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14. ABSTRACT

The United States must recognize the credible and viable threat of biological weapon employment by a Violent Non-State Actor (VNSA). Compared to its traditional Weapon of Mass Destruction (WMD) counterparts, the biological weapon is more financially affordable than the nuclear or radiological weapon and is more lethal than the chemical weapon when compared by mass. The documented history of biological weapon procurement or employment by non-state actors is robust and supports the credibility of the threat. Modern advances in the field of biology have resulted in a greater availability of biological agents than at any previous point in history and have increased the viability of the VNSA threat. The biological weapon offers significant incentives and disincentives for use, however despite its legal classification as a WMD the use of a biological weapon will not necessarily result in a mass casualty event. This potential to scale the size and impact of the weapon results in flexibility for the user and the broadly expanded potential to obtain a weapon.

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Executive Summary

Title: The Biological Weapons Threat Posed by Violent Non-State Actors

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Thesis: The United States must recognize the credible and viable threat of biological weapon employment by a Violent Non-State Actor (VNSA).

Discussion: With both significant incentives and significant disincentives for use, the biological weapon presents a unique opportunity to the VNSA. Compared to its traditional Weapon of Mass Destruction (WMD) counterparts, the biological weapon is more financially affordable than the nuclear or radiological weapon, and it is more lethal than the chemical weapon when compared by mass. Despite its legal classification as a WMD, use of a biological weapon will not necessarily result in a mass casualty event. This potential to scale the size and impact of the weapon results in flexibility for the user and the broadly expanded potential to obtain a weapon. The documented history of biological weapon procurement or employment by non-state actors is robust, and there is currently no indication that interest in biological attacks will decline in the future. Modern advances in the field of biology and the proliferation of specific knowledge and laboratory equipment have resulted in a greater availability of biological agents than at any previous point in history. When assessing the threat of biological weapon employment by a VSNA, the key question involved is the intended scale of attack, which will determine the threshold of resources and knowledge which the VNSA must cross in order to obtain a suitable weapon.

Conclusion: The credibility of the biological threat from VNSAs is supported by the documented history of weapon procurement or employment. The viability of the threat is increasing with the proliferation of knowledge and equipment in the field of biology. The United States must recognize this valid threat.

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Table of Contents

Page

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Introduction

Among the three traditional categories of Weapons of Mass Destruction (WMD), the biological weapon presents a unique opportunity for use by a violent non-state actor (VNSA). The biological weapon is a more efficient killer than the chemical weapon when compared by mass, and a more financially affordable weapon than a nuclear or radiological device. The biological weapon has the potential to inflict catastrophic human casualties and provide the means to conduct a "spectacular" attack. For example, one study conducted in 2003 determined that the successful airborne release of one kilogram of anthrax on a metropolitan area with a population of 11.5 million people --- smaller than the population of the New York City metro region --- could infect up to 1.49 million people and result in 123,000 fatalities.[1] A mass casualty event is not the only potential outcome of a biological attack, however; small scale attacks are also possible. Regardless of the specifics or size of an attack, the United States must recognize the credible and viable threat of biological weapon employment by a VNSA.

In order to appreciate the threat of biological weapon employment by a VNSA, it is important to first gain context through the definition and legal classification of the weapon itself, as well as the definition of the VNSA. From that common platform it is possible to examine the threat through the lens of historical examples of weapon employment, current advances in biological science and technology, and ultimately a discussion of the incentives and disincentives for a VNSA to employ a biological weapon in the future.

Biological Weapons

Biological weapons, as defined by the United Nations (UN) Office at Geneva, are "systems that disseminate disease-causing organisms or toxins to harm or kill humans, animals

or plants."[2] This definition neatly lays out the two primary components of a biological weapon, the biological agent and the means to deliver the agent to a target. The UN also notes that, in addition to military applications, biological weapons "can be used for political assassinations, the infection of livestock or agricultural produce to cause food shortages and economic loss, the creation of environmental catastrophes, and the introduction of widespread illness, fear, and mistrust among the public."[3] It is worth noting that the biological weapon, as defined by the UN, fits neatly into the US legal definition of WMD, which specifically identifies "any weapon involving a biological agent, toxin, or vector" in US law (18 USC §2332a).[4]

