 1920s but did not ratify the 1925 Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare ("Geneva Protocol"), which prohibits the use of chemical and biological weapons of war, until 1970.[3] In fact, as the Geneva discussions were ongoing, Shiro Ishii, a young Army doctor and Lieutenant at the time, recognized that because the world was against the development of biological weapons (and especially if these weapons were to be officially banned), the Japanese would likely benefit from their possession and use in coming wars. Ishii, who possessed both an MD degree and a PhD in microbiology, further noted that BW did not require iron and other raw materials that were difficult for the Japanese to acquire, and would likely be far less costly than conventional weapons despite comparable or even greater lethality. Ishii ascended rapidly to become Japan's primary catalyst for BW research and development.

During the 1930s, Ishii's efforts evolved from a small lab at the Tokyo Army Medical School's Department of Immunology to the so-called "Togo Detachment" (after Ishii had changed his name to Hajime Togo in order to maintain secrecy) to facilities in Manchukuo (Manchuria), a region defined by the borders of China's three north-eastern provinces. In Manchuria, after working temporarily in the town of Harbin and then for an extended period at a relatively advanced research station at the Zhong Ma Prison Camp in Beiyinhe, Ishii settled on Pingfan (a.k.a. Heibo), a cluster of villages approximately 24 kilometers south of Harbin, as the primary site of Japan's BW program.

The program was largely carried out under the auspices of the Epidemic Prevention and Water Supply Unit, also known as Water Purification Detachment 731 or "Unit 731." Unit 731 explored the weapons utility of numerous biological agents, including *Bacillus anthracis*, which causes anthrax; *Yersinia pestis*, which causes plague; and such food- and waterborne pathogens

[2] For an in-depth account of Japanese BW activities, see Guillemin J. Hidden Atrocities. New York: Columbia University Press, 2017.
[3] https://2009-2017.state.gov/t/isn/4784.htm

as *Vibrio cholerae* and *Salmonella* and *Shigella* species. Prisoners were often used in experiments to this end, including direct challenge testing by ingestion and injection as well as incendiary testing at Anta Station, Pingfan's proving ground. Incendiary experiments included the field testing of two different Japanese-made bombs, the *Ha* and the *Uji*. The *Ha* bomb was composed of 1,500 cylindrical projectiles immersed in a half-liter of anthrax solution and walled by thin steel; upon impact, the shrapnel would cause anthrax-infected wounds over a diameter of roughly 40 meters. The *Uji* was an "eggshell" bomb with walls made of porcelain instead of steel, and was used to deliver fleas infected with *Y. pestis* into Chinese civilian populations during the war.

Ishii was transferred from Unit 731 in 1942 and replaced by Lieutenant General Masaji Kitano, previously second in command of the BW program, but was reappointed Chief of Detachment 731 in March 1945, after which he orchestrated the dismantlement and cover-up of the Unit's operations. Soviet forces in the region captured and eventually tried 12 Japanese soldiers for BW-related activities, while the US offered immunity in exchange for information on the program. A Washington sub-committee for the Far East, representing a cross-section of military branches, divisions, departments, and offices, addressed the decision as follows:

> "Data already obtained from Ishii and his colleagues have proven to be of great value in confirming, supplementing, and complementing several phases of US research in BW, and may suggest new fields for future research. This Japanese information is the only known source of data from scientifically controlled experiments showing the direct effect of BW agents on man. In the past it has been necessary to evaluate the effects of BW agents on man from data through animal experimentation. Such evaluation is inconclusive and far less complete than results obtained from certain types of human experimentation… Since it is believed that the USSR possesses only a small portion of this technical information, and since any 'war crimes' trial would completely reveal such data to all nations, it is felt that such publicity must be avoided in interests of defense and security of the US. It is believed also that 'war crimes' prosecution of Ishii and his associates would serve to stop the flow of much additional information of a technical and scientific nature."[4]

Ultimately, the Japanese BW program failed to produce a reliably effective biological weapon despite its actual deployment of BW in the field, demonstrated for example by the 1941 attack of

[4] US War Department. War Crimes Office. Judge Advocate General's Office. Appendix B. Declassified 8 July 1977.

Changteh in which *V. cholerae* was apparently used as a BW agent by the Japanese but then boomeranged, leading to nearly 10,000 cholera cases and 1,700 deaths among their own troops.[5]

The United States. By the end of World War II, the US maintained a well-funded BW program of its own. Like Japan, the US did not ratify the Geneva Protocol until after the war (1975) and deliberately retained the right to retaliate-in-kind to any BW attack. In a June 8, 1943 speech President Franklin D. Roosevelt stated:

> "Use of such weapons has been outlawed by the general opinion of civilized mankind. This country has not used them, and I hope that we never will be compelled to use them. I state categorically that we shall under no circumstances resort to the use of such weapons unless they are first used by our enemies."[6]

The US BW program began with the 1941-1942 establishment of the War Bureau of Consultants (WBC) under Dr. Edwin B. Fred, Professor of Bacteriology at the University of Wisconsin, and War Research Service (WRS), a parallel civilian agency. WRS evaluated biological agents for weapons utility and passed the most promising candidates on to the Chemical Weapons Service (CWS, which was established near the end of the First World War) for offensive and defensive application, signifying a transfer from civilian to military oversight. In 1944, the WRS was absorbed by the War Department, eliminating the civilian component and consolidating BW research and development under CWS's Special Projects Division. The Special Projects Division's parent CBW research and pilot plant center was housed at the US Army's Camp Detrick, later renamed Fort Detrick, in Frederick, Maryland. Fort Detrick became the recognized epicenter of the US BW program, and today still houses key defensive research facilities including the United States Army Medical Research Institute of Infectious Diseases (USAMRIID).

Also within the War Department, the U.S. Biological Warfare Committee (USBWC) was established to work in conjunction with the Special Projects Division, and George Merck, notable pharmaceutical entrepreneur and Chairman of the WRS prior to its dissolution, was appointed USBWC Chair responsible for final decisions of mass production and use. Merck

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[5] Riedel S. Biological warfare and bioterrorism: a historical review. Proc (Bayl Univ Med Cent). 2004;17(4):400-406. doi:10.1080/08998280.2004.11928002.
[6] https://2009-2017.state.gov/t/isn/4784.htm

summarized BW-related accomplishments during World War II in a report to the Secretary of War as follows:

1. Development of methods and facilities for the mass production of microorganisms and their products.

2. Development of methods for the rapid and accurate detection of minute quantities of disease-producing agents.

3. Significant contributions to knowledge of the control of airborne disease-producing agents.

4. Production and isolation for the first time of a crystalline bacterial toxin, which has opened the way for the preparation of a more highly purified immunizing toxoid.

5. Development and production of an effective toxoid in sufficient quantities to protect large scale operations should this be necessary.

6. Significant contributions to knowledge concerning the development of immunity in human beings and animals against certain infectious diseases.

7. Important advances in the treatment of certain infectious diseases of human beings and animals, and in the development of effective protective clothing and equipment.

8. Development of laboratory animal propagation and maintenance facilities to supply the tremendous number of approved strains of experimental animals required for investigations.

9. Applications of special photographic techniques to the study of airborne microorganisms and the safety of laboratory procedures.

10. Information on the effects of more than 1000 different chemical agents on living plants.

11. Studies of the production and control of certain diseases and plants.[7]

Postwar BW efforts initially focused on *B. anthracis*, botulinum toxin, and other agents. In 1953, Pine Bluff Arsenal, formerly a manufacturing center for magnesium and thermite munitions outside One Bluff, Arkansas, was repurposed for BW and CW production. Its biological plant, renamed the Directorate of Biological Operations (DBO), became the BW program's primary large-scale production facility with an operating budget that ballooned to $7 million per year by 1969.

