Testimony

The Challenge of North Korean Biological Weapons

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Chairman Thornberry, Ranking Member Langevin, and members of the Subcommittee, thank you for inviting me to testify at this hearing, "Biodefense: Worldwide Threats and Countermeasure Efforts for the Department of Defense." While there is evidence of North Korean biological weapons, little is known with certainty about the biological weapon agents the North has developed, which of these agents it has weaponized, and how it would use them. Still, North Korean biological weapons could pose a fearsome threat to the Republic of Korea (ROK) and even the United States, and the ROK and the United States need to be prepared for that threat to be carried out.

This testimony addresses the nature of the potential North Korean biological weapon threat and how the ROK and United States should prepare to counter potential biological weapon attacks. It discusses the biological agents that North Korea may have pursued, how those agents could be spread, and the potential damage that biological weapon attacks could cause. It then describes options for countering biological weapon attacks, from interdicting such attacks to detecting them and treating the affected people. Some of these counters have been fielded, supporting deterrence of a North Korean biological weapon attack. But more effort is warranted in these areas in order to avert the effects North Korea could cause and thereby strengthen deterrence of a North Korean biological weapon attack.

North Korean Biological Weapons

North Korea has been very effective in denying the world information about its biological weapon programs. North Korea practices such information denial across almost all of its military

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activities.[3] Biological weapon programs are easier to hide than most military programs because they can be developed in a university setting or hidden within efforts to develop related vaccines. As a result, the outside world has little direct information on North Korean biological weapons and therefore has mainly indirect inferences, creating substantial uncertainties.

Information Available About North Korean Biological Weapons

Among the evidence available, several observations stand out. The first, from a Republic of Korea Ministry of Defense White paper, traces the initiative for North Korean biological weapons development back to the 1980s.

> "In the 1980s, the military turned to the development of biological weapons according to Kim Il-sung's directive that 'poisonous gas and bacteria can be used effectively in war.' … The North is also suspected of maintaining numerous facilities for cultivating and producing the bacteria of anthrax and other forms of biological weapons."[4]

A second observation comes from a Russian intelligence report from the early 1990's.

> "In 1993, the Russian Foreign Intelligence Service, successor to the Soviet Union's KGB, released a statement that said, in part: 'North Korea is performing applied military-biological research in a whole number of universities, medical institutes and specialized research institutes. Work is being performed in these research centers with inducers of malignant anthrax, cholera, bubonic plague and smallpox. Biological weapons are being tested on the island territories belonging to the DPRK (Democratic Peoples Republic of Korea).' Mr. Gordon Oehler, director of the CIA's [Central Intelligence Agency's] Non-Proliferation Center, confirmed this Russian report."[5]

And a third open-source reference cites reports from North Korean defectors over the past decade.

> "Sporadic reports by defectors during 2003–2004 and 2009 state that the DPRK has conducted testing of biological agents on political prisoners. For example, '...tests are conducted on political prisoners by the College for Army Doctor and Military Officers and Kim Il-sung University Medical College.' While these reports present numerous details, they are extremely difficult to confirm. They do, however, conform to older reports of this nature that have occasionally appeared since the late 1970s. Taken as a whole, and within the context of what is currently known about the treatment of political prisoners within the DPRK, such

[3] "The DPRK [Democratic People's Republic of Korea] is the most closed and security-conscious society in the world. This situation has developed since the earliest days of Kim Il-sung's rule as a means of isolating and eliminating potential internal threats, controlling society and limiting foreign intelligence collection. The KWP [Korean Workers' Party] and National Defence Commission, through a host of overlapping organisations and security agencies, maintain near-absolute control over its citizens and soldiers and the information to which they have access." "North Korea: Strategic Weapons Systems," *Jane's Sentinel Security Assessment* - China and Northeast Asia, July 7, 2011.

[4] The Republic of Korea Ministry of National Defense, *Defense White Paper, 2000*, p. 58.

[5] Frederick R. Sidell, et al., *Medical Aspects of Chemical and Biological Warfare*, 1997, pp. 461–462, available at http://www.bordeninstitute.army.mil/published_volumes/chemBio/ch21.pdf (accessed on Oct. 23, 2009). This document cited the original source as: J. Fialka "CIA says North Korea appears active in biological, nuclear arms," *Wall Street Journal.* Feb 25, 1993, p. A-10.

> reports suggest a long-standing DPRK policy of low-level lethal testing of biological agents on unwilling human subjects."[6]

Other suspicions grow out of the North Korean vaccine programs:

> "During the past ten years DPRK scientists and researchers have engaged in research to produce vaccines and diagnostic test kits for avian flu, Severe Acute Respiratory Syndrome (SARS) and anthrax. In 2004 scientists and researchers from the Central Hygiene Center, Ministry of Health, produced a[n] anthrax rapid diagnostic kit. Such research is not only valuable for defensive biological warfare but could be directly applicable to offensive operations."[7]

Since anthrax is not a major health concern in North Korea, one must wonder, in particular, about the motivation behind the North Korean anthrax defensive programs.