Biological Agents

While biological weapon agents are separate from chemical weapon agents, the two categories of WMD are related and are best understood as two ends of one spectrum. On the extreme chemical end are the organic chemicals that can be used to produce nerve agents, and on the extreme biological end are the disease producing agents. Some chemical agents, as well as some biological agents, exist in the middle of the spectrum.[5] Selection of an agent for use as a weapon is an exercise that involves weighing the benefits versus the drawbacks of a selected agent.[6] The usefulness of a specific biological agent for weaponized usage is dependent on a number of factors; these can include such criteria as toxicity, stability, persistence, ease of dissemination, communicability, and ease of cure. A good agent is easy to find or produce, highly lethal or highly incapacitating, easily disseminated, and stable enough to be stored for indefinite periods of time.[7] The biological agents that are considered most useful for employment in weaponized form can be broadly divided into four primary groups: bacteria, viruses, rickettsia, and toxins.[8]

Bacteria are single-celled micro-organisms which can reproduce rapidly under specific conditions, and some species are naturally toxic to humans. Specific examples include anthrax, plague, tularemia, and typhoid. Anthrax is considered an excellent agent for biological weapons due to its high stability, relatively long shelf life, and high toxicity.[9] The viruses function by entering a host cell and altering the cellular DNA. In some cases this can cause the cell to reproduce uncontrollably; in others, the cell may actually cease functioning.[10] Virus examples include smallpox, encephalitis, Rift Valley fever, and yellow fever. Rickettsia function in a manner similar to viruses, but are larger micro-organisms that usually live in the digestive system of blood sucking insects and infect humans while the host parasite is feeding.[11] Rickettsia cause diseases such as typhus, Q fever, and Rocky Mountain spotted fever. The toxins are essentially non-living products of certain plants or micro-organisms and tend to be relatively stable and tough when compared to the other groups of biological agents.[12] Toxin examples include botulism, ricin, and staphylococcal enterotoxin B.

Separate from the division of biological agents by group, the US Centers for Disease Control and Prevention (CDC) have created a tiered structure of categories which identifies agents by the potential risk they pose to national security.[13] These categories are designated Categories A, B, and C, with Category A representing the highest risk and Category C representing the lowest. Category A agents can be easily disseminated from person to person, result in high mortality rates and have the potential for major public health impact, might cause public panic or disruption, and require special action for public health preparedness.[14] Category B agents are moderately easy to disseminate, result in moderate morbidity rates and low mortality rates, and require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance.[15] Category C agents include emerging pathogens that could be engineered

for mass dissemination in the future because of availability, ease of production and dissemination, and the potential for high morbidity and mortality rates.[16] The CDC categories are available online and provide a readily available list of agents, by category, for public reference and knowledge. Importantly, the categories prioritize the national level of threat presented by various agents. Conversely, the CDC categories also provide a prioritized list that is readily available for reference by any nefarious actor seeking to identify agents that present the greatest threat to public safety and national security.

Delivery Systems

The delivery of a biological agent to a target is possible through a variety of means. In the earliest forms of biological warfare, the agents were delivered to the target by using a physical transmission vector, such as a corpse or blanket. More recent means of delivery incorporated a method of aerosolizing the agent and disseminating it at the target. Military munitions developed to deliver agents in this manner include missiles, bombs, grenades, and rockets.[17] Other programs have been documented which intended to use spray tanks attached to aircraft, automobiles, or watercraft.[18] Delivery methods have been developed for assassination or sabotage that transmit agents via injection, sprays, brushes, or the contamination of food.[19] The potential also exists to deliver a biological agent by moving the target to the agent, rather than the agent to a target. This could take the form of driving a human or animal population into an environment where an agent has already been disseminated and is still viable in weaponized form.