Field testing was primarily conducted at Dugway Proving Ground approximately 80 miles west of Salt Lake City, Utah, where it was established as a CW testing facility by the Army in 1942 and remains active today. Open-air BW testing was also conducted by the Deseret Testing Center (DTC), established in 1962 to obtain empirical data on BW use. Tests were conducted in various locations often outside of the continental United States, for example attacking a makeshift naval fleet on multiple occasions under Project SHAD ("Shipboard Hazards and Defenses").[8]

On November 25, 1969, President Richard Nixon unilaterally banned all offensive BW activities by the US. The US was in possession of a nearly 80 ton BW stockpile at the time. The ban was followed by a similar ban of toxin weapons less than 3 months later, justified by the President as follows:

> "These decisions have been taken with full confidence that they are in accord with the overall security requirements of the United States. These decisions also underline the United States support for the principles and objectives of the United Kingdom Draft Convention for the Prohibition of Biological Methods of Warfare. The United States hopes that other nations will follow our example with respect to both biological and toxin weapons. The renunciation of toxin weapons is another significant step, which we are willing to take unilaterally, to bring about arms control and to increase the prospects of peace."[9]

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[7] US Department of the Army. US Army Activity in the US Biological Warfare Programs. Volume I, 24 February 1977 (UNCLASSIFIED), pp. 70-1.
[8] See, for example, Institute of Medicine 2007. Long-Term Health Effects of Participation in Project SHAD (Shipboard Hazard and Defense). Washington, DC: The National Academies Press. https://doi.org/10.17226/11900.
[9] The Department of State Bulletin, Vol. LXII, No. 1594, January 12, 1970, pg. 227.

The UK Draft Convention for the Prohibition of Biological Methods of Warfare referenced by President Nixon would become the first international treaty to ban an entire class of weapons – the Biological Weapons Convention (BWC). The BWC prohibited the development, production, and stockpiling of biological weapons, marking a significant step forward from the 1925 Geneva Protocol's limitation of BW use only. The UK, US, and Soviet Union (along with a number of other nations) were signatories of the Convention from its inception, April 10, 1972. Upon ratification by these three countries—the depository states—on March 26, 1975, the BWC went into force.

The Soviet Union and Russian Federation. Unlike the United States, the Soviet Union did not discontinue its BW program with the establishment of the BWC.[10] Soviet BW efforts began in the 1920s but accelerated after World War II and revelations of the Japanese, US, UK, and Canadian BW programs. In the 1950s, the Kirov Institute became the lead BW research and development institute under the Soviet Ministry of Defense's (MOD) 7th Directorate of the General Staff, headed by Colonel-General Yefim I. Smirnov. Two additional MOD institutes were established: a virology institute near Zagorsk (now renamed Sergiev Posad) and a combined bacteriology institute/production plant in Sverdlovsk (now renamed Yekaterinburg). In 1979, an accidental release of *B. anthracis* spores from the Sverdlovsk institute caused a large civilian inhalational anthrax outbreak that lead to closure of the production plant and relocation of bacterial production activities to Stepnogorsk, Kazakhstan. The three MOD facilities – Kirov, Zagorsk/Sergiev Posad, and Sverdlovsk/Yekaterinburg – remain the core of Russian military biological activities that are widely assessed as both offensive and defensive in nature but the specifics of which are largely unknown.

By 1970, the program had successfully weaponized *B. anthracis*, *Francisella tularensis*, *Y. pestis*, *Coxiella burnetii*, *Rickettsia prowazekii*, *Brucella* species, Venezuelan equine encephalitis virus, smallpox virus, and botulinum toxin. Many of these agents were tested on

[10] For an abbreviated history of the Soviet BW program, see Zilinskas RA. The Soviet Biological Weapons Program and Its Legacy in Today's Russia. Center for the Study of Weapons of Mass Destruction, Occasional Paper No. 11 (National Defense University Press; Washington, DC: July 2016).

Vozrozhdeniye Island in the Aral Sea, the Soviet Union's primary open-air testing location for biological weapons since the 1950s.

While the Soviet Union's primary focus throughout the Cold War was the US, multiple inside sources have indicated that the Soviet BW program may instead have focused on China, particularly in the late 1960s. The Soviet Union and China shared a 4,300 km Sino-Soviet border where escalating military clashes culminated in overt conflict in 1969, prompting Moscow to publicly threaten and privately consider a preemptive nuclear strike on China's fledgling nuclear program.[11] Numerous Soviet weapons scientists have cited China's overwhelming population advantage as a key driver of Soviet BW activities during this period given the clear utility of BW against human populations.[12]

In the early 1970s, the establishment of the BWC and the coincident advent of potentially dual-use genetic engineering techniques provided a strategic opportunity for the Soviet Union to gain a military advantage by expanding its BW program significantly. Influenced by respected scientist Yuri Ovchinnikov and led by YI Smirnov under the MOD General Staff's newly-formed 15th Directorate (which replaced the 7th Directorate), the expanded BW program applied genetic engineering and other modern biotechnologies to develop enhanced or novel biological weapons. As MOD facility activities continued, the 15th Directorate established a large, ostensibly civilian component of the BW program called Biopreparat, which comprised numerous geographically-dispersed institutes responsible for conducting both offensive and defensive BW research and development. Key Biopreparat facilities – including its primary civilian bacteriology institute the State Research Center for Applied Microbiology and Biotechnology, Obolensk (SRCAM)[13] and primary civilian virology institute the State Research Center of Virology and Biotechnology (VECTOR)[14] – continue to work with dangerous pathogens for defensive purposes today.

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[11] See, for example, Gerson M. The Sino-Soviet Border Conflict. Center for Naval Analyses: November 2010. https://www.cna.org/CNA_files/PDF/D0022974.A2.pdf. See also: https://nsarchive2.gwu.edu/NSAEBB/NSAEBB49/index2.html

[12] Leitenberg M and Zilinskas RA. The Soviet Biological Weapons Program. Cambridge, Harvard University Press, 2012. Page 207.

[13] See https://www.obolensk.org/eng/index.htm

[14] See http://www.vector.nsc.ru/

The Soviet Union formally dissolved on December 25, 1991. In 1992, Russian President Boris Yeltsin ordered the cessation of offensive BW activities and publicly stated that the Soviet Union had conducted an offensive program in violation of the BWC.[15] Whether enhanced or novel biological agents were successfully weaponized before the program's disbandment is uncertain; however, program defectors reported significant achievements employing modern biotechnological techniques,[16] and open source scientific publications revealed the successful application of such techniques to enhance BW surrogates of *B. anthracis*[17]and the smallpox virus[18] during the 1990s.

It is unclear what if any such activities continued into the 2000s; however, a widely-publicized 2012 essay by then-Prime Minister Vladimir Putin calling for the development of genetic weapons systems renewed concerns that the Russian Federation may be pursuing BW capabilities in breach of the BWC. Prime Minister Putin's essay read:

> "In the more distant future, weapons systems based on new principles…genetic, psychophysical and other technology) will be developed. All this will…provide entirely new instruments for achieving political and strategic goals. Such high-tech weapons systems will be comparable in effect to nuclear weapons but will be more 'acceptable' in terms of political and military ideology."[19]

While the implications of President Putin's statement on genetic weapons remain clouded, the Russian Federation continues to invest heavily in potentially dual-use genetic research and development, with the expressed goal of becoming a world leader in the technical space.[20]

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15 https://www.latimes.com/archives/la-xpm-1992-09-15-mn-859-story.html#:~:text=On%20April%2011%2C%20Russian%20President,Deputy%20Foreign%20Minister%20Grigory%20V.

