

PROJECT ON MANAGING THE MICROBE

North Korea's Biological Weapons Program

The Known and Unknown

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HARVARD Kennedy School

BELFER CENTER

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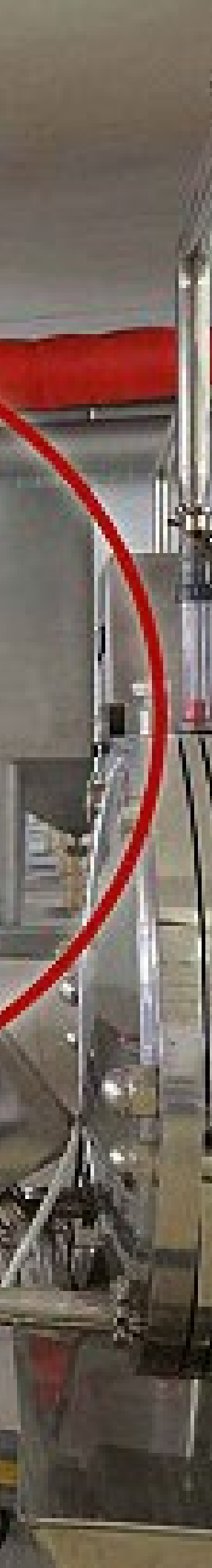
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North Korean leader Kim Jong-un tours facilities at the Pyongyang Bio-Technical Institute, July 2015. Circled in this photo are potential dual-use fermenters.
Rodong Sinmun



1. Introduction

Amidst the growing threat of North Korea's nuclear program, the assassination of Kim Jong-Un's half-brother via VX nerve agent in February 2017 brought renewed interest in North Korea's other weapons of mass destruction (WMD) programs—chemical and biological weapons. If used on a large scale, these weapons can cause not only tens of thousands of deaths, but also create panic and paralyze societies. Nevertheless, the vividness of the nuclear threat has overshadowed other weapons programs, limiting the attention and policy input that they deserve. This paper focuses on North Korea's biological weapons (BW).

Accurately assessing the threat from North Korea's biological weapons is challenging. Whereas North Korea has publicly declared its will to become a nuclear power many times, it has been less overt about its intention or capability for biological weapons. BW capabilities are inherently hard to detect and measure. While nuclear programs can be monitored by the number of nuclear tests and the success of missile tests, weaponizing and cultivating pathogens can stay invisible behind closed doors. Moreover, equipment used for BW production are often dual-use for agriculture, making external monitoring and verification virtually impossible. Limited information on North Korea's BW program leads to a low threat perception that may undermine preparation and response efforts.

Nonetheless, preparation against BW is urgent and necessary, which will also serve as defense against naturally occurring epidemics that increasingly threaten the 21st century. Military and public health sectors should cooperate to urgently prepare for “dual-response” mechanisms. Components of a well-established “dual-response” program should include the best possible threat assessment by military and intelligence communities, a strong public health detection and response system, a well-coordinated crisis communication strategy among multiple stakeholders, and compliance from an informed public.

In this paper, we examine the state of knowledge on North Korea's BW program. Current literature describes North Korea's BW program with

mixed levels of credibility. Using publicly available information, including articles, books, governmental and non-governmental reports, as well as interviews with subject matter experts and former government officials, the authors map the known and unknowns of North Korea's BW program.

Second, we examine where policy on North Korea's BW stands. We focus our analysis on the policies of South Korea and the United States, rather than at an international level, as North Korea has had limited participation in the Biological Weapons Convention (BWC).

Lastly, we present recommendations on how to improve assessment and surveillance of North Korea's BW program, especially with new technologies, and how to improve current policies regarding North Korea's BW program.

2. The Known

Intelligence reports and testimonials from defectors over the last several decades indicate that North Korea has the intent and capability for sustaining a biological weapons program. Here we review the current state of knowledge on North Korea's capacity for biological weapons production.

North Korea's Biological Weapons Interests

South Korean sources report that North Korea established a biological weapons program under Kim Il-Sung.¹ During the Korean War (1950-1953), North Korea's population experienced outbreaks of cholera, typhus, typhoid, and smallpox, which North Korea falsely attributed to biological weapons attacks by the United States. This provided an impetus for creating its own BW program. The exact timeline is unclear. According to recent defector Tae Young-Ho, a former North Korean diplomat, North Korea's chemical and biological weapons program started in the early 1960s,² and according to a South Korean Defense White Paper, North Korea began weaponizing biological agents in the 1980s.³ Furthermore, it is known that North Korea's soldiers are vaccinated against smallpox,⁴ suggesting either an interest in an offensive BW program or a biodefense precaution.

Unlike its current rhetoric regarding its nuclear program, however, North Korea has at times adamantly denied the existence of its BW program. In 2005, in response to a U.S. State Department report to Congress alluding to North Korea's BW development,⁵ North Korea stated through their state newspaper

1 "North Korea's Chemical and Biological Weapons Programs"; International Crisis Group, 18 June 2009; (신성택, "북한의 생물학전 능력은?" [Shin Sung-taek, "What is North Korea's BW capacity?"] 한 국일보[*Hanguk Ilbo*]), September 24, 2010.

2 김병규, "태영호, 김정 은으로선 김한솔도 제거해야만 할 존재" [Byungyu Kim, "Tae Youngho says that Kim Jung-Eun would target Kim Hansol too for assassination"], 연합뉴스[*Yonhap*], March 9, 2017.

3 Republic of Korea, Ministry of National Defense, "2000 Defense White Paper."

4 Robert G. Darling et al., "Virologic and pathogenic aspects of the Variola virus (smallpox) as a bioweapon", in *Biological Weapons Defense: Infectious Diseases and Counter Bioterrorism* edited by Luther Lindler, Frank Leveda, George Korch, Humana Press, 2005.

5 "北, '생물무기 단 한 개도 없어'" ["North Korea claims it does not have any biological weapon"], *Daily NK*, September 12, 2005.

Rodong Sinmun that it “does not possess any biological weapon and has been implementing the Biological Weapons Convention with good will.”

North Korea has even attempted to reverse the narrative around its BW program by falsely claiming that the United States is willing to engage in biological warfare against North Korea as it did in the Korean War. In 2015, when U.S. forces accidentally brought live *Bacillus anthracis* test samples and *Yersinia pestis* samples to the Osan Air Force base in South Korea, North Korea immediately issued a statement denying the existence of its BW program and accused the United States of targeting North Korea with a biological weapons attack. It even called on the UN Security Council to investigate the United States.⁶

The current status and the future of North Korea’s BW program remain unclear. Sources from the 1990s claim that North Korea intends to develop an offensive BW program,⁷ but recent official statements from North Korea do not support this claim. Regardless, it is certain from government statements, defector testimonies, and circumstantial evidence such as the smallpox vaccination of North Korean soldiers that at least in the past, North Korea has held an interest in developing biological weapons.

