A Complementary Approach to Bioterrorism Prevention

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Bioterrorism is a particularly horrific crime, and the premeditation and deliberation required to mount a successful attack make bioterrorists a special breed of criminal. Therefore, criminology theory can help to inform and shape bioterrorism prevention efforts. Successful crime prevention strategies include those that view criminals as opportunists who search for and exploit opportunities to commit crime. One opportunity theory, the rational choice perspective, argues that a criminally motivated person engages in a cost-benefit analysis before committing a particular crime.[1] This cost-benefit analysis is driven by four key considerations:

1. Perceived effort
2. Perceived risk
3. Anticipated rewards
4. Excuses or rationalizations.

If—upon consideration of these four rational choice categories—the benefits appear to outweigh the costs, the theory argues that the potential offender will be more likely to commit the crime. By understanding the considerations that drive a potential offender's cost-benefit analysis, interventions can be designed to prevent a crime's commission. These measures aim to increase the perceived effort and risk of committing the crime, reduce the anticipated rewards expected from the crime's commission, and remove excuses that justify the crime.

While the rational choice perspective is usually applied to very specific criminal opportunities (for example, bus driver robberies in a particular city, automobile thefts in a certain parking lot, violence in a specific prison setting), the theory applies to crimes with broader implications.[2] Terrorists associated with the September 11th attacks, for example, engaged in significant planning.[3] They allegedly considered alternative targets and methods of attack and weighed such factors as the feasibility of completing the attacks and the potential harm that they could cause.[4] The idea that terrorists are rational actors is not new to national security policy. Indeed, the Bush administration's *National Strategy for Homeland Security* recognizes that "[t]errorists are opportunistic,"—deliberately choosing targets based on perceived vulnerabilities.[5]

This article recommends viewing potential bioterrorists as rational actors and analyzing their decisionmaking processes in order to foster a deeper understanding of current bioterrorism prevention measures, identify gaps in current measures, and identify new and complementary measures.

BIOTERRORISTS AS RATIONAL ACTORS

For the foreseeable future, biological weapons represent one of the greatest threats to U.S. national security.[6] However, no terrorist group or state potentially hostile to the United States is known to possess the weapons systems necessary to mount a significant, military-style biological attack directly against the United States.[7] Even if a group or state actor had the capability, an overt attack is unlikely given the overwhelming response such an attack would elicit. It is far more plausible, therefore, that a biological attack against the United States will be carried out through bioterrorism—defined here as a covert biological weapons attack by a state *or* non-state actor for which attribution and retribution are extremely difficult.[8] Thus, as defined, bioterrorism refers to a particular method of conducting a biological attack, and not to the type of attacker or the goals of the attack as do some other definitions.[9] As such, in this context a bioterrorist can be a state or a non-state actor.

Executing a biological attack depends critically on acquiring or producing a sophisticated delivery system. Biological weapons proliferation is a complex undertaking that requires a rational, deliberate, and systematic approach.[10] For example, as shown in Figure 1, the Office of Technology Assessment (OTA) developed a proliferation pathway for *state actors* seeking a military biological weapons capability.[11] According to this assessment, proliferation has five major phases, each with multiple elements:

- Research and development
- Agent production
- Munitions design, testing, and building
- Delivery system acquisition
- Operational capability.

The specific proliferation pathway undertaken depends, in part, on the type of bioterrorist: state actor, terrorist organization, lone actor, or some combination thereof. Proliferation by state actors raises special concerns because they are more likely than non-state actors to have access to the resources—knowledge base, technical skills, financial assets, infrastructure—necessary to engage in the production of both biological agents and the weapons systems to deliver them. While there would be certain similarities, the proliferation pathway that non-state actors might pursue would depend on the non-state actor's more limited goals, abilities, and resources. For example, in comparison to state actors pursuing a military biological weapons capability, non-state actors likely would not require large-scale agent production, would not be constrained by long-term storage requirements, and would pursue low-tech (i.e., non-military) delivery systems.[12] However, there is also tremendous concern that state actors could supply these biological weapons systems to non-state actors either conspiratorially or unwittingly through theft.[13]