16 See, for example, Ken Alibek and Stephen Handelman. Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World, Told from the Inside by the Man Who Ran It (New York: Random House, 2000)

17 Stepanov AV, Marinin LI, Pomerantsev AP, Staritsin NA. Development of novel vaccines against anthrax in man. J Biotechnol. 1996;44(1-3):155-160. doi:10.1016/0168-1656(95)00092-5.

18 Shchelkunov SN, Stavitskii SB, Batenko LI, et al. Viral chimeric protein including a determinant of myelin basic protein is capable of inducing allergic encephalomyelitis in guinea pigs. Biomed Sci. 1991;2(5):493-497.

19 Prime Minister Vladimir Putin. Rossiiskaya Gazeta. February 20, 2012.

20 See for example http://publication.pravo.gov.ru/Document/View/0001201904260007?index=1&rangeSize=1; https://www.bbc.com/russian/features-52470990

Summary. This brief timeline of key State-level BW activities in the 20-21st century provides useful context for subsequent analysis of biological threats and options for control, with key points as follows:

- States have successfully developed biological weapons in the past but have largely refrained from deploying them, with the notable exception of World War II-era Japan
- Historical motivations for developing biological weapons included perceived strategic advantage and deterrence, including the ability to "retaliate in kind"
- While the BWC uniformly banned biological weapons, it was unsuccessful in preventing significant BW advances by the Soviet Union (as well as other States such as Iraq)
- Modern biotechnological advances have lowered technical barriers to biological weapons development while reducing cost, such that technologically sophisticated States like the Russian Federation are capable of developing enhanced or novel biological weapons and, more broadly, potentially dual-use biological capabilities are now widespread in most countries around the world

b. BW Threat Assessment Methodology

To systematically assess State-level biological threats, we typically evaluate two key contributing factors: capability (i.e., whether a potential actor has the technical capability to pursue or enact the threat), and intent (i.e., whether a potential actor has the motivation to pursue or enact the threat).

Assessing BW capabilities. To establish the capability to mount a biological attack, four key technical hurdles must be overcome: a pathogenic (or toxigenic) strain of a biological agent must be acquired; a sufficient amount of the agent (or toxin) must be produced; the agent must be formulated for stability and effectiveness during storage and delivery (not an absolute requirement); and the agent must be successfully delivered. Accordingly, a BW *capability* may be boiled down to three primary building blocks: pathogens, infrastructure, and expertise (***Figure 1***).

Pathogens are widely available in laboratories around the world and ubiquitous in the environment. Infrastructure and expertise are similarly available across academia and industry because of their dual-use nature, meaning that the same materials and knowledge utilized for peaceful purposes may be diverted toward illicit ends with relative ease. Therefore, in the absence of such highly suspect BW signatures as blast chambers and field-testing facilities, we

Figure 1. Building Blocks for a Biological Weapon

(1) The hazardous biological agent itself [1]
(2) The equipment/infrastructure necessary for its acquisition, production, formulation, and delivery as a weapon [2]
(3) The expertise necessary for the same [2]

[1] Most biological agents are widely available in both nature and the laboratory (where legitimate research, e.g., on pathogenesis and therapy, is performed).

[2] Both the equipment/infrastructure and expertise necessary to produce a bulk amount of agent, formulate it, and deliver it are largely dual use in nature, meaning that the same materials and thus knowledge required for the peaceful development and production of experimental and commercial products like food additives, pesticides, pharmaceuticals, and vaccines can be diverted with relative ease toward weapons-related applications.

must be able to gauge *intent* in order to distinguish between legitimate and illegitimate, BW-related activities.

Technological change. Emerging technologies continue to lower technical barriers to establishing a BW capability while reducing cost. For example:

- *Acquisition*. De novo gene synthesis enables the synthesis of known or novel pathogens in the laboratory, with examples including polio virus (2002), 1918 pandemic influenza virus (2005), Ebola virus (2019), and SARS-CoV-2 (2002).
- *Production*. Single-use and clean-in-place technologies enable covert BW development while additive manufacturing and cloud laboratories enable perpetrators to circumvent existing dual-use technology controls.

- *Delivery*. Unmanned aerial vehicles (UAVs) enable remote dissemination of biological weapons at low risk to the perpetrator.

Assessing BW intent. Biological weapons development requires a conscious and necessarily covert decision to invest money, human and material resources, and time in contravention to interventional law. Indicators of interest in or pursuit of biological weapons may be derived from statements by political leadership, state media reports, government budgetary allocations, and scientific publications or lack thereof. Additional data sources include social media posts, electronic communications (Internet, tweet, text), and online communities, chat rooms, and message boards. Ultimately, understanding a potential proliferator's motivations is extremely challenging in the absence of timely and accurate intelligence.

c. BW Threats in the Asia-Pacific

China. While the People's Republic of China has played a central role in the historical context of BW as described earlier – both having suffered BW attacks at the hands of the Japanese and having been suggested as a potential target of Soviet biological weapons due to neighboring China's large population advantage – there is no corroborated evidence in the open source domain that China has ever maintained an offensive BW program, past or present.

As noted above, biological weapons development requires a conscious and necessarily covert decision to invest money, human and material resources, and time in contravention to international law. China acceded to the BWC in 1984,[21] and has submitted annual Confidence Building Measure (CBM) reports – which aim to improve cooperation of States Parties under the Convention, including CBM F on "Declaration of past activities in offensive and/or defensive biological research and development programmes"[22] – since 1989. China has restricted these submissions to States Parties only, such that their contents are not publicly available;[23] however,

[21] http://disarmament.un.org/treaties/t/bwc
[22] https://www.unog.ch/80256EDD006B8954/(httpAssets)/DE1EE44AFE8B8CF9C1257E36005574E4/$file/cbm-guide-2015.pdf
[23] https://bwc-ecbm.unog.ch/state/china

it is reasonable to assume that the contents of these submissions are consistent with China's unwavering formal position that it has never engaged in offensive BW activities.[24]

The US State Department's 2019 report on Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments (Compliance Report) stated that "[i]nformation indicates that the People's Republic of China (China) engaged during the reporting period in biological activities with **potential dual-use applications**, which raises concerns regarding its compliance with the BWC," and "[t]he United States does not have sufficient information to determine whether China eliminated its assessed biological warfare (BW) program, as required under Article II of the Convention."[25] The report further states the that "[t]he United States assesses China possessed an offensive biological warfare program from the early 1950s to at least the late 1980s…China's CBM reporting has never disclosed that it ever pursued an offensive BW program." While it is unclear what information led the US to cite an "assessed" BW program on behalf of China, the US position on China's dual-use capabilities is certainly accurate: as described in the previous section of this paper, virtually all countries possess the building blocks for a BW capability, and as a global technology leader China's corresponding capabilities are more advanced than most. The question is whether China would attempt to pursue such a capability in breach of its BWC obligations?

While countries such as the Soviet Union and Iraq have breached the BWC in the past, an argument can be made that each country's breach was strategic – the Soviet Union to gain an asymmetric advantage over the US in the great power competition that characterized the Cold War (as well as, possibly, possessing a mass casualty weapon to counter neighboring China's population advantage, as noted), and Iraq to counter superior military manpower and perceived

[24] For sake of completeness, it should be noted that some Chinese authors of unknown influence have suggested that China should consider BW as a viable and perhaps even more humane alternative to other forms of war. For example, a 2006 paper by Ji-Wei Guo of the Department of Medical Affairs, Southwest Hospital, Third Military Medical University, Chongqing argued that "[m]odern biotechnology…can be used to bring damages and injuries to individuals in war in a more accurate and effective fashion. Different military biotechnologies can be chosen in accordance with different pathogenic factors to meet different military goals. The attack, therefore, will wound different levels of specific gene, protein, cell, tissue, and organ. It no doubt will be more effective to cause damages than conventional weapons, yet the nonlethal effect will remain to be civilized in terms of postwar reconstruction and hatred control." Ji-Wei Guo, The Command of Biotechnology and Merciful Conquest in Military Opposition, Military Medicine, Vol. 171, November 2006.

