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. As such, 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.[2] 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. The theory also suggests that by manipulating this cost-benefit analysis, interventions can be designed to prevent a crime's commission—specifically, interventions that increase the perceived effort and risk of committing the crime, reduce the anticipated rewards expected from the crime's commission, and remove the excuses that justify the crime.

While the rational choice perspective is usually applied to very specific crimes (for example, bus driver robberies in a particular city, automobile thefts in a certain parking lot, violence in a specific prison setting), the general theory that a criminal engages in a cost-benefit analysis prior to committing a crime can be applied more broadly.[3] Terrorists associated with the September 11th attacks, for example, engaged in significant planning.[4] 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.[5]

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.[6] 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.[7] 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.[8] 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 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.[9] 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.[10]

Acquiring or producing a biological weapon is a complex undertaking that requires a rational, deliberate, and systematic approach.[11] 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.[12] 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 acquisition.

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 goals and likely more limited 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.[13] However, there is also tremendous concern that state actors could supply biological weapons to non-state actors either conspiratorially or unwittingly through theft.[14]

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. Instead, the objective is to determine where along the pathway a combination of "opportunity-reducing"[15] 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. 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 combination of measures should seek to:

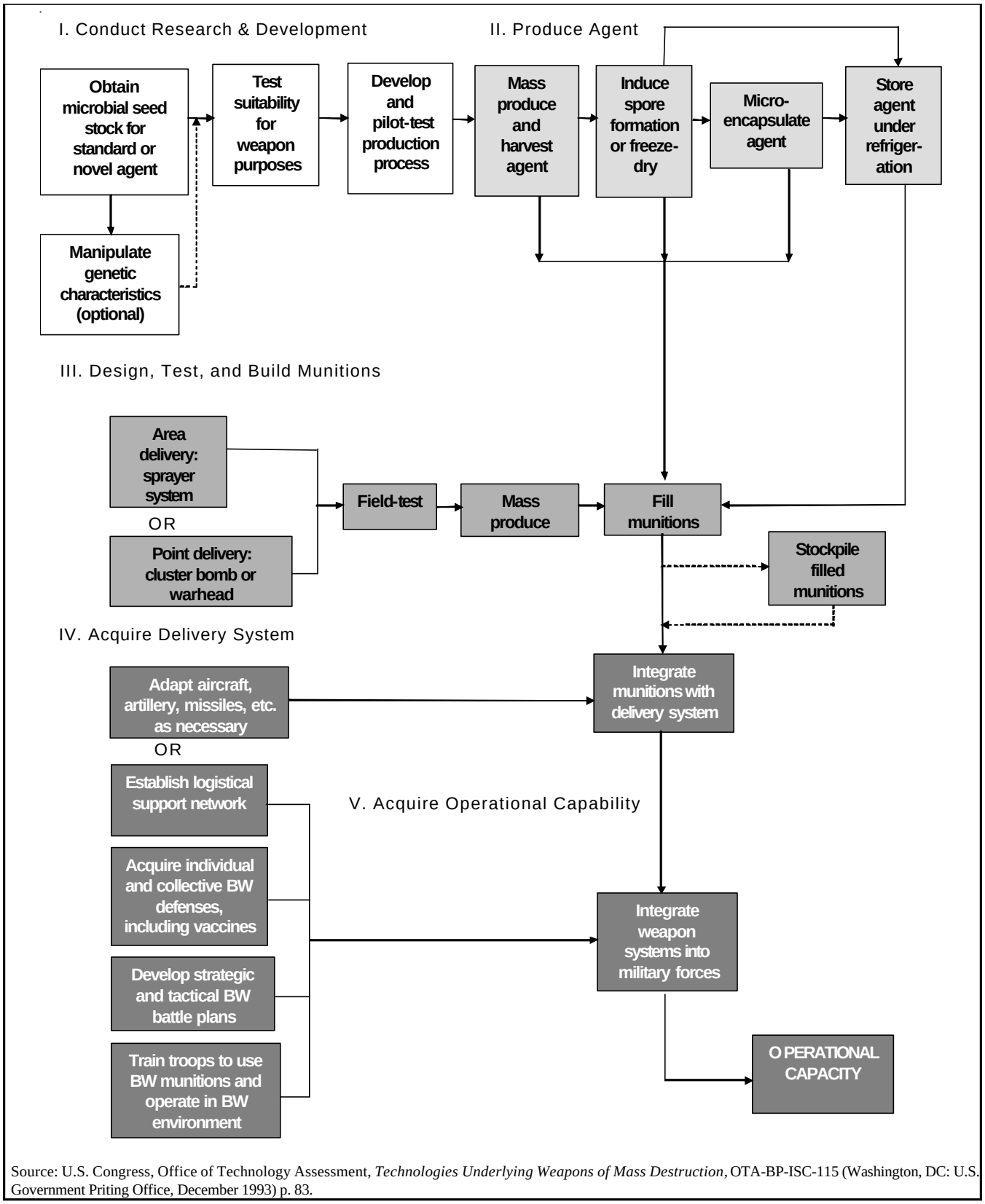
1. Make it more difficult to produce biological weapons (increase perceived effort)
2. Make it more likely that potential bioterrorists will be discovered (increase perceived risk)
3. Make it less likely that the desired results will be achieved (reduce anticipated rewards)
4. Make it more difficult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

