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AN UNWELCOME FUTURE:
Updating United States Countering Weapons of Mass Destruction Strategy Regarding
Emerging Technology

by

Christopher A. Grice

Lieutenant Colonel, U.S. Army

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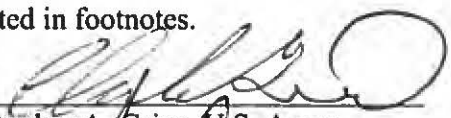
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A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

This paper is entirely my own work except as documented in footnotes.

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ABSTRACT

This thesis reviews the United States Government strategy to counter proliferation of Weapons of Mass Destruction (WMD). The U.S. strategy to deny adversary WMD capability includes support to international barriers to proliferation, export controls on technology, and reducing threat capabilities. It expresses concern that the U.S. national strategy is too broad and lacks focus for departments and agencies. The paper identifies barriers to proliferation in the strategy that may not prevent future procurement or use of WMD by actors who threaten the United States or their interests. Budget issues are shown to amplify the need to prioritize U.S. efforts to counter WMD use by threat actors. Evidence is presented to show that improved access to technology and decreased barriers to use makes it more likely that a state or non-state actor will seek to use a WMD against the United States. Use of a WMD could have significant impact on U.S. leadership decision space and influence U.S. actions abroad.

The issue for debate is the need to change U.S. strategy in order to prevent coercion of broader U.S. strategies and policies by the threat or use of WMD weapons. The counter claim is to maintain the status quo regarding U.S. strategy since an effective attack against the United States using chemical or biological (CB) weapons has not occurred. The analysis identifies vulnerabilities of the U.S. strategy due to changes in technology. The paper recommends changes to the strategy that take advantage of technology to deter or deny adversaries CB weapons. Due to the level of classification regarding nuclear proliferation, the paper looks at CB weapon proliferation only. This paper uses past actions of non-state actors who sought or used CB weapons to demonstrate the potential uses of new technology.

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INTRODUCTION

The Problem

The possession and use of WMD provide states and non-state actors disproportionate influence on U.S. actions. The threat of CB weapons resulted in military or diplomatic intervention by the United States in Iraq, Libya, and Syria at a significant cost in lives and resources. Concern over WMDs resulted in development of a U.S. strategy to deny states and non-state actors CB weapons through deterrence, treaties, non-proliferation activities, export controls, cooperative threat reduction activities, and other elements of national power.

States and non-state actors seek or maintain WMD in violation of international treaties and agreements banning their use because they perceive an advantage against the United States through possession of WMD.¹ During World War I both sides used crude chemical weapons, ushering in new treaties against future use.² Disregarding those treaties, Japan conducted gruesome experiments to catalog the effects of biological warfare agents on humans and shelled China with chemical munitions in World War II.³ Iran and Iraq used chemical weapons during their war from 1980 to 1988.⁴ Most recently

¹ Monterey Institute of International Studies, "Chemical and Biological Weapons: Possession and Programs Past and Present," James Martin Center for Nonproliferation Studies. <http://cns.miiis.edu/cbw/possess.htm> (accessed December 19, 2014).

² Encyclopedia Britannica, "Hague Convention," www.britannica.com, September 28, 2014, <http://www.britannica.com/EBchecked/topic/251644/Hague-Convention>, (accessed December 15, 2014).

³ Peter Williams, *Unit 731: Japans Secret Biological Warfare in World War II*, (New York, Free Press; 1989).

⁴ Monterey Institute of International Studies, "Chemical and Biological Weapons: Possession and Programs Past and Present," James Martin Center for Nonproliferation Studies, <http://cns.miiis.edu/cbw/possess.htm> (accessed December 19, 2014).

the Syrian government is believed to have used chemical munitions to shell rebel held territory within its own borders.⁵

While not considered a biological attack, the spread of the Ebola virus to the U.S. in 2014 demonstrates the unique threat posed from a biological warfare agent.⁶ An attack by biological agents could occur in the same way Ebola crossed the Pacific, through infected human carriers of the disease. A biological attack using Ebola would likely present itself as an outbreak of a contagious illness with symptoms similar to the flu before identification as an attack.⁷ Biological agents like Ebola and the Plague have already been turned into weapons according to the former Deputy Head of the Soviet Union biological weapons program, Dr. Ken Alibek.⁸

Emerging technology provides the means to challenge successful implementation of the U.S. strategy. Since 2002 the U.S. strategy for combating WMD has remained the same. Strategy documents updated by President Obama's administration in 2009, 2010, and 2014 contain nuanced changes that task domestic U.S. agencies with more responsibility for the countering WMD mission space.⁹ These technologies use materials and processes not covered by existing international treaties. New industrial processes provide advanced manufacturing for limited cost. These advances provide adversaries

⁵ The White House, Intelligence assessment released by White House Aug 30, 2013, [www.whitehouse.gov, http://www.whitehouse.gov/the-press-office/2013/08/30/government-assessment-syrian-government-s-use-chemical-weapons-august-21](http://www.whitehouse.gov/the-press-office/2013/08/30/government-assessment-syrian-government-s-use-chemical-weapons-august-21), (accessed December 19, 2014).

⁶ Centers for Disease Control and Prevention, "Cases of Ebola Diagnosed in the United States," [www.cdc.gov](http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/united-states-imported-case.html), (December 16, 2014), <http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/united-states-imported-case.html>, (accessed January 18, 2015).

⁷ Centers for Disease Control and Prevention, "Questions and Answers About Ebola," [www.cdc.gov](http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/united-states-imported-case.html), (January 12, 2015), <http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/united-states-imported-case.html>, (accessed January 18, 2015).

⁸ Ken Alibek, *Biohazard*, (New York, Dell Publishing, 2000), 126.

⁹ Department of Defense, *DOD Strategy for Countering Weapons of Mass Destruction*, (Washington D.C., Government Printing Office, June 2014) 12; U.S. President, *National Strategy for Countering Biological Threats*, (Washington D.C., Government Printing Office, November 2009), 3; U.S. President, *National Security Strategy*, (Washington D.C., Government Printing Office, May 2010), 18-24.

the ability to develop specialized production material and delivery systems for CB weapons. The scale of these systems lowers the signature for U.S. intelligence to collect on threat actors seeking CB weapons. Improved access to technology by adversaries increase the potential for use of CB weapons agents against the United States. Therefore, the United States must revise its countering WMD strategy to preserve U.S. policy options, maintain confidence in U.S. security, and the reduce economic impact of an attack.

The Analytical Plan

I used the Toulmin method to organize the thesis by showing current policy for countering WMD, changes in the technological environment, and potential threat actors willing to use CB weapons to attack the United States. State and non-state actor efforts to achieve a nuclear capability are briefly discussed at the unclassified level to demonstrate the potential for access to advanced technology. I reviewed U.S. policy and strategy documents, information on disruptive technologies, and data points from WMD use throughout history. I discuss threat actors who have openly expressed a desire to harm U.S. interests and have attempted to access WMD. The paper concludes by making recommendations to improve U.S. counter WMD strategy and encourages investment in researching disruptive technologies.

CHAPTER 1: THE CURRENT POLICY ENVIRONMENT

U.S. National Strategies for Countering WMD

U.S. national strategies address a wide range of methods to counter WMD threats from state and non-state actors. The end state for the U.S. strategy is to ensure the United States and its allies are neither attacked nor coerced by actors with WMD. U.S. strategy since 2002 focused on three pillars: nonproliferation, counter-proliferation, and consequence management. Nonproliferation activities seek to deter states or non-state actors from seeking or producing WMD. Counter-proliferation activities target threat actors or transnational groups to reduce or remove their WMD capability. Consequence management focuses on U.S. response to reduce a WMD attack's effect. The U.S. strategy for countering WMD is described in the 2014 Department of Defense (DoD) Strategy for Countering WMD, the 2010 National Security Strategy (NSS) and the 2009 National Strategy to Counter Biological Threats.¹

Department of Defense Strategy for Countering WMD (2014)

The Office of the Secretary of Defense (OSD) updated the DOD strategy to counter WMD proliferation in 2014, replacing the 2006 National Military Strategy for Combating WMD. The new strategy establishes three lines of effort; prevent acquisition, contain and reduce threats, and respond to crisis. A strategic enabler for the strategy is “to prepare,” defined as a continuous cycle of maintaining capability to respond to the use of a WMD. The strategy establishes three end states; no new actors obtain WMD, those possessing WMD do not use them, and the effects of WMD use are minimized. There are

¹ U.S. President, *National Strategy to Combat Weapons of Mass Destruction*, (Washington D. C., Government Printing Office, December 2002), 2.

some modifications to the supporting methods under each line of effort in the new strategy.²

The 2014 DOD Strategy calls for a whole of government approach to deny adversary states and non-state actors access to WMD. The strategy identifies technology as an enduring feature of the security environment and the need to accept risk in some areas due to fiscal constraints. An indicator of changed resourcing priorities is in the language used to describe DOD implementation of the strategy, “DOD prioritizes capabilities that counter operationally significant risks and that are not available elsewhere in the U.S. Government...DOD will continue to support countering WMD efforts for which other agencies and departments have responsibilities.”³ This changes the focus of deterrence and response with DOD in a support role while other agencies manage response to CBRN hazards that are not operationally significant. These changes may modify funding distribution between U.S. government agencies and create gaps for an adversary to exploit.