[25] https://www.state.gov/2019-adherence-to-and-compliance-with-arms-control-nonproliferation-and-disarmament-agreements-and-commitments-compliance-report/, pp. 45-46.

WMD threats in the region (e.g., on the part of Iran).[26] Would pursuing an offensive biological weapons capability similarly fit China's prevailing strategy?

China's grand strategy is founded upon technological superiority and economic expansion in the Global South. That strategy has enjoyed remarkable success – China's corresponding Belt and Road Initiative has engaged more than 60 countries and invested over $200B in infrastructure development to date.[27] However, one enduring risk to the strategy's ultimate success is the perception of China on the global stage. A negative perception would undermine China's ongoing soft power investment, which might explain the PRC's concerted efforts during the ongoing COVID-19 pandemic not only to project strength but to emerge as a global leader in the area of global health security.

The discovery of a covert offensive BW program in China would threaten not only China's external relationships with both partner nations and key international organizations like the World Health Organization (WHO), World Trade Organization (WTO), and World Bank, but also China's internal stability. Biological weapons are widely abhorred, perhaps nowhere more so than in China (where, as noted, the Chinese people suffered BW attacks at the hands of the Japanese during the Second Sino-Japanese War that coincided with World War II).[28] And China has other, more predictable military options for area denial and deterrence, which form the basis of its national military strategy.[29]

In summary, 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.

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[26] Republic of Iraq, Biological Full Final and Complete Disclosure (FFCD) to the United Nations, September 1997, Chapter 1.8.1.
[27] See, for example, https://www.cfr.org/backgrounder/chinas-massive-belt-and-road-initiative
[28] See, for example, https://www.nytimes.com/1997/02/04/world/germ-war-a-current-world-threat-is-a-remembered-nightmare-in-china.html.
[29] See, for example, https://www.csis.org/analysis/chinas-new-2019-defense-white-paper; https://www.rand.org/content/dam/rand/pubs/conf_proceedings/CF145/CF145.chap7.pdf

North Korea. The Democratic People's Republic of Korea acceded to the BWC in 1987 but has submitted no annual CBM reports since 1990.[30] The US State Department's 2019 Compliance Report stated that "[t]he United States assesses that the Democratic People's Republic of Korea has an offensive BW program and is in violation of its obligations under Articles I and II of the BWC,"[31] but little information is available in the open source domain to support or refute the US position.[32] Despite public denials of the existence of an offensive BW program, which the US claims has been in existence since the 1960s, North Korea's strategic need to "counter US and South Korean military superiority" (per the US Compliance Report) might provide the necessary motivation to pursue biological weapons in contravention of international law, and North Korea's open breach of international law in the nuclear sphere may lend some credence to this notion.

A 2015 media event by leader Kim Jong Un provided some insight into North Korea's dual-use capabilities that could be diverted toward BW efforts if the intent existed. Kim toured the Pyongyang Biotechnical Institute, a pesticide facility that publicly-shared photographs revealed to be well-equipped for the production of *Bacillus thuringiensis*, a biopesticide that is related to *B. anthracis*.[33] Many Western analysts have connected this media event – perhaps as a veiled threat – with the widely publicized, inadvertent shipment of viable *B. anthracis* spores by the US's Dugway Proving Ground to dozens of laboratories in multiple countries around the world, including South Korea, over a period of years.[34] Research collaborations between North Korean and foreign scientists that might advance dual-use biological capabilities have also been well-

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[30] http://disarmament.un.org/treaties/t/bwc; https://bwc-ecbm.unog.ch/?field_form_year_tid=555

[31] https://www.state.gov/2019-adherence-to-and-compliance-with-arms-control-nonproliferation-and-disarmament-agreements-and-commitments-compliance-report/, pp. 47-48

[32] For various open source assessments and commentary on North Korea and biological weapons, see, for example: https://www.rand.org/content/dam/rand/pubs/testimonies/CT400/CT486/RAND_CT486.pdf; https://www.belfercenter.org/sites/default/files/2017-10/North%20Korea%20Biological%20Weapons%20Program.pdf; https://www.nytimes.com/2019/01/15/science/north-korea-biological-weapons.html; https://www.38north.org/2019/01/jparachini013019/; https://thebulletin.org/2017/07/potemkin-or-real-north-koreas-biological-weapons-program/

[33] https://www.38north.org/2015/07/mhanham070915/

[34] http://www.documentcloud.org/documents/2178546-dod-anthrax-review-committee-report-23july2015.html?_ga=2.3006899.22627998.1599157323-1221756464.1596566377

documented, including work on *Bacillus* species related to *B. anthracis*.[35] These open source data points, while establishing that North Korea (like most countries around the world) possesses the building blocks for a biological weapon, provide no definite evidence that North Korea either possesses or is in pursuit of such weapons.

India, Pakistan, and other nations of the Asia-Pacific. Both India and Pakistan are original signatories of the BWC and ratified the Convention in 1974.[36] Despite their status as nuclear powers, neither country has been assessed as possessing an offensive BW program, though both maintain extensive dual-use capabilities within their burgeoning tech sectors. Likewise, no other Asia-Pacific countries are assessed as possessing an offensive BW program despite widespread dual-use capabilities

Control

Options for BW control span the sequential steps along the timeline leading up to, including, and following a biological attack: (1) the decision to pursue a BW capability; (2) the successful development of a biological weapon, namely by overcoming the above-described four key technical hurdles of acquisition, production, formulation, and delivery; (3) the decision to use this weapon; and (4) successful attack. A systemic approach to establishing corresponding BW controls follows the "seven D's" of national security: dissuasion, disarmament, denial, disruption, deterrence, detection, and defense, each of which is discussed in turn below.[37]

Dissuasion. The goal of dissuasion is to decrease an adversary's interest in and pursuit of biological weapons. The primary mechanism of dissuasion is international policy, including incentives and disincentives (e.g., sanctions) that influence the international political environment to decrease BW demand. A secondary mechanism of dissuasion is to reduce

[35] https://www.nonproliferation.org/wp-content/uploads/2018/12/op43-dprk-international-scientific-collaborations.pdf. The report cites 224 international collaborations with North Korean scientists in the biology domain between 1958 and 2018.
[36] http://disarmament.un.org/treaties/t/bwc
[37] Pilch, R., "Arms Control Measures," in Heggenhougen, H.K., International Encyclopedia of Public Health, 2nd Edition (San Diego: Elsevier Inc., 2016).

vulnerabilities in order to limit the likelihood of success or anticipated impact of a biological attack, making the use of biological weapons an unappealing choice.

Disarmament. The goal of disarmament is to eliminate existing BW capabilities. The primary mechanism of disarmament is the BWC. The BWC consists of 15 short sections, or Articles, four of which (Articles I, III, IV, and X) are of particular relevance. Article I contains the primary prohibition against biological weapons.

> *Each State Party … undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:*
>
> *1. 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;*
>
> *2. Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict. (BWC, 1972: 2)*

Article III restricts the transfer of all items covered by Article I to substate actors, including terrorist groups:

> *Each State Party to this Convention undertakes not to transfer to any recipient whatsoever, directly or indirectly, and not in any way to assist, encourage, or induce any State, group of States or international organizations to manufacture or otherwise acquire any of the agents, toxins, weapons, equipment or means of delivery specified. … (BWC, 1972: 2)*

Article IV affirms the need for *national* measures to impede proliferation in accordance with the provisions of the Convention.