Every counterproliferation measure implemented raises the hurdle that must be cleared in order to produce biological weapons. And every time the hurdle is raised, there are fewer potential bioterrorists who can clear the hurdle—thus reducing the bioterrorism threat.

Analysis of Current Counterproliferation Measures

One way to understand current counterproliferation measures is to plot them on a 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 analysis. While some measures may significantly affect only one category,

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.

others may affect several of the categories simultaneously. Therefore, the categories are more effectively conceptualized as areas of influence that may overlap.

In this analysis, it is the perspective of the potential bioterrorist that is important, and therefore social, cultural, and economic factors must be considered. For example, a country whose military capabilities fall far below those of its perceived enemies might justify the proliferation of biological weapons as one of the few options available to achieve a balance of power. Because the 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.

Example Analysis—OTA Pathway Phase I: Research & Development

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

1. Restricting access to potentially dangerous pathogens[16]
2. Limiting student visas[17]
3. Preventing access to sensitive information[18]
4. Conducting surveillance on foreign students[19]
5. Conducting surveillance on shipping and receiving of potentially dangerous pathogens[20]
6. Controlling exports of dual-use equipment and materials[21]
7. Maintaining the Strategic National Stockpile (SNS)[22]
8. Redirecting former Soviet Union weapons scientists.[23]

These measures affect the four rational choice categories in different ways (Table 1). Certain measures increase the perceived effort of developing a bio-weapons R&D program. Current restrictions on access to potentially dangerous pathogens do this 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 also increase the perceived effort by making it more difficult to obtain the knowledge, training, and materials necessary to undertake such a program.

Measures that increase the perceived effort sometimes also increase the perceived risk. Conducting surveillance on foreign students increases the perceived risk of developing a bio-weapons R&D program by making it more likely that students who attempt to exploit loopholes in the U.S. foreign student visa system in order to acquire necessary expertise and materials will 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, thus increasing the perceived risk. These measures also increase the difficulty of obtaining the equipment and materials necessary to create a biological weapon increasing the perceived effort.

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 perceived 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 certain threat agents, thereby reducing the anticipated rewards of an attack. The SNS also increases the perceived 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).[24] But as shown in this analysis, it also serves as an effective counterproliferation measure.

From the foregoing analysis it might appear that it is quite difficult for a state actor to institute a biological

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

weapons R&D program. But in fact, while current counterproliferation measures create difficulties, most of the necessary materials, equipment, and information remain readily available.[25] The vast majority of scientific 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 or advanced biological weapons.[26] With the exception of smallpox, moreover, the pathogens considered the most likely biological weapon agents[27] occur naturally and can be obtained from the environment.

Further Analysis

The analysis above is for illustrative purposes only. It superficially examines the main counterproliferation measures that address the R&D phase of biological weapons production by a state actor. A more in-depth analysis of these and other such measures is required, and it should include implementation issues. 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.

A similar but more in-depth analysis should be conducted on counterproliferation measures that address the other four phases of the OTA proliferation pathway for state actors (Figure 1). These separate analyses should then be combined for an overall assessment of all current

counterproliferation measures. In addition, likely proliferation pathways for other potential actors (e.g., state/nonstate 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 Homeland Security* could help to develop these different pathways and aid this type of analysis.[28] 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.[29] 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 in-depth knowledge of 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 to focus 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 appears to have been done with respect to reducing anticipated rewards and removing excuses. 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 thereby removing the incentive to commit such acts.[30] A similar strategy could be pursued more fully with respect to bioterrorism.