North Korea’s Biological Weapons Capability

Accurately assessing North Korea’s BW capability is challenging without access to classified intelligence. The ROK Ministry of National Defense has disclosed partial intelligence reports via White Papers, reports, and testimonies at the request of the South Korean legislature. These reports, in addition to several sources from the United States, South Korea, and the former Soviet Union, indicate that North Korea has the capability to

6 “North Korea accuses US of targeting it with anthrax and asks UN for help,” *The Guardian*, June 12, 2015.

7 Yevgeny Primakov, Director, Foreign Intelligence Service of the Russian Federation, “A new challenge after the cold war: Proliferation of weapons of mass destructions”, translated from the Russian by FBIS and distributed as a JPRS Report by the U.S. Senate Committee on Governmental Affairs, February 24, 1993.

cultivate pathogens for BW purposes and weaponize them.⁸ However, language describing North Korea's BW program has been softened in some U.S. assessments.⁹ With a healthy grain of skepticism, a reasonable assessment is that North Korea has the capability to cultivate and produce biological weapons.

North Korea is assumed to have several pathogens in possession. The 2000 ROK Defense White Paper mentions anthrax and smallpox most frequently. Since 2012, the plague (*Yersinia pestis*) and others have been on the list as well (see Appendix for a more detailed description of North Korea's BW program in the White Papers since 2000, and in unclassified U.S. intelligence reports). Agents mentioned in the White Papers, however, are not exhaustive. More information on North Korea's BW has been disclosed through other occasions (Table 1), which maps out 13 agents: *Bacillus anthracis* (Anthrax), *Clostridium botulinum* (Botulism), *Vibrio cholerae* (Cholera), *Bunyaviridae hantavirus* (Korean Hemorrhagic Fever), *Yersinia pestis* (Plague), *Variola* (Smallpox), *Salmonella typhi* (Typhoid Fever), *Coquillettidia fuscopennata* (Yellow Fever), *Shigella* (Dysentery), *Brucella* (Brucellosis), *Staphylococcus aureus* (Staph), *Rickettsia prowazekii* (Typhus Fever), and T-2 mycotoxin (Alimentary Toxic Aleukia).

In addition to possessing these agents, the Ministry of National Defense assessed that North Korea may even have capabilities to weaponize them. Section 3 includes a discussion on the extent to which it can weaponize and deliver the agents to targets.

8 Yevgeny Primakov Op.Cit.; U.S. Office of the Director for Central Intelligence, "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 July Through 31 December 2003," 2004.; ROK Agency for National Security Planning's parliamentary testimony in 1992("北韓 생화학무기 대량생산"[North Korea mass produces biochemical weapons], 연합뉴스[Yonhap], October 23, 1992).

9 Expert interview provided to MTM.

Table 1: Descriptions of North Korea’s BW Program in public ROK documents.

Year	Source	Description of North Korea’s BW Program
2002	ROK Parliamentary Audit	North Korea has 13 types of biological agents, and it has the capability to produce one ton of biological weapons annually. ^A
2009	Report to the Member of Parliament Ok-Yi Kim	North Korea has 13 types of biological agents, and it has the capability to cultivate and weaponize them. ^B
2012	Distribution of ‘Guidelines on Bioterrorism’ front-line troops	According to the guideline, North Korea has 13 types of biological agents. Among these agents, seven have vaccines available, of which the government is securing five. The Korea Center for Disease Control and Prevention (KCDC) is developing a vaccine for anthrax. In the meantime, anthrax is preventable and curable with antibiotics. ^C
2015	ROK Parliamentary Audit	North Korea has 13 types of biological weapons in the form of agents, and it can cultivate and weaponize them within ten days. In an emergency, it is likely that the North would prioritize using anthrax which is highly fatal and smallpox which is highly contagious. Special forces, airplanes, and contaminated carcasses are the potential delivery means. It appears that the North has not developed missile warheads with BW payload. ^D
2015	Press Conference of the U.S-ROK Joint Investigation WG on the USFK import of live anthrax test samples	“North Korea is assumed to have 13 types of biological agents including anthrax and the plague, and it is possible that it would use them in bioterrorism or in an all-out war.” ^E

A 한평수, “北, 화학무기 연 4500톤 생산능력”[Pyung-Su Han, “North Korea has capability to produce 4500 tons of chemical weapons per year”], 문화일보 [Munhwa Ilbo], September 16, 2002.

B 이상현, “北, 화학무기 5천톤, 생물학무기 13종 보유”[Sang-Hun Lee, “North Korea has 5000 tons of chemical weapon, 13 types of biological weapons”], 연합뉴스 [Yonhap], October 5, 2009.

C 하중훈, “생물무기 테러 대응지침 일선부대 배포”[Jong-Hun Ha, “MND distributes guidelines on bioterrorism responses to front-line troops”], 서울신문 [Seoul Sinmun], March 3, 2012.

D “북한, 생물학무기 열흘내 무기화.. 백신치료제 확보 시급” [North Korea can weaponize its BW within ten days...Urgent need for securing vaccines], MBN News, June 17, 2015.

E 최정아, “주한미군, 한국에 탄저균 16차례 반입해 실험.. 북한 생물무기 사용에 대비”[Junga Choi, “USFK has imported anthrax samples 16 times to Korea to be prepared for NK’s use of bioweapons”], 동아일보 [Donga Ilbo], December 18, 2015.

Evaluating North Korea's Potential for Dual-use BW Facilities

North Korea's BW capability is difficult to verify in part due to the dual-use nature of equipment and facilities used for culturing BWs. As seen in the cases of Iraq's Al Hakam Factory and the Soviet Union's 'Progress Scientific and Production Association' in Stepnogorsk, Kazakhstan, bio-pesticide plants can be covers for bioweapons production. Here we evaluate the possibility of dual-use in North Korea.

Since his inauguration, Kim Jong-Un has clearly stated the importance of agricultural reform as “the frontline of socialism.”¹⁰ A large aspect of this reform is to increase pesticide production. While most pesticides worldwide are chemical, North Korea's interest in organic, biological pesticides has increased. Some point out that this shift from chemical to bio-pesticides could signal an expansion of North Korea's BW program,¹¹ though it could simply be a consistent part of Kim Jong-Un's priority to enhance agricultural productivity. In March 2017, according to the *Rodong Sinmun*, North Korea built an organic fertilizer production complex that covers “thousands of square meters” in Gangnamgun, Pyongyang that is claimed to be capable of producing thousands of tons of organic fertilizers.¹² North Korea intends to continue exponential increase in bio-pesticide production to achieve Kim Jong-Un's goal of producing “*Juche fertilizer*,” named after North Korea's self-reliance ideology. Such emphasis on agricultural self-reliance suggests the legitimate use of pesticide facilities for civilian use only.

However, a series of photos of the Pyongyang Bio-technical Institute released by the North Korean state media in 2015 raised concerns for dual-use. Analysis of these images revealed that the Pyongyang Bio-technical Institute could produce military-sized batches of BWs, specifically anthrax.¹³ The modern equipment visible in these images also showed a

10 “비료는 농업전선의 탄약”[Pesticide is the bullet of our agricultural frontline], 로동신문[*Rodong Sinmun*], January 13, 2016.