> *Each State Party to this Convention shall … take any necessary measures to prohibit and prevent the development, production, stockpiling, acquisition, or retention of the agents, toxins, weapons, equipment and means of delivery specified in article I of the Convention, within the territory of such State, under its jurisdiction or under its control anywhere. (BWC, 1972: 2)*

Article X preserves 'peaceful' applications of corresponding dual-use capabilities:

> *… the economic or technological development of States Parties to the Convention or international cooperation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) agents and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins*

> *for peaceful purposes in accordance with the provisions of the Convention. (BWC, 1972: 3–4)*

Denial. The goal of denial is to prohibit development of new BW capabilities via security, export control, and scientific oversight of biological weapon building blocks, i.e., pathogens, infrastructure, and expertise. Security measures are primarily applied in laboratories, which house each of these building blocks, in particular pathogens. Historically, the vast majority of attempts to illicitly acquire pathogen have involved a laboratory "insider," defined as anyone with legitimate access to the laboratory. Thus, security measures traditionally reflect an "inside-out" approach, such that the insider is addressed first, beginning with personnel reliability programs to minimize the potential for insiders, then protecting pathogens at the point of storage (e.g., a secured freezer) and point of use (e.g., a secured laboratory), and expanding outward out from there to secure pathways into and out of the laboratory, the respective building, and the facility as a whole.

The primary source of dual-use infrastructure is purchase on the open market. Thus, import/export and transfer controls are necessary to permit legitimate purchases while monitoring purchase orders for red flag indicators that might suggest nefarious intent. So-called "Know-Your-Customer" guidance uses national and international control lists such as the US Department of Commerce Bureau of Industry and Security's Entity List to screen purchasers.[38] Purchased items are similarly screened against national and international control lists such as the Common Control Lists of the Australia Group, an informal international body charged with harmonizing global export controls related to biological and chemical weapons,[39] as well as evaluated for discrepancies in materials or quantities from those anticipated based on the purchaser's declared business.

Scientific oversight is performed in conjunction with the above security and export control activities to address the third biological weapon building block, relevant expertise. This expertise can come from former weapons programs or from legitimate scientific programs, by way of direct personnel hire, open sharing of information (e.g., in scientific publications), or intangible transfers such as phone calls, faxes, or emails. The knowledge of former

[38] https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern/entity-list
[39] https://www.dfat.gov.au/publications/minisite/theaustraliagroupnet/site/en/index.html

bioweaponeers and the so-called brain-drain phenomenon remain of concern with respect to the former Soviet offensive BW program, and are primarily addressed by cooperative programs designed to bring these scientists into the international scientific community and aid them in establishing legitimate research collaborations. Open transfer of information stems from the virtually unlimited amount of science with potential dual-use implications, most of which holds the potential for vast benefits and thus requires oversight measures founded on the principle of scientific self-regulation, such that national and international scientific communities establish their own boundaries for such activities (and any resulting data) to maximize benefits while minimizing risks. Patent applications, declassified military documents, and other so-called gray literature require a similar approach. The oversight of intangible transfers is a special case that generally necessitates national legislation in accordance with Article IV of the BWC.

Disruption. The goal of disruption is to interdict new BW capabilities or a biological weapon itself before or upon reaching the prospective end user. Such disruption measures include border and maritime security programs, import/export, and transfer control measures mirroring those described previously, and, perhaps most importantly, the diligent "tasking" of intelligence systems to identify trafficking networks. Unfortunately, because both biological weapons-related activities and the resulting weapons have few signatures and are readily concealable (i.e., weapons are small enough to be hidden on a person in many cases), disruption measures have proven challenging in comparison to, for example, those targeting radiological materials, which possess signatures that are clearly identifiable by dosimeters and the like. Thus, while disruption remains a necessary barrier in the biological threat continuum, its contribution may be limited.

Deterrence. The goal of deterrence is to prevent the deployment and employment of biological weapons. Deterrence primarily involves the criminalization of any biological weapons-related activity (including use), backed by a substantial law enforcement capability. Corresponding national legislation in accordance with Article IV of the BWC – for example, the U.S. Biological Weapons Anti-Terrorism Act of 1989 – has been invoked on numerous occasions in the past two decades to convict perpetrators of biological weapons-related plots and activities.[40]

[40] See, for example, https://www.france24.com/en/20200326-tunisian-handed-ten-years-for-ricin-bomb-plot-in-Germany; https://law.justia.com/cases/federal/appellate-courts/ca2/16-819/16-819-2018-08-27.html

Detection. The goal of detection is to ensure early warning of attack in order to enable effective intervention. In general, a biological attack is most likely to be detected in one of two ways. First, a detection system "alarm" may be triggered. Second, populations (animal or human) may begin to fall ill.

In the first instance, detection systems may identify an increased level of a biological agent over "background" levels that exist naturally in the environment, suggesting a biological attack and thus setting in motion a dedicated response. In the US, for example, both military and civilian systems are in place to this end, with the civilian BioWatch program active in over 30 undisclosed US cities.

In the second and arguably more likely instance, ill animal or human populations and epidemiological trace-back may lead to awareness of a common exposure, with certain characteristics of that exposure indicating a biological attack, for example, occurrence of an unusual disease for an area or animal, or the unusual presentation of a given disease in humans (e.g., if a patient presents with respiratory symptoms and signs indicative of an inhalational exposure as opposed to symptoms and signs that would be expected from infection via more common routes of natural exposure). Affected populations may be identified by individual diagnosis and case reporting to public health agencies, sentinel surveillance in which representative subsets of a population are monitored for trends in such indicators of illness as over-the-counter pharmaceutical sales and child absenteeism (animal populations may be similarly monitored), or syndromic surveillance in which subsets of a population are monitored for certain constellations of symptoms and signs associated with, for example, flulike, respiratory, gastrointestinal, cutaneous, or neurological illness.

Other possible ways in which a biological attack may be detected include law enforcement interdiction, whether pre-attack, at the time of attack, or postattack; an allegation by a state or non-state entity that it has been subjected to an attack; notification or tipoff, possibly on the part of the perpetrator; or identification and subsequent characterization of a visible substance such as a powder.

Defense. The goal of defense is to ensure effective response in the event of attack. This catch-all term encompasses crisis and consequence measures that rely on a field-tested incident response capability; adequate health-care surge capacity; the availability, mobilization, and administration of therapeutic countermeasures; rapid and reliable forensics to ensure attribution; and ready, proven decontamination technologies. Notably, the adequate safety of responders and health-care workers is of primary consideration in crisis and consequence management, and is critical in preventing exposure to persistent agents and/or propagation of infection. Perhaps most importantly, good communication, which serves as the backbone of all defensive efforts not only among those involved in a response but extending to policymakers and the general public, cannot be overemphasized. The improved understanding of specific disease pathogenesis and therapy, as well as the validation of approaches to mass casualty response, attribution, and environmental remediation, will contribute considerably to defense efforts in the future.

Nuclear Deterrence in the Pandemic Era

To this point, we have described the threat and control of biological weapons in a vacuum. The reality of biological weapons threats and their control is far more complex, however. For example, the Asia-Pacific is home to multiple nuclear-weapon states – how does their nuclear deterrent capability impact the threat and control of biological weapons? Furthermore, natural outbreaks and pandemics might be misinterpreted as deliberate attacks, or used to mask them – how do we avoid nuclear escalation and potential brinksmanship when we are unable to discern an outbreak's origin? In this section, we grapple with some of these real-world challenges in the Asia-Pacific, with the goal of deriving practical recommendations for regional stability and security.