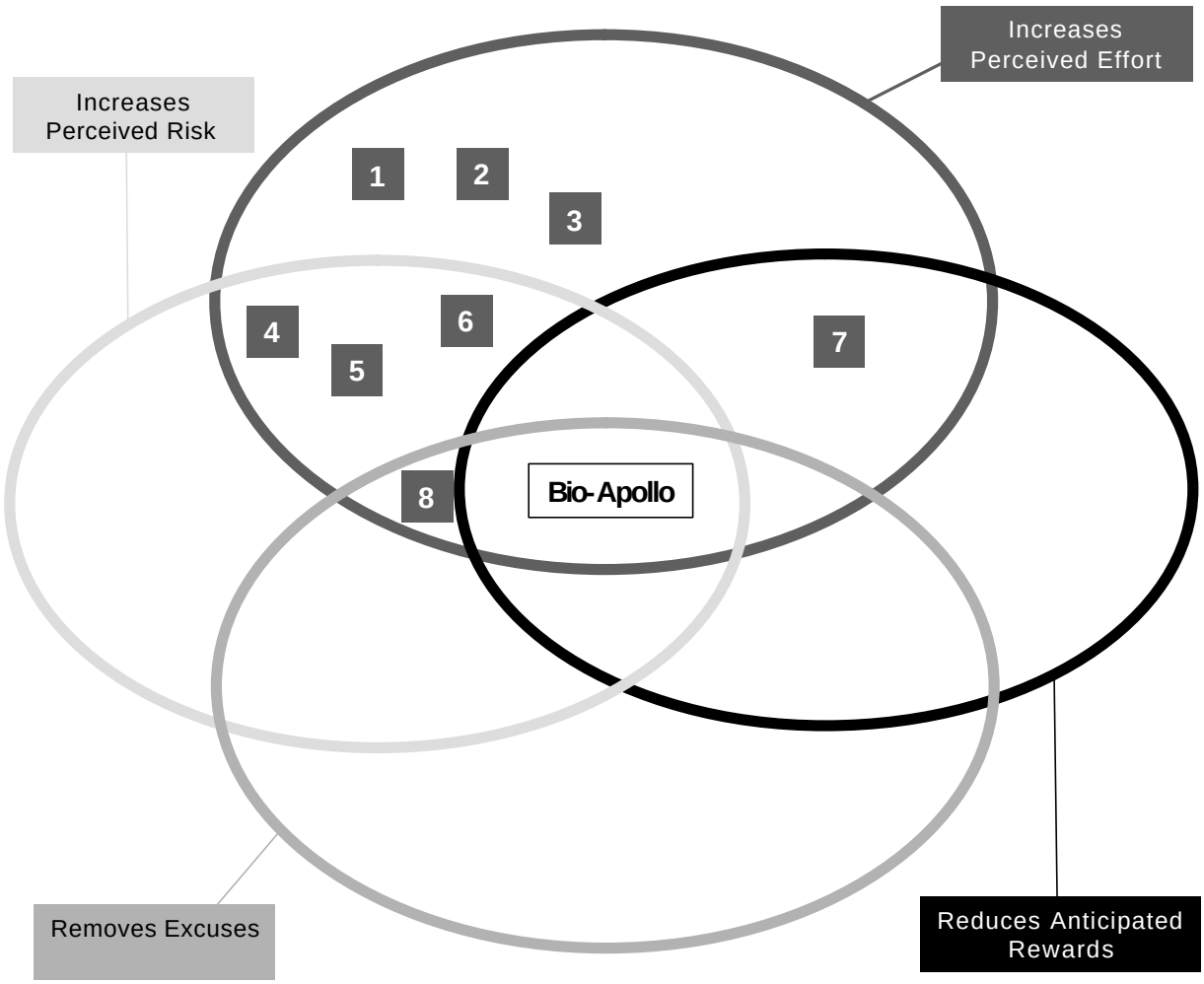
One measure that potentially could reduce anticipated rewards, as well as affect the other three rational choice categories (Figure 2), is a large-scale R&D program to counter the threat of infectious diseases—whether from a natural or intentional outbreak.[31] By enhancing our ability to counter infectious diseases (for example, through new antibiotics, antiviral medications, and vaccines) and advancing early diagnostic and detection capabilities, an R&D program of this scale could mitigate the effectiveness of a biological attack, thus reducing the anticipated rewards to potential bioterrorists. Medical breakthroughs that came about as a result of such an R&D program might also increase the perceived effort of potential bioterrorists, who would need to undertake their own advanced R&D programs in order to overcome advances of the U.S. program. In turn, substantially increasing the size and scope of their biological weapons programs would increase the likelihood of detection, thus increasing the perceived risk. The development of new biological markers and surveillance systems might also enhance our ability to trace biological weapons attacks back to their original source, further increasing the perceived risk. In addition, such an R&D program could augment existing programs to redirect former weapons scientists by generating greater opportunities for legitimate employment, further removing the excuses to work for a biological weapons program. Finally, mobilizing the scientific community on the scale suggested by such a program would likely strengthen the research community's opposition to biological weapons proliferation and help to remove the excuses of scientists who still might be lured into such programs.