COUNTERPROLIFERATION—REDUCING OPPORTUNITIES

Every step along a given proliferation pathway provides opportunities to prevent proliferation, although it is not necessary to intervene at every step. The counterproliferation approach to intervention determines where along the pathway a combination of "opportunity-reducing" counterproliferation measures can be reasonably applied with the greatest likelihood of affecting the potential bioterrorists' cost-benefit analysis such that producing or acquiring biological weapons is no longer attractive.[14] No single step must be completely blocked for the strategy to be effective. For example, it is not necessary to attempt to block access to all potential biological weapon agents if the information, equipment, or materials necessary to turn those agents into weapons cannot be acquired. The goal of the counterproliferation approach is to find a combination of measures that:

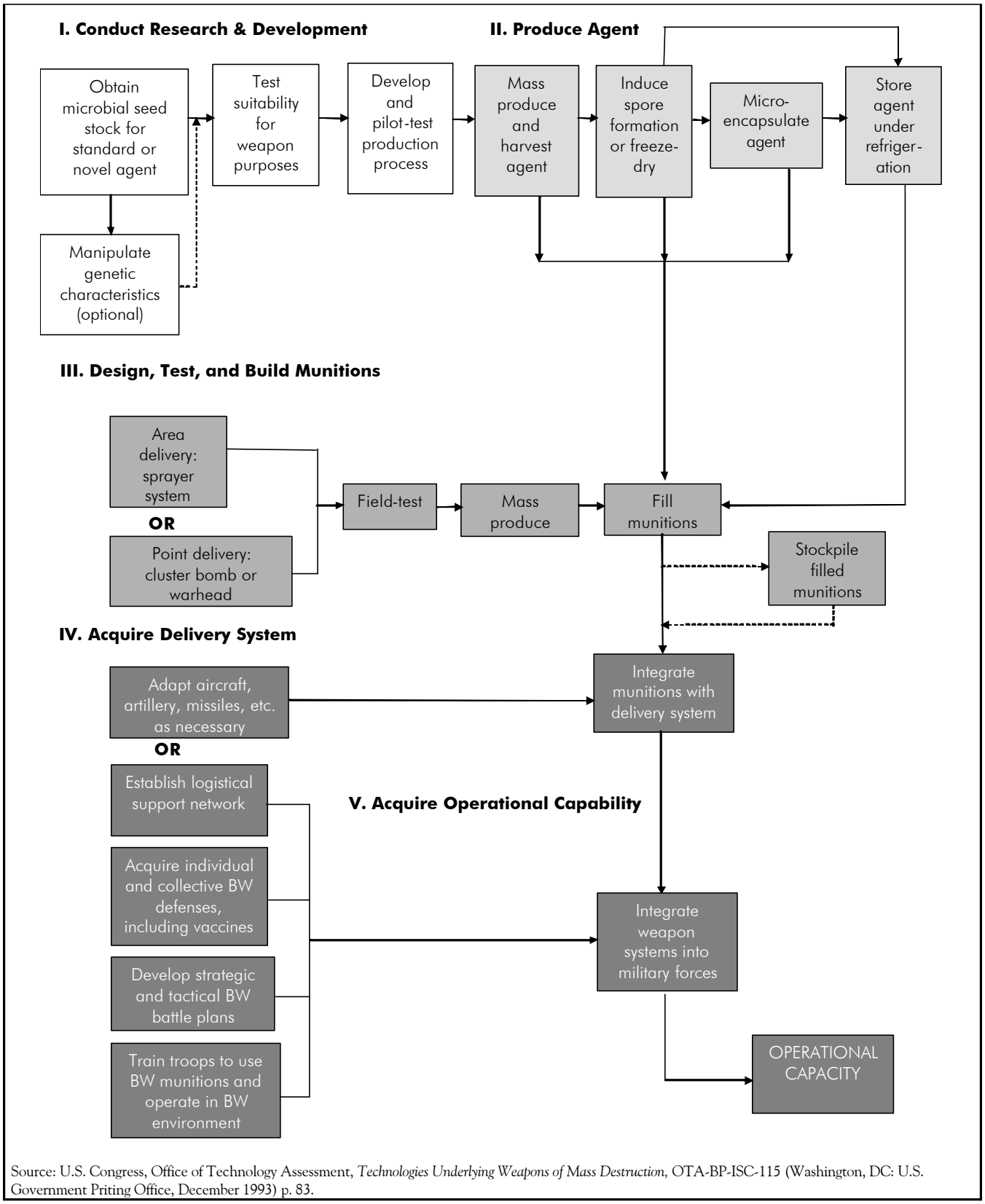
1. Make it much more difficult to produce biological weapons (increase perceived effort)
2. Make it far more likely that potential bioterrorists will be discovered (increase perceived risk)
3. Make it far less likely that the desired results will be achieved (reduce anticipated rewards)
4. Make it much more difficult for potential bioterrorists to justify their actions (remove excuses).