As another example, Korean Hemorrhagic Fever (also called Hemorrhagic Fever with Renal Syndrome, or HFRS) is endemic to North and South Korea. Anxious to reduce the impact of this disease, Dr. H. W. Lee of South Korea developed a "human inactivated" virus vaccine for Korean Hemorrhagic Fever.[8] More than 20 years ago, Dr. Lee reported that the North Koreans developed a similar vaccine, which in 1990 had already been given to 30,000 people.[9] Since North Korea rarely provides antibiotics for most public health challenges, the development of this vaccine suggests a possible military interest in its availability.

Likely North Korean Biological Agents

The many biological agents that North Korea apparently has been or could be developing are listed in Table 1. This table shows the type of each biologic agent, its potential lethality, the number of cases reported in Korea and the United States in recent years, and references (if any) that identify these agents as part of the North Korean biological weapon program.

It is important to note that the initial detectability of an attack varies by biological agent. With diseases like malaria, Korean Hemorrhagic Fever, and especially tuberculosis, the initial number of cases resulting from a biological weapon attack might not differ from the number of naturally occurring cases enough to cause doctors or other health care professionals to recognize that an attack has occurred. It may take many hours or longer before it is clear that a disease outbreak is not a natural occurrence.

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[6] "North Korea: Strategic Weapons Systems," *Jane's Sentinel Security Assessment* - China and Northeast Asia, July 7, 2011.

[7] *Ibid.*

[8] H. W. Lee, *et al.*, "Field trial of an inactivated vaccine against hemorrhagic fever with renal syndrome in humans," *Archives of Virology*, Supplement 1, 1990, pp. 35–47.

[9] *Ibid.*, p. 46.

There has been widespread discussion of North Korea developing anthrax as a biological agent, as well as many references to it developing cholera, plague, and smallpox. For example, speaking of the smallpox virus, Dr. Ken Alibek, a former senior scientist in the Soviet biological weapon program, has said:

> "I'm 100% sure North Korea still has this virus. Even in the late 80s, we had some information obtained from Soviet intelligence service that North Korea was developing biological weapons, involving anthrax, plague, smallpox and several others."[13]

Potential North Korean Uses of Biological Weapons

The Republic of Korea Ministry of Defense asserts that "[t]he North may also dare to launch a secret attack in the rear through its SOF [special operations forces] troops armed with biological weapons."[14] Even a kilogram of many types of biological weapons could disrupt most military targets if delivered properly,[15] and this quantity could easily be delivered by special operations forces. Missiles and aircraft could also deliver this quantity of biological weapons.[16]

Indeed, North Korea special forces are a likely means for delivering North Korean biological weapons. North Korea has some 200,000 special forces,[17] a small fraction of which could deliver devastating biological attacks against South Korea, Japan, and even the United States.[18] North Korea could use biological agents in isolation, perhaps as an escalated provocation in which it seeks to infect a limited number of people, or it could use biological agents as the leading edge of an invasion of the ROK, hoping for thousands or even more infections to weaken the ROK's defenses and will to fight. Biological weapon use in the latter context is particularly worrisome.

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[13] "Interview —Dr. Ken Alibek," Homeland Defense, September 28, 2000.

[14] The Republic of Korea Ministry of National Defense, *op. cit.*

[15] As will be discussed below, 1 kilogram of anthrax would potentially infect people in a 2.6 square kilometer area.

[16] For example, the AN-2 aircraft North Korea would use for delivering special forces into the ROK are difficult to intercept, and could carry biological weapon sprayers in addition to special forces.

[17] The Republic of Korea Ministry of National Defense, *2012 Defense White Paper,* p. 31.

[18] North Korean special forces could bring biological agents into the United States covertly, long before an attack. They could also infect the noncombatants leaving Korea with contagious biological agents, causing disease to emerge, after incubation, in the United States.