11 Expert interview provided to MTM.

12 “유기질 복합비료기지 건설, 생산시작 강남군에서”[Organic compound fertilizer production facilities are built and productions start in Gangnamgun], 로동신문[*Rodong Sinmun*], March 7, 2017.

13 Melissa Hanham, “Kim Jong Un tours pesticide facility capable of producing biological weapons: A 38 North Special Report,” 38 North, U.S.-Korea Institute at SAIS, July 9, 2015.

violation of the Australia Group's dual-use items list, and showed that it is possible to convert the facility from pesticide to BW production.¹⁴

In response to this study, North Korea's National Defense Commission (NDC) issued a statement strongly refuting the claim that the Biotechnology Institute is an anthrax production facility. It furthermore invited every member of the U.S. Congress to inspect the Pyongyang Bio-technical Institute.¹⁵ South Korea's Ministry of National Defense pointed out that the facilities in the images were not equipped with biosafety equipment and that staff were not wearing protective suits,¹⁶ emphasizing that the possibility of the Institute being a dual-use facility should be considered with caveats. North Korea may not, however, adhere to international biosafety standards, considering its historical record of treating people as expendable entities¹⁷; testimonies from defectors allege that North Korea uses human subjects in testing biological and chemical weapons.¹⁸ Also, biosafety equipment and protective suits would only be required during the actual production of BW agents. Thus, the fact that the Pyongyang Bio-technical Institute was not equipped with a Level 3 biosafety cabinet and safety suits does not necessarily rule out its dual-use. Altogether, we cannot exclude the possibility that these large-scale pesticide production facilities and Bio-technology Institute have dual-use potential.

The ambiguity surrounding the dual-use potential of bio-pesticide facilities could be used to North Korea's advantage. For example, the date of Kim Jong-Un's visit to the Pyongyang Bio-technical Institute, which is run by the Korean People's Army Unit 810, could be interpreted as strategic messaging. The visit took place only ten days after the U.S. Forces Korea's accidental import of live anthrax samples into a South Korean air base

14 Ibid.

15 Lizzie Dearden, "North Korea could produce military-size batches of anthrax at pesticide factory, researcher claims," *The Independent*, July 16, 2015.

16 조정훈, "北, 평양생물기술연구소가 탄저균 생산? 국방부 '어렵다'" [Jung-Hun Cho, "North Korea's PY Bio-technology Institute produces anthrax agents? MND says it's hard"], *통일뉴스[Tongil News]*, July 10, 2015.

17 Expert interview provided to MTM.

18 These testimonies allude to North Korea's lack of consideration of safety and human rights because of the foremost focus on the military, but they have not been verified. On the allegation of human testing, the UN Commission of Inquiry (COI) mentioned that the Commission "has received no first-hand accounts of these allegations, and thus is not in a position to confirm them." But it noted them for further investigation. (United Nations Office of the High Commissioner for Human Rights, "Report of the detailed findings of the Commission of Inquiry on human rights in the Democratic People's Republic of Korea," A/HRC/25/63, February 7 2014, para 328, p.93.).

was publicized. It is plausible that North Korea intended to signal its BW capability to the United States and South Korea by showing its leader praising the military-run Bio-technical Institute. Furthermore, the Pyongyang Bio-technical Institute has been recently alleged to be responsible for the implementation of the assassination of Kim Jong-Nam as well.¹⁹

Separately, the South Korean government believes that North Korea maintains at least three possible BW production facilities and seven BW or BW-related research centers. These facilities include the No. 25 Factory in Chongju, the Central Biological Weapons Research Institute in Pyongyang, and a plant in the City of Munchon, Kangwon Province.²⁰

All of these circumstances considered, it is reasonable to conclude that North Korea has dual-use facilities. It would be difficult to analyze the state of facilities at each institution and whether they are used for their BW program, but investing in efforts to monitor the flow of dual-use equipment would be an important part of BW preparedness.

19 이봉석, "김정남 독살 개입설, 北 생물기술연구원 실체는?" [Bong-suk Lee, "What do we know about the Biotechnology Institute that was allegedly involved in Kim Jong-Nam's poisoning?"], 연합뉴스 [Yonhap], February 22, 2017.

20 International Crisis Group, Op.Cit., p.11.

3. The Unknown

It is clear that North Korea has the potential for a large-scale BW program, but the current state of such a program is not well-understood or confirmed in the public domain. In this section, we outline the unknowns regarding BW weaponization, potential delivery means, tactical and strategic uses for BW, North Korea's procurement channel for dual-use items, and credibility of intelligence sources.

The Extent of Weaponization

There is much debate on the extent to which North Korea can weaponize biological agents. Some claim that North Korea has already weaponized biological agents that are only waiting to be loaded onto missiles, while others believe that it only has samples of BW agents.²¹ The most recent statement made by the South Korean Defense Ministry is that “North Korea has 13 types of BW agents which it can weaponize within ten days, and anthrax and smallpox are the likely agents it would deploy.”²²

Weaponization requires stabilizing and formulating biological agents for dissemination. Stabilization prevents degradation of biological agents from environmental factors such as high salt concentrations, dryness, and heat. How to achieve these technical challenges depends on the agent. Some pathogens such as *Bacillus* and *Clostridium* naturally form spores that allow survival in heat, dryness, and excessive radiation. Once stabilized, typically by freeze-drying (lyophilization), biological agents can be disseminated by spraying.²³

21 “Country Profile: North Korea's Biological Weapons”, Nuclear Threat Initiative, Accessed March 20, 2017. (<http://www.nti.org/learn/countries/north-korea/biological/>)

22 *MBN News*, Op.cit.

23 “Biological Warfare Agent Delivery,” GlobalSecurity.org, accessed May 8, 2017.(http://www.globalsecurity.org/wmd/intro/bio_delivery.htm)

Historically, most national biological warfare programs focused on ten to fifteen agents²⁴ that differ in their nature and quantity needed for weaponization. Some agents are better suited for large-scale dissemination or aerosolization than others.²⁵ Agents like anthrax could cause mass casualties with a small amount: only a few kilograms of anthrax, equivalent to a few bottles of wine, released into a dense city could kill 50% of the population.²⁶

It is unknown whether North Korea has the capability to weaponize all 13 types of agents, and whether North Korea has the capacity to produce a mass stockpile of stabilized biological agents. Regarding the first aspect, little information is available. The ROK Defense White Paper mostly mentions anthrax and smallpox, so these could be agents that North Korea has higher capability to weaponize. However, it is important to note that despite an investment of 40,000 personnel over 63 years (1928-1991), the Soviet Union's BW program yielded only 13 weaponizable agents. Although increase in biological knowledge in the modern era could expedite weaponization, it is highly unlikely that all of North Korea's agents are ready for weaponization.²⁷

Regarding the second aspect of mass production, Kim Jong-Un's visit to the Pyongyang Bio-technical Institute showed bio-pesticide production facilities at a massive scale, which could allude to its capacity to mass-produce BW agents. However, some experts doubt that North Korea can mass produce BWs²⁸ and little is verified by publicly available information.