Once implemented, every counterproliferation measure raises a barrier to the production of biological weapons. And with each new barrier are fewer potential bioterrorists who can overcome it—thus reducing the bioterrorism threat.

Analysis of Current Counterproliferation Measures

One way to understand current counterproliferation measures is to plot them on the proliferation pathway to determine where and how they intervene to inhibit proliferation. Each measure can then be analyzed to determine how it *most* affects the four rational choice categories that drive the potential bioterrorist's cost-benefit

FIGURE 1
OTA BIOLOGICAL WEAPONS PROLIFERATION PATHWAY



Source: U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction,* OTA-BP-ISC-115 (Washington, DC: U.S. Government Priting Office, December 1993) p. 83.

analysis. For example, a potential bioterrorist's socioeconomic status may factor into the rationalization category: A country whose military capabilities fall far below those of its enemies might justify the proliferation of biological weapons as one of the few options available to achieve a balance of power. However, the four rational choice categories are not always distinct—a particular counterproliferation measure may affect several of the categories simultaneously. Because the less advantaged country may view its options as few, it may also tolerate a higher level of risk in producing or acquiring these weapons. Conversely, a country more concerned with its status among the global community might be more risk-averse in its proliferation activities because of the potential ramifications of engaging in such activities. Therefore, the categories are more effectively conceptualized as areas of influence that may overlap.

Example Analysis—OTA Pathway Phase I: Research & Development

Looking only at Phase 1 of the OTA proliferation pathway (Figure 1), current U.S. counterproliferation measures that seek to prevent the research and development (R&D) phase of biological weapons production by a state actor include:

- Restricting access to potentially dangerous pathogens[15]
- Limiting student visas[16]
- Preventing access to sensitive information[17]
- Surveilling foreign students[18]
- Surveilling shipping and receiving of potentially dangerous pathogens[19]
- Controlling exports of dual-use equipment and materials[20]
- Redirecting former Soviet Union weapons scientists[21]
- Implementing the Strategic National Stockpile (SNS)[22]

Certain measures are designed to increase the perceived effort of developing a bio-weapons program. Current restrictions on access to potentially dangerous pathogens increase the effort of undertaking an R&D program by making it more difficult to obtain a microbial seed stock from a laboratory source. Placing limits on student visas and preventing access to sensitive information make it more difficult to obtain the knowledge, training, and materials necessary to undertake such a program.

Measures to increase the perceived effort often overlap with those designed to increase the perceived risk. Surveilling foreign students increases the risk of exploiting loopholes in the U.S. foreign student visa system in order to acquire expertise and materials, because such students are more likely to be caught. This measure also increases the perceived effort by making access to expertise and materials more difficult.

Likewise, conducting surveillance on shipping and receiving of potentially dangerous pathogens and maintaining export controls on dual-use equipment and materials makes detection of an illicit attempt to obtain these materials more likely. These measures also increase the difficulty of obtaining the equipment and materials necessary to create a biological weapon.

Redirecting former biological weapons scientists toward legitimate scientific endeavors has a three-fold advantage. While redirect programs increase the perceived effort of developing an R&D program by making it more difficult to obtain the knowledge necessary to create a biological weapon, they also increase the risks involved by tracking former weapons scientists, increasing the likelihood that their involvement in a weapons program would be detected. Finally, redirect programs remove the excuse of unemployment that former weapons scientists may use to justify working for a biological weapons R&D program.

The Strategic National Stockpile—composed of pharmaceuticals and equipment that should enable U.S. officials to respond quickly to a biological or chemical attack—mitigates the destructive potential of threat agents, thereby reducing the anticipated rewards of an attack. The SNS also increases the effort involved by forcing states that are developing biological weapons to exert more resources (time, funding, expertise) either to manipulate the genetic characteristics of a particular agent in order to overcome the SNS's mitigative effects or to develop new biological agents not currently addressed by the SNS.

The SNS is an example of a measure with benefits not initially aimed at counterproliferation. The SNS was established to enhance the ability to respond to the effects of a chemical or biological weapons attack (see discussion on the significance of the difference between biological weapons proliferation and use below).[23] It now also serves as an effective counterproliferation measure.