U.S. National Strategy for Countering Biological Threats (2009)

This strategy addresses the continuing expansion of the life sciences to improve the environment and the inherent risk to public health of epidemic diseases. The term “life sciences” primarily refers to the study of living organisms, including biology, botany, zoology, microbiology, physiology, biochemistry, and related subjects. This broad term is used throughout the strategy to emphasize the expanse of potential threats contained in this grouping of scientific disciplines. The strategy established its goal as

² Department of Defense, *DOD Strategy for Countering Weapons of Mass Destruction*, (Washington D.C., Government Printing Office, June 2014), 1.

³ *Ibid.*, v.

promoting, “The on-going revolution in the life sciences to ensure that resulting discoveries and their applications, used solely for peaceful and beneficial purposes, are globally available.”⁴ The strategy focuses on the behavior of states and international organizations that are already partners with the United States instead of addressing adversaries.⁵

The strategy focuses on promoting responsible use of life science as opposed to countering biological threats and fails to message any deterrent capability or intent if these types of weapons were used against the United States. For example, only one of the seven objectives focuses on use of biological agents to conduct attacks and refers to this potential adversary as a “perpetrator.”⁶ The first description of this objective focuses on law enforcement and other domestic responses with no mention of the military or larger national responses. The next section calls on citizens to report illicit activity by organizing communities who are willing to discuss and report risks.

A key statement in the strategy sums this up, “Encouraging activities by academia and the private sector to develop community-based mechanisms for sharing experiences and best practices for risk management; promoting discussions among U.S. scientific experts and their international colleagues to raise awareness of the risk and advance thoughts on how to best address it.”⁷ The other objectives aspire to gain agreement to manage the risk from biological agents (not adversaries) and seek responsibility at the international, federal, local, private business, and individual level for successful implementation.

⁴ U.S. President, *National Strategy for Countering Biological Threats*, (Washington D.C., Government Printing Office, November 2009), 1.

⁵ Ibid., 23.

⁶ Ibid., 15.

⁷ Ibid., 13.

The need to partner with other international groups concerned with interdicting illicit proliferation of biological agents and material is discussed once. This is the only section that identifies a means to deny non-state actors a capability by referencing the Proliferation Security Initiative (PSI).⁸ This initiative supports counter-proliferation only when other nations agree to take action against suspect cargo. Another risk to successful implementation accepted throughout the document is reliance on industry and academia to internally establish and implement necessary controls to prevent illicit use.

The strategy establishes an objective as reinforcing norms of safe and responsible conduct by supporting the “culture of responsibility” in the life sciences.⁹ Industry and scientific societies, economically driven organizations, are considered key enablers who are expected to enact at times expensive internal controls on unique and dangerous experiments. Corporations are financially incentivized to minimize costs related to controls and may not readily implement the intent of the strategy without an enforcement mechanism. Academia has similar challenges in denying their researchers access to deadly pathogens due to their interest in making a positive breakthrough as well as fear of alienating their base of scientists.

The Cost of an Effective Strategy versus the Cost of an Attack

The U.S. national debt challenges all elements of U.S. power used to support the strategies discussed. As Chairman of the Joint Chiefs of Staff, Admiral Mike Mullen, stated in May 2011, “Our National debt is the largest national security threat our nation

⁸ Ibid., 16.

⁹Ibid., 8.

faces because we would have fewer available resources for defense spending.”¹⁰ Admiral Mullen goes on to explain in more detail the nuances of this statement, clarifying the need for the nation to make hard trade-offs and prioritize efforts. He further takes the stand that the nation needs to prioritize what it will and will not do within the current budgetary environment. The idea of trade-offs between security and domestic policy (and their budgets) impacts successful implementation of the strategies discussed since the trade space affects U.S. deterrence, nonproliferation, counter-proliferation, and consequence management activities.

The theoretical savings realized by reducing military forces may be offset by the reduction in capacity to implement U.S. strategy. The GAO estimates that DOD requested \$19.1 billion to fund all areas of countering WMD in 2010.¹¹ Over half of this request funded missile defense with 20% going to offensive operations.¹² Considering that 6.5% of this request funds the U.S. ability to predict, track, and conduct interdiction of suspect cargo or transfers of dual use technology, any reduction will degrade this capability.¹³ The effect of these changes could influence actors willing to challenge U.S. interests by making it appear the U.S. defense against WMD weapons has weakened. These actors may see an opportunity to procure WMD to gain an asymmetrical advantage over the United States, thereby reducing its influence. U.S. allies relying on the United States to provide security may change their stance on pursuing CB weapons as well if they believe regional adversaries have developed CB weapons.

¹⁰ Committee for a Responsible Budget, “ADM Mike Mullen on Debt and Defense Spending,” <http://crfb.org/blogs/adm-mike-mullen-debt-and-defense-spending>, (accessed December 14, 2014).

¹¹ U.S. Government Accountability Office, *Weapons of Mass Destruction: Actions Needed to Track Budget Execution for Counter-proliferation Programs and Better Align with Combating WMD Strategy*, (September 2010), by David M. D’Agostino, Defense Capabilities and Management.

¹² Ibid.

¹³ Ibid.

The cost of an effective CB weapon used against the United States could change the way policy makers calculate this trade space. The 9/11 attacks cost the U.S. over 3 trillion dollars including the loss of property, clean up, rebuilding, the resulting war effort, and the impact to the global economy.¹⁴ A WMD to attack would add the requirement to decontaminate the site of the attack and render it off limits for extended periods of time.

The 2009 strategy to counter biological threats estimates the cost of a biological attack at one trillion dollars to the U.S..¹⁵ Delivery of two letters with anthrax spores to Congressional offices in 2001 required \$27 million dollars just to decontaminate the building.¹⁶ The trillion-dollar estimate may seem high, but the actual cost could be greater. The cost to treat two Ebola patients for two weeks in Nebraska cost approximately 1.16 million dollars.¹⁷ Based on the cost from only a few patients it is not hard to see the economic challenge of a large-scale attack using a deadly agent like Ebola. Additional impacts could be felt if other nations chose to ban exports from the United States. This could cripple the U.S. economy by restricting travelers in and out of the United States; reducing exports for U.S. based food items, and developing long-term distrust of U.S. products. This is a short list of the likely outcomes of a major biological attack in the United States.

¹⁴ Tim Fernholz and Jim Tankersly, "The Cost of bin Laden: 3 Trillion over 15 years," *National Journal Magazine*, May 7, 2011, <http://www.nationaljournal.com/magazine/the-cost-of-bin-laden-3-trillion-over-15-years-20110505>, (accessed January 8, 2015).

¹⁵ U.S. President, *National Strategy for Countering Biological Threats*, (Washington D.C., Government Printing Office, November 2009), 1.

¹⁶ U.S. General Accounting Office, *Capitol Hill Anthrax Incident*, by John B. Stephenson, Report to the Chairman Committee on Finance, (June, 2003).

¹⁷ Marina Koren, "Who Will Pay Ebola Patients Medical Bills in the U.S.?", *National Journal*, November 24, 2014, <http://www.nationaljournal.com/health-care/who-will-pay-ebola-patients-medical-bills-in-the-u-s-20141124>, (accessed February 16, 2015).

CHAPTER 2: BARRIERS TO USE AND ADVANCING TECHNOLOGY

Overview of Barriers to Proliferation

U.S. strategy to counter WMD focuses on creating barriers to acquisition by limiting access to required information, equipment, and material specific to the production of CB weapons. Trade restrictions reduce access to required specialized equipment and training. The U.S. supports international treaty arrangements that outlaw the use of these weapons. The U.S. supported legislation that funded elimination activities in Russia following the collapse of the Soviet Union to minimize the potential for Russian scientists and WMD weapons from going to the highest bidder. These actions bolster the existing technical challenges to developing and employing these weapons.

Developing a chemical or biological weapon requires the funding, specialized knowledge, key materials (pathogens or pre-cursor chemicals), and access to required unique equipment. An additional challenge is the delivery of the agent in a manner that maintains its lethality. Dr. Raymond Zilinskas, Director, Chemical & Biological Weapons Nonproliferation Program at the Middlebury Institute of International Studies at Monterey, defined vital steps for acquisition and employment of biological weapons, “Secure a culture of suitable pathogen or toxin; or develop an appropriate formulation, obtain an appropriate container to store and transport, apply an efficient mechanism to disperse the pathogen or toxin, and have favorable meteorological conditions for the act of dispersion.”¹ These requirements apply to chemical weapons as well if you replace the pathogen with the required chemicals. The U.S. strategy to counter WMD relies on

¹ Richard Pilch and Dr. Raymond Zilinskas, *Encyclopedia of Bioterrorism Defense*, (Hoboken, NJ. Wiley-Liss, June 2005), 76.

international treaties and groups discussed below to provide barriers to the production and use of CB weapons.

International Treaty Agreements

Since the Brussels Conference of 1874, groups of states have sought to ban the use of CB weapons from warfare.² These international treaties were meant to deter actors from pursuing chemical or biological weapons due to potential recourse by other nations through trade or security agreements. These international treaties established norms for state interaction with other states. Fifteen European states codified an agreement in article twelve against the employment of poisonous weapons in the “International Declaration Concerning the Laws and Customs of War” at the Brussels Conference 1874.³ The “1899 Hague Convention and Regulations Respecting the Laws and Customs of War” prohibited the use of asphyxiating gases and was agreed to by fifty states.⁴ These conventions and others aimed to prevent or limit the spread of weapons.⁵ The U.S. strategy relies on enforcement of the following treaties and agreements for successful implementation.