24 Spertzel, Wannemacher, and Linden, *Global Proliferation*, Vol. 4, p. 11; and David R. Franz, "Medical Countermeasures to Biological Warfare Agents," in Alexander Kelle, Malcolm Dando, and Kathryn Nixdorff, eds., *The Role of Biotechnology in Countering BTW Agents*, (Dordrecht, Netherlands: Kluwer, 2001), p. 228.

25 Gregory Koblenz, "Pathogens as Weapons," *International Security*, Vol.28 (3), Winter 2003/04, p. 90.

26 Mark G. Kortepeter and Gerald W. Parker, "Potential Biological Weapons Threats," *Emerging Infectious diseases* Vol. 5(4), U.S. Army Medical Research Institute of Infectious Diseases, 1999, p.524.

27 Expert interview provided to MTM.

28 Expert interview provided to MTM.

Means of Delivery

North Korea's choice of delivery vehicle is unknown and will likely be tailored to the strategic and tactical objectives for each weapon. Missiles, drones, airplanes, sprayers, and human vectors are potential means of BW delivery. North Korea's 240 mm Multiple Rocket Launcher (MRL) is also identified as a potential delivery vehicle for biological weapons.²⁹ Biological agents, however, are difficult to keep intact on missile payloads due to heat and changing conditions that can degrade the agent. Drones and airplanes using aerosol to disperse BW agents are also theoretically possible; North Korea regularly flies drones into South Korea.³⁰

Lastly, human agents have been discussed consistently as plausible BW delivery means. Its culture of North Korea prioritizing military objectives over human lives could drive it to use human vectors to deliver and spread BW. North Korea has 200,000 special forces; even a handful of those special forces armed with BW would be enough to devastate South Korea.³¹ What is alarming about human vectors is that they do not need sophisticated training or technology to spread BW amongst the targets, and they are difficult to detect in advance of an attack. It is theoretically possible that North Korean sleeper agents disguised as cleaning and disinfection personnel could disperse BW agents with backpack sprayers.³² Another possibility is that North Korean agents will introduce BW into water supplies for major metropolitan areas. However, it is difficult to ascertain North Korea's BW delivery strategy without discussing the strategic objectives and doctrine of North Korea's BW which will be discussed in the following section.

29 박진여, "김정은 협박 속에 담긴 생화학 무기 공포의 위력" [Jinyeo Park, "The power of CBW threat indicated in Kim Jung-Eun's intimidation"], 데일리안[Dailian], March 2016.

30 Adam Taylor, "Take a closer look at North Korea's alleged drones," *The Washington Post*, April 2, 2014.

31 Expert interview provided to MTM.

32 Ibid.

Strategic and Tactical Usage

Although the objectives and doctrine of North Korea's BW are not well understood, security experts point out that BW could be tactical: North Korea is likely to use biological weapons before or at the beginning of a conflict to disrupt society and create panic, incapacitate societies, and/or cause a significant military diversion. Furthermore, North Korea would ensure that the BW does not decimate its own fighting force.³³

North Korea's broad objective is to "drive out the aggressive forces of the U.S., terminate the dominance and interference of foreign forces... and fight for the unification of the motherland through the unite [sic] of our nation [the Korean peninsula]."³⁴ As a strategic purpose, BW could achieve a longer-term goal of disabling free deployment of military forces, and driving U.S. forces out of the Korean Peninsula by creating fear and aversion.

Procurement Channel for Dual-Use Items

Images of the Pyongyang Bio-technical Institute in 2015 revealed that North Korea has dual-use equipment that violates export control based on the Australia Group.³⁵ Compared to the thorough monitoring of dual-use items used for North Korea's nuclear program, procurement channels and the flow of BW dual-use items are less well understood. Part of the reason for this is that in the case of BW, distinguishing between items intended for military purposes, agricultural applications, and public health efforts is difficult. For example, a European non-governmental organization provided training and basic equipment for bio-pesticide production to the North that may have inadvertently contributed to North Korea's ability to produce BW.³⁶ Currently there is a need for clearer identification of procurement channels through which North Korea obtains its equipment and technology to produce BW.

33 Expert interview provided to MTM.

34 "Charter of the Workers' Party of Korea: Preamble", Workers' Party of Korea (WKP), 2010.

35 Melissa Hanham, Op.cit.

36 Ibid.

Credibility of the Sources

Mapping out a complete picture of North Korea's BW capability is limited due to difficulties in judging the credibility of sources. Furthermore, views and opinions are likely to be unconsciously biased to sensationalize stories in order to raise awareness. Since government assessments on North Korea's BW program rarely disclose sources or include supporting analysis, the credibility of open source information is difficult to verify and the analysis difficult to replicate. Defector testimonies should be considered with caution. Much of the information on North Korea's BW and its testing on human subjects originates from defectors. This source is valuable in that it provides clues for areas that need further investigation, but it should be noted that some defectors also have motives to exaggerate or fabricate facts either for money or to demonize the North Korean regime.

4. Where Policy Stands

In this section, we examine the current policies of the United States and the Republic of Korea on North Korea's BW program, and identify areas where further policies are needed.

Current Policies of the United States and the ROK

Vaccination of U.S. Troops on the Ground: As a preventive measure against North Korea's BW threat, U.S. Forces in Korea (USFK) are vaccinated against smallpox and anthrax since 2004, as decided by the U.S. Department of Defense.³⁷ Anthrax and smallpox vaccination is also mandatory for Department of Defense personnel and contractors assigned or deployed to the Korean Peninsula for 15 consecutive days or longer, which will also include forward-deployed naval forces.³⁸

Korea-U.S. Joint Exercise: The ROK and the United States have held joint exercises to respond to bio-threats since 2011. The *Able Response (AR)* exercise aims to “coordinate inter-ministerial procedures inside Korea and international procedures in requesting the medical resources urgently between the ROK and USA, and among the ROK, the UN, and nongovernmental organizations.”³⁹ The exercises hosted by the Korean Ministry of National Defense and the Ministry of Health and Welfare encompass related military and civilian agencies from both South Korea and the United States. It started as a tabletop exercise in 2011 in which virtual scenarios were presented and discussed. In the 2013 and 2015 exercises, these exercises had a greater focus on operational aspects. In 2016, the exercise was conducted during the Ulchi Freedom Guardian (UFG) maneuvers

37 Soon-Taek Kwon, “U.S. Forces to be vaccinated for anthrax and smallpox,” *Donga Ilbo*, July 1, 2004.

38 U.S. Department of Defense, Deputy Secretary of Defense for Health Affairs Memorandum, “Clarifying Guidance for Smallpox and Anthrax Vaccine Immunization Programs,” November 12, 2015.