Table 1
Potential North Korean Biological Agents

BW Agent	Type of Agent	Untreated Lethality	Korean Cases 2010*	Korean Cases 2011*	U.S. Cases 2011**	NK BW Source[19]
Anthrax	Bacteria	High	0	0	1	KRIS, USFK, Alibek, WP
Botulinum	Toxin	High	0	1	153	USFK
Brucellosis	Bacteria	<5%	31	19	79	KRIS
Cholera	Bacteria	50+%	8	3	40	KRIS, USFK
Dengue fever	Virus	1%[a]	125	72	3	—
Diphtheria	Bacteria	5–10%	0	0	?	KRIS
Dysentery	Bacteria	Low	?	?	?	KRIS
E. coli	Bacteria	3-5%[a]	56	71	2,575	—
Hemorrhagic fever (HFRS)	Virus	5–15%	473	370	23	KRIS, USFK, Alibek, WP
Hepatitis	Virus	Low	?	7,247[c]	4,301[c]	KRIS
Japan. Encep.	Virus	≤60%	26	3	?	—
Malaria	Parasite	Low	1,772	838	1,724	—
Pertussis	Bacteria[b]	Low[a]	27	97	18,719	—
Pnm. plague	Bacteria[b]	High	0	0	3	KRIS, USFK, Alibek, WP
Q Fever	Bacteria	Low	13	8	134	—
Smallpox	Virus[b]	20–40%	0	0	0	USFK, Alibek, WP
Tuberculosis	Bacteria[b]	High	36,305	39,557	10,528	KRIS
Tularemia	Bacteria	Moderate	0	0	166	KRIS, WP
Typhoid fever	Bacteria	Moderate	133	148	390	KRIS, USFK
Typhus	Rickettsia	Moderate	54	23	?	KRIS
Yellow fever	Virus	Moderate	0	0	0	Alibek, USFK

[a] With treatment
[b] Contagious
[c] Hepatitis A and B
* Data from the Korea Centers for Disease Control and Prevention (KCDC): http://www.ksid.or.kr/admin/mail/download.php?num=69
** Data from the U.S. Centers for Disease Control and Prevention (CDC): http://www.cdc.gov/mmwr/PDF/wk/mm6053.pdf; typhus is not reported.

[19] Sources: USFK = General Leon J. LaPorte, "Statement before the Senate Armed Services Committee," April 1, 2004; KRIS = *The Strategic Balance in Northeast Asia, 2003*, Korea Research Institute for Strategy (KRIS), December 2003, p. 363; Alibek = "Interview—Dr. Ken Alibek," Homeland Defense, September 28, 2000 and "Biological War: Are We Prepared? Dr.'s Q&A," Ivanhoe Broadcast News, October 2001 (http://search.ivanhoe.com/archives/ p_archive.cfm?storyid=1437& channelid=CHAN-100021); WP = The Republic of Korea Ministry of National Defense, *2012 Defense White Paper,* p. 36.

The Potential Effects of North Korean Biological Weapons

The People Infected. North Korea could use biological weapons against a variety of military and civilian targets in South Korea. Biological weapons would likely be delivered as an aerosol of some kind that would be dispersed and then carried by the wind. Many people downwind of the release location would be exposed unless they wore some form of protection or were physically located in a place that protected them from exposure. This is particularly true if the attacker creates a line source by spraying, for example, the BW agent while driving along a road perpendicular to the wind. According to one source, 1 kilogram of anthrax could spread lethal effects over 0.2 to 2.6 square kilometers, depending on wind and weather conditions.[20] The nighttime population density of Seoul averages about 20,000 people per square kilometer, meaning that upward of about 50,000 people could be effectively exposed by 1 kilogram of anthrax. But in conditions less favorable to the attacker, including poor atmospheric conditions and many people living in high-rise buildings that lack central heating and ventilation, as few as 2,000 people might be effectively exposed by 1 kilogram of anthrax. Multiple attacks could increase these results.

Contagious Agent Infections. A key agent characteristic is whether the agent is contagious, as in the cases of plague and smallpox. These diseases may affect not only those exposed by an initial North Korean attack, but those who become sick by being infected by others. The ability to spread a contagious disease is reflected in the term R_o, which represents the average number of people who are infected by each person having the disease. The R_o for smallpox is estimated as 5 to 7.[21] For example, with an R_o of 6, if 1,000 people initially became sick from a smallpox attack, they could infect 6,000 others, and those 6,000 could infect 36,000, and so forth—the secondary and tertiary infections would, of course, occur over time. But if the R_o were 15 (true for diseases like Pertussis and measles), a first generation of 1,000 cases could swell to 15,000 cases in the second generation and to 225,000 cases in the third generation in a heavily populated area unless there was an intervention in the form of treatment, vaccination, isolation of the infected, or quarantine.

Physical Effects After Infection. As the result of an anthrax attack, some of those exposed would develop inhalation anthrax (quite deadly), and some would develop cutaneous (through the skin) anthrax (less deadly). By three or four days after the attack, many people would be sick, and

[20] Steve Fetter, "Ballistic Missiles and Weapons of Mass Destruction," *International Security*, Summer 1991, pp. 25–26.