Nuclear doctrine and pandemic context. The pandemic context carries a neglected risk for the Asia-Pacific region: the risk that nuclear-weapon states operating in the region could not only mistake a natural pandemic or accidental biological release for an intentional biological weapons attack but compound this error by responding with a nuclear attack. After all, many of these states have published nuclear doctrines that declare that they are prepared to respond to biological weapons attacks with nuclear ones, leaving open the question of how and when such attacks would be attributed. In particular:

United States. The United States has wrestled openly with the question of whether to retain the option of responding to a perceived BW attack with nuclear weapons but continues to maintain that option. In its 2010 Nuclear Posture Review (NPR), for example, the Obama administration debated whether to adopt a "universal policy that the 'sole purpose' of US nuclear weapons is to deter nuclear attack on the United States and our allies and partners," but backed away from doing so in part because of the perceived need to deter biological weapons. Thus, while strengthening its 'negative security assurances' that "the United States will not use or threaten to use nuclear weapons against non-nuclear weapon states that are party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and in compliance with their nuclear non-proliferation obligations," the NPR included a caveat for biological weapons:[41]

> Given the catastrophic potential of biological weapons and the rapid pace of bio-technology development, the United States reserves the right to make any adjustment in the assurance that may be warranted by the evolution and proliferation of the biological weapons threat and U.S. capacities to counter that threat.

The 2010 NPR went on to state that:

> In the case of countries not covered by this assurance–states that possess nuclear weapons and states not in compliance with their nuclear non-proliferation obligations–there remains a narrow range of contingencies in which U.S. nuclear weapons may still play a role in deterring a conventional or CBW attack against the United States or its allies and partners."

The Trump administration in its 2018 Nuclear Posture Review did not make explicit changes when it came to how it would respond to a potential biological attack. However, more generally it appeared to broaden the potential use of nuclear weapons, particularly against non-nuclear-weapon states:

> 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 U.S., allied, or partner civilian population or

[41] See U.S. Secretary of Defense, 2010 Nuclear Posture Review Report (Washington, D.C.: Office of the Secretary of Defense, 2010), 15–16, https://www.hsdl.org/?view&did=777468

> infrastructure, and attacks on U.S. or allied nuclear forces, their command and control, or warning and attack assessment capabilities. [42]

It also pointed to "the proliferation of highly-lethal biological weapons" as a form of technological uncertainty that could change the threat environment and "dramatically affect U.S. nuclear force requirements, policy, and posture."[43]

Russia. Russia, likewise, has promulgated a military doctrine which retains the option of responding to a perceived biological attack with a nuclear one. [44] For example, its 2010 military doctrine stated that Russia "reserves the right to utilize nuclear weapons in response to the utilization of nuclear and other types of weapons of mass destruction against it and (or) its allies."[45] In Early June 2020, Russia released a new document, titled "On Basic Principles of State Policy of the Russian Federation on Nuclear Deterrence," that outlined the threats and circumstances that could lead to Russia's use of nuclear weapons. The document lists a number of threats that Russia might face and circumstances under which it might consider the use of nuclear weapons. It indicates that Russia could order a nuclear strike in response to the "use of nuclear weapons or other types of weapons of mass destruction by an adversary against the Russian Federation and/or its allies." [46]

China. China continues to declare that it will not engage in the first use of nuclear weapons and has not carved out any exceptions.[47] In the past, this declaratory policy was buttressed by China's small and largely un-mated arsenal. However, China has moved to a larger, more diverse arsenal, including naval systems where operational warheads are not separated from missiles. Concurrently, military experts in China are engaged in a growing debate about either

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[42] U.S. Secretary of Defense, Nuclear Posture Review 2018 (Washington, D.C.: Office of the Secretary of Defense, 2018), 21, https://media.defense.gov/2018/Feb/02/2001872886/ -1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF.

[43] Ibid 14. .

[44] For an excellent summary of Russian military doctrine, see Amy Wolff, *Russia's Nuclear Weapons: Doctrine, Forces, and Modernization* , Congressional Research Service, No. R45861 (Washington, D.C.: Congressional Research Service, July 20, 2020) https://crsreports.congress.gov/product/pdf/R/R45861

[45] https://carnegieendowment.org/files/ 2010russia_military_doctrine.pdf.

[46] Ministry of Foreign Affairs of the Russian Federation, On Basic Principles of State Policy of the Russian Federation, Moscow, June 2, 2020, https://www.mid.ru/en/web/guest/foreign_policy/international_safety/disarmament/-/ asset_publisher/rp0fiUBmANaH/content/id/4152094.

[47] http://english.www.gov.cn/archive/white_paper/2015/05/27/content_281475115610833.htm

abandoning the no-first-use doctrine altogether or carving out exceptions. Outsiders, meanwhile, increasingly question the credibility of Beijing's no-first-use declaration.

North Korea. North Korean suspicions of the United States and South Korea could lead the DPRK to mistake a natural outbreak/pandemic or laboratory accident for a deliberate nuclear attack. Ever since the Korean War, when it falsely accused the United States of employing BW,[48] Pyongyang has been primed for a biological attack from the United States or South Korea. Therefore, a natural outbreak (particularly if it appears first in the DPRK) is likely to be viewed as a deliberate attack until proven otherwise. And Pyongyang also is primed to believe that even in the case of a natural outbreak, the United States or the ROK can be expected to exploit the crisis as an opportunity for subversion and a threat to the regime. [49]

India. India has long and loudly proclaimed that a cardinal principle of its nuclear doctrine is that it will not engage in the first use of nuclear weapons. However, it has been largely overlooked that for two decades this policy has included a significant caveat when it comes to biological weapons. India's 2003 nuclear doctrine states that "in the event of a major attack against India, or Indian forces anywhere, by biological or chemical weapons, India will retain the option of retaliating with nuclear weapons."[50] Interestingly, this caveat was not included in the initial draft doctrine India released after its 1998 nuclear tests. [51]

Pakistan. Given India's overwhelming conventional advantage, Pakistan has refused to renounce the first use of nuclear weapons. Government officials have not spoken specifically, however, on how Pakistan might respond to a chemical or biological attack. Whether and how these declaratory policies would play out under real-life circumstances is far from clear, however. These doctrines are primarily intended to communicate to potential adversaries as a

[48] Milton Leitenberg, "False Allegations of U.S. Biological Weapons Use during the Korean War," in Anne L. Clunan, Peter R. Lavoy, and Susan B. Martin, eds., *Terrorism, War, or Disease? Unraveling the Use of Biological Weapons* (Palo Alto, CA: Stanford University Press, 2008) 120-143

[49] Correspondence with North Korea expert Joshua Pollack, 8 September 2020.

[50] Prime Minister's Office. 2003. *Cabinet Committee on Security Reviews Progress in Operationalizing India's Nuclear Doctrine*. New Delhi: Government of India.

[51] Kumar Sundaram and M. V. Ramana, "India and the Policy of No First Use of Nuclear Weapons," *Journal for Peace and Nuclear Disarmament*, 1:1, 152-168, DOI: 10.1080/25751654.2018.1438737

form of deterrence; in the end, policymakers will decide, in the moment of crisis, how to respond to any outbreak and the possibility that it might stem from the use of biological weapons.

Bioterrorism and nuclear escalation. As we have seen, deciding that an outbreak is natural, accidental, or intentional is highly challenging. Furthermore, this attribution challenge could be intentionally or unintentionally exacerbated by non-state actors to leverage nuclear escalation for their own purposes.