The Biological and Toxin Weapons Convention (BTWC)

The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, entered into force in 1975. The BTWC established a ban against any actions regarding

² Cultural Policy Research Institute, “1874 Brussels Declaration,” [www.cprinst.org](http://www.cprinst.org/Home/cultural-property-laws/1874-brussels-declaration), <http://www.cprinst.org/Home/cultural-property-laws/1874-brussels-declaration>, (accessed December 14, 2014).

³ Ibid.

⁴ Encyclopedia Britannica, “Hague Convention,” www.britannica.com, September 28, 2014, <http://www.britannica.com/EBchecked/topic/251644/Hague-Convention>, (accessed December 15, 2014).

⁵ Ibid.

biological agents and toxins for any purpose other than prophylactic, protective, or other peaceful purposes. The “general purpose” provision included all biological agents, toxins, and their means of delivery. It further banned all weapons, equipment or means of delivery designed to use agents or toxins for hostile purpose. The implementation of the convention goes through the UN Security Council for enforcement. Any state that is party to the convention can lodge a complaint about any other state party to the convention. However, a challenge to enforcement of the BTWC is lack of a verification or monitoring protocol. States who signed the treaty are expected to honor their obligations without any external motivation.⁶

The Chemical Weapons Convention (CWC)

The CWC is a multilateral treaty that bans chemical weapons and requires their destruction within a specified period of time.⁷ The treaty is of unlimited duration and is more comprehensive than the 1925 Geneva Protocol, which outlawed the use but not the possession of chemical weapons.⁸ The initial deadline for destruction of reported WMD stockpiles was 2007, established as 10 years after the treaty entered into force.⁹ The United States and Russia failed to meet this deadline and received five-year extensions to 2012.¹⁰ Both countries again missed the deadlines; the U.S. estimates completion of destruction in 2025 while Russia has projected 2015.¹¹

⁶ Department of Peace Studies of the University of Bradford, “The Biological and Toxin Weapons Convention Website,” <http://www.opbw.org/>, (accessed December 14, 2014).

⁷ OPCW, Destruction of Chemical Weapons, www.opcw.org, <http://www.opcw.org/our-work/demilitarisation/destruction-of-chemical-weapons/>, (accessed December 14, 2014).

⁸ Ibid.

⁹ Ibid.

¹⁰ Tom Z. Collina, The Chemical Weapons Convention (CWC) at a Glance, www.armscontrol.org, September 2013, <http://www.armscontrol.org/factsheets/cwcglance> (accessed December 14, 2014).

¹¹ Ibid.

CWC negotiations started in 1980 at the UN Conference on Disarmament. The convention opened for signature on January 13, 1993, and entered into force on April 29, 1997. The Organization for the Prohibition of Chemical Weapons (OPCW), headquartered in The Hague, implements the treaty. The OPCW receives declarations from states that are party to the treaty, detailing chemical weapons-related activities or materials and relevant industrial activities. After receiving declarations, the OPCW inspects and monitors the states facilities and activities that are relevant to the convention to ensure compliance.¹²

There are 189 states-parties to the CWC. A “states party” is a country that signed the document and ratified it through their legislative body. Two signatories who have not ratified the convention with their internal governing bodies and that are suspected of maintaining stockpiles of WMD include Israel and Myanmar (Burma). Non-signatory states include North Korea, long suspected of having chemical weapons, and Egypt.¹³ Syria was a non-member until President Assad said Syria would observe CWC obligations in 2013.¹⁴ The OPCW accepted Syria on September 14, 2013 and the treaty went into force on October 14, 2013.¹⁵

The Australia Group (AG)

The Australia Group (AG), an informal forum of countries, seeks to ensure that exports do not contribute to the development of chemical or biological weapons. States participating in the AG are parties to the Chemical Weapons Convention (CWC) and the

¹² OPCW, Destruction of Chemical Weapons, [www.opcw.org, http://www.opcw.org/our-work/demilitarisation/destruction-of-chemical-weapons/](http://www.opcw.org/our-work/demilitarisation/destruction-of-chemical-weapons/), (accessed December 14, 2014).

¹³ Ibid.

¹⁴ OPCW, “Member State Syria”, [www.opcw.org, http://www.opcw.org/about-opcw/member-states/member-states-by-region/asia/member-state-syria/](http://www.opcw.org/about-opcw/member-states/member-states-by-region/asia/member-state-syria/), (accessed January, 8, 2015).

¹⁵ Ibid.

Biological and Toxic Weapons Convention (BTWC). The AG focuses on member state enforcement of export controls to provide another means to limit proliferation.

The AG provides states parties a means to coordinate national export control measures. The AG also provides a common licensing methodology to assist participants to fulfill their obligations under the CWC and the BTWC. The AG has no legally binding obligations, instead the effectiveness of the AG depends on a shared commitment to non-proliferation of CBW goals and individual states national controls. Export licensing measures are intended to be effective, practical, and not impede normal trade for legitimate purposes.¹⁶

The Proliferation Security Initiative (PSI)

The Proliferation Security Initiative (PSI) provides a group of states the framework to interdict suspect shipments and enforce international treaties collectively. In May of 2003, the U.S. agreed to lead this effort. President George W. Bush announced that the goals of the group are to interdict shipments of weapons of mass destruction (WMD) and related goods to terrorists and countries of proliferation concern. The initiative's aim is "to keep the world's most destructive weapons away from our shores and out of the hands of our common enemies."¹⁷ Endorsement of the PSI Statement of Interdiction Principles, a non-binding document that lays out the framework for PSI activities, is the only membership requirement with 102 countries publicly committed to the initiative.

¹⁶ Government of Australia, Activities of the Australia Group, <http://www.australiagroup.net/en/introduction.html>, (accessed December 14, 2014).

¹⁷ Kelsey Davenport, The Proliferation Security Initiative (PSI) at a Glance, www.armscontrol.org, <http://www.armscontrol.org/factsheets/PSI>, (accessed December 10, 2014).

The goal of the initiative is to stop delivery of shipments to terrorists or countries suspected of trying to acquire biological, chemical, and nuclear weapons, as well as missiles and dual use materials. Enforcement relies on existing international law allowing interdictions in international waters or airspace. PSI participants agree to permit their own vessels and aircraft to be searched if suspected of transporting such goods and are called on to not engage in WMD-related trade with countries of proliferation concern. Information sharing agreements in the initiative are intended to enable action when suspicious activity is discovered. Member states are expected to search vessels "reasonably suspected" of carrying dangerous cargo when they pass through national airports, ports, and other transshipment points. Members hope the initiative will dissuade other countries from pursuing weapons in the first place or to delay their acquisition efforts.¹⁸

Military Deterrence

Deterrence provides another avenue to discourage proliferation or use of chemical or biological weapons. Deterrence requires a state to believe in the legitimacy and capability of the threats from another state. The intent of deterrence is to change the cost benefit calculus of the adversary state. U.S. policy regarding its right to the use of nuclear weapons has long been seen as a strong deterrent to negative actions by other states. Some would argue the United States lack of resolve to use a nuclear option has reduced the effectiveness of this deterrent to adversary states.¹⁹ Nuclear weapon deterrence against non-state actors is questionable as well since they cannot be targeted

¹⁸ Ibid.

¹⁹ Al Mauroni, "Seeking a Strategy to Counter Weapons of Mass Destruction," www.smallwarsjournal.com, May 22, 2012, <http://smallwarsjournal.com/jrnl/art/seeking-a-strategy-to-counter-weapons-of-mass-destruction-0>, (accessed 14 December, 2014).

effectively inside another state's borders. The United States also uses sanctions to change the behavior of other states seeking weapons of mass destruction. In the case of Iran and North Korea, the U.S. utilizes economic sanctions to influence their behavior regarding nuclear weapons.

U.S. deterrence may have weakened from a failure to act decisively regarding Syrian use of CB weapons. President Obama established the "red line" regarding use of chemical weapons by Syria in remarks to reporters on 20 August, 2012. During a press conference he stated, "We have been very clear to the Assad regime, but also to other players on the ground, that a red line for U.S. is we start seeing a whole bunch of chemical weapons moving around or being utilized. That would change my calculus. That would change my equation."²⁰ Syria crossing the "red line" as described by the President of the United States did not elicit a military response. Even though the United States did not respond with overwhelming military force in Syria, the United States played a significant role in the destruction of the declared Syrian chemical weapons stockpile.²¹

Cooperative Threat Reduction (CTR)

The United States used elimination operations to advance its strategy by removing weapons in Russia, Libya, and now Syria.²² Removal of these stockpiles reduced the

²⁰ Glenn Kessler, "President Obama and the 'red line' on Syria's chemical weapons," *The Washington Post*, <http://www.washingtonpost.com/blogs/fact-checker/wp/2013/09/06/president-obama-and-the-red-line-on-syrias-chemical-weapons/> (accessed December 19, 2014).

²¹ OPCW, U.S. Completes Destruction of Sarin Precursors from Syria on Cape Ray," [www.opcw.org](http://www.opcw.org/news/article/U.S.-completes-destruction-of-sarin-precursors-from-syria-on-the-cape-ray/), <http://www.opcw.org/news/article/U.S.-completes-destruction-of-sarin-precursors-from-syria-on-the-cape-ray/>, (accessed January 8, 2015).