[21] See W. Orenstein, Director of the National Immunization Program, "Introduction to Smallpox," briefing for the Centers for Disease Control. Available at http://www.bt.cdc.gov/agent/smallpox/overview/intro-to-smallpox.pdf.

some of those sick would be dying. By day 10, roughly 60 percent of those exposed would be dead unless effectively treated with antibiotics. Even if treated with antibiotics, many of the survivors of an anthrax attack could suffer debilitating chronic illness. A study done at the end of 2002 examined 15 of the 16 victims of the anthrax letters mailed in 2001. The study found:

> "…that the infected adults experienced physical ills, psychological distress and a reduced quality of life. They had chronic coughs, fatigue, joint swelling and pain and memory loss, and suffered from depression, anxiety, obsessive-compulsive disorders and displays of hostility, researchers found. Survivors who had inhaled anthrax suffered worse health problems than those who became ill through skin contact with the biological agent. Eight of the study participants had not returned to work by December 2002, more than a year after anthrax was delivered by mail to Washington, New York and other areas…."[22]

Protracted Incapacitation. In the 1960s, the U.S. offensive biological weapons program pursued nonlethal, incapacitating agents. The U.S. program reportedly focused on a cocktail of SEB, VEE, and Q-Fever,[23] each having different incubation and effects periods. This cocktail would have led to the SEB toxin affecting people in roughly 3 to 12 hours and incapacitating them for a week or so.[24] Before the SEB effects would fully wear off, VEE would make people sick, and as the VEE effects wore off, Q-Fever would make people sick. The illness from each of these diseases can be incapacitating, keeping many people from performing their missions for a month or more, though relatively few people would die.

Other Effects. While the casualties caused by biological weapons are a concern, biological weapons would have many other effects. These include:

- **Loss of facilities.** In the aftermath of the 2001 anthrax letters, it took months to several years to fully decontaminate the facilities where anthrax had been spread, and those facilities were not used until decontamination was completed. Most biological weapons decay within hours to days of their release, but some, like anthrax, can persist indefinitely.

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[22] Only five of the 16 survivors had inhalation anthrax. Chris Schneidmiller, "Anthrax Survivors Suffered Long-Term Effects, Study Finds," Global Security Newswire, April 28, 2004.

[23] Judith Miller, Stephen Engelberg, and William Broad, *Germs: Biological Weapons and Americas Secret War*, (New York: Simon and Schuster), 2001, pp. 56–57.

[24] Some in the infectious disease community debate the ability of SEB to incapacitate for very long. The US military's official reference book says: "Although an aerosolized SEB toxin weapon would not likely produce significant mortality, it could render 80 percent or more of exposed personnel clinically ill and unable to perform their mission for 1-2 weeks." *USAMRIID's Medical Management of Biological Casualties Handbook*, USAMRIID, 5th Edition, August 2004, p. 93.

- **Medical care.** A large number of persons sick from biological weapons could overwhelm the medical care system. In addition, many people who were not sick would be diverted from their normal activities to help sick family members or friends obtain medical care. And there is a tendency of uninfected persons to perceive that they have been infected, constituting a so-called "worried well" population. In the aftermath of the terrorist use of the chemical weapon Sarin in Tokyo in 1995, the number of "worried well" people who sought hospital care (many because of acute anxiety that caused physical symptoms) was three times the number of people who actually had physical symptoms of chemical exposure.[25]

- **Biological weapon protection.** Once the symptoms of biological weapons began to develop somewhere, people throughout the area would seek protective measures. With biological weapons, that would imply the use of at least a surgical mask, though P-95 respirators would provide better protection against biological weapons. These protective measures would impose some degree of degradation in people's actions, especially as they avoid physical activities that could break the seal on their masks.
- **Psychological reactions.** Biological weapon use would cause severe psychological reactions in some percentage of the population in addition to the "worried well" problem. For example, during the 1994 natural plague outbreak in Surat, India, some 600,000 people fled the city in one night, responding to 5,000 reported plague cases, of which only 167 cases were confirmed.[26]

Societal Effects in the ROK. Biological weapons can cause these and other strategic impacts, as illustrated in Figure 1. Thus the civilian casualties and loss of infrastructure from biological contamination could significantly impact a nation's economy. Especially if contagious biological weapons were used, many trading partners would refuse to send their goods to the affected country and more likely would not accept goods from the affected country, fearing that the goods could be contaminated. There would also be the fear of new biological weapon attacks, particularly against those countries "helping" the country that was initially attacked. The country affected by biological weapons could also suffer international isolation. For example, during the 1972 outbreak of smallpox in Kosovo, neighboring nations closed their borders with Yugoslavia.[27] There could also be second- and third-order effects if health care and other resources were