Bioterrorism, Biocrime, and Agroterrorism

Bioterrorism, biocrime, and agroterrorism are all viable classifications for the way in which a VNSA could employ biological weapons. According to the US Code of Federal Regulations, terrorism is "the unlawful use of force against persons or property to intimidate or coerce a government, the civilian population or any segment thereof, in the furtherance of political or social objectives."[20] To further refine the definition for relevance to biological weapons, biological terrorism is the use of biological agents by a group not otherwise recognized as an extension of the government of a state to achieve a political or ideological objective.[21] As a form of terrorism, the imposition of psychological as well as physical damage is important. The biological weapon serves as the means of inflicting both the physical and psychological damage upon a target audience. Biocrime is similar but distinct in that it entails the malevolent use of biological agents when the perpetrator's motive is personal, and is not associated with a broader ideological, political, or religious objective. Agroterrorism, although related to bioterrorism and biocrime, is an attack on the livestock or crops of a state rather than the human population. Agroterrorism has the potential to cause extensive economic damage, as well as extensive physical damage to the food stock of a state.[22]

Violent Non-State Actors

For the purposes of this paper, the VNSA is an entity which does not recognize the legitimate monopoly on the use of violence by a nation-state within its own sovereign territory. VNSAs are not a homogenous group of entities, and various types of VNSAs have been recognized and identified by the international community. These types include: warlords, militias, paramilitary forces, insurgencies, criminal organizations, lone actors, and terrorist organizations.[23] Based on recent historical examples the types most relevant to the discussion of biological weapons are the terrorist organizations and the lone actors.

In order to differentiate one VNSA from another, and more importantly to determine whether or not a particular VNSA is a candidate for the use of biological weapons, it is necessary to examine different dimensions of the entity. These key dimensions are:[24]

- Motivation and purpose of the VNSA
- Strength and scope of the VNSA
- Organizational structure
- Role and acceptable leverage of violence
- Relationship of the VNSA to state authorities
- Ways in which the VNSA obtains funding or access to resources
- Functions which the VNSA fulfills for members and supporting constituencies

The VNSA who is a candidate to employ biological weapons requires the motivation to conduct an attack, the willingness to use violence to obtain an objective, the funding and resources to obtain a biological weapon, and a function for the VNSA members and any supporting constituencies that is fulfilled by the use of biological weapons.

Scale

While biological weapons are legally classified as WMD, the employment of a biological weapon will not necessarily result in a mass casualty event. Biological agents can be used in a weapon to target an individual, a small group, a large group, or to cause a mass casualty event. The scope of casualties from a biological weapon attack will be dependent upon factors that include the intention of the originator of the attack, the characteristics of the biological agent, the design and effectiveness of the weapon, the environmental conditions at the attack, and the medical response to the attack. An example individual casualty attack occurred in 1978, when

members of the Bulgarian secret service assassinated Bulgarian exile Georgi Markov by directly injecting a poison pellet into Markov's leg from the tip of a modified umbrella.[25] The pellet was assessed to contain the toxin ricin. On the other hand, biological weapons can also lead to mass casualties and widespread impact. In 2013, *Scientific Reports* published the results of one modeling exercise that focused specifically on highly pathogenic agents and human mobility in modern societies. The exercise determined that the intentional release of smallpox within a country "will have global effects," and that "the release may trigger outbreaks in countries lacking the health infrastructure necessary for effective containment."[26]

Historical Employment of Biological Weapons

By leveraging history as a predictive tool for future events, it is logical to assume that the use of biological weapons will continue where conflict exists or arises. The early use of biological weapons included the contamination of water wells with carcasses, employment of amphibian derived toxins to poison arrows, and allowing enemy forces to occupy positions or terrain where an infectious agent was endemic.[27] Hannibal of Carthage employed serpent toxins in the naval battle of the Eurymedon against the forces of King Eumenes of Pergamum in 184 BC.[28] The Romans are known to have used animal corpses to poison enemy water wells in 1155. In 1346, during the battle between the Genoese and the Mongols at the Genoese colony of Caffa, the Mongol forces hurled the bodies of their forces who had died of the plague over the walls of the city and sparked an outbreak of the disease amongst the population.[29] In North America in 1763, during the French and Indian War, the British commander at Ft. Pitt, Captain Ecuyer, gave blankets and a handkerchief infected with smallpox to Native Americans.[30]