From the foregoing analysis (see Table 1), one might conclude that it is quite difficult for a state actor to institute a biological weapons R&D program. However, while current counterproliferation measures create difficulties, most of the requisite materials, equipment, and information remain readily available.[24] The vast majority of sci-

TABLE I
EFFECT OF BIOLOGICAL WEAPONS R&D COUNTERPROLIFERATION MEASURES ON RATIONAL CHOICE CATEGORIES

Counterproliferation Measure	Effect on Rational Choice Category			
	Increases Perceived Effort	Increases Perceived Risk	Reduces Anticipated Rewards	Removes Excuses
Restricting access to potentially dangerous pathogens	X			
Limiting student visas	X			
Preventing access to sensitive information	X			
Conducting surveillance on foreign students	X	X		
Conducting surveillance on shipping and receiving of potentially dangerous pathogens	X	X		
Controlling exports of dual-use equipment and materials	X	X		
Maintaining the Strategic National Stockpile	X		X	
Redirecting former Soviet Union weapons scientists	X	X		X

Source: Authors

entific knowledge is disseminated through scientific literature in the public domain, and much of this knowledge is widely accessible through massive databases over the Internet. In addition, blocking access to all potentially dangerous pathogens is impossible. U.S. domestic laws and international agreements governing the shipping and receiving of these pathogens cannot cover all agents that conceivably can be used to cause harm, especially considering the potential use of modern biotechnology techniques to create novel pathogens.[25] With the exception of smallpox, moreover, the pathogens considered the most likely biological weapon agents[26] occur naturally and can be obtained from the environment.

Further Analysis

The analysis above is for illustrative purposes only. It superficially examines current counterproliferation measures that address the R&D phase of biological weapons production by a state actor. A more indepth analysis of these particular measures—one that addresses implementation issues—is required. For example, export controls on dual-use equipment and materials will be ineffective if they are not stringently and broadly enforced or if there are insufficient resources to implement the program properly.

In addition, a similar, but more indepth analysis should be undertaken on counterproliferation measures that address the other four phases of the OTA proliferation pathway for state actors (Figure 1). Also, likely proliferation pathways for other potential actors (e.g., state/non-state actor partnerships, terrorist groups, lone actors) should be developed and analyzed in the same fashion.

The use of "red teams" (groups of individuals charged with simulating terrorist activity to learn how to counteract them) as proposed in the *National Strategy for Home-*

land Security could help to develop these different pathways and aid this type of analysis.[27] For example, a U.S. Department of Defense (DoD) program entitled Project Bacchus employed a red team to set up a clandestine biological weapons laboratory within the United States using materials and equipment purchased on the open market.[28] The team produced a sufficient amount of a nonpathogenic agent to kill 10,000 people—were it actually anthrax. Project Bacchus provided the DoD with indepth knowledge about how a terrorist group might undertake biological weapons production and how such activities might be detected and countered.

Gaps in Current Efforts and Promising New Counterproliferation Measures

Understanding how current counterproliferation measures affect a potential bioterrorist's cost-benefit analysis offers a unique perspective by which to identify gaps in the current strategies, which in turn will suggest areas for future efforts. As Table 1 indicates, current U.S. measures designed to prevent a state-run R&D program in support of biological weapons proliferation focus largely on increasing the perceived effort and risk of that undertaking. Much less has been done with respect to reducing anticipated rewards and removing excuses. In fact, the United States has a long and arguably successful history of reducing anticipated rewards in its counterterrorism policy with respect to hostage taking by not conceding to terrorist demands and thereby removing the incentive to commit such acts.[29]