²² Justin Bresolin, "Fact Sheet: The Nunn-Lugar Cooperative Threat Reduction Program," [www.armscontrolcenter.org](http://armscontrolcenter.org), June 2014, http://armscontrolcenter.org/publications/factsheets/fact_sheet_the_cooperative_threat_reduction_program/, (accessed 22 February, 2015).

potential for a non-state actor or other state to access WMDs. The United States expended significant funds through its Cooperative Threat Reduction (CTR) program to eliminate these stockpiles.²³ U.S. Sen. Dick Lugar described the goals of the program in August 28, 2007, “The experience of the Nunn-Lugar program has demonstrated that the threat of weapons of mass destruction can lead to extraordinary outcomes based on mutual interest.”²⁴ The CTR program established the means to assist states in destroying their stockpiles subject to arms control treaties. The act also provided a way to help scientists from Soviet WMD programs find work in legitimate organizations and removed tons of chemical weapons through the support of the UN and its member nations

Summary

The barriers to WMD discussed in this chapter focus on restricting access to precursor materials for the production of CB agents through treaties or export controls. These barriers challenge efforts by rogue states to procure or maintain a CB weapon stockpile. The AG and PSI provide for a more flexible enforcement mechanism but each treaty or agreement relies on the member state to implement and hold itself accountable to the terms of the agreements. The CWC provides an enforcement mechanism through the UN but member nations can, and in the case of Iraq did, circumvent the restrictions. U.S. military deterrence may have weakened recently through debates in the media on reduction of the size of the U.S. military and the apparent lack of resolve to act following the use of chemical weapons in Syria. The CTR program effectively reduced known stockpiles of CB weapons and knowledge that could be stolen by non-state actors.

²³ Ibid.

²⁴ Defense Threat Reduction Agency, Nunn Lugar Global Cooperative Initiative, [www.dtra.mil](http://www.dtra.mil/Missions/nunn-lugar/nunn-lugar-home.aspx), <http://www.dtra.mil/Missions/nunn-lugar/nunn-lugar-home.aspx>, (accessed December 01, 2014).

The technologies listed in the next chapter reduce these barriers to state and non-state actors access to CB weapons by scaling down or eliminating the critical requirements these agreements restrict. The OPCW looks for compliance with the CWC by looking for known equipment and materials used in production of CB weapons. New technology no longer requires these known equipment and materials to produce CB weapons. The AG and PSI target known pre-cursor chemicals and biological agents in suspect shipments but synthetic biology and nanotechnology can create CB weapons without these pre-cursors.

CHAPTER 3: TECHNOLOGY

The Threat of Future Technology

The globalization of technology, driven by unprecedented access to information, provides opportunities for individuals, non-state actors and nations to develop CB weapons. These weapons could provide rogue states a deterrent to intervention by stronger powers by raising the potential costs of conflict to unacceptable levels. Many individuals and non-state actors seek these types of weapons over conventional alternatives because of the potential to create highly lethal effects. Western nations exert a great deal of effort to deny these actors access to the technology and required materials for production due to fear that successful acquisition would result in use or become an effective deterrent.

Recent technological innovations provide both states and non-state actors the ability to bypass many barriers and gain access to CB weapons. This technology requires information, trained chemists and biologists, miniaturization of industrial processes, and increased access to materials and processes. Each technology described below has experienced a dramatic increase in its capability and ease of access since 2002. The future risk enabled by these technologies is that a wider range of actors could target the United States with CB weapons resulting in negative impacts on the economy and security of U.S. interests. The loss of life and destruction of property experienced during 9/11 could be multiplied by ten as a result of an effective CB weapon attack. The resulting political and social fallout in the United States could cause significant harm to U.S. freedoms and engender a large-scale response in kind if the attack was attributed to a state.

Internet Access

Internet access across the world provides a link to the technology needed to produce chemical and biological weapons. Colin Gray noted in his book *Another Bloody Century*, that, “...it is little short of amazing to discover just how much information about them [chemical weapons], and their nuclear cousins also, is readily available.”¹ Anyone with Internet access can find academic books containing the formulas and processes for making chemical weapons and explosives. Amazon.com carries the books such as, *A Laboratory History of Chemical Warfare Agents* and *The Preparatory Manual of Explosives*, for as little as forty U.S. dollars.

The social media fueled “Arab Spring” revolutions in 2013 demonstrated the power of Internet connectivity. The penetration of the Internet increased dramatically since 2001 with world Internet access doubling between 2005 and 2012.² Growth in individuals using the Internet rose globally from 15.8 to 35.5 percent.³ The population covered by a mobile cellular network in the Middle East and North Africa region grew to almost 93 percent from 67 percent while outpacing the world numbers between 2005 and 2012.⁴ Mobile cellular subscriptions grew 70 percent and households with Internet access rose by 20 percent in this region.⁵

The same access to the Internet that allowed demonstrators to share tweets and video can also provide links to a variety of sites with technical data on CB weapons technology. A RAND study identifies the Internet as creating more opportunities to

¹ Gray, Colin, *Another Bloody Century; Future Warfare*, (London; Phoenix, 2006), 260.

² The World Bank, *The Little Data Book on Information and Communication Technology*, (Washington D.C. 2014) <https://openknowledge.worldbank.org/handle/10986/18427> (accessed December 19, 2014).

³ Ibid.

⁴ Ibid.

⁵ Ibid.

become radicalized, acting as an echo chamber to re-enforce beliefs, and accelerate the process of radicalization.⁶ Individual actors or “lone wolves” radicalized over the Internet may possess skills to build their own WMDs or have access to chemical stockpiles awaiting destruction. The former Major Nidal Hasan, who killed Soldiers at Ft Hood, Texas may have possessed the skills required to produce biological weapons and could have had access to restricted biological agents as a military medical officer. He received an undergraduate degree in biochemistry from Virginia Tech before his commission and training as a psychiatrist.⁷

Synthetic Biology

Synthetic biology is the manipulation of material at the genetic level to modify or create new biological products.⁸ This capability exists now and may in the future provide a state, with interests counter to the United States, the ability to target specific people, races, or genders.⁹ The technology deals with manipulating a cell’s instructional material, called deoxyribonucleic acid (DNA), which contains the blueprint of both prokaryotic (no nucleus) and eukaryotic (nucleus) cells.¹⁰ Sergio Peisajovich, in *Bio Building Basics: A Conceptual Instruction for Synthetic Biology*, defined synthetic biology as, “An emerging field of biology that aims at designing and building novel biological systems. Synthetic biology extends its focus on whole systems of genes and

⁶ Ines von Behr, Anais Reding, Charlie Edwards, Luke Gribbon, *Radicalization in the Digital Era; The use of the internet in 15 cases of terrorism and extremism*, (Cambridge, UK; RAND EUROPE, 2013), 17.

⁷ WFAA staff, “Who is Maj. Nidal Malik Hasan?” www.wfaa.com, November 12, 2009, <http://www.wfaa.com/story/local/2015/02/22/13530754/>, (accessed February 22, 2015).

⁸ Noah Helman, Wendell Lim, Sergio Peisajovich, David Pincus, and Nili Sommovilla, *Bio Building Basics: A Conceptual Instruction Manual for Synthetic Biology*, (University of California San Francisco, 2007), 2.

⁹ Andrew Hessel, Marc Goodman, and Steven Kotler, “Hacking the President’s DNA,” www.theatlantic.com, (24 October 2012), http://www.theatlantic.com/magazine/archive/2012/11/hacking-the-presidents-dna/309147/?single_page=true, (accessed 17 March 2014).

¹⁰ National Genome Research Institute, “Deoxyribonucleic Acid,” www.genome.gov, <http://www.genome.gov/25520880>, (accessed December 8, 2014).

gene products and aims to add or modify biological functions to existing organisms or create novel organisms with tailored properties.”¹¹ Synthetic biology is augmented by the human genome project.

The entire human genome was released in 2003.¹² Francis Collins, Director of the National Human Genome Research Initiative (NHGRI) explained the release this way, “[It is a] book with multiple uses. It’s a history book - a narrative of the journey of our species through time. It’s a shop manual, with an incredibly detailed blueprint for building every human cell.”¹³ The blueprint of the human genome provides the synthetic biologist a template to create existing biological material or novel combinations resulting in new biological material.¹⁴ For example, in 2002, scientists at Stony Brook University of New York re-created the poliovirus using synthetic biology¹⁵.

Reproduction of various other pathogenic viruses occurred after that successful experiment.¹⁶ Two of these experiments produced the SARS virus and the previously extinct strain of the “Spanish Flu” virus, which was responsible for the 1918-19 pandemic affecting over one third of the world and killing nearly five percent of the population.¹⁷ The development of synthetic biology provides the potential to advance life sciences and treat of a range of diseases. However, combining the best or worst traits of deadly pathogens presents a unique challenge to U.S. policy makers, protective

¹¹ Noah Helman, Wendell Lim, Sergio Peisajovich, David Pincus, and Nili Sommovilla. *Bio Building Basics: A Conceptual Instruction Manual for Synthetic Biology* (University of California San Francisco, 2007), 2.

¹² National Institutes of Health (NIH), An Overview of the Human Genome Project, www.genome.gov, <http://www.genome.gov/12011238>, (accessed December 7, 2014).

¹³ Ibid.

¹⁴ Ibid.

¹⁵ Stony Brook State University of New York, First *de novo* Virus Synthesis, www.stonybrook.edu, <http://www.stonybrook.edu/ovprpub/tsc/polio.html>, (accessed 22 February, 2015).

¹⁶ Ibid.