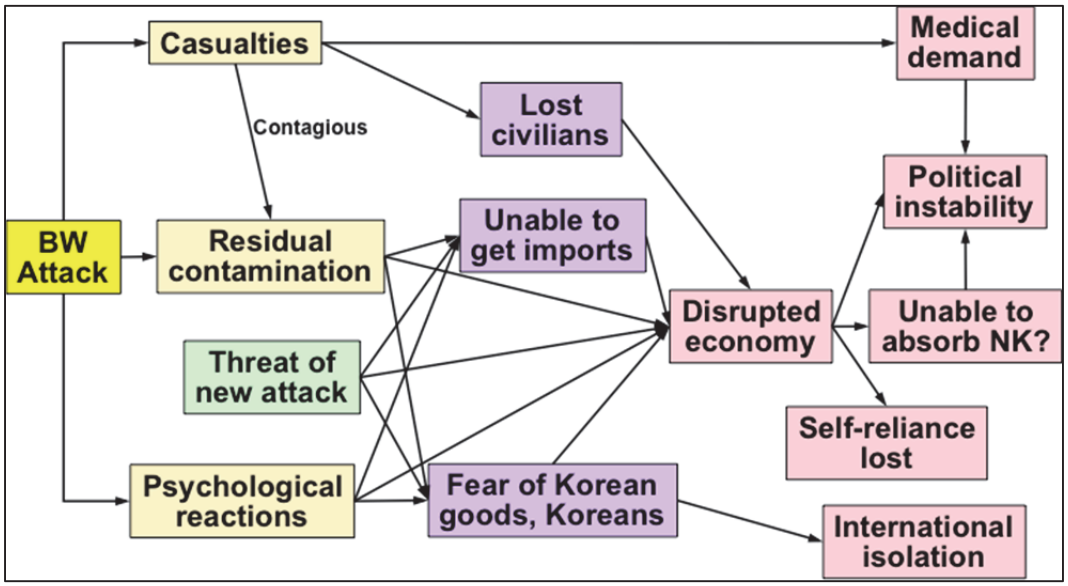
[25] Rosalee Meyer, *The Psychological Effects of a Chemical Attack on Military and Civilian Personnel*, Battelle Memorial Institute, January 2003, section 3.2.3.

[26] V. Ramalingaswami, "Psychosocial Effects of the 1994 Plague Outbreak in Surat, India," *Military Medicine*, Vol. 166, Supplement 2, December 2001, pp. 29–30.

[27] D.A. Henderson, "Bioterrorism as a Public Health Threat," *Emerging Infectious Diseases*, Vol. 4, No. 3, July–September 1998, p. 490, at http://wwwnc.cdc.gov/eid/article/4/3/pdfs/98-0340.pdf.

insufficient to meet demands. Much of the military could be diverted to sustaining internal order and/or imposing quarantine and vaccination requirements.[28] In Korea's case, the ROK could even find itself unable to carry out a counteroffensive into North Korea or to deal with a failed government in North Korea, being fully absorbed with internal problems and losing the economic resources to cover the costs of unification.

Figure 1
Potential Strategic Impacts of Biological Weapon Use



To illustrate the potential challenges, consider the terrorist attacks on the United States that occurred on September 11, 2001. In those attacks, the United States lost less than 0.002 percent of its population, but various estimates put the loss of gross domestic product that year due to the attack in the 1 to 5 percent range. If the economic impact of such events can be hundreds of times the casualty percentage impact, consider the implications of biological attacks that would affect, say, 100,000 people in the ROK, or about 0.2% of the population.

[28] After an outbreak of smallpox in Kosovo in 1972, "Health authorities launched a nationwide vaccination campaign. Mass vaccination clinics were held, and checkpoints along roads were established to examine vaccination certificates. Twenty million persons were vaccinated. Hotels and residential apartments were taken over, cordoned off by the military, and all known contacts of cases were forced into these centers under military guard. Some 10,000 persons spent 2 weeks or more in isolation." In that outbreak, there were a total of 175 cases of smallpox. *Ibid*.

Preparing for and Responding to Biological Weapon Attacks

North Korea's apparent development and testing of biological weapons on certain members of its own population suggests that the ROK needs to be prepared for North Korean biological weapon use against the ROK. Indeed, while there have been no proven North Korean uses of BW against the ROK, North Korea may have experimented with small amounts of endemic biological agents, like dysentery, to assess the ROK's ability to detect biological agents use and manage the consequences of that use.[29] It is clearly important to identify the means for countering North Korean biological weapon use.