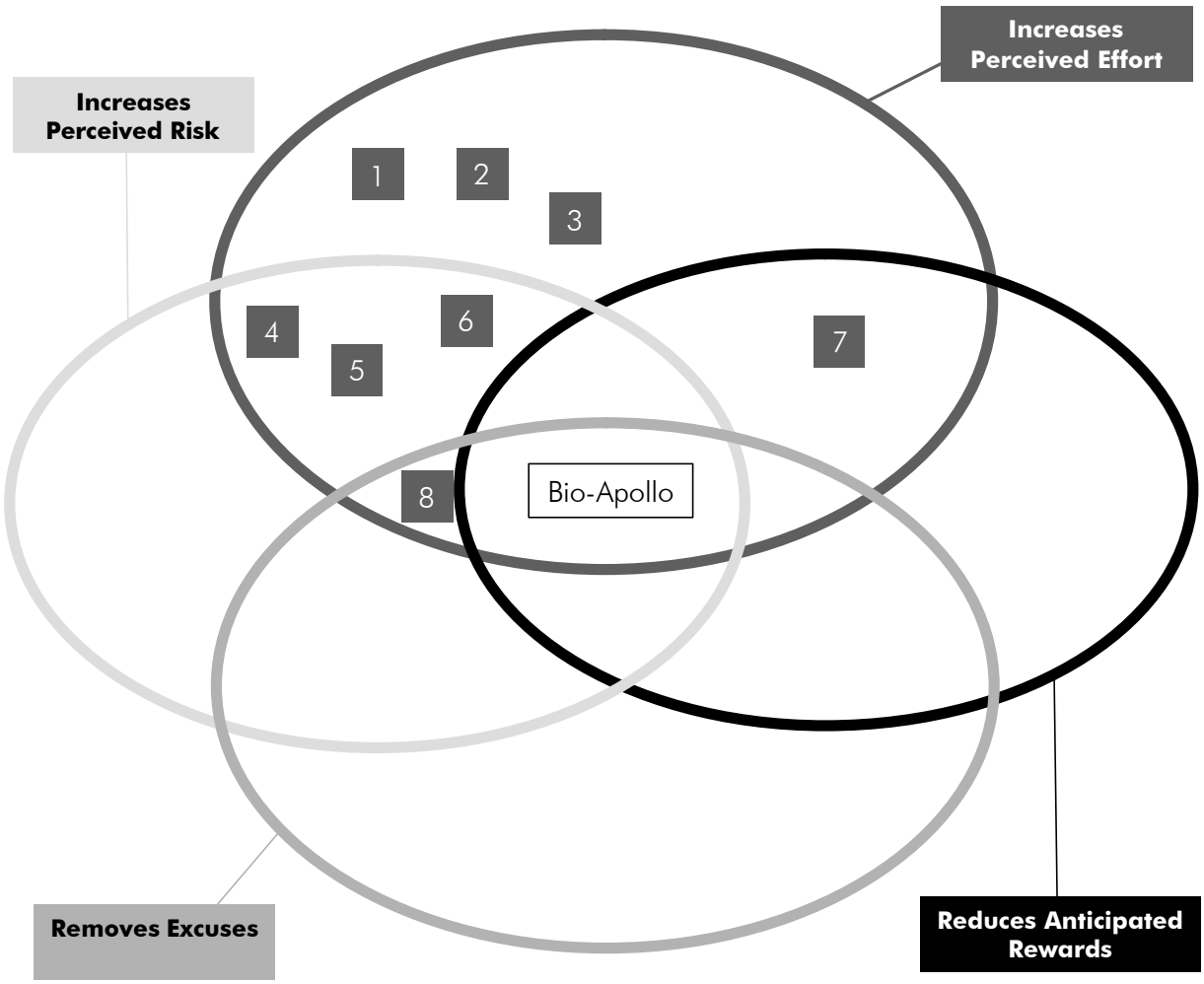
With respect to bioterrorism, a dedicated R&D program to counter the threat of infectious diseases—whether from a natural or intentional outbreak—may be a valuable counterproliferation tool not only by reducing anticipated rewards but by affecting the other rational choice categories as well (Figure 2). To be effective, this R&D program would have to equal the magnitude of the Apollo Program, which put a man on the moon in 10 years. It would be far more broadly focused and ambitious than the proposed Project Bioshield, which focuses largely on countermeasures directed at specific biological weapon threat agents (such as anthrax, smallpox, and botulinum toxin).[30] A "bio-Apollo program" would require the collaboration of the biotechnology, medical, public health, and security communities and sustained funding from congress.[31]

By enhancing our ability to counter infectious diseases through new antibiotics, antiviral medications, and vaccines, and advancing early diagnostic and detection capabilities, a bio-Apollo program would mitigate the effectiveness of a biological attack, thus reducing the anticipated rewards to potential bioterrorists. These breakthroughs might also potentially increase the perceived effort of potential bioterrorists, who would need to undertake their own advanced R&D programs in order to overcome the advances of the new program. In turn, increasing the size and scope of their biological weapons programs would increase the likelihood of detection and, thus, increase the perceived risk. The development of new biological markers and surveillance systems would enhance our ability to trace biological weapons attacks back to their original source, further increasing the perceived risk. In addition, a bio-Apollo program could remove the excuses of scientists who might be lured into working for a biological weapons program by augmenting existing diversion programs to generate opportunities for legitimate employment and mobilizing the research community's opposition to biological weapons proliferation.