¹⁷ Guatam Mukunda, Kenneth A. Oye, Scott C. Mohr, “What Rough Beast? Synthetic biology, uncertainty, and the future of biosecurity,” *Politics and Life Sciences* 28, no.2, (September 2009), 8.

measures, and medical response. These challenges go beyond traditional non-proliferation concerns into the ethical, legal, and social spheres. Synthetic biology could provide a completely new threat that is not accounted for in the current U.S. strategy.

Nanotechnology

Nanotechnology provides scientists the ability to manufacture materials at the nanometer or nm particle size by manipulating material at the atomic level.¹⁸

Nanotechnology could enable development of targeted weapons against specific individuals or groups. An adversary could create particles that combine autonomously to create a weapon or cause death, and then disappear. The development of this technology has grown significantly in the last twenty years from idea to reality.¹⁹ Inside the United States alone developers spent fourteen billion dollars since 2000 maturing this technology.²⁰ In 2014, researchers at the University of California placed artificial micro-motors orally into a mouse to successfully deliver a payload directly into the mouse's stomach wall.²¹ The micro-motors then dissolved in the acid of the stomach, leaving no trace.²²

The potential for manipulation at the nanometer level exploits capability in other life sciences like chemistry, biochemistry, quantum physics, and materials sciences.²³ Managing the potential negative outcomes of this new technology becomes difficult due to the likelihood of unexpected uses being developed. They could increase persistency of

¹⁸ Nick Pidgeon, Barbara Hawthorne, and Terre Satterfield, "Nanotechnology Risk Perceptions and Communication: Emerging Technologies, Emerging Challenges," *Risk Analysis* 31, No 11 (2011), 1694.

¹⁹ Ibid.

²⁰ Ibid.

²¹ Wei Gao, Renfeng Dong, Soracha Thamphiwatana, Jinxing Li, Weiwei Gao, Liangfang Zhang, and Joseph Wang, "Artificial Micromotors in the Mouse's Stomach: A step toward in Vivo use of Synthetic Motors," *ACS NANO*, 9, No. 1 (December 2014), 117-123.

²² Ibid., 117.

²³ Nick Pidgeon, Barbara Hawthorne, and Terre Satterfield, 1694.

biological warfare agents that would otherwise be destroyed by environmental conditions like sunlight or temperature. Nanotechnology may allow for design of weapons that would bypass current barriers and detection technologies in the U.S. strategy. This technology defies current policy and the barriers of traditional treaty regimes potentially giving a hostile nation its own “nuclear” like deterrent capability against other nations.

The Third Industrial Revolution

The ability to take an idea and turn it into reality almost instantaneously underpins this idea of technological expansion. Another aspect is the “Internet of things,” which covers the integration of “big data” at the macro level to develop efficiencies.²⁴ This concept led Jeremy Rifkin to coin the term “The third industrial revolution” that encompasses the emerging technologies of the Internet and renewable energy.²⁵ The premise of the revolution involves management of resources through connected networks.²⁶ This interconnectivity provides numerous risks that an adversary could exploit.

The production and use of hazardous chemicals provides terrorists an area to attack through these connected systems. The adversary could attack by a malicious computer program causing a significant industrial chemical release that would have effects similar to a chemical weapon. The terrorist initiating the attack would only expose himself through the digital access to the control systems. An attack by this means could cause significant numbers of deaths and injuries. An adversary could harm the

²⁴ Jeremy Rifkin, *The Third Industrial Revolution*, (Palgrave Macmillan Trade, January 8, 2013), 5.

²⁵ Ibid.

²⁶ Ibid.

U.S. economy or attack a utility system remotely to change the behavior of the United States or its involvement in international events.

Drones

Successful delivery of biological agents to a target is itself a barrier to use by a threat actor. The use of rockets, sprayers, or artillery to deliver biological agents are easier to track, harder to deploy, and may destroy the biological agents prior to infecting the target. Drones provide a means to not only deliver the agent but also provide a way to bypass U.S. security of sensitive sites. This threat was recently demonstrated by the drone penetration of the White House grounds on January 26, 2015.²⁷ Applications for this technology continue to advance while policy makers struggle with the proper safety regulations to support its use in free trade and industry.

Industry and criminal networks are exploiting drones to move material in quantities that could produce significant casualties if used to deliver biological agents. Criminal networks have been caught using drones to fly packages of up to 13 kilos of drugs over the border from Mexico to the United States.²⁸ The Drug Enforcement Agency (DEA) registered 150 drones transporting nearly two tons of drugs since 2012.²⁹ Amazon is exploring the potential for drones to deliver packages to your doorstep. The

²⁷ Peter Bergen, "Could Drones Be used Against the U.S.?", www.cbs.com, <http://www.cnn.com/2015/01/26/opinion/bergen-drones-future/>, (accessed February 17, 2015).

²⁸ Nick Valencia and Michael Martinez, "Drone Carrying Drugs Crashes South of U.S. Border," www.cnn.com, January 23, 2015, <http://www.cnn.com/2015/01/22/world/drug-drone-crashes-U.S.-mexico-border/>, (accessed 22 February, 2015).

²⁹ Camilo Mejia Giraldo, "Mexico's Cartels Building Custom Made Narco Drones: DEA," www.insightcrime.org, July 11, 2014, <http://www.insightcrime.org/news-briefs/mexico-s-cartels-building-custom-made-narco-drones-dea?highlight=WyJkcm9uZXMiXQ==>, (accessed 22 February, 2015).

plan for “Amazon Prime Air” is to deliver your purchase from a distribution center to your door within thirty minutes of purchase.³⁰

Drones expand the number of targets a terrorist can access. A drone could increase the lethality of an attack by accurately delivering and releasing enough biological agents to kill or sicken thousands of people. The terrorist can program or pilot the drone to deliver the package for them while taking real time video to exploit on the Internet. Terrorist groups like Hezbollah use large drones now to penetrate Israeli air defenses and reportedly used a drone to attack targets in Syria³¹.

Bio-regulators

Bio-regulators are another unique type of chemical agent currently unregulated by the existing treaty and export control regimes. These agents may provide analogous effects to chemical or biological weapons.³² The chemicals are naturally produced in the body to control functions like heart rate, temperature, and sleep.³³ Drug companies and other researchers already developed a potential method to deliver individual doses.³⁴ The Applied Research Laboratory and College of Medicine in Pennsylvania published research in 2000 on the potential use of bio-regulators as calmativ agents for law enforcement and counter-terrorism uses.³⁵ Russia may have used a type of bio-regulator in a rescue attempt at the Dubrovka Theater in 2002. The Russians failed at negotiating

³⁰ CBS News, Amazon Drones, [www.cbs.com, http://www.cbsnews.com/news/amazon-unveils-futuristic-plan-delivery-by-drone/](http://www.cbs.com/news/amazon-unveils-futuristic-plan-delivery-by-drone/) (accessed on December 8, 2014).

³¹ Peter Bergen, “Could Drones Be used Against the U.S.?” [www.cbs.com, http://www.cnn.com/2015/01/26/opinion/bergen-drones-future/](http://www.cbs.com/news/amazon-unveils-futuristic-plan-delivery-by-drone/), (accessed February 17, 2015).

³² Tucker, Jonathan B., The body’s own bioweapons, *Bulletin of the Atomic Scientists*, 64, No. 1, (March/April 2008), 21.

³³ Ibid.

³⁴ Ibid., 19.

³⁵ Ibid.

with the terrorists and attempted a hostage rescue using a gas. It has been hypothesized the gas was a bio-regulator.³⁶

Summary

The technology described in this chapter challenges successful implementation of the U.S. strategy because they bypass traditional barriers to proliferation. Increased Internet access in the Middle East provides terrorist organizations operating in these areas better technology and knowledge to develop CB weapons and target the United States. The Internet gives U.S. adversaries the capability to target individuals with specialized skills in order to procure or gain access to existing CB weapons. New technology provides the means to create novel CB weapons that can overcome existing protective measures and controls. Drone technology and the Third Industrial Revolution provide pathways to deliver CB weapons across borders and past defensive systems to strike sensitive targets or U.S. populations. The next chapter describes three current threats who could use this technology to circumvent U.S. strategy and attack the United States using WMD.

³⁶ Monterey Institute of International Studies, The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare, Center for Non-proliferation Studies, <http://cns.miis.edu/stories/02110b.htm>, (accessed December 9, 2014).

CHAPTER 4: THREATS

Why Do Actors Seek WMD?

States develop weapons to deter intervention, provide security, or threaten other states. Many states suspected of maintaining CB programs are non-nuclear weapon states.¹ Others achieved nuclear weapons status after developing CB weapons first as a cheaper alternative.² Nuclear weapons present many more challenges to production and weapon creation than CB weapons. In particular, the raw materials and engineering expertise are well controlled and regulated. State actors are more likely to have the resources and expertise to produce chemical or biological agents without reliance on external suppliers, making it an attractive alternative to nuclear weapons development.

Open source intelligence links China and Iran to development of WMDs.³ The former Soviet Union exploited new technologies to great effect per reports by Vil S. Mirzayanov, a former Soviet Union weapons scientists.⁴ Rogue states like North Korea and states in conflict like Syria demonstrate the threshold required for a state to develop, and in the case of Syria, use a weapon of mass destruction. North Korea conducted a nuclear weapon test to prove that they successfully developed nuclear weapon.⁵ In Syria, the threat of national survival against an active insurgency appears to have been enough

¹ Monterey Institute of International Studies, “Chemical and Biological Weapons: Possession and Programs Past and Present,” James Martin Center for Nonproliferation Studies. <http://cns.miis.edu/cbw/possess.htm> (accessed December 19, 2014).