For example, a millennial terrorist group such as Al Qaeda or ISIS could launch a biological attack against countries such as the United States, North Korea or Russia with hopes that it would be perceived as an attack by that country's adversary, with consequent retaliation. Or Kashmiri militants with links to Pakistan could launch such an attack against India with or without support from Islamabad and with or without publicly acknowledging their responsibility. Alternatively, such militants could claim that what was in fact a natural outbreak on either side of the line of control was a BW attack, bringing nuclear escalation dynamics into play. The potential for the latter such effort is illustrated by a 1994 plague outbreak in Western India which was initially suspected to be a bioterrorist attack. [52]

Discerning between natural and deliberate outbreaks. As described in the "detection" discussion above, there are two most likely scenarios in which a biological attack may play out: a detection system may be triggered, or human or animal populations may begin to fall ill. While the former scenario is largely specific to an attack (though false positives commonly occur due to detection of natural biological agents above expected background levels), the latter scenario requires that that the outbreak's origin – natural versus deliberate[53] – be determined to inform nuclear deterrence and, potentially, escalation options.

[52] Ron Barrett, " The 1994 Plague in Western India: Human Ecology and The Risks of Misattribution," in Anne L. Clunan, Peter R. Lavoy, and Susan B. Martin, eds., *Terrorism, War, or Disease? Unraveling the Use of Biological Weapons* (Palo Alto, CA: Stanford University Press, 2008), 49-71

[53] In practice, as we have seen with the SARS-COV 2 pandemic, investigators actually might have to distinguish between three scenarios—natural outbreak, accidental laboratory release, and a deliberate attack. See, for example, Felippa Lentzos, "Natural spillover or research lab leak? Why a credible investigation is needed to determine the origin of the coronavirus pandemic," Bulletin of the Atomic Scientists, May 1, 2020, https://thebulletin.org/2020/05/natural-spillover-or-research-lab-leak-why-a-credible-investigation-in-needed-to-determine-the-origin-of-the-coronavirus-pandemic/. For the purposes of this paper, however, we have simplified the discussion to leave out this potential scenario,

Initially, suspicion of a deliberate attack would likely be low in the absence of unique indicators (e.g., detection system alarm, law enforcement interdiction, allegation, tipoff, or visible substance such as a powder). Thus, a typical epidemiological investigation would most likely be conducted to determine the who, what, when, where, why and how of the outbreak. First, investigators would perform case histories and interviews to determine who is being infected, by what disease agent, when did infection occur, and in what location; this is called "descriptive epidemiology." Investigators would then seek to determine how infection occurred and why by assessing (a) the epidemiological triangle for indicators of convergence that would enable spillover of the infecting agent from its natural reservoir to humans, and (b) the infecting agent genome for indicators of geographical and temporal spread; this is called "analytical epidemiology." Throughout the investigative process, findings may suggest the possibility of a deliberate attack, as summarized in ***Figure 2***.

The epidemiological triangle is a simplified representation of the relationship between (1) a disease agent, typically in an animal reservoir; (2) a human host; and (3) the environment, which form the three points of a triangle. The lines of the triangle that connect these points can be long or short, and can be lengthened or shortened. The goal of the assessment is to determine whether the lines have shifted in a way that has brought the infecting agent (or its animal reservoir) into contact with the human host. Initially, assessment focuses on tracing back human cases to any known animal reservoirs, whether exposed through direct contact, consumption of byproducts, or another route. If no epidemiological link is apparent, investigators can seek to identify risk factors that might enable such exposure by asking the following key questions:

- Has the human population expanded into areas where the disease agent resides in animal reservoirs, for example due to wildlife trade, deforestation, or industrial farming?
- Has the disease agent expanded into human populations, for example due to animal reservoir overgrowth, vector population overgrowth (e.g., ticks, fleas), or interspecies spillover?
- Has the environment brought animal and human populations closer together, for example due to short-term meteorological shifts or longer-term climate shifts?

Like the epidemiological triangle, the infecting agent's genome may also hold clues to the outbreak's origin. This is especially true for viral agents, and RNA viruses in particular, where mutations routinely occur as the virus replicates (i.e., reproduces, which requires infection of a host cell). Mutations that offer a selective advantage for the virus survive, providing a geospatial and temporal map of the outbreak based on prevailing mutations. By comparing the infecting agent's genome with the genomes of well-characterized reference strains in the public domain, investigators can (1) identify the closest known relative of the infecting agent; and (2) determine whether the infecting agent's genome has amassed mutations consistent with known patterns of natural emergence. Investigators can further determine whether the infecting agent's genome so closely resembles a given reference strain that a period of limited or no replication is likely. Such so-called "frozen evolution," when an infecting agent's genome lacks the expected accumulation of mutations over time, suggests that alternative origin hypotheses such as a laboratory accident or deliberate attack must be explored.[54]

Figure 2. Potential Indicators of Deliberate Attack

Descriptive Epidemiology

Multiple, geographically-dispersed index cases are identified
Infecting agent is a traditional biological warfare agent
Infecting agent is unusual for location or time of year
Symptoms are unusual or unexpected (e.g., pulmonary symptomatology)
Animal populations are affected in concert with humans
Animal effects are unusual or unexpected for the species

Analytical Epidemiology

(a) Epidemiological Triangle Assessment

Lack of recognizable animal-human interface (e.g., exposure to sick animal, tick bite)
Epidemiological traceback of multiple cases to a common location or exposure

(b) Genome Assessment

Infecting agent genome matches known weapons strain
Infecting agent genome displays "frozen evolution"
Infecting agent genome has been engineered / edited

Based on descriptive and analytical epidemiology findings, investigators may collect and/or analyze additional animal, human, or environmental samples with the goal of closing information gaps in the prevailing origin hypothesis. For example, if contact with an animal reservoir is suspected, investigators may collect animal or environmental samples at the suspected animal-human interface, whether a market, farm, abattoir, or in the wild; analysis of these samples may identify the reservoir or provide additional clues that can be traced back epidemiologically and genetically. "Banked" human samples predating the outbreak may also be tested to this end; often, such clinical samples are retained for extended periods of time, and may be revisited for

[54] See, for example, Pascall DJ, Nomikou K, Bréard E, Zientara S, Filipe AdS, Hoffmann B, et al. (2020) "Frozen evolution" of an RNA virus suggests accidental release as a potential cause of arbovirus re-emergence. PLoS Biol 18(4): e3000673. https://doi.org/10.1371/journal.pbio.3000673

further analysis, for example if they came from patients with clinical presentations resembling the current outbreak.[55] In addition, investigators may actively collect human samples that might indicate exposure or infection in so-called sentinel populations at the animal-human interface; for example, serological testing of hunters or wildlife traders may identify antibodies against the agent causing the current outbreak, indicating exposure that may then be traced back to an animal reservoir.[56]

If findings of the outbreak investigation suggest the possibility of a deliberate attack, law enforcement must become involved either at the national level, possibly with support from other states, or at the international level under the UN Secretary General's Mechanism (UNSGM), likely in coordination with other relevant international organizations such as the World Health Organization (WHO) or World Organisation for Animal Health (OIE). A law enforcement investigation would likely be initiated, involving additional sample collection, careful documentation of chain-of-custody, and analysis in an accredited laboratory to ensure the integrity of evidence in a court of law; supplementary evidence collection and examination; targeted patient and witness interviews; and coordination with intelligence officials regarding adversary capabilities and motivations.