39 Seoung Sun Kim, Dong Whan Oh, Hyun Jung Jo, Chae Shin Chu, “Introduction of the ROK-US joint exercise against biothreats in 2013: Able Response 13,” *Osong Public Health and Research Perspectives*, October 4(5), 2013, p. 285.

indicating that bio-threats from North Korea are real, and that response against bio-threats should take a more integrated approach.

The JUPITR Program: The Joint United States Forces Korea portal and Integrated Threat Recognition (JUPITR), a program led by the U.S. Army's Joint Program Executive Office for Chemical and Biological Defense is underway in the ROK as well. The JUPITR program supports new bio-surveillance equipment that increase the speed and ease of monitoring bio-threats. For example, new equipment such as the BioFire Array can run Dry Filter Unit samples in five to six hours, compared to the current system that runs samples in a couple days.⁴⁰ In January 2017, the USFK decided to deploy JUPITR equipment in the port of Busan. The USFK has not confirmed whether the equipment has already deployed.⁴¹

U.S. Government Funded Programs for Rapid Detection and Response

to Pathogens: The U.S. Department of Defense, through the Defense Advanced Research Projects Agency (DARPA), supports academic and industry research for rapid detection and response to pathogens. DARPA's Biological Technologies Office (BTO), with an annual budget of \$296 million, has prioritized the "Outpacing Infectious Disease" program to rapidly identify pathogens via DNA and RNA sequencing. Pathogen sequences would be then used to make DNA/RNA vaccines within a matter of days or weeks, compared to the months or years required for traditional vaccine pipelines.⁴² In particular, DARPA has funded Moderna Therapeutics, a biotech startup, to develop RNA vaccine platforms.⁴³ Such public-private partnerships ensure the development of technologies important for national security that may not be incentivized by commercial profits. Multiple benefits will ensue from such government-funded innovation: the United States will be more resilient and better prepared for pandemics, and technological innovations could boost the economy; for example,

40 U.S. Department of the Army, "JUPITR program takes shape on Korean Peninsula," *ECBC Communications*, March 12, 2014.

41 김준용, "미군, 주피터 장치 부산항 배치 결정" [Joon-Yong Kim, "USFK decides to deploy JUPITR equipment in the port of Busan"], *부산일보* [*Busan Ilbo*], April 5, 2017.

42 Dina Maron, "DARPA's Biotech Chief Says 2017 Will 'Blow Our Minds,'" *Scientific American*, January 9, 2017.

43 Laura DeFrancesco, "The 'anti-hype' vaccine," *Nature Biotechnolog.* February 27, 2017.

DARPA-funded research programs contributed to the digital revolution in Silicon Valley.⁴⁴

Government-funded research is also supporting the use of DNA sequencing to conduct detailed analysis on possible BWs. The U.S. Department of Homeland Security recently funded a project that used DNA sequencing to assess whether a Soviet strain of anthrax could have been genetically engineered.⁴⁵ In 1979, a military facility in Sverdlovsk accidentally released anthrax spores, causing about 100 deaths. During the Cold War, the Soviets were rumored to have genetically manipulated *Bacillus anthracis* to be resistant to vaccines and antibiotic treatment. By sequencing the genomes of anthrax from two victims, the study authors found no trace of genetic manipulation. Instead, they found that the Sverdlovsk strain was a wild-type anthrax strain endogenous to Russia. This study led to determining a unique, geographical molecular fingerprint, which could be important for tracing the source of potential biological weapons attacks.

International Limits to North Korea's Biological Sciences: North Korea's access to WMD-relevant training in biological sciences and access to dual-use items is purposefully limited by UN resolutions and other voluntary international coalitions. UN Resolutions since UNSCR 1718 (2006) have decided that member states "shall prevent the direct or indirect supply, sale or transfer" to North Korea of "items, materials, equipment, goods and technology" that are deemed by the Security Council or 1718 Committee as potential contributors to any weapons of mass destruction related programs.⁴⁶ Furthermore, member states are banned from providing "technical training, advice, services or assistance" to North Korean nationals that would contribute to its advancement of WMD programs.⁴⁷ However, as earlier evidence demonstrated, such international resolutions may not be sufficient as North Korea is still able to obtain restricted dual-use materials.

44 April Dembosky, "Silicon Valley rooted in backing from US military," *Financial Times*, June 9, 2013; Expert interview provided to MTM.

45 Jason Sahl, Talima Pearson, Richard Okinaka, James Schupp, John Gillece, Hannah Heaton, Dawn Birdsell, Crystal Hepp, Viacheslav Fofanov, Ramon Nosedá, Antonio Fasanella, Alex Hoffmaster, David Wagner, and Paul Keim, "A *Bacillus anthracis* Genome Sequence from the Sverdlovsk 1979 Autopsy Specimens," *mBio*, September 27, 2016.

46 United Nations Security Council Resolution 1718, S/RES/1718 (2006), October 14, 2006.

47 Ibid.

The Australia Group and the Wassenaar Arrangement are two international nonproliferation regimes that maintain export control lists, including biological weapons dual-use items. United Nations Security Council Resolution 1540 (2004) includes binding obligations for member states to adopt domestic legislation to prevent the proliferation of biological weapons and their means of delivery, and to establish domestic controls to prevent the illicit trafficking of their related or component materials. Unsurprisingly, North Korea does not participate in these regimes and has never submitted a compliance report to the 1540 Committee.

Gaps in the Current Policies

Vaccination of the ROK military: Unlike the USFK, the ROK military is not vaccinated against anthrax and smallpox. The main reason for this is the lack of vaccines. According to open sources, the Korean Center for Disease Control and Prevention had smallpox vaccines for less than 30 percent of the Korean population as of 2014, and the Ministry of National Defense had stockpiled vaccines since only 2014.⁴⁸ The Ministry aims to secure the appropriate amount of anthrax and smallpox vaccines by 2020, but it is likely that this goal would not be met by then considering the delay in the anthrax vaccine clinical trial. The Defense Ministry budget for smallpox vaccines was earmarked in 2015, and the actual vaccines will not be distributed to the military until 2019. Open sources indicate that the United States declined to provide vaccines to the ROK military as vaccine stockpile is insufficient, and there is no precedent for overseas vaccines sales.⁴⁹

Dismantlement of the BW Program: The United States and South Korea should prepare to lead the dismantlement of the North Korean biological weapons program in the event that the state collapses and reunified with South Korea, or it reaches a comprehensive disarmament agreement with the international community. Troop units should be designated and trained for this task, and vaccinated ahead of time. Units should also stockpile the necessary equipment to carry out the neutralization of biological

48 유용원, “北, 13종 생물학무기 10일내 무기화 가능” [Yong-Won Yoo, “North Korea has 13 types of agent which they can weaponize in ten days”], 조선일보 [Chosun Ilbo], June 17, 2015.