² Ibid.

³ Ibid.

⁴ Vil S. Mirzayanov, *State Secrets; An Insiders Chronicle of the Russian Chemical Weapons Program*, (Denver, CO: Outskirts Press, Inc., 2009), 148.

⁵ Nuclear Threat Initiative, “North Korea,” [www.nti.org](http://www.nti.org/country-profiles/north-korea/), December, 2014, <http://www.nti.org/country-profiles/north-korea/>, (accessed December 14, 2014).

to lead the regime to use chemical weapons, even after threatened intervention by the United States.⁶

Prior to the use of chemical weapons in Syria in 2012, President Obama made Syrian use of chemical weapons a “redline”.⁷ The use of chemical weapons by the Syrian government prompted a terse response from the U.S. State Department but did not result in U.S. military action. The U.S. Secretary of State, John Kerry, condemned the Syrian government of Bashar Al-Assad for using chemical weapons against Syrian citizens near Damascus in August of 2013. Declassified U.S. reports released at the same time provide evidence to support this claim.⁸ Secretary Kerry went on to state that the Al-Assad regime of Syria used chemical weapons to shell neighborhoods held by Syrian rebels after conventional munitions failed to clear them out.⁹ Syrian rebel groups appear to have then used chlorine gas to attack Iraqi government forces in Duluiya, Iraq in October of 2014.¹⁰ Non-state actors have also sought WMD’s to advance their interests and challenge U.S. policies.

This chapter will review three non-state actors who expressed the desire to gain and use CB weapons as a means to challenge U.S. strategy. The potential for these groups to procure and use CB weapons may significantly improve by using the

⁶ Glenn Kessler, “President Obama and the Red Line on Syria's Chemical Weapons,” www.washingtonpost.com, September 6, 2013, <http://www.washingtonpost.com/blogs/fact-checker/wp/2013/09/06/president-obama-and-the-red-line-on-syrias-chemical-weapons/>, (accessed December 19, 2014).

⁷ Ibid.

⁸ The White House, Intelligence assessment released by White House, www.whitehouse.gov, August 30, 2013, <http://www.whitehouse.gov/the-press-office/2013/08/30/government-assessment-syrian-government-s-use-chemical-weapons-august-21>, (accessed December 19, 2014).

⁹ Washington Post, “Public statements by Secretary of State John Kerry”, www.washingtonpost.com, August 30, 2013, http://www.washingtonpost.com/world/national-security/nearly-1500-killed-in-syrian-chemical-weapons-attack-U.S.-says/2013/08/30/b2864662-1196-11e3-85b6-d27422650fd5_story.html, (accessed December 3, 2014).

¹⁰ Elena Becatoros and Diaa Hadid, “Militant Groups Said to be using Chlorine Bombs,” [www.news.yahoo.com](http://news.yahoo.com), October 24, 2014, <http://news.yahoo.com/syrian-government-forces-shell-rebel-areas-kill-9-111115671.html>, (accessed December 3, 2014).

technologies described in chapter three. These non-state groups are Aum Shinrikyo, Al Qaeda and its affiliates (AQAA), and the group called the Islamic State of Iraq and Syria (ISIS).

Aum Shinrikyo

Aum Shinrikyo, meaning the “supreme truth” possessed the desire, capability, and resources to develop their own CB weapons program.¹¹ Shoko Asahara, the cult’s leader, preached about the coming Armageddon from a U.S.-Japanese nuclear war and prophesied that the only survivors would be his followers. The group strove to cause this apocalyptic event to bring about the end of time by exploiting the Internet, buying support from actors with technological expertise, and small-scale laboratories to create CB weapons while circumventing Japanese authorities in the early 1990s.¹² This group shows how an adversary could survive inside the United States and develop a CB weapon to use as a “doomsday” device.

Aum Shinrikyo developed a large following and amassed millions of dollars in funds, perhaps as much as \$1 billion in net worth. The group gained wealth and influence by drawing in up to 80,000 followers between Japan and Russia. The cult expanded by purchasing land in Russia and even a farm in Australia. They owned worldwide corporations giving them cover for their clandestine activities as well as enhancing recruitment. The cult used Japanese religious freedom laws to restrict government

¹¹ David E. Kaplan and Andrew Marshall, *The Cult at the End of the World*, (New York, Crown Publishers, 1996).

¹² Sara Daly, John Parachini, William Rosenau, *Aum Shinrikyo, Al Qaeda, and the Kinshasa Reactor*, (RAND Project Air Force 2005).

organizations from intervening in its activities.¹³ David Kaplan and Andrew Marshall described recruitment in their book:

Aum leaders systematically targeted top Japanese universities, recruiting brilliant, but alienated, young scientists from chemistry, physics, and engineering departments. They forged relations with Japan's ruthless crime syndicates, the Yakuza, and with veterans of the KGB and Russian and Japanese militaries. They enlisted medical doctors to dope patients and perform human experiments that belong in a horror movie.¹⁴

The RAND project review assessed the recruits were likely brilliant at a normal university, but were likely second-rate students at the prominent universities.¹⁵ The students may have felt alienated, providing a “hook” for Aum Shinrikyo recruiters to exploit. This may have resulted in some of the groups failed delivery system for its chemical agents and the lack of virulence in its use of anthrax.

The cult attempted to buy a weapon from Russia to use in Japan.¹⁶ A leader of the group, Hayakawa Kiyohide made eight trips to Russia in attempts to purchase a nuclear weapon.¹⁷ At the same time, the group began development of their own weapon systems in Australia.¹⁸ Australia, Russia, and Japan all took steps to deny visas to the cult’s members by jailing many of the cult’s followers and closing down their facilities. Ultimately, these actions denied the cult access to a ready-made nuclear weapon forcing it to pursue an alternative option.¹⁹

The group exploited the Internet in its attempts to develop its own weapons technology by hacking into classified computers in Russia, the Ukraine, the Republic of

¹³ Ibid.

¹⁴ David E. Kaplan and Andrew Marshall, 190.

¹⁵ Sara Daly, John Parachini, William Rosenau, *Aum Shinrikyo, Al Qaeda, and the Kinshasa Reactor*, (RAND Project Air Force 2005), 11.

¹⁶ D.W. Brackett, *Holy Terror: Armageddon in Tokyo*, (New York, Weatherhill Inc, 1996), 92.

¹⁷ David E. Kaplan and Andrew Marshall, 190.

¹⁸ D.W. Brackett, 94-96.

¹⁹ Ibid.

China, and others.²⁰ Data found in the cult's computers included details of Japan's own nuclear power program suppliers, transporters, and key corporations involved in the industry.²¹ The cult built a database on the personal lives of the nuclear power plant workers and researchers working on nuclear projects.

Ultimately, the cult successfully developed its own biological and chemical weapons. The contacts they had developed in Russia led them to the illicit arms market and success at developing weapons grade agents.²² The result was the successful formulation of the chemical weapon Sarin, which was dispersed in plastic bags on the Tokyo subway system on March 20, 1995.²³ The dispersion device failed to work effectively, potentially saving the lives of thousands.²⁴ The attacks still killed thirteen and injured over five thousand.²⁵ Aum Shinrikyo allegedly made numerous other attempts at using biological and chemical agents that have not been well publicized. The Monterey WMD Terrorism database attributes ten attack using nerve agents (Sarin and VX) as well as choking agents (phosgene) and a blood agent (hydrogen cyanide) to Aum Shinrikyo.²⁶ The database links the group to nineteen other CB events.²⁷

²⁰ Sara Daly, John Parachini, William Rosenau, *Aum Shinrikyo, Al Qaeda, and the Kinshasa Reactor*, (RAND Project Air Force 2005), 12, 19.

²¹ Ibid.

²² Ibid.

²³ Maan Pamentuan-Lamorena, "Japan remembers Tokyo subway's sarin gas attack, 19 years after," www.JapanDailyPress.com, 21 March 2014, <http://japandailypress.com/japan-remembers-tokyo-subways-sarin-gas-attack-19-years-after-2146109/> (accessed December 14, 2014).

²⁴ Ibid.

²⁵ Ibid.

²⁶ Monterey Institute of International Studies, The Moscow Theater Hostage Crisis: Incapacitants and Chemical Warfare, Center for Non-proliferation Studies, <http://cns.miis.edu/stories/02110b.htm>, (accessed December 9, 2014).

²⁷ Ibid.

The cult attempted a mass release of anthrax in Kameido, Tokyo in 1993.²⁸ During the attack, the cult sprayed a mist from the top of an eight-story building for four days.²⁹ Authorities did not have the legal authority to force entry into the building due to lack of proof the mist caused a hazard following complaints from local residents.³⁰ It was not until after the successful Sarin attack that U.S. and Japanese authorities examined samples collected from the mist incident and discovered anthrax spores in the residue.³¹

Expertise in synthetic biology or nanotechnology could have resulted in development of a virulent form of anthrax and improved dispersal of the agent. The reason for the absence of human infections following the Aum Shinrikyo anthrax release relates to the type of anthrax used and the dispersion device. Study of the anthrax used revealed the strain used by the cult came from attenuated spores used to vaccinate animals against anthrax, while the sprayer did not make the particulate small enough for even distribution.³² Similarly, the group synthesized and produced an effective nerve agent but failed to disperse it efficiently through the Tokyo subway during their 1995 attack.³³ A functional dispersion device would have significantly increased the lethality of the group's most publicized attack. Aleph, the current incarnation of Aum Shinrikyo, could learn from their failures and bypass Japanese controls to develop a more lethal agent for its next attack on Tokyo or the United States by using advanced technology.