To be effective, this R&D program would likely have to be on the magnitude of the Apollo Program, which put a man on the moon within 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).[32] A "bio-Apollo" program would also require the collaboration of the biotechnology, medical, public health, and security communities and sustained funding from Congress.[33]

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. For example, the effort devoted to blocking access to dangerous pathogens 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.[34] Therefore, any additional legislation meant to further deny potential bioterrorists access to potentially dangerous pathogens must be crafted carefully so as not to unduly inhibit legitimate research and development with those agents.[35]

It is also important to recognize how these new measures might affect the motivation to engage in future terrorism. Measures intended to prevent bioterrorism may

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

unwittingly precipitate future acts of terrorism if they focus only on short-term security. 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.[36] Similarly, 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.

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. Prior to an actual attack, several opportunities exist to implement prevention efforts. These are most effectively realized by recognizing that biological weapons *proliferation* and *use* are two separate, yet inextricably linked, endeavors. A bioterrorist cannot conduct an attack without first acquiring the weapons, but acquiring the weapons does not ensure their successful use. However, focusing prevention efforts solely on proliferation and use assumes that the motivation (and intent) to engage in these activities already exists. Therefore, a better strategy is to conceptualize a bioterrorist attack 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.

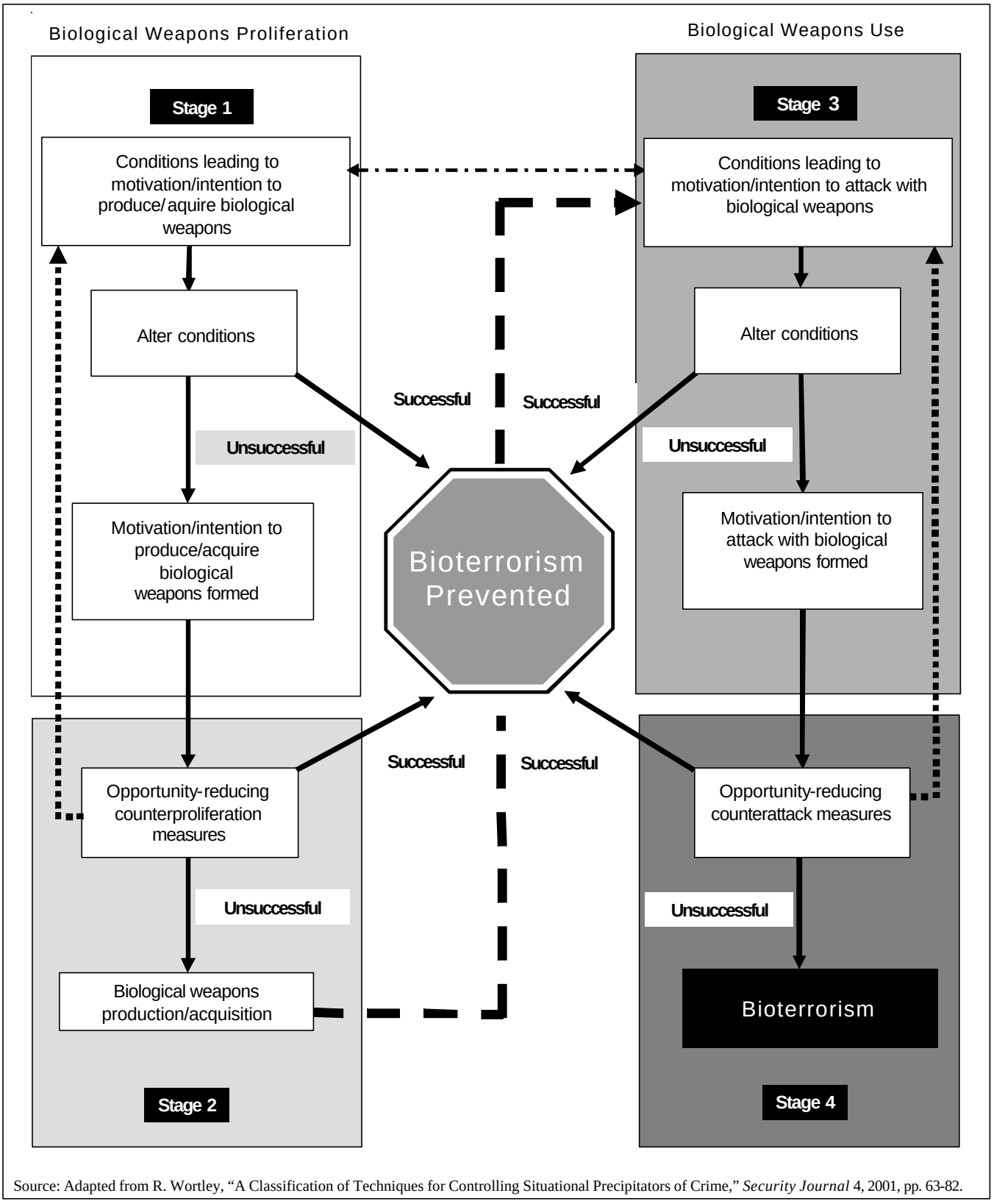
In Stage 1, the motivation to produce or acquire biological weapons has not yet been formed. Effective prevention measures at this stage—aimed at addressing the conditions that give rise to this motivation—can prevent the motivation from forming. If those efforts fail, proliferation will proceed provided 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 example analysis above. If counterproliferation efforts are unsuccessful and biological weapons are produced or acquired, at Stage 3, measures can be applied to prevent the motivation to *use* biological weapons from forming. Should those measures fail, and the motivation to use weapons is formed, an attack will proceed provided that the cost-benefit analysis is favorable. An attack, though, can still be prevented at Stage 4 by reducing the opportunities that enable an attack to occur, thus making the use of biological weapons an unattractive alternative.