49 양낙규, “한국군 생물학전 왜 미군에 의지하나” [Nak-Gyu Yang, “Why does the ROK military depend on U.S. Forces in biowarfare?”], 아시아경제 [Asia Gyungje], December 17, 2015.

weapons production facilities and stockpiles. The procedure for neutralizing any biological agents will depend in part on the state in which they are stored. The United States military has experience with assisting others in efforts to dismantle biological weapons program infrastructure. The U.S. Department of Defense Cooperative Threat Reduction (CTR) program effort in the former Soviet Union in 1991 is one such example.⁵⁰

Efforts to Close Procurement Channels: Despite the international community's efforts to stem North Korea's various illicit trade and money laundering activities, it continues to evade sanctions with "techniques that are increasing in scale, scope and sophistication."⁵¹ The international community should, therefore, increase its efforts to close off North Korea's illicit procurement channels, which may provide it with infrastructure, funds, and knowledge that enable it to advance its biological weapons program.

The international community should be cautious in providing scientific training to North Korea without mechanisms to conduct follow-up surveillance for potential misuse. For example, the Center for Agriculture and Biosciences International (CABI), an international non-profit agency that runs agricultural aid programs, established a facility in North Korea for producing *Bacillus thuringiensis* (Bt) as a bio-pesticide.⁵² This facility and the knowledge for Bt cultivation could be easily used to manufacture Bt's close relative *Bacillus anthracis* (anthrax). While bio-pesticide production is an appropriate goal for North Korea to achieve food security for its population, there should be policies in place to ensure that scientific knowledge and infrastructure provided by the international community under the intentions of aid are not misused for biological weapons production.

The international community should also prioritize better accounting of existing biological weapons to prevent stockpiles from falling into the wrong hands. A 2014 report from the U.S. Department of Homeland

50 U.S. Department of Defense, Defense Threat Reduction Agency and United States Strategic Command Center for Combating Weapons of Mass Destruction, "The Cooperative Biological Engagement Program Research Strategic Plan: Assessing Biological Threat Reduction Through Research," June 2015.

51 United Nations Security Council, "Report of the Panel of Experts established pursuant to resolution 1874 (2009)," S/2017/150, February 27, 2017.

52 Melissa Hanham, Op.cit.

Security revealed that 27 biological agents and toxins used in research in the U.S. - including *Bacillus anthracis* (anthrax), *Yersinia pestis* (the plague), and botulinum neurotoxin - were not properly registered with the Federal Select Agent Program.⁵³ Although these agents have since been secured, and the U.S. government is clearly taking these alarming gaps in inventory control with serious concern, it is worth noting that missing laboratory inventory could easily end up in the wrong hands.

Effective Communication Strategy Between Stakeholders: Effective communication between stakeholders including the ROK, the United States, and the public is lacking. The live anthrax incident at Osan Air Force base in 2015 demonstrates miscommunication between the South Korean and the U.S. governments, as well as poor communication to the public on the risk posed by these agents. The public ought to have been alerted of the import of biological agent samples and provided information on preparation efforts against biological threats. In fact, a large number of the Korean public wrongly perceived that the United States was unjustly conducting bio-hazardous activity on Korean soil, exploiting the alliance.⁵⁴

After the incident, the South Korean and U.S. governments increased their communication efforts by disclosing the *Able Response* exercise for the first time in September 2015. The South Korean public, however, is still averse even to the idea of having biological agent-related equipment on their soil. When it became public that the USFK is deploying the JUPITR biodefense equipment at the ports of Busan, there were public protests. For a more robust and effective preparation effort, the ROK and the U.S. government should effectively coordinate information-sharing, and communicate facts and risks accordingly to the public.

53 U.S. Department of Homeland Security, "Fact Sheet: Biosafety and Biosecurity in the United States," December 16, 2014.

54 최진성, "탄저균 실험 역풍, 광우병 이후 7년만에 반미감정 살아나나"[Jin-Sung Choi, "U.S. anthrax experiment backlashes as anti-American sentiment"], 헤럴드경제 [*Herald Gyungje*], December 18, 2015.

5. Proposals for Future Steps

Biological weapons policy and preparedness for BWs incidents have been undertaken by the United States, South Korea, and other members of the international community. More must be done, however, to enhance intelligence on this vital issue and to pursue non-military tracks to improve understanding, preparedness, deterrence in this area.

Intelligence Gathering and Validation of Sources

The international community, led by the United States, South Korea, and China, should invest in further efforts to gather intelligence on North Korea's biological weapons capability. This should be done at the governmental level as well as through open source research at the level of think-tanks, universities, and other research institutions. The North Korea security studies community has a strong precedent of analyzing open source information such as publicly released photos and video footage from North Korea and satellite images of industrial sites for the country's nuclear and missile programs. More must be done to cultivate intelligence on its biological weapons facilities.

Gathering Intelligence Online: Internet usage in North Korea has been increasing despite tight government control of access. In September 2016, an accident allowed worldwide access to all websites hosted on North Korean servers, revealing 28 websites.⁵⁵ Screenshots revealed that many of these sites were available in both Korean and English, and some in Russian, Mandarin, German, French, and Arabic, pointing to a possibility that their websites are accessed by non-Korean speakers. As more communication, both internal and external to North Korea, takes place on the web, there is potential to mine information from these websites. In particular, websites that are not indexed by search engines, referred to as the “deep web,” may hold valuable information.

55 Arjun Kharpal, “North Korea accidentally lets world access its internet and it only has 28 websites,” *CNBC*, September 21, 2016.

The continual growth of open source data on the internet provides a means by which North Korea could potentially acquire third-party knowledge relevant to developing internal BW capability. In turn, it also offers the potential to identify and monitor activities of organizations and individuals that may be engaging in biological research with North Korea. Emerging intelligence tools that mine the internet with data processing are making it possible to generate surveillance intelligence at a scale and speeds that have previously not been possible; one such example is AMPLYFI's artificial intelligence platform DataVoyant. Applying machine learning algorithms to analyze the deep web for key trends, people, and patterns, to assess whether any signal can be detected for associations between North Korea and biological weapons-related search terms could open new leads of information and investigation. Such tools can be used to monitor activity on North Korea hosted websites. To date, AMPLYFI has mined 840,000 websites that contain a curated list of pertinent biological search terms. Of these, they found 23,000 websites with weak associations to North Korea, 170 of which point to particular organizations and institutions. While it remains to be seen whether any meaningful signals exist after rigorous follow-up analyses to eliminate false positives, such new algorithms should be considered as an additional tool to strengthen surveillance and detect North Korea's biological activities.

Assessing North Korea's Research Interests: Similar to efforts for its nuclear weapons program, North Korea may seek training for its scientists abroad, particularly in Russia and China. Documentation of these international exchanges are not always publicly recorded and are thus difficult to access. North Korea's international research and training efforts, however, can be evaluated if they result in academic publications. UN member states are banned from providing BW development training to North Korean nationals as noted above. As part of this effort, it is important to monitor other biology-related training that North Korean nationals receive.