In designing and implementing new bioterrorism countermeasures, it is important to recognize the limits of what can be reasonably accomplished and work within those limits to avoid undermining other potential countermeasures. The effort devoted to blocking access to dangerous pathogens, for example, must be balanced with the level of security expected in return. It is the legitimate scientists who will develop vaccines and therapeutics to protect society from biological weapons, helping to render these weapons useless in the process. Any legislation designed to deny potential bioterrorists access to potentially dangerous pathogens must therefore not unduly inhibit legitimate research and development with those agents.[32]

While a national strategy should aggressively identify and implement a variety of bioterrorism prevention measures, it should also seek to understand how those measures might affect the motivation to engage in future terrorism. Measures meant to prevent bioterrorism may unwittingly precipitate future acts of terrorism if not designed and implemented with consideration for their potential long-term effects in addition to immediate security concerns. For example, unduly restricting student visas from states suspected of weapons proliferation could prevent legitimate learning and cross-cultural exchange and, in turn, foster resentment against the United States.[33] In addition, export controls on dual-use equipment and reagents could be perceived as unjust and oppressive if the equipment and reagents are needed for legitimate purposes.

Figure 2
Effect of Biological Weapons R&D Counterproliferation Measures on Rational Choice Categories



Counterproliferation Measure

1. Restricting access to potentially dangerous pathogens
2. Limiting student visas
3. Preventing access to sensitive information
4. Conducting surveillance on foreign students
5. Conducting surveillance on shipping and receiving of potentially dangerous pathogens
6. Controlling exports of dual-use equipment and materials
7. Maintaining the Strategic National Stockpile
8. Redirecting former Soviet Union weapons scientists

Source: Authors

BEYOND COUNTERPROLIFERATION: THE FOUR STAGE MODEL

While counterproliferation efforts are a logical starting point for reducing the threat of bioterrorism—bioterrorism entails more than proliferation. Prevention efforts can be developed and implemented to reduce the likelihood that an attack will occur. This point is best understood by recognizing the difference between *proliferation* and *use*. A bioterrorist cannot conduct an attack without first engaging in weapons proliferation by acquiring the weapons; however, acquiring the weapons does not ensure their successful use. Furthermore, focusing prevention efforts solely on proliferation and use assumes that the motivation (and intent) to engage in these activities already exists.

A bioterrorist attack, therefore, can be conceptualized in four major stages (Figure 3). Specific prevention measures can be designed and applied at each stage to reduce the likelihood that an attack will occur. In Stage 1, the motivation to produce or acquire biological weapons has not yet been formed. Effective prevention measures at this stage—aimed at addressing the conditions that give rise to this motivation—can prevent the motivation from forming. If those efforts fail, proliferation will proceed provided that the bioterrorist's cost-benefit analysis is favorable. An attack still can be prevented at Stage 2 by reducing the opportunities for proliferation to proceed using measures such as those discussed in the analysis above. If counterproliferation efforts are unsuccessful and biological weapons are produced or acquired, there are still opportunities to intervene. At Stage 3, measures can be applied to prevent the motivation to use biological weapons from forming. Should those measures fail, plans for an attack will proceed given a favorable cost-benefit analysis. At Stage 4 the use of weapons can still be prevented by reducing the opportunities for an attack to occur.