Separating bioterrorism into four stages has several benefits for prevention. First, it helps to clarify the opportunities where prevention efforts can be focused. And by doing so, it highlights areas that may need more attention. One such area is the development of likely biological weapon "attack-pathways." It has been suggested, for example, that the food supply is a likely means through which terrorists might carry out a biological attack. Understanding the likely scenarios for such an attack will allow counterattack measures to be developed and implemented.[37]

The four-stage model also provides a better understanding of particular bioterrorism prevention measures. For example, an articulated goal of the current national smallpox vaccination program is to "increase deterrence" by fostering preparedness for a smallpox attack—in other words, reducing anticipated rewards.[38] 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. The precise definition of the goal, though, has important implications for implementing and gauging the success of the program.

The U.S. military has achieved a level of smallpox vaccination that will likely deter a smallpox attack against deployed military forces, but the civilian program has not been as successful to date.[39] As of September 26, 2003, only 38,489 civilians have been vaccinated, leaving the vast majority of the U.S. population vulnerable to an attack.[40] It is unlikely that this level of coverage is sufficient to deter an attack by a bioterrorist already armed with smallpox or with easy access to it. Indeed, 500,000 or even 1 million or 10 million smallpox vaccinations in a country of 291 million people might not, by itself, be an adequate deterrent to such a terrorist. However, a limited vaccination program that confers the ability to respond rapidly and effectively to a smallpox attack (thereby reducing the anticipated rewards) in conjunction with other counterproliferation efforts might prevent a potential bioterrorist without ready access to the smallpox virus from exerting the considerable effort and resources necessary to acquire it and turn it into a weapon. The level of vaccination coverage—short of mass vaccination—that might deter proliferation compared to the level that may deter use requires more study, but this example illustrates the potential of the four-stage model to allow for a more refined analysis of the goals and potential success of specific prevention measures.[41]

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.