The modern era of biological weapons began with the birth of scientific bacteriology in the 19th century.[31] The Hague Conventions of 1899 and 1904 outlawed the use of "poison or poison arms" for warfare, but did not address the possibility of weapons developed through bacteriology.[32] During World War I, the German government sponsored the first scientific biological weapons program known to exist, and German biological operations against crops and livestock are known to have targeted multiple nations including the United States.[33] After the war, the 1925 Geneva Protocol outlawed the use of bacteriological methods of warfare along with various forms of chemical warfare, but the protocol addressed the programs of nation-states only.[34] It also lacked an enforcement mechanism. In the interwar period, and moving into World War II, nations that began research programs on biological weapons included Belgium, Canada, France, Great Britain, Italy, Netherlands, Poland, the Soviet Union, Japan, and the United States. During the Korean War of 1950 to 1953, and during the Cold War in the second half of the 20th century, the United States and the Soviet Union leveled various unsubstantiated allegations against each other over the use of biological weapons, primarily in proxy wars fought by Capitalist or Communist forces around the globe.

In 1972 the United Nations Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological and Toxin Weapons and on their Destruction was signed by 103 nations, and prohibited any malicious research, production, or use of biological agents.[35] The nations who signed the convention agreed to "never develop, produce, stockpile, or otherwise acquire or retain microbiological agents or toxins" for hostile purposes or use in armed conflict. As an agreement reached by nation-states of the international community, the 1972 Biological Weapons Convention (BWC) had no bearing over the activities or actions of VNSAs.

In recent history, VNSAs have used biological weapons several times within the borders of multiple nation-states. Due to the significance of either the accumulated stockpile of biological agents or the successful employment of the agent as a weapon, three events in particular are worth noting. The first of these incidents occurred in 1984 in Dalles, Oregon, where members of the Bhagwan Shree Rajneesh cult attempted to influence the outcome of a local election by sickening voters in a small town. Members of the cult poured slurries of Salmonella typhimuruim into the salad bars, salad dressings, and coffee creamers of ten local restaurants, which resulted in 751 cases of enteritis and 45 hospitalizations.[36] The second significant event took place during the early 1990s in Tokyo, Japan, when members of the Aum Shinrikyo cult built a research facility to produce anthrax and botulinum toxin.[37] From approximately 1990 to 1995 the cult attempted to attack ten targets, including Japan's crown prince and the US Navy base at Yokosuka, with biological weapons.[38] All of the attempts to use biological weapons failed due to factors which included ineffective dispersal devices, biological agent strains with low effectiveness, and possibly subversion on the part of cult members who were hesitant to conduct bioterrorism.[39] Of note, the group ultimately conducted a successful sarin (chemical weapon) attack on the Tokyo subway on March 20, 1995. The third significant incident took place in the United States during the fall of 2001, when at least four (possibly as many as seven) letters containing anthrax were mailed through the US postal system on September 18 and October 9.[40] The letters were addressed to targets that included civilian news media outlets and two US Senators in the Hart Senate Office Building. Ultimately, eleven cutaneous anthrax cases and eleven inhalation anthrax cases were reported from the attack, five of which were fatal. [41] In addition to the human toll, the anthrax letters cost approximately $2

million for decontamination, and were estimated to have caused over $1 billion in economic damage.[42]

To highlight the threat to nation-states from biological agents and weapons in the last twenty years, other notable events include:

- The 1995 arrest of Thomas Levy for attempting to smuggle 130 grams of ricin across the US- Canadian border in 1993.[43]
- The 1995 conviction of Debora Green, a physician, for attempting to murder her estranged husband with ricin.[44]
- The 1996 attack by Diane Thompson, a laboratory technician, on twelve coworkers by contaminating pastries with shigella dysenteriae in an office break room.[45]
- The 1998 arrest of Wayne Larry Harris for possession of anthrax, although epidemiological tests later determined that he actually obtained a non-pathogenic strain.[46] Harris had previously been arrested under suspicion that he had planned to attack the New York City subway and had purchased three vials of bubonic plague by posing as a legitimate medical researcher.[47]
- The 2003 raid of an apartment in London which contained small amounts of ricin and manuals for developing other biological and chemical agents.[48] The one individual convicted as a result of the raid was linked to Al Qaeda.
- The 2003 seizure of a "bio-terror manual" from Jemaah Islamiyah by Philippine security forces.[49]
- The 2006 and 2007 listing by the US State Department of four nations (Cuba, Iran, North Korea, and Syria) with established biological weapons programs that are known to support VNSAs classified as terrorist organizations.[50]