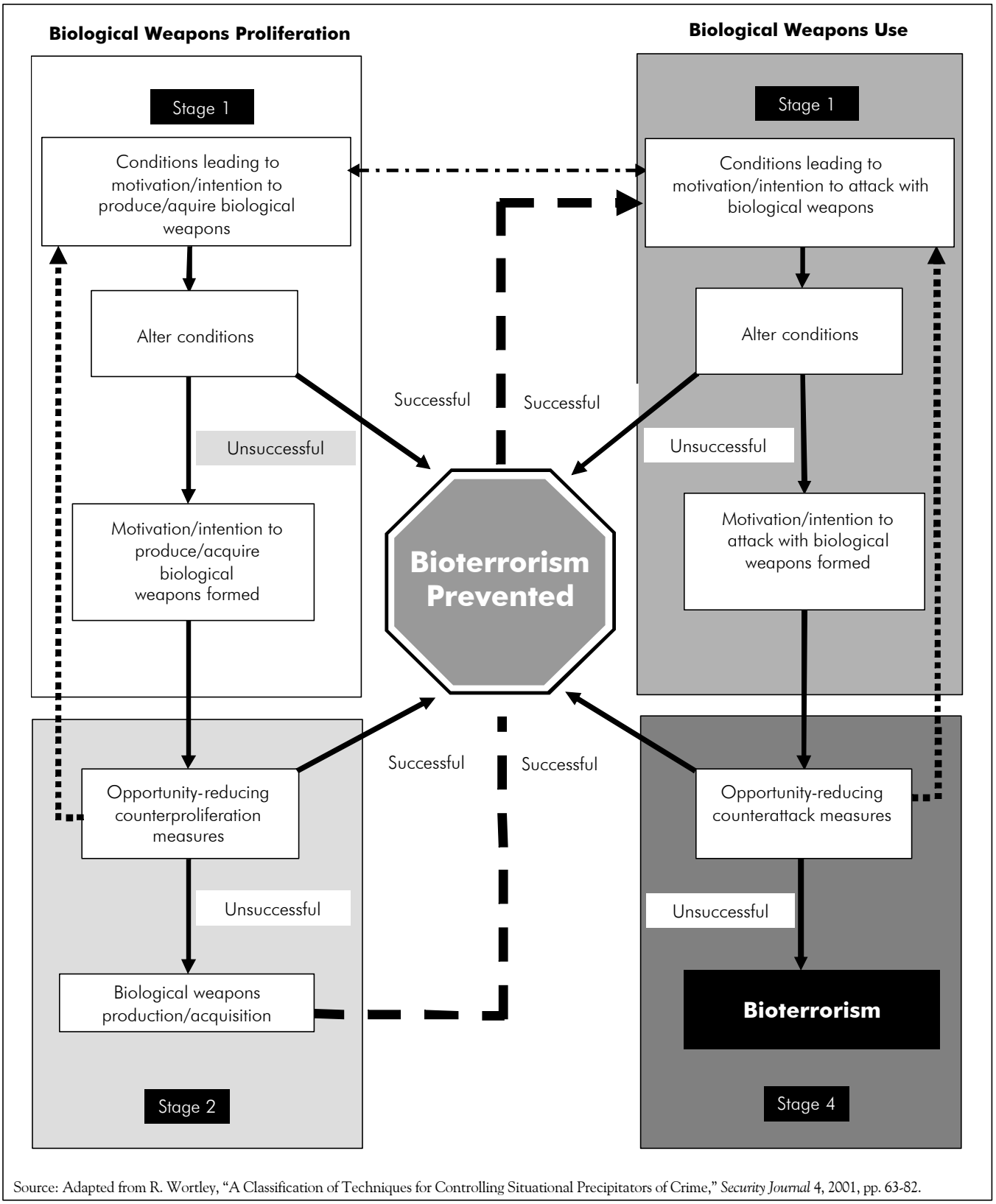
Separating bioterrorism into four stages helps to focus prevention efforts on specific points of opportunity and, in so doing, highlights areas that may need more attention. For example, similar to the development of *proliferation* pathways, likely weapons *use* pathways need to be developed to inform the development of effective counterattack measures. If threat assessments deem that the food supply is a likely target of a biological attack, building a pathway will provide an understanding of how such attacks would likely occur and allow counterattack measures to be developed and implemented.[34]

The four stage model also provides a better understanding of particular bioterrorism prevention measures. For example, the articulated goal of the current national smallpox vaccination program is to "increase deterrence" by fostering preparedness for a smallpox attack—in other words by reducing anticipated rewards.[35] The phrase "increase deterrence" could mean to prevent the *proliferation* of smallpox as a weapon, or to prevent the *use* of smallpox as a weapon, or both. How the goal is defined however, has important implications for gauging the successful implementation of the program.

The U.S. military has implemented a vaccination program that will likely deter a smallpox attack against deployed military forces, but the civilian program has not been as successful to date.[36] As of June 13, 2003, only 37,608 civilians had been vaccinated, leaving the vast majority of the U.S. population vulnerable to an attack.[37] It is therefore unlikely that this level of coverage is sufficient to deter an attack by a bioterrorist *already armed with smallpox*. Indeed, 500,000 or even 1 to 10 million smallpox vaccinations in a country of 291 million people might not, by itself, be an adequate deterrent to a terrorist in possession of or access to the smallpox agent. However, limited vaccination programs in conjunction with other counterproliferation efforts, might prevent a potential bioterrorist from exerting the considerable effort and resources necessary to acquire smallpox and turn it into a weapon. What level of coverage—short of mass vaccination—might deter proliferation requires more study, but the four stage model allows for a more refined analysis of the goals and potential success of specific prevention measures.[38]