²⁸ Centers for Disease Control and Prevention, *Bacillus anthracis* Bioterrorism Incident, Kameido, Tokyo, 1993, *Emerging Infectious Diseases Journal*, January 2004, http://wwwnc.cdc.gov/eid/article/10/1/03-0238_article, (accessed December 14, 2014).

²⁹ Ibid.

³⁰ Ibid.

³¹ Ibid.

³² Ibid.

³³ D.W. Brackett, *Holy Terror: Armageddon in Tokyo*, (New York, Weatherhill Inc, 1996), 94-96.

Al Qaeda and its Affiliates (AQAA)

AQAA's stated intent is to remove western influence from lands it believes belong to the followers of Mohammed.³⁴ The group has repeatedly demonstrated its capability and reach through sophisticated and well-coordinated terrorist attacks around the world. The most spectacular asymmetric attack utilized commercial airliners to attack highly visible U.S. landmarks on September 11, 2001.³⁵ Bin Laden called on Muslims to use weapons of mass destruction in an interview with Rahimulla Yusufzai for Time magazine, "Acquiring weapons for the defense of Muslims is a religious duty...It would be a sin for Muslims not to try to possess the weapons that would prevent the infidels from inflicting harm on Muslims."³⁶ To this end, AQAA has attempted to purchase a suitcase nuclear device as early as 1998.³⁷ In that report, Bin Laden may have paid up to two million dollars for the device; although it appears the transaction was never consummated.³⁸ AQAA approached dissident political groups in Sudan like the National Islamic Front (NIF) as well as Sudan government organizations like the Military Industrial Corporation (MIC) to help develop a nuclear device.³⁹

The U.S. attack on the Al-Shifa plant in Sudan was likely the result of Bin Laden's attempt to develop weapons of mass destruction following the attacks on 9/11.⁴⁰ The U.S. suspects AQAA of researching and attempting to produce chemical and

³⁴ Yusufzai Rahimulla, "Conversation with Terror," Time, (January 11, 1999).

³⁵ Ibid.

³⁶ Ibid., 14.

³⁷ Marie Colvin, "Holy War with U.S. in his Sights" Times London, (August 16, 1988).

³⁸ Ibid.

³⁹ Sara Daly, John Parachinim, William Rosenau, *Aum Shinrikyo, Al Qaeda, and the Kinshasa Reactor*, RAND, (Washington D.C.) 30.

⁴⁰ Ibid.

biological weapons in Afghanistan.⁴¹ Troops near Kandahar discovered a facility apparently built to research biological agents in 2002.⁴² In several Al Qaeda safe houses trace evidence of ricin and production materials were found.⁴³ CNN showed a video of AQAA testing cyanide on dogs in Afghanistan in 2002 that appears to have been made prior to the 9/11 attacks.⁴⁴ The former U.S. Secretary of Defense, William Cohen, provided more evidence of AQAA's desire for WMD when he said in 2004, "Looming on the horizon is the prospect that these terror [WMD] weapons will increasingly find their way into the hands of individuals and groups of fanatical terrorists or self-proclaimed apocalyptic prophets. The followers of Osama bin Laden have, in fact, already trained with toxic chemicals."⁴⁵ Based on these incidents, it is clear that AQAA has attempted to procure CB weapons. The U.S. strategy seeks to deny these types of non-state actors the ability to develop, access, or use WMD.

AQAA uses the Internet to show its followers how to develop and deploy their own chemical or biological weapons.⁴⁶ The Center for Nonproliferation Studies (CNS) developed a report that reviewed the accuracy of AQAA website information on chemical

⁴¹ Rolf Mowatt-Larssen, "Al Qaeda's Pursuit of Weapons of Mass Destruction: The Authoritative Timeline," www.foreignpolicy.com, January 25, 2010, <http://foreignpolicy.com/2010/01/25/al-qaedas-pursuit-of-weapons-of-mass-destruction/> (accessed February 22, 2015).

⁴² Ibid.

⁴³ Ibid.

⁴⁴ Judith Miller, "Qaeda Video Seems to Show Chemical Tests," www.nytimes.com, August 19, 2002, <http://www.nytimes.com/2002/08/19/world/qaeda-videos-seem-to-show-chemical-tests.html> (accessed on December 14, 2014).

⁴⁵ Government Documents Department, *Statement of William S. Cohen to The National Commission on Terrorist Attacks Upon the United States*, [www.govinfo.library.unt.edu](http://govinfo.library.unt.edu), http://govinfo.library.unt.edu/911/hearings/hearing8/cohen_statement.pdf (March 23, 2004).

⁴⁶ Rolf Mowatt-Larssen, "Al Qaeda's Pursuit of Weapons of Mass Destruction: The Authoritative Timeline," www.foreignpolicy.com, January 25, 2010, <http://foreignpolicy.com/2010/01/25/al-qaedas-pursuit-of-weapons-of-mass-destruction/> (accessed February 22, 2015).

and biological agent production.⁴⁷ The research found that the quality of information varied between specific guidance that would be easy to follow to vague guidance missing key information.⁴⁸ Changes to current controls on certain biological agents (generally those capable of causing epidemics) could provide improved data for the authors of these terrorist web sites.

The most disturbing potential use of this technology is the ability to radicalize individuals with access to chemical stockpiles in the United States. A radicalized individual or group could seize one of these stockpiles and cause a release of chemical agents affecting the communities around these sites. An example of this is Dr. Bruce Ivins, a disgruntled U.S. scientist working on an anthrax vaccine, who mailed envelopes with weapons grade anthrax through the U.S. postal service to Washington D.C., New York, and Florida in 2001 killing five people and causing illness in seventeen others.⁴⁹ This attack highlights the potential for an adversary to take advantage of individuals with access to small quantities of agent in the United States to conduct an attack using CB weapons.

New technologies provide the means for AQAA personnel operating anywhere in the world to produce CB weapons and effective dissemination devices. The crude biological agent facilities uncovered in Afghanistan could be replicated with better production systems in other states or ungoverned territory.⁵⁰ The absence of signatures at

⁴⁷ Sammy Salama, Lydia Hansell, "Does Intent Equal Capability? Al Qaeda and Weapons of Mass Destruction," *Non-proliferation Review* 12, No 3, (November 2005), <http://cns.miis.edu/npr/pdfs/123salama.pdf>, (accessed December 10, 2014).

⁴⁸ Ibid.

⁴⁹ The United States Department of Justice, Amerithrax Investigative Summary, (February 19, 2010), 5.

⁵⁰ Rolf Mowatt-Larssen, "Al Qaeda's Pursuit of Weapons of Mass Destruction: The Authoritative Timeline," [www.foreignpolicy.com](http://foreignpolicy.com), January 25, 2010, <http://foreignpolicy.com/2010/01/25/al-qaedas-pursuit-of-weapons-of-mass-destruction/> (accessed February 22, 2015).

these sorts of smaller processing facilities could make them harder to identify by U.S. intelligence agencies.

Islamic State of Iraq and Syria (ISIS)

The Islamic State of Iraq and Syria (ISIS) combines the doomsday beliefs of Aum Shinrikyo with the reach and resources of AQAA.⁵¹ ISIS aims to create an Islamic State in Iraq and Syria across Sunni majority areas.⁵² ISIS controls large areas where state authority has evaporated giving them the space and autonomy to produce and weaponize CB agents. Indeed, they may have access to unreported stockpiles of chemical and biological weapons in Syria.⁵³ ISIS shows how a U.S. adversary could gain CB weapons through state capture of an existing CB weapons stockpile. ISIS may have accessed Iraqi CB weapons when they overtook former Iraqi WMD sites and then used them to target Kurdish rebels with what appears to be a mustard (blistering) agent.⁵⁴

The significant instability in Syria today, a product of the on-going civil war, has increased terrorist access to weapons in Syria and Iraq. This combination of threat and access led the United States, with the support of other nations, to conduct elimination operations of Syrian chemical weapons declared in Syria's report to the OPCW. The United States provided a maritime vessel and the equipment to destroy their stockpile at

⁵¹ Graeme Wood, "What ISIS Really Wants," [www.nationaljournal.com](http://www.nationaljournal.com/defense/what-isis-really-wants-20150217), February 17, 2015, <http://www.nationaljournal.com/defense/what-isis-really-wants-20150217>, (accessed February 20, 2015).

⁵² Ibid., 2.

⁵³ Lorenzo Ferrigno, Ann Roche, and Richard Roth, "Diplomat: Syria Has Four Chemical Weapons Facilities It Did Not Declare," www.cnn.com, October 8, 2014, <http://www.cnn.com/2014/10/07/world/meast/syria-chemical-weapons/index.html> (accessed December 05, 2014).