- The 2009 Al Qaeda video, authenticated by American counterterrorism officials, threatening to smuggle a biological weapon into the US via the border with Mexico.[51]
- The 2011 announcement of evidence that Al Qaeda operatives were attempting to produce ricin in Yemen. Intelligence officials indicated that the toxin was intended for use in attacks on a contained space, such as a shopping mall, airport, or subway station.[52]
- The 2011 detention of four men in Georgia after authorities determined that they had equipment, instructions, and ingredients to produce ricin. The men had previously discussed their intention to conduct attacks on government personnel and facilities with the toxin.[53]
- The 2012 release of Al Qaeda in the Arabian Peninsula's magazine *Inspire*, which included an article by Anwar Al-Awlaki condoning attacks on civilians using methods which include biological weapons.[54]
- The conviction in 2014 of Everett Dutschke for mailing ricin filled envelopes to the White House, Senator Roger Wicker, and a Mississippi judge.[55]
- The 2014 conviction of Shannon Richardson in Texas after she admitted to mailing ricin tainted letters to President Obama, New York City Mayor Bloomberg, and the leader of a gun control group.[56]

Biological agents and delivery systems have been used in multiple arenas of conflict across military, political, and social lines, and are not limited to modern history or the recognized field of battle. The key point to be made by a historical perspective of biological weapons is that the history is extensive and the threat of continued use in the future is credible.

Emerging Technologies

Scientific developments and the field of synthetic biology are likely to be the most important additive to the threat of biological weapons usage by VNSAs. Synthetic biology gained traction at the beginning of the twenty first century, and emerged with a stated goal of "making biology easier to engineer."[57] The field promotes research designed to make biology more accessible, and has led to an increase in the proliferation of "dual use"* technology.[58] Concern over "dual use" developments surfaced widely in 2011, when scientists discovered a means of modifying the H5N1 avian flu to spread between mammals, and then published articles for the broader scientific community which described the process in detail.[59] Prior to the experiment, the virus had not been a hazard for human to human transmission, but the publication of the research led to conjecture that a nefarious actor could replicate the research and intentionally release the virus on a target human population.[60] Epidemiologist Marc Lipsitch summed up his concern over the public release of such scientific developments when he stated: "You're making something that doesn't exist in nature and combines high virulence for people with the ability to transmit efficiently."[61] Developments in other fields of contemporary science, such as genetic engineering, also present the opportunity for nefarious "misuse." The availability of genetic data in the public domain and developments in genetic engineering could theoretically be leveraged to target humans with organisms which are designed to survive longer, take advantage of different vectors, or impart a more intense pathogenic effect.[62]

* The term "dual use" refers to research which is relevant for peaceful purposes, but also has the potential to be "misused" for biological weapon applications.

The broader field of synthetic biology has also fueled a rise in the "do-it yourself"[†] biology community.[63] Many in the "do-it yourself" community assemble home laboratories from household tools and used equipment that is purchased online, highlighting the increased commercial availability of "dual use" technology and the ease with which an average consumer with internet access and an interest in biology can construct a viable facility. The increase in available information, available equipment, and an available online scientific community present an opportunity for any VNSA with motivation to misuse "dual use" technology. Terrorists in particular are likely to recognize the utility of new technology, making bio-terrorism a potential unintended consequence of synthetic biology.[64] According to Dr. Reynold Salerno of Sandia National Laboratory, "There's no good way to track or control expertise. There are few, if any, pieces of technology used to make bio-weapons that are not also used for some other legitimate purpose. There are a lot of pathogens naturally occurring and widely available for weaponization."[65]

With access to expertise, the potential for a VNSA to employ biological weapons increases dramatically. An existing VNSA could recruit or conscript members of the scientific community in order to gain expertise, or members of the scientific community could form a VNSA with an inherent interest in biological weapons. In either scenario the VNSA would have the knowledge, and potentially the physical materials and access, to construct a biological weapon.