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, and cultural perspectives where cause-and-effect is difficult to quantify and interests frequently differ.[42] 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 terrorist motivations will enable the United States to find strategies to help prevent such motivations from forming.

CONCLUSION

The threat of bioterrorism cannot be treated in the same manner as the threat 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.[43] Analyzing 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 identify 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 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.[44] 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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[2] Ronald V. Clarke, "Introduction," in Ronald Clarke, ed., *Situational Crime Prevention: Successful Case Studies*, Second Edition (Guilderland, NY: Harrow and Heston, 1997), pp.1-43; Julie Samia Mair and Michael Mair, "Violence Prevention and Control Through Environmental Modifications," *Annual Review of Public Health* 24 (2003), pp. 209-225.

[3] Julie Samia Mair, et al., "Violence Prevention and Control Through Environmental Modifications."

[4] U.S. Senate and House of Representatives, Intelligence Committees, *Joint Investigation of September 11 Intelligence Failures*, 107th Congress, 2nd Session, October 17, 2002.

[5] BBC News, "Al-Qaeda 'plotted nuclear attacks'," September 8, 2002, <http://news.bbc.co.uk/2/hi/world/middle_east/2244146.stm>.

[6] Office of Homeland Security, "National Strategy for Homeland Security," July, 2002, <http://www.whitehouse.gov/homeland/book/nat_strat_hls.pdf>.

[7] The United States Commission on National Security/21st Century, "New World Coming: American Security in the 21st Century— Supporting Research and Analysis," September 15, 1999, <http://www.nssg.gov/NWR_A.pdf>; William F. Perry, "Preparing for the Next Attack," *Foreign Affairs* 6, (November/December 2001), pp. 31-45.

[8] Central Intelligence Agency, "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January Through 30 June 2002," (April 2003), <http://www.cia.gov/cia/publications/bian/bian_jan_2002.htm>.

[9] Richard A. Falkenrath, Robert D. Newman, and Bradley A. Thayer, *America's Achilles' Heel - Nuclear, Biological, and Chemical Terrorism and Covert Attack*, (London: MIT Press, 1998).

[10] Center for Law and the Public's Health at Georgetown and Johns Hopkins Universities, "The Model State Emergency State Health Powers Act," Decem-

ber 21, 2001, <http://www.publichealthlaw.net/MSEHPA/MSEHPA2.pdf>; Michael Osterholm, "Bioterrorism: a Real Modern Threat," in W. Michael Scheld, William A. Craig, and James M. Hughes, eds., *Emerging Infections, Volume 5*, (Washington DC: ASM Press, 2001), pp. 213-222.

[11] Richard A. Falkenrath, et al., *America's Achilles' Heel.*

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

[13] Richard A. Falkenrath, et al., *America's Achilles' Heel.*

[14] Michael Evans, "Whitehall dossier says Saddam plans biological weapons for Palestinians," *Times [London]*, August 3, 2002, <http://www.timesonline.co.uk/article/0,,3181-374978,00.html>; Michelle Stem Cook and Amy F. Woolf, "Preventing Proliferation of Biological Weapons: U.S. Assistance to the Former Soviet States," Congressional Research Service RL31368, April 10, 2002.

[15] Ronald V. Clarke, "Introduction," in Ronald Clarke, ed., *Situational Crime Prevention*.

[16] Genevieve J. Kenzo, "Possible Impacts of Major Counter Terrorism Security Actions on Research, Development, and Higher Education," Congressional Research Service RL31354, April 8 2002; The Australia Group, "AG Common Control List—List of Biological Agents for Export Control," June 6, 2002, <http://www.australiagroup.net/control_list/bio_agents.htm>.

[17] Genevieve J. Kenzo, *Possible Impacts of Major Counter Terrorism Security Actions;* Ruth Ellen Wasem, *Foreign Students in the United States: Policies and Legislation*, Congressional Research Service RL31146, March 28, 2002.

[18] Elizabeth Rindskopf Parker and Leslie Gielow Jacobs, "Government Controls of Information and Scientific Inquiry," *Biosecurity and Biodefense: Biodefense Strategy, Practice, and Science 2* (2003), pp.83-95; Dana A. Shea, "Balancing Scientific Publication and National Security Concerns: Issues for Congress ," Congressional Research Service RL31695, January 10, 2003; and William J Broad, "U.S. Is Tightening Rules On Keeping Scientific Secrets," *New York Times*, February 17, 2002, Section 1; Page 1; Column 6; National Desk.