Despite a national or international investigative body's best efforts, it may not be possible to definitely determine the origin of a particular outbreak. For example, a 1942 outbreak of tularemia among German and Soviet troops during the Battle of Stalingrad has been alternately attributed to natural and deliberate causes. The most widely accepted explanation cites natural convergence on the epidemiological triad as the likely cause: the war's disruption of the local grain harvest led to population overgrowth of infected rodents, which passed the disease to both

[55] For example, banked samples from a December 2019 patient with influenza-like illness and pneumonia in France were retested after the emergence of COVID-19 and found to be positive for the pandemic coronavirus, thus predating all previously identified cases outside of China. See Deslandes A, Berti V, Tandjoui-Lambotte Y et al. SARS-CoV-2 was already spreading in France in late December 2019. International Journal of Antimicrobial Agents. Volume 55, Issue 6, June 2020, 106006. https://doi.org/10.1016/j.ijantimicag.2020.106006

[56] See, for example, Dovih P, Laing ED, Chen Y, Low DHW, Ansil BR, Yang X, et al. (2019) Filovirus-reactive antibodies in humans and bats in Northeast India imply zoonotic spillover. PLoS Negl Trop Dis 13(10): e0007733. https://doi.org/10.1371/journal.pntd.000773

armies.[57] However, allegations that the outbreak was caused by a Soviet biological attack have persisted, including on the part of former Soviet bioweaponeers themselves.[58]

A similar debate today might spark an unfounded nuclear escalation spiral, the evidentiary basis of which becomes lost in the "fog of war." Similarly, imprecise analysis, for example the misinterpretation of environmental interferents as has commonly occurred with fielded biological detection devices,[59] might inadvertently lead to an asymmetric response. The risk of misattributing a natural event as a BW attack necessitates a deliberate, data-to-decisions approach that emphasizes degrees of certainty when determining proportional response. At a minimum, nuclear-weapon states must carefully consider how they operationalize doctrines the leave open the possibility of a nuclear response to a perceived BW attack.

Asymmetric opportunities for exploitation of a natural outbreak or pandemic. As described previously, we typically assess the threat of a deliberate biological attack by evaluating the two key contributing factors of capability (i.e., whether a potential actor has the technical capability to pursue or enact the threat) and intent (i.e., whether a potential actor has the motivation to pursue or enact the threat). A predisposing or concurrent natural outbreak holds the potential to alter each of these threat dimensions while also conferring potential advantages on the perpetrator, for example the ability to mask a BW attack since symptoms such as fever and flu-like illness are common across a range of infections regardless of origin. Options for control include disruption, deterrence, and defense.

From a capability perspective, natural outbreaks offer targetable reservoirs for acquisition of harmful biological agents while potentially enabling production, formulation, and delivery requirements to be circumvented if the agent causes contagious disease. Illicit attempts to acquire biological agents during outbreaks has been documented; for example, the apocalyptic

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[57] See, for example, Leitenberg M and Zilinskas RA. The Soviet Biological Weapons Program. Cambridge, Harvard University Press, 2012; and Geissler E. Alibek, Tularemia, and the Battle of Stalingrad. CBWCB 69+70, September/December 2005.

[58] Alibek, Ken. Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World, Told from the inside by the Man Who Ran It. New York: Random House, 1999.

[59] Institute of Medicine (US) and National Research Council (US) Committee on Effectiveness of National Biosurveillance Systems: Biowatch and the Public Health System. Biowatch and Public Health Surveillance: Evaluating Systems for the Early Detection of Biological Threats: Abbreviated Version. Washington (DC): National Academies Press (US); 2011. Available from: https://www.ncbi.nlm.nih.gov/books/NBK219708/ doi: 10.17226/12688; pg. 50

cult Aum Shinrikyo, which perpetrated the Tokyo subway sarin attack in 1995 (sarin is a chemical weapon), reportedly attempted to acquire Ebola virus by posing as medical workers during a 1992 outbreak in Zaire (now the Democratic Republic of Congo).[60] During outbreaks of contagious disease such as influenza and COVID-19 (Ebola virus does not cause contagious disease), an ill constituent may be all that is needed to deliberately infect a target population; for example, a 2020 threat assessment by the US Department of Homeland Security (DHS) stated that "[m]embers of extremist groups are encouraging one another to spread the virus, if contracted, to targeted groups through bodily fluids and personal interactions."[61]

In 2019, the James Martin Center for Nonproliferation Studies (CNS) completed a detailed assessment of the risk that Islamist terrorists might use infected humans to spread a contagious disease. Our experts found that Islamist terrorists, and extremist groups more generally, are not bound by ideological or psychosocial norms that prohibit such behavior. In addition, the use of infected humans to spread a contagious disease requires comparatively limited technical know-how on the part of the perpetrator. And one of the primary limiting factors to such an attack – recruiting humans willing to infect themselves – does not apply in this case because potential perpetrators are those who are already infected with the virus. Our experts concluded that such an attack "could prove to be highly lethal to the targeted population(s), provide a low cost weapon, have a traumatic psychological shock value…undermine a country's public health and medical infrastructure's ability to respond, and erode faith in the government's ability to protect the public."[62]

From the perspective of intent, any potential perpetrator seeking a radical leveling approach—whether an asymmetrical state actor like North Korea or a motivated terrorist organization—may be influenced by the demonstrated impact of natural outbreaks/pandemics to pursue biological weapons. For example, COVID-19's public health, economic, and social impact has unequivocally demonstrated the vulnerability of US and global populations to biological threats, whether of natural or deliberate origin. In our global society, pathogens have ready access to

[60] See, for example, https://wwwnc.cdc.gov/eid/article/5/4/99-0409_article

[61] https://www.cnn.com/2020/03/25/us/missouri-man-killed-fbi-investigation/index.html

[62] Bale JM, Hynes NA, and Reidy TJ. Assessing the Risk of Islamist Terrorists using Human Vectors to Deploy Contagious Pathogens. James Martin Center for Nonproliferation Studies Report for the Smith Richardson Foundation (2019).

much of the world, traveling on or inside humans, animals, plants, or commerce. The US healthcare system is lean and depends on global supply chains, both of which contribute to capacity limitations during a large-scale event. Medical countermeasures such as diagnostics, therapeutics, and vaccines require resources and time to develop, test, and deploy. Citizen compliance with risk-reduction measures is influenced by civil liberties communication deficiencies and confusion spurred by fractured leadership at the state and federal level, and, importantly, disinformation from malign influence campaigns. And perhaps most notably, the economic fallout of COVID-19 has been far more severe than anticipated.

Options for preempting the exploitation of a natural outbreak or pandemic include disruption, deterrence, and defense. Disruption involves the interdiction of a potential actor as he attempts to acquire or spread the causative agent. Deterrence involves preventing the use of the agent as a weapon by ensuring severe consequences, whether through criminal legislation or various means of retaliation that include nuclear options in the extreme. Defense involves a range of measures that reduce the potential impact of an attack.

Conclusion

The Asia-Pacific has witnessed BW attacks on military and civilian populations, the first and only use of nuclear weapons, and now the emergence of SARS-CoV-2 and the global COVID-19 pandemic. Excluding Russia, the region is home to three historical nuclear powers – China, India, and Pakistan – and one emerging nuclear power, North Korea. Like most countries around the world, countries of the Asia-Pacific possess dual-use biological capabilities that could be diverted to an offensive BW program, though no such program exists based on available information in the public domain. Countries in the region should be monitored for indicators of intent to enable early identification and mitigation of any such divergence.

The region comprises more than half of the world's population and is projected to amass more than half of the world's GDP in the next twenty years. Such unchecked population growth, industrial expansion, and corresponding ecological disruption increases the likelihood that novel disease agents will come into contact with naïve human populations, leading to emerging infectious disease outbreaks and pandemics. Because biological events of both natural and deliberate origin may be met with nuclear deterrence, escalation, or even use, corresponding origin investigations must bridge epidemiological and law enforcement principles and involve international bodies such as the UNSGM as appropriate. At the same time, given the risks of unclear or incorrect attribution, countries should, at a minimum, reconsider how they operationalize doctrines which leave open the possibility of a nuclear attack in response to a perceived BW attack. Natural biological events may also be leveraged for illicit ends, and therefore must be met with controls that include disruption, deterrence, and defense.

Ultimately, the Asia-Pacific's unique combination of nuclear-weapon states, dual-use biotechnological advance, and ecological disruption provide opportunities for intersection that warrant the highest level of vigilance on the part of regional stakeholders and their allies.