Incentives for Employment

[†] "Do-it-yourself" is a collective term which refers to individuals who obtain a great volume of information through open source online forums in order to conduct biology work in their homes, or in community laboratories.

For the VNSA, there are multiple incentives to use biological weapons. First and foremost, VNSAs are not constrained by the conditions of the BWC and therefore have no binding international agreements to constrain their development, procurement, or employment of biological weapons. The possession of a biological weapon alone, independent of actual plans for employment, could serve several purposes for a VNSA on the international stage. Since biological weapons have historically been possessed by powerful state actors, the weapon itself could enhance the status of a VNSA in relation to existing states and competing VNSAs.[66] The weapon could serve as a powerful negotiating tool with which to confront state actors, or conversely serve as a powerful tool for blackmail.[67] At a more basic level, by simply announcing an interest in biological weapons, and demonstrating a credible capability to procure or develop one, a VNSA could even succeed in generating fear in target populations without ever having succeeded in acquiring the weapon.[68] In each of the cases above, the possession of a weapon, or the threat of possession, provides a means for a VNSA to shape events at the international level. This could arguably be considered the strategic incentive for the biological weapon. There are also incentives at more tactical levels for the VNSA.

The procurement of biological agents by VNSAs for weapons use is more feasible now than at any point in history. As previously discussed, advances in synthetic biology and increasingly available scientific information have increased the opportunities for nefarious actors outside of the traditional scientific community. Advances in the professional scientific community have also increased the potential for VNSAs to procure agents through theft, subversion, or purchase on the black market. State sponsored resources, such as scientists working in academic, commercial, or government laboratories, could be coopted by a motivated VNSA.[69] Even simple mistakes and accidents provide an opportunity for agent acquisition. In

two striking examples, the Galveston National Laboratory lost a vial containing the Guanarito virus in March 2013, and in April 2014 the Pasteur Institute in Paris lost 2,000 vials of the SARS virus.[70] While neither incident resulted in the agent being combined with a delivery system for an attack, both incidents highlight the danger of pathogenic agents escaping from the strictly professional scientific realm.

Once developed, biological weapons can be used to incapacitate, kill, or contaminate targets, and therefore provide a high degree of flexibility to the user.[71] Due to the delayed onset of symptoms and effects caused by many of the biological agents, the employment of a weapon can be executed in a clandestine or even covert manner.[72] The target's ability to identify vectors used to deliver the biological agent could take time, and the initial symptoms of the attack could be classified as a more routine illness or outbreak of disease.[73] This allows the employer of the weapon time to travel away from the target area, or additional time to further craft a message which directly addresses the reaction of the target. The employment of a contagious agent on an open population may also facilitate harm that quickly multiplies far beyond the scope of the damage expected from the same amount of agent used against a contained target.[74] In this manner, a biological attack could quickly overwhelm the available medical resources, and the problem of the "worried well"[‡] would be an amplifying factor of the impact.[75] An example of the "worried well" scenario occurred in the Philippines on October 3, 2001, when over one thousand students in Manila overwhelmed medical clinics with flu-like symptoms after rumors of a bioterrorism attack circulated on text messages.[76] The biological attack itself, and the stress imposed upon the target population and associated infrastructure, would cause large scale disruption and impose a high cost on the targeted society.[77] Fears of a follow-up attack would

[‡] The term "worried well" refers to the portion of the population who are not in contact with the agent, but seek medical attention due to concern over the attack or the exhibition of symptoms which are unrelated to the attack.

compound the problem. According to former Secretary of the Navy Richard Danzig, "biological terrorism affords the possibility of repeated attack, undermining confidence and forcing ever-escalating investments of resources to achieve a modicum of defense."[78]