There are many ways to respond to the North Korean biological weapon threat. At the strategic level, it is best to deter North Korean biological weapon use. But deterrence rests squarely on being able to deny North Korea the effective use of biological weapons. Denial capabilities also provide the means to defeat biological weapon use. The plan for defeating North Korean biological weapons must focus on preventing the delivery of biological weapons against the ROK, detecting the presence of biological weapon agents or disease, preventing exposure to biological weapons, preparing people physiologically to prevent biological weapon infection, and handling the consequences of biological weapon use.[30]

Preventing the Delivery of Biological Weapons. North Korea may attempt to deliver biological weapons in a number of ways. The ROK must be prepared to intercept each of these delivery methods. A failure to protect against any option makes North Korean use of that option more likely. The first step in interception is to detect any delivery systems carrying biological weapons, followed by efforts to intercept those delivery means.

North Korean use of special forces to deliver biological weapons seems most likely.[31] The technology involved is fairly simple, and North Korea has a large number of special forces who would want such empowerment. The special forces would seek to covertly deliver biological weapons against the ROK before the start of a conflict, making their actions difficult to detect. One intercept opportunity is at the ROK border, where ROK immigration should be connected to

[29] This point was suggested by a senior ROK military officer several years ago.

[30] In theory, the ROK could also destroy the North Korean biological weapons in their storage sites or other areas in North Korea before the weapons are used. But such efforts are beyond the scope of my testimony today.

[31] The North Korean military culture is important to understand. The founder of North Korea, Kim Il-Song, felt he had served as a special forces operator against the Japanese. He thus gave priority to special forces capabilities, as did his son, Kim Jong-Il. Biological weapons would significantly empower special forces, consistent with this culture.

the passport databases of its Asian neighbors and able to identify a falsified passport (since North Korean special forces are unlikely to enter the ROK on North Korean passports).

Inside the ROK, organizations that have the ability to spray in broad areas (such as crop dusters or commercial pest control organizations) should be periodically examined to discern any connections to North Korean culture or groups. Suspicious behavior such as spraying outside of normal seasons or in unexpected areas should be investigated.

It would be relatively easy to detect North Korean military aircraft or missiles that might be carrying biological weapons. The interception of aircraft would be easier than the interception of missiles. When possible, the ROK and/or the United States should destroy the North Korean delivery means over North Korean territory, as some of the biological weapons would likely survive interception and reach the earth's surface.

Detecting the Presence of Biological Weapon Agents or Disease. Protections against biological weapon agents are difficult and expensive to sustain; they are usually relaxed when an immediate threat is not perceived. Detecting the presence of a biological weapon agent is therefore critical to significantly enhancing the level of protection in a timely manner. Identification of the agent's use is also critical to appropriately treating those infected.

Detection can be done in several ways. First, a biological weapon agent can be detected by sampling the environment, including air, water, and food. Because U.S. military facilities, including those in Korea, would be likely targets of biological weapon attacks[32] if North Korea was preparing for a major war, air sampling is done continuously around some bases with a system called portal shield, which can provide warning of a biological weapon attack. The ROK also has means for detecting biological weapon attacks.

An alternative detection approach is disease surveillance. Typically performed in a hospital setting, this procedure is applied to people with flu-like symptoms to determine what disease they have contracted. If the disease is determined to be a potential biological weapon agent, detection provides warning unless the disease is endemic to that area, in which case local health authorities must look for other cases to determine whether the disease development is normal or reflects an unusual pattern that could have resulted from a biological attack. The ROK and U.S. authorities in Korea have developed good, well-coordinated disease surveillance.

[32] For example, North Korea cannot defeat US/ROK combat aircraft in the air. The North must instead attack them on the ground, and biological weapons would give them an option for doing so.

Preventing Exposure to Biological Weapons. There are various ways to prevent exposure to biological weapons once they have been used. One primary approach is to stop the movement into or out of areas where BW contamination is known to exist. Another approach used after the 2001 anthrax letter attacks involved closing the buildings where exposure occurred until they could be decontaminated.

Because many biological agents decay rapidly, decontamination will not be required after all biological weapon attacks. But with diseases like anthrax, decontamination is required due to the length of time that the agent can survive and remain a threat. Decontamination of most biological agents can be done with anything that kills biological agents, though with spores like anthrax, a more complex decontamination protocol is required. The ROK and the United States can likely handle selective decontamination in the ROK but would have problems handling many buildings or large areas.

With contagious diseases, exposure can be prevented in various ways, as illustrated by the 1972 smallpox outbreak in Yugoslavia. Neighboring countries closed their borders with Yugoslavia until the spread of the disease was under control. Also, schools can be closed and public activities suspended.[33] Those infected with a contagious disease should be physically isolated from healthy people as long as they are contagious. And those who may have had contact with the infected can be put into quarantine for the incubation period of the disease to make sure they do not develop the disease.[34] The ROK and the United States are not well prepared to implement isolation and quarantine in Korea or in the United States, generally lacking the laws and plans for such efforts.