Finally, the four stage model underscores the importance of the far more difficult task of addressing the motivations of bioterrorists. The conditions that give rise to and support the motivation to commit acts of bioterrorism (or terrorism in general) are mired in political, socioeconomic, ideological, religious, and cultural perspectives where cause-and-effect is difficult to quantify and interests frequently differ.[39] Designing policies to alter those conditions favorably is no less daunting. While an in-depth analysis of the various conditions that give rise to terrorism is beyond the scope of this article, addressing these conditions should be a vital part of any bioterrorism prevention strategy. This does not imply that the United States should cater to terrorist demands. As with extremists groups in the United States, terrorists must be marginalized and their activities condemned. But a sober understanding of the conditions that ultimately help form

Figure 3
Four Stage Model of Bioterrorism



Source: Adapted from R. Wortley, "A Classification of Techniques for Controlling Situational Precipitators of Crime," *Security Journal* 4, 2001, pp. 63-82.

terrorist motivations will enable the United States to work effectively toward addressing those conditions.

CONCLUSION

The effects of a bioterrorist attack are not the same as those posed by naturally occurring infectious diseases because there is a "thinking enemy" whose aim is to inflict as many casualties and cause as much damage as possible.[40] Studying a potential bioterrorist's decisionmaking process, as suggested in this article, offers a new and complementary approach for reducing the threat of bioterrorism. By deconstructing bioterrorism into discrete steps and focusing on the cost-benefit analysis of the potential terrorist, this approach provides a framework with which to analyze our current counterproliferation measures in a broader context. It also helps to identify gaps in our current efforts and promising new prevention measures—such as a bio-Apollo program—that go well beyond target hardening. In addition, various stakeholders—policymakers and members of the national security, biotechnology, biomedical research, and public health communities—can better understand their roles in preventing bioterrorism and how their efforts interact with those of other stakeholders. This shared understanding will foster a more collaborative and coherent bioterrorism prevention strategy. Finally, this approach highlights the importance of addressing the conditions that help form the motivation to acquire and use biological weapons.

Viewing potential bioterrorists as rational actors, though, is only one possible way to help address the very complicated and challenging threat posed by bioterrorism. It complements other activities such as intelligence gathering and analysis. Whatever approach is ultimately employed must be systematic, comprehensive, and engage the necessary stakeholders. An uncoordinated, patchwork approach is likely to miss areas of vulnerability and opportunities for intervention. Worse still, an uncoordinated approach might encourage future terrorism if prevention measures are not understood and implemented within a broad national security context. The *National Strategy for Homeland Security* recognizes that our society provides a nearly endless supply of targets vulnerable to attack by a variety of methods.[41] But the United States also has vast resources—intellectual, technological, economic—that can be mobilized to reduce the risk of attack. While a national strategy should seek to reduce the opportunities that enable terrorist attacks to occur, it must also seek to understand and address the conditions that help produce terrorists in order to disrupt the cycle of violence and foster long-term security.

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[36] Donald G. McNeil Jr., "After The War: Biological Defenses; 2 Programs To Vaccinate For Smallpox Come to a Halt," *New York Times,* June 19, 2003, Section A, p. 13; John D. Grabenstein and William Winkenwerder Jr., "US Military Smallpox Vaccination Program Experience," *Jama* 4, June, 25 2003, pp. 3278-3282.

[37] "Smallpox Vaccination Program Status by State," *US Centers for Disease Control & Prevention* (June 13, 2003), <http://www.cdc.gov/od/oc/media/spvaccin.htm>; Tara O'Toole, Michael Mair, Thomas V. Inglesby, "Shining light on 'Dark Winter,'" *Clinical Infectious Diseases* 7, April 1, 2002, pp. 972-983.

[38] This article does not advocate mass vaccination at this time. The complications of the current smallpox vaccine make that intervention untenable. Either evidence of an imminent smallpox attack or the development of a safer vaccine is required to warrant consideration of such an intervention.

[39] Martha Crenshaw, *The Causes of Terrorism*, in Charles W. Kegley, Jr., ed., *The New Global Terrorism—Characteristics, Controls, Causes*, (Upper Saddle River, NJ: Pearson Education, Inc., 2003), pp. 92-105; Paul R. Pillar, *Terrorism and US Foreign Policy*.

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