The fear of a follow-up attack and the scenario of the "worried well" speak to the psychological impact that can be imposed by a biological weapon attack. As evidenced by the SARS outbreak in 2003, and the Ebola outbreak in 2014, a naturally occurring infectious outbreak in the information age will generate widespread media coverage and a public level of concern that may be disproportionate to the actual rate of infection.[79] Rather than providing a naturally occurring event for public focus, the biological weapon attack is an event that is deliberately initiated against a target population, is specifically designed to cause harm, and is possible to repeat. According to an article in *The American Journal of Psychiatry* by Cleto DiGiovanni Jr., a "biological incident poses a sudden, unanticipated, and unfamiliar threat to health that lacks sensory cues, is prolonged or recurrent, perhaps is contagious, and produces casualties that are observed by others. These are the factors that, historically, have spawned fear, panic, and contagious somatization."[80]

Disincentives for Employment

Despite the scientific advances supporting biological weapon development and the distinct tactical advantages that a biological weapon may offer, significant disincentives to the procurement or use of a biological weapon still confront any rational VNSA. At the strategic level, the employment of any weapon that can legally be classified as a WMD could incur massive retaliation from the international community, and presents the risk of alienating present and future supporters.[81] In the case of a state sponsored VNSA, employment of a biological weapon could expose the sponsor to harsh retribution from the international community.[82] For

any VNSA with strictly political ends, target discrimination and the targeting of a specific subset of the population in a territorial area could also prove highly challenging. Due to the unpredictable nature of pathogens after delivery, particularly in the case of contagious agents, the potential for collateral damage among the untargeted population may prove too high for the rational employment of a biological weapon.[83] Regardless of the specific ends to be achieved, any rational VNSA considering the use of biological weapons would likely weigh the benefits of biological weapon employment against the potential costs imposed by the international community, the targeted state, and the supporters of the VNSA.

For a VNSA determined to employ a biological weapon, significant resources are required for both the acquisition and delivery of a biological agent. Resource challenges fall in both the financial realm and the intellectual capital realm. With the increase in the size and reach of the "do-it-yourself" community, laboratory equipment has become more cost efficient and available, but simply obtaining the required equipment does not guarantee success in weapon development. Effectively producing an agent requires intellectual capital in the form of "tacit knowledge," which can be broadly defined as the skills and techniques acquired through hands-on learning, or the close observation of a proper example.[84] Experience in the field of biology could provide tacit knowledge, but simply acquiring information and equipment through the "do-it-yourself" community would not provide tacit knowledge to a novice individual or group. Further complicating the weapon employment problem, a large scale attack could require higher degrees of knowledge in fields including microbiology, aerosol physics, pathology, and pharmacology.[85]

The case of Aum Shinrikyo provides a striking example of a well-funded and well equipped VNSA that failed to deliver a biological weapon. In the 1990s Aum Shinrikyo

possessed assets estimated between $300 million and $1 billion, and the cult constructed functional laboratory facilities to develop biological agents.[86] Despite these assets, the cult never successfully employed a biological weapon. For any VNSA that is able to construct or access laboratory facilities, challenges of agent production must be overcome. While the production of agents can be easy to initiate, various sources compare the process to brewing beer at home: refining the process to produce a quality and volume of agent sufficient for a weapon can prove highly challenging.[87] After producing an agent of sufficient quality and quantity to construct a weapon, storing the agent until it can be effectively delivered presents yet another technical hurdle since many agents are susceptible to destruction by environmental conditions. Aum Shinrikyo was able to overcome all of the production and storage challenges, but failed to effectively deliver the weaponized agent.

In the same manner that environmental factors present a challenge to the storage of an agent, environmental factors can present significant challenges to the delivery by negatively impacting the agent after release, but before it ever reaches a target.[88] In the delivery scenario of bringing a target to the agent, targeting decisions and agent selection must account for the environmental factors in the area to be contaminated. In the delivery scenarios involving transmission of the agent to the target, other challenges to weapon success arise. Delivery of an agent in aerosolized form, which is an attractive delivery method for a large target area or a mass human casualty event, requires a precise particle size for efficient dispersal and maximum transmission via the human respiratory system. The required particle size of one to five microns is technically difficult to produce.[89] Improperly sized particles can clog dispersal devices or fall immediately to the ground, where they present little hazard for ingestion via the respiratory system. While direct delivery of an agent is also possible via various means, for example

injection, it is generally only practical against an individual or small group. The use of humans or other animals as the delivery vector is also a challenging scenario. The behavior of an infected animal is unpredictable, and an animal vector may fail to reach a target or fail to transfer the agent to the target. Similarly, the use of humans as vectors is not as simple as it first seems. The vector may be too debilitated to travel, or may be so visibly ill that the target population is suspicious. Additionally, if the desired effect is a mass human casualty event, a few successful transfers of the illness may not trigger an epidemic.[90] Across all configurations of a biological weapon, the technical challenges facing a VNSA extend from agent acquisition to agent delivery across the entire spectrum of weaponization.