Another approach was applied during the SARS outbreak in 2002–2003 (and subsequently), in which people arriving by aircraft in some countries (including the ROK) were (and are) scanned for a fever to determine if they had been infected with some disease,[35] and if so, they were isolated until their fever subsided or further testing determined that the cause of their illness was not threatening.

Preventing Biological Weapon Infection. There are also several ways to prevent infection. Vaccines improve the individual immunity to a disease and are usually sufficient to prevent disease development during their effective period. Unfortunately, despite the long list of potential

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[33] F. Fenner, D. A. Henderson, I. Arita, Z. Jezek, I. D. Ladnyi, *Smallpox and its Eradication*, (Geneva: World Health Organization, 1988), p. 1093.

[34] As noted in an earlier footnote, during the 1972 Yugoslavian smallpox outbreak, “Some 10,000 persons spent 2 weeks or more in isolation [quarantine].” D. A. Henderson, *op. cit.*

[35] Some countries still scan all arriving visitors to determine if they have a temperature.

biological agents in Table 1, current vaccines are disease-specific. Of these agents, the U.S. military focuses its preventative measures on anthrax and smallpox because of the severity of the threat they pose.

Vaccines can also be effective in preventing the spread of contagious disease. For example, the use of smallpox vaccine eventually led to the eradication of natural smallpox. The spread of contagious disease can be controlled through vaccination by reducing the rate of disease transmission to less than one person per previously infected individual. The level of vaccination required to stop disease spread is referred to as "herd immunity," and equals: $(R_o - 1)/R_o$. Thus, if the smallpox R_o value is 6, herd immunity would require vaccinating about 83 percent of the population,[36] especially in the geographic area around the infection. In the years during the eradication of smallpox, most countries achieved herd immunity levels of vaccination or more. However, since the late-1970s, almost none of the world population has been vaccinated, making it vulnerable to smallpox. To be prepared against North Korea's use of smallpox, the Korea Centers for Disease Control (KCDC) acquired 7 million doses of smallpox vaccine, not enough to cover the entire country (just 15 percent of the population), but hopefully enough to cover the area where the disease breaks out if disease spread is contained. But the media has reported that the smallpox vaccines acquired by the ROK "…have either expired or failed to pass toxicity tests."[37]

It is worth noting that vaccines are not always assured protection. For example, the individual who was the source of the 1972 smallpox outbreak in Yugoslavia had been vaccinated for smallpox two months before he went to Iraq, where he was apparently exposed to smallpox. But the vaccine only suppressed his symptoms, preventing him from developing the kind of rash that usually leads to a prompt clinical diagnosis of smallpox. As a result, 11 people who had contact with him after he returned to Yugoslavia developed the disease, while medical officials were unaware that he was suffering from smallpox.[38]

Another way to prevent infection is through the use of face masks to block inhalation of a biological weapon agent. Surgical masks are typically used for this purpose, but they provide inadequate protection because some air can move around the mask. Respirators provide better protection, as they create a degree of seal with the face. The ROK should have in supply tens of

[36] In practice, the required level of smallpox vaccination appears to be less than this herd immunity value. See W. Orenstein, *op. cit.*

[37] Robert Lee, "Smallpox vaccines against N.K. attack unusable," *The Korea Herald*, September 7, 2011, at http://www.koreaherald.com/national/Detail.jsp?newsMLId=20110907000602.

[38] F. Fenner, *op. cit.*, p. 1092.

millions of P-95 respirators, and the U.S. military in Korea should have tens of thousands of such respirators to be used in areas where full chemical masks are not required.

Some diseases can also affect people through the eyes or through cuts in the skin,[39] and thus precaution must be taken for broader protection against those diseases. This can be done with a typical chemical agent face mask, but the use of such a mask significantly impacts the performance of individuals, and few people other than the military have such masks in the ROK. Also, some diseases are carried by mosquitos, fleas, or other insects. With such diseases, action needs to be taken to protect people from those vectors and reduce the vector population.

Another way to prevent infection is through collective protection that can be added to a facility. Such a collective protection system filters all incoming air, preventing most or all biological weapon agents from entering the facility. The facility needs to maintain a degree of overpressure that keeps air from coming in when people enter. Facilities also need a means for decontaminating people as they enter to prevent them from bringing in the biological weapon agent on their clothes or bodies. It does not appear that there are many such protected facilities in the ROK—more efforts in this area are required and hopefully will be taken as U.S. facilities are built at Camp Humphreys.[40]

Treating the Consequences of Biological Weapon Use. Once it is known that a biological agent has been used, and the agent has been identified, medical treatment can focus on countering that agent. As noted above, with bacterial agents, some form of antibiotic can be used to treat the victims. In practice, treatment of the inhalation anthrax victims in 2001 employed a mixture of antibiotics to increase the chances of success.[41] While the ROK likely has a good supply of antibiotics for everyday use, it likely has far less than would be demanded by those who are sick and the "worried well" in the aftermath of a major biological weapon attack.