⁵⁴ Joe Cirincione and Paul F. Walker, "Is ISIS using Chemical Weapons?," October 14, 2014, www.defenseone.com, (accessed February 22, 2015).

sea using hydrolysis, a means of neutralizing chemical agents.⁵⁵ While this appears to be a successful action by the international community to eliminate a CB weapon, the chief of the OPCW reported in June of 2014, “We cannot say for sure it [Syria] has no more chemical weapons...all we can do is work on the basis of verifying a country’s declarations of what they have. I would not make any speculation to possible remaining assets, substances, [and] chemical weapons.”⁵⁶ The Syrian regime reportedly used chlorine gas in October of 2014 to attack three villages from helicopters; a date after Syria claims to have relinquished all of its chemical weapons.⁵⁷ Verification of the Syrian regime’s compliance is difficult since the OPCW teams are investigating compliance in the middle of Syrian violence and unrest. The same problems challenge destruction of the reported facilities used for production and storage of Syria’s chemical weapons facilities.⁵⁸

In October of 2014, ISIS gained control of a former chemical weapons depot northwest of Baghdad, Iraq with known quantities of chemical weapons discovered during Operation Enduring Freedom.⁵⁹ The facility was sealed in 2005 and Iraq had

⁵⁵ Ashley Fantz, and Diana Magnay, *Syria Ships Last of Declared Chemical Weapons*, www.cnn.com, June 23, 2014, http://www.cnn.com/2014/06/23/world/meast/syria-chemical-weapons/index.html?iid=article_sidebar, (accessed December 05, 2014).

⁵⁶ Lorenzo Ferrigno, Ann Roche, and Richard Roth, “Diplomat: Syria Has Four Chemical Weapons Facilities It Did Not Declare,” www.cnn.com, October 8, 2014, <http://www.cnn.com/2014/10/07/world/meast/syria-chemical-weapons/index.html> (accessed December 05, 2014).

⁵⁷ U.S. Department of State, *Statement of John Kerry on OPCW Report and Ongoing Concerns with Chemical Weapons use in Syria*, www.state.gov, September 21, 2014, <http://www.state.gov/secretary/remarks/2014/09/231908.htm>, (accessed December 15, 2014).

⁵⁸ OPCW, “OPCW/UN Joint Mission Draws to a Close,” www.opcw.org, <http://www.opcw.org/news/article/opcw-un-joint-mission-draws-to-a-close/>, (accessed January 8, 2015).

⁵⁹ New York Times, *Iraq’s Draft Full Final and Complete Declaration on CW Programme*, www.nytimes.com, October 14, 2014, http://www.nytimes.com/interactive/2014/10/14/world/middleeast/iraqs-disclosure-of-chemical-weapons-findings-to-un.html?_r=0, (accessed December 19, 2014).

planned to destroy the weapons and facility.⁶⁰ The chemical weapons and equipment at the facility are likely degraded and would be difficult to use. However, the effect of controlling areas with known agents shows the potential for a U.S. adversary to gain CB weapons.

Summary

Aum Shinrikyo, AQAA, and ISIS have demonstrated the ability to exploit the Internet. The Internet and the media have provided these groups extended reach to message inside the United States. AQAA and Aum Shinrikyo showed a capability to produce WMDs and circumvent the U.S. nonproliferation efforts while ISIS captured terrain with existing chemical stockpiles. The Aum Shinrikyo case study showed how a motivated and well-financed organization could develop and employ effective WMD weapons in the 1990s. New technologies could significantly improve the lethality of these types of attacks against the United States by AQAA or ISIS.

⁶⁰ Joe Cirincione and Paul F. Walker, "Is ISIS using Chemical Weapons?," October 14, 2014, www.defenseone.com, (accessed February 22, 2015).

CHAPTER 5: ANALYSIS

The current U.S. strategy to counter CB weapon proliferation relies heavily on treaty arrangements and export controls to deny adversaries access to these CB weapons. These barriers need to be strengthened since they have not deterred rogue nations (or even U.S. allies) from seeking CB weapons.¹ The CWC and BTWC regimes were designed to hold states parties accountable and were not envisioned to keep non-state actors from gaining WMDs. Additional agreements like the AG and PSI between states provides a tenuous international approval to deny movement of specialized or dual use materials and knowledge to rogue states or non-state actors. The fields of biotechnology, nanotechnology, and more connected industrial processes provide a way for these adversaries to bypass these counter-proliferation efforts. State and non-state actors continue to seek CB weapons to counter the military and economic advantages of the United States as evidenced by the case studies. Actors seeking these new capabilities through the Internet or known proliferators expose themselves and provide an opportunity for the U.S. strategy to deny them WMD. The U.S. military needs to be postured to respond when intelligence identifies these adversaries.

The potential outcomes from technology, and the impact of a successful WMD attack, are so vast that the United States needs to expand the safety net beyond the clean lines of a National Strategy for Countering WMD or Countering Biological Threats. The National Strategy for Countering Biological Threats starts to move toward this idea of making industry responsible for policing its own technology but it relies too heavily on

¹ Monterey Institute of International Studies, "Chemical and Biological Weapons: Possession and Programs Past and Present," James Martin Center for Nonproliferation Studies, <http://cns.miis.edu/cbw/possess.htm>, (accessed December 19, 2014).

an expectation that all stakeholders will simply “do what is right.” In order for the U.S. strategies for countering WMD to be successful, other mission areas need to understand the potential outcomes if an adversary gains or uses CB weapons.

Policy Recommendations

1) Maintain a strong conventional and strategic military deterrent. A strong and credible military deterrent raises the stakes of any actor attempting to gain or use a WMD. The threat of unilateral U.S. military action needs to remain visible to our adversaries. This threat must convince state and non-state actors of the intent and capability for U.S. forces to respond in a manner that would threaten their survival if they used a WMD against the United States. This message should be clearly articulated in U.S. strategy documents and re-enforced by U.S. actions when necessary. The U.S. needs to maintain a forward presence to assure our allies that they can rely on a U.S. military response; loss of credibility in this area could result in them seeking other security assurances. The U.S. should budget for expenditure of funds to modernize and maintain the necessary capabilities to deter a broad range of states from using WMD.

2) Establish specific responsibilities within agencies and departments. Clearly designate lead and supporting agencies for countering WMD mission sets while ensuring all departments understand the potential unintended consequences of emerging technology to provide a rogue state or non-state actor access to WMD. The United States must prioritize its spending, and designate a lead agency for each mission area to provide the guidance for implementation and budgeting of requirements. This would also require each department to support funding in areas that fall out of their designated missions.

3) Destroy the U.S. chemical stockpile and maintain Cooperative Threat Reduction and elimination capabilities. Complete the destruction of the remaining U.S. chemical weapon inventory; this task would legitimize United States arguments for action against other states-parties to the CWC at The Hague. Until destruction of the U.S. stockpile is complete other actors will accuse the U.S. of undercutting the treaty. The U.S. requires an effective elimination capability to reduce the quantity of chemical and biological agents available to non-state actors. Elimination operations are a niche capability that cannot be generated on short notice when the next rogue state, like a North Korea, provides the United States an opportunity to assist in destruction of their WMD stockpile.

4) Fund research into the potential unintended consequences of technology. Each technology described in this paper provides a “Pandora’s box” of unique risks. Planning to deny rogue states or non-state actors the capability provided by these technologies requires an understanding of how they can be used and what potentially negative outcomes are possible. Just as important, protective capabilities and mitigation methods must be designed to account for the most likely outcomes of these technologies when placed in an adversary hands. Sites like Dugway Proving Grounds in Salt Lake City, Utah and the Edgewood Chemical And Biological Center in Aberdeen, Maryland provide DOD capabilities to conduct this type of research.

5) Exploit the Internet for defense. The cyber domain may provide opportunities to identify individuals in sensitive positions being targeted for exploitation. This would require expanded authorities to appropriate agencies like U.S. Cyber Command (USCYBERCOM), the Counter-Proliferation Research Center (CPRC), the National

Counter Terrorism Center (NCTC) and the National Security Agency (NSA) to sense, track, and attribute nefarious use of the Internet for proliferation of these technologies.

6) Strengthen existing multi-lateral organizations. This includes the BTWC, CWC, AG, and PSI. While the United States may not want to limit its options regarding dual use technology or restrict its own research, it needs a group to influence decisions of states supporting illegitimate weapons development. The treaties provide a working structure and process to influence new technologies outside U.S. borders. Linking other export-control regimes, like the Missile Technology Control Regime (MCTR), to help counter potential CB weapon delivery systems could indirectly target adversary critical capabilities. The United States may want to explore other export control regimes that make it harder for a rogue state or non-state actor to access the required material and knowledge to exploit emerging technologies.

Closing

The success of the U.S. counter WMD strategy is hard to quantify, since United States territory has not been attacked with an effective (causing over 1,000 deaths) CB weapon. However, the lack of an effective attack against the U.S. may stem from our adversaries deciding that the cost of developing CB weapons or complicated delivery means is too risky versus attacking with explosives. The terror attacks of 9/11 found the most efficient manner to strike a symbolic target in the U.S. without advanced technology. A re-evaluation of the U.S. strategy is needed to create new barriers that will continue to deny adversaries the technology required to use CB weapons against the United States.

Specifically, the U.S. strategy needs to address the deterrence of adversaries who seek to counter U.S. interests and gain WMD to attack the United States. The U.S. strategy should prioritize efforts to legitimize United States' actions globally by meeting its own treaty requirements and improving the capability for enforcement of treaty regimes like the CWC and BTWC. The United States needs to set priorities for its departments and agencies for counter-proliferation as well as to cast a broad net to identify potential unwelcome results of new technology. The appropriate authorities and capabilities need to be delegated to agencies that can exploit technology and identify CB weapon-related adversary action, or deny them access to those weapons. Until these issues are addressed, the U.S. strategy will continue to be challenged by technologies that expose gaps in existing barriers to adversary development of WMD.

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