Threat Assessment

According to a 2006 report on bioterrorism prepared for the Weapons of Mass Destruction Commission, the threat of a bioterrorism attack can be described by the following equations:

BIOTERRORIST THREAT = CONSEQUENCES OF ATTACK * LIKELIHOOD OF ATTACK[91]

Where

LIKELIHOOD OF ATTACK = MOTIVATION * CAPABILITY OF ATTACKERS[92]

These equations specifically address a "bioterrorism" threat, but they provide an excellent starting point for the assessment of the threat presented by VNSA employment of biological weapons in any capacity.

While biological weapons provide a wide array of advantages to a VNSA, the incentives for employment are not so great that future use of biological weapons is guaranteed by all capable VNSAs. Conversely, while significant disincentives to biological weapons employment confront VNSAs, these disincentives and the challenges of developing a weapon are not so great that they will preclude a motivated VNSA from employing a biological weapon. If capability and motivation are the primary variables in the threat of biological weapons employment by a specific VNSA, then the key question in assessing the threat is the scale of attack which is intended.[93] The scale of the attack will determine the level of resources and knowledge that the motivated actor must obtain to be capable of executing the attack. A mass casualty event represents one extreme on the scale of attack, and an attack on a single individual represents the opposite extreme of the scale. The most likely scenario for an attack by a VNSA is one which employs a biological agent with suboptimal characteristics, delivered by an imperfect or inefficient system, conducted under imperfect conditions.[94] This does not guarantee a failed attack, and it also does not rule out the possibility of a mass casualty event. The VNSA conducting the attack may simply devise tactics which maximize the impact of the suboptimal weapon, or ensure that the target selected is sufficiently "soft" to achieve the desired effect.[95] It is also worth noting that VNSA biological weapons programs should not be viewed through the lens of, or judged against, state-sponsored biological weapons programs. The intended effect of state-sponsored military biological weapons designed for use against a symmetrical state-sponsored military are often far different than the intended effect of biological weapons to be employed by VNSAs against unarmed, or unprepared, asymmetrical targets.[96]

Conclusion

The biological weapon presents a unique opportunity to the VNSA. Compared to its traditional WMD counterparts, the biological weapon is more financially affordable than the nuclear or radiological weapon and is more lethal than the chemical weapon when compared by mass. As a result of advances in the field of biology, and the proliferation of specific knowledge and laboratory equipment, biological agents are more available to VNSAs now than at any point in history. Large scale production and delivery of agents, however, remains a challenge. This leads to an interesting divergence between the legal classification of the biological weapon and the common understanding of weapons that cause mass destruction. Under current US law any biological weapon is categorized as a WMD, but it is important to note that this designation does not mean that the employment of a biological weapon will result in a mass casualty event. As demonstrated by the documented history of biological agent and weapon employment, many historical events were designed to target an individual or small group. The documented history supports the credibility of a VNSA biological weapon threat. The increasing availability of biological agents supports the viability of a VNSA threat for future weapon employment.

In the discussion and evaluation of the current threat presented by a generic VNSA to employ a biological weapon there are several factors which must be considered. First, the structure and purpose of the VNSA in question must allow for the employment of a biological weapon, and the VNSA must be examined to determine if the employment of a biological weapon is appropriate for the group, its goals, and its unique situation. Then a cost-benefit analysis must be conducted, and the incentives for employment must equal or outweigh the disincentives for employment. The most important factor, however, is the desired scale of attack. The scale of attack will determine the threshold of resources and knowledge which the

motivated VNSA must cross in order to acquire a suitable biological weapon. Regardless of the scale, or the specific VNSA in question, the United States must recognize the valid biological weapons threat posed by VNSAs.

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