On January 25, 2016, North Korea acceded to the Svalbard Treaty, announcing through its state news agency, Korean Central News Agency (KCNA), that its accession provided North Korea “with an international legal guarantee for conducting economic activities and scientific researches

in the Svalbard Islands.”⁵⁶ The treaty affords parties equal rights to access the Norwegian islands for commercial, mining, and industrial purposes, including scientific research and the procurement of biological samples.⁵⁷ North Korea’s research participation in the Svalbard is worth monitoring for two reasons: to gain a better understanding of North Korean life science research capabilities, and to monitor specimens it procures from permafrost.

Few states maintain active economic and research activities on the islands. In 2015 and 2016, Chinese and North Korean academic scientists jointly published research undertaken in the Svalbard Islands: on the detection of novel bacterial species from permafrost.⁵⁸ These studies employed DNA sequencing to identify novel species of bacteria isolated from the tundra soil of Svalbard islands, resulting in new species of the *Hymenobacter*, *Terrimonas*, and *Roseomonas* genera. It is highly unlikely that the typing of these genomes will provide know-how for biological weapons development efforts. It is unclear whether North Korean scientists involved in these works were commissioned to do so from a high level within the North Korean government, or part of a basic science inquiry in conjunction with Chinese scientists, as studying organisms that live in extreme conditions is important for advancements in basic science and bio-technology. It is noteworthy, however, that North Korean scientists undertook these studies as the first authors, i.e. the lead scientist, given that its capacity and track record of conducting research internationally is limited.

56 “DPRK accedes to Svalbard Treaty,” KCNA Watch, January 30, 2016.

57 “The Svalbard Treaty,” University of Oslo Faculty Law, Accessed April 20, 2017.

58 Kim, Myong Chol, Songguk Rim, Sehong Pak, Lvzhi Ren, Yumin Zhang, Xulu Chang, Xuhuan Li, Chengxiang Fang, Congyi Zheng, Fang Peng, “*Roseomonas arcticisoli* sp. nov., isolated from Arctic tundra soil,” *International Journal of Systematic and Evolutionary Microbiology*, 66: 4057-4064, October 1, 2016; Kim, Myong Chol, Ok Chol Kang, Chol Myong Kim, Yumin Zhang, Zuobing Liu, Ziyang Wei, Yao Huang, Wangmu Danzeng, Fang Peng, “*Terrimonas crocea* sp. nov., isolated from the till of high Arctic glacier Midtre Lovénbreen in the West Svalbard Archipelago,” *International Journal of Systematic and Evolutionary Microbiology*, 67: 868-874, May 5, 2017.; “*Hymenobacter rutilus* sp. nov., isolated from marine sediment in Arctic,” *International Journal of Systematic and Evolutionary Microbiology*, 67: 856-861, May 5, 2017.

Improving Nonproliferation Policy

The international community should improve policy to cut off dual-use supply chains to North Korea. The 1540 Committee, established pursuant to Security Council Resolution 1540 (2004) to prevent the proliferation of nuclear, chemical, and biological weapons, maintains frameworks for assessing these efforts and conducts an annual review. The Committee's implementation matrix for UN member states is designed to facilitate assistance to states and act as a tool to enhance dialogue among member states on implementation. In 2016, the Committee reported increased adherence to the terms of UNSCR 1540 pertaining to states' obligations in biological weapons amounting to a 62 per cent overall implementation rate.⁵⁹

These efforts, however, are targeted more towards preventing non-state actors from producing or procuring biological weapons, and less focused on trans-shipment issues and limiting access of states like North Korea to dual-use materials. Improving national export control lists is one such effort that stands to stem proliferation of BW dual-use items to both North Korea and non-state actors of concern. The Committee noted that the overall number of states that maintain control lists pertaining specifically to biological weapons has increased to 77 since its last count.

Engaging North Korea through Multilateral Global Health Efforts

The United States and South Korea should use existing frameworks to engage North Korea in dialogue regarding its illegal biological weapons program. The United States, South Korea, and other international partners maintained a dedicated effort for advancing negotiations on the North Korean nuclear program throughout the 1990s and 2000s, but have made little progress on such negotiations for the last half-decade. These negotiations have not extended to North Korea's biological weapons capability.

⁵⁹ United Nations Security Council, "Report of the Security Council Committee established pursuant to resolution 1540 (2004)," S/2016/1038, December 9, 2016. According to this report, the Department of Defense removed smallpox vaccination as a mandatory requirement for the U.S. Central Command, and removed anthrax and smallpox vaccination as a mandatory requirement for the U.S. Africa Command in 2014 and 2013 respectively.

The new presidential administrations inaugurated in the United States and South Korea in 2017 may choose to prioritize WMD talks with North Korea, but it is too early to assess their policies.

A path forward outside of the traditional negotiation pathway includes engaging North Korea through “softer” issues of public health, agricultural health, or laboratory safety. The goal of these fora would be to improve public health and safety around biological sciences that will have positive impact on North Korean citizens, and to improve information sharing about the current state of standards in North Korea.

The Global Health Security Agenda (GHSA), a multilateral effort launched in 2014, may provide one avenue through which to engage North Korea on issues tangential to its biological weapons program. The GHSA is a voluntary partnership of more than 50 states and non-governmental organizations that engages in “capacity-building efforts to achieve specific and measurable targets around biological threats.”⁶⁰ North Korea’s health infrastructure stands to benefit from improvements included in the GHSA’s expert-developed “Action Packages,” including those for bio-safety and bio-security, or the national laboratory system package.

Engagement in these health or agricultural fora present opportunities to build relationships between negotiators and representatives from respective parties, and offer a chance to glean information about North Korea’s biological weapons program.

Increase Interdisciplinary Exchange

As part of the preparedness effort against pandemics and bioweapons, it is important to continually engage scientists and healthcare workers. While there is no evidence that North Korea is genetically modifying biological agents for weaponization,⁶¹ the ease in genome engineering thanks to new tools such as CRISPR warrants new frameworks for monitoring in

60 “About,” Global Health Security Agenda, Accessed May 7, 2017.

61 Expert interview provided to MTM.

the future. Currently, senior level scientists in synthetic biology and epidemiology in the United States have been part of national committees on biosecurity. It is important to continue such engagement with the scientific community to ensure that governments are up-to-date and informed about the latest tools for effective response, should North Korea's bioweapons program advance to a new level of sophistication.⁶²

Additionally, unless North Korea makes an explicit announcement, the first signs of a BW attack will likely be encountered by a nurse or a physician, as pathogens typically require several days of incubation before the onset of symptoms. As the expectation of a BW attack is very low by healthcare workers, misdiagnosis is highly possible. Healthcare providers, particularly those in primary care and infectious disease in select geographical locations, should be regularly engaged by government officials and trained to detect and treat these rare disease scenarios.⁶³

Improve “Dual-Response” Health Preparedness Effort Against Pandemics and BWs

Investing resources to strengthen health systems will mitigate against the risk posed by North Korea's BW program as well as against natural infectious disease outbreaks, which we label as “dual-response.” Preparedness efforts should be undertaken even if the international community makes incremental progress on engaging North Korea on this issue.