Against viruses, antivirals offer the possibility of countering the diseases (antivirals do not always work against all viruses). Where vaccines are available, they may also be useful in treatment, especially in that of people who have been exposed but are not yet symptomatic.[42] The ROK

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[39] For example, percutaneous anthrax infections can become serious at cuts in the skin.

[40] Buildings with collective protection potential were built at the U.S. Osan Air Force Base in Korea.

[41] John A. Jernigan, et. al., "Bioterrorism-Related Inhalational Anthrax: The First 10 Cases Reported in the United States," *Emerging Infectious Diseases*, Vol. 7, No. 6, November-December 2001.

[42] For example, the smallpox vaccine is considered very useful especially during the first five days after exposure. Even if it does not prevent the disease from developing, it tends to produce a more mild case of the disease. D.A. Henderson, "Smallpox as a Biological Weapon: Medical and Public Health Management," *Journal of the American Medical Association*, Vol. 281, No. 22, June 9, 1999, p. 2132.

does not appear to have large stockpiles of antivirals; both the United States and the ROK should assure the ability to treat large parts of their populations in Korea for many days.

Finally, with regard to toxins, an agent-specific antitoxin is required. There are relatively few kinds of antitoxins that have been developed, and they are available only in small quantities in most countries, in part because of their cost.

As suggested in the discussion of the effects of biological weapon attacks, the inability to treat people exposed to biological weapons could lead to very high numbers of casualties and many deaths. The ROK should thus seek to participate in the development of new vaccines and treatments, an area in which the United States appears to be making some progress.[43]

Managing Human Remains. Many biological weapon attacks will lead to fatalities. Because some diseases (especially ones that are contagious) will remain a threat inside infected cadavers for a period of time, cremation of the dead is often recommended to prevent further spread of the disease. If cremation is not practiced, the body should be contained in some way (e.g., the use of a body bag and a sealed coffin) to prevent disease spread. It is unlikely that sufficient supplies of containment items exist in the ROK.

Conclusions

North Korean biological weapons could pose serious threats to the ROK, other countries in Northeast Asia, and the United States. The exact nature of the North Korean biological weapon threat is not known, but a variety of serious biological weapons agents may have been developed by North Korea, and North Korea is also reported to have experimented on political prisoners with some of these agents. While it is therefore difficult to determine when or how North Korea would use biological weapons, any such use could cause many casualties and be highly disruptive to ROK and even U.S. society.

The ROK and the United States have made efforts to prepare for biological weapon attacks and be ready to respond to them. Given adequate ROK/U.S. preparations, North Korean biological weapon attacks will hopefully remain deterred. But such preparations are technologically challenging and costly, and much more can be done. If assessments of North Korean capability

[43] "A significant number of experimental vaccines and other drugs for treating people exposed to biological weapons agents are due within a half-decade to undergo federal assessment, a U.S. Health and Human Services Department office said in a five-year plan issued on Tuesday." "Bioweapon Countermeasure Progress Seen Within Half-Decade," Nuclear Threat Initiative, October 7, 2011, at http://gsn.nti.org/gsn/nw_20111006_4385.php.

are correct (or if North Korean capability is even at the mid-point of these estimates), then the following recommendations should be pursued:

- The ROK and U.S. governments should protect themselves against the delivery of biological weapons. In peacetime, their immigration authorities should link to the passport databases of Northeast Asian countries in order to aid in the identification of forged passports that North Korean agents would be using to carry BW into the ROK or the United States. In crisis and war, the ROK and U.S. militaries should be better prepared to detect and intercept North Korean aircraft and missiles.
- The ROK and U.S. governments should detect and attribute biological weapon attacks and identify the biological weapon agents used. They should pursue research to better perform these tasks.
- The ROK and U.S. governments should prevent exposure to and infection with biological weapons and be ready to deal with the consequences of biological weapon infection. They should prepare to close or closely regulate borders, close schools and other venues where disease spread is expected, impose isolation on those with contagious disease and the quarantine of those potentially exposed, and decontaminate infected areas when necessary. They should make sure the legal basis for these actions is in place and provide for the personnel needed to perform these functions. And they should pursue cooperative research on potentially needed vaccines and treatments and acquire appropriate amounts of such vaccines and treatments.

Chairman Thornberry, Ranking Member Langevin, and members of the Subcommittee, thank you again for inviting me to testify before you today. I look forward to taking your questions.