One such measure is improving continually-deployed and nationally-funded surveillance technology in South Korea along the border, at border crossings, and in major cities to detect pathogens and BWs in the atmosphere. Systems that conduct environmental sampling or “sniff” the air for aerosolized biological agents are examples. Another example is deploying technologies that detect water-viable BW agents and harmful toxins for screening water supplies in major cities and near U.S. military

62 Expert interview provided to MTM.

63 David R. Franz, et al., “Special Communications: Clinical Recognition and Management of Patients Exposed to Biological Warfare Agents,” *JAMA*, August 6, 1997.

bases, which are likely targets for North Korean biological operations. These systems can be built into South Korea's existing efforts in environmental surveillance, including air pollution monitoring and water quality control. Such systems may also be designed to detect chemical weapons.

When the MERS epidemic spread through major South Korean cities in 2015, the country implemented screening of commuters at transportation hubs such as intercity bus terminals, visually inspecting passengers as they disembarked. Screening at airports, bus terminals, and train stations may be useful to monitor for human vectors of biological weapons once knowledge of an imminent attack is known; however, this approach would be cost-ineffective, and it may not be useful in catching the initial infected person(s). Unless law enforcement agencies have additional intelligence to indicate an impending biological weapons attack, these screening mechanisms may be useful to mitigate spread of a suspicious infectious disease.

Increase the Effectiveness and Transparency of Risk Communication

As seen in the live anthrax import incident in 2015 and the controversy around the USFK's deployment of the JUPITR program, preparation efforts against BW would not be fully effective without the understanding and approval of the general public. It is important to communicate the risk and needs for preparation measures against North Korea's potential BWs more effectively to the public. The ROK and the United States should design their risk communication with the "Comprehensive Risk Management Framework" in mind, establishing strategies appropriate to each phase of management: prevention, protection, response, recovery, and resilience.⁶⁴

Notwithstanding the sensitive nature around North Korea's BW program and preparation efforts, government agencies should include discussions on effective communication strategies when they are making decisions that affect the health and safety concerns of the general public at the prevention

64 Herman B. "Dutch" Leonard and Arnold M. Howitt, "Acting in Time Against Disaster: A Comprehensive Risk Management Framework," Chapter 2 in *Learning from Catastrophes: Strategies for Reaction and Response*, edited by Howard Kunreuther and Michael Useem, p.18–41, Wharton School Publishing, 2009.

stage. In order for the ROK government to effectively communicate with the public, the United States should also maintain transparency regarding its preparedness efforts on the Korean Peninsula with the Korean people.

6. Conclusion

Decades of open source information affirm that North Korea has held an interest in developing a bioweapons program. Although the lack of recent and reliable public information prevents a comprehensive assessment of its current capability, threats posed by North Korea's biological weapons program must be considered a realistic proposition and addressed by the international community. Several reports have construed the types of biological agents North Korea may possess, the state of weaponization of these agents, and the means through which North Korea might deliver them. Efforts to counter and neutralize North Korea's BW threats should be led by South Korea and the United States. Strategies for counter-measures should include military and "dual-response" public health preparations, as well as formal and informal efforts to engage North Korea in biological fields. Overall, the goal of the international community should be to simultaneously gather more information about North Korea's BW capability and reduce this threat posed by North Korea. It should not be comforted by the scarcity of information on the program, but should instead redouble efforts to better understand the threat and prepare to respond to it.

Appendix

Description of North Korea's BW Program in the ROK Defense White Papers

Year	Description of North Korea's BW Program
2016	It appears that the North can independently cultivate and produce such biological weapons as the bacteria of anthrax, smallpox and pest.
2014	It appears that North Korea is also capable of cultivating various types of biological agents such as anthrax, smallpox, and pest on its own and producing them into biological weapons.
2012	North Korea likely has the capability to produce a variety of biological weapons including anthrax, smallpox, pest, francisella tularensis, and hemorrhagic fever virus.
2010	The North is also suspected of maintaining numerous facilities for cultivating and producing the bacteria of anthrax and other forms of biological weapons.
2008	The North is also suspected of being able to independently cultivate and produce such biological weapons as the bacteria of anthrax, smallpox and cholera.
2006	North Korea is able to produce biological weapons such as the bacteria of anthrax, smallpox, and cholera.
2004	The North is suspected of being able to independently cultivate and produce such biological weapons as the bacteria of anthrax, smallpox and cholera.
2000	The North is also suspected of maintaining numerous facilities for cultivating and producing the bacteria of anthrax and other forms of biological weapons.

Description of North Korea's BW Program in U.S. intelligence reports

Year	Description of North Korea's BW Program
2017	<i>No mention of North Korea's BW Program.</i>
2016	<i>No mention of North Korea's BW Program.</i>
2015	<i>No mention of North Korea's BW Program.</i>
2014	<i>No mention of North Korea's BW Program.</i>
2013	<i>No mention of North Korea's BW Program.</i>
2012	North Korea has a biotechnology infrastructure that could support the production of various BW agents. We judge that North Korea possesses a conventional munitions production infrastructure that could be used to weaponize BW agents.
2011	North Korea has a biotechnology infrastructure that could support the production of various BW agents. We judge that North Korea possesses a conventional munitions production infrastructure that could be used to weaponize BW agents.
2010	North Korea has a biotechnology infrastructure that could support the production of various BW agents. We judge that North Korea possesses a conventional munitions production infrastructure that could be used to weaponize BW agents.
2009	North Korea has a biotechnology infrastructure that could support the production of various BW agents. We judge that North Korea possesses a conventional munitions production infrastructure that could be used to weaponize BW agents.
2008	North Korea has a rudimentary biotechnology infrastructure that could support the production of various biological warfare agents. We judge that North Korea possesses a conventional munitions production infrastructure that could be used to weaponize BW agents.
2007	North Korea has a rudimentary biotechnology infrastructure that could support the production of various biological warfare agents: We judge that North Korea possesses a conventional munitions production infrastructure that could be used to weaponize BW agents.
2006	Pyongyang's resources presently include a rudimentary biotechnology infrastructure. North Korea has the scientists and facilities for producing biological products and microorganisms, and has the ability to produce traditional infectious BW agents or toxins. North Korea produces conventional munitions that could be used to deliver BW agents. In 2005, North Korea requested, but was subsequently denied, a preventive vaccine manufacturing facility from South Korea.
2005	North Korea has the scientists and facilities for producing biological products and microorganisms, and has the ability to produce traditional infectious biological warfare agents or toxins. Pyongyang's resources presently include a rudimentary biotechnology infrastructure. In 2004, Pyongyang acquired dual-use bio-technical equipment, supplies, and reagents that could be used to support a BW program. North Korea possesses a conventional munitions production infrastructure that could be used to weaponize BW agents.

For years 2005 to 2012, the citation is from the “Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions,” also known as “721 Reports.” This report was discontinued as of 2012. For subsequent years, the citation is from the Director of National Intelligence’s “Statement for the Record Worldwide Threat Assessment of the US Intelligence Community.”

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