[19] Genevieve J. Kenzo, *Possible Impacts of Major Counter Terrorism Security Actions*; Ruth Ellen Wasem, *Foreign Students in the United States.*

[20] Genevieve J. Kenzo, *Possible Impacts of Major Counter Terrorism Security Actions*; The Australia Group, "AG Common Control List—List of Biological Agents for Export Control."

[21] Ian F. Fergusson, Craig Elwell, Jeanne Grimmett, "Export Administration Act of 1979 Reauthorization," Congressional Research Service RL30169, March 11, 2002; Dianne E. Rennack, *Nuclear, Biological, Chemical, and Missile Proliferation Sanctions: Selected Current Law*, Congressional Research Service 98-116 F, January 17, 2001; The Australia Group, "AG Common Control List—List of Dual-Use Biological Equipment for Export Control," June 6, 2002.

[22] U.S. Department of Homeland Security, "Strategic National Stockpile," <http://www.dhs.gov/dhspublic/display?theme=15&content=327>.

[23] Michelle Stem Cook, et al., *Preventing Proliferation of Biological Weapons.*

[24] U.S. Department of Homeland Security, "Strategic National Stockpile."

[25] Richard A. Falkenrath, et al., *America's Achilles' Heel.*

[26] Bradley T. Smith, Thomas V. Inglesby, Tara O'Toole, "Biodefense R&D: Anticipating Future Threats, Establishing a Strategic Environment," *Biosecurity and Biodefense: Biodefense Strategy, Practice, and Science* 3 (2003), pp. 193-202; James B. Petro, Theodore R. Plasse, Jack A. McNulty, "Biotechnology: Impact on Biological Warfare and Biodefense," *Biosecurity and Biodefense: Biodefense Strategy, Practice, and Science* 3 (2003), pp. 161-168; Gigi Kwik, Joe Fitzgerald, Thomas V. Inglesby, and Tara O'Toole, "Biosecurity: Responsible Stewardship of Bioscience in an Age of Catastrophic Terrorism," *Biosecurity and Biodefense: Biodefense Strategy, Practice, and Science* 1 (2003), pp.27-35.

[27] Centers for Disease Control and Prevention, "Biological Diseases/Agents List," February 26, 2003, <http://www.bt.cdc.gov/Agent/agentlist.asp>.

[28] U.S. Department of Defense, Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics, "Defense Science Board Task Force on Intelligence Needs for Homeland Defense," January, 2002, pp. H1-H7; Office of Homeland Security, "National Strategy for Homeland Security."

[29] Judith Miller, "Next to Old Rec Hall, a 'Germ-Making Plant,'" New York Times, September 4, 2001, Section A; Page 6; Column 2; Foreign Desk.

[30] Paul R. Pillar, *Terrorism and US Foreign Policy* (Washington DC: Brookings Institution Press, 2001), pp. 12-40.

[31] Tara O'Toole, "Institutional Issues in Biodefense," Campbell Public Affairs Institute, Maxwell School of Citizenship and Public Affairs (2002), <http://www.maxwell.syr.edu/campbell/Governance_Symposium/o'toole.pdf>; Bradley T. Smith, et al., "Biodefense R&D."

[32] The White House, "President Details Project BioShield," February 3, 2003, <http://www.whitehouse.gov/news/releases/2003/02/20030203.html>.

[33] Tara O'Toole, "Institutional Issues in Biodefense."

[34] Bradley T. Smith, et al., "Biodefense R&D."

[35] Gigi Kwik, et al., "Biosecurity."

[36] Ted Anthony, "Chinese Students Denied Visas Protest Outside U.S. Embassy," Associated Press, News Tribune, Tacoma, WA, August 8, 2002, <http://www.tribnet.com/24hour/world/story/492464p-3928476c.html>; Mohammed Alkhereiji, Essam Al-Ghalib, "Visa Rules Continue to Strain Saudi-US Relations," Arab News, October 2, 2003, <http://www.arabnews.com/?page=1&section=0&article=32889&d=2&m=10&y=2003>.

[37] Julie Samia Mair, et al., "Violence Prevention and Control Through Environmental Modifications."

[38] U.S. Department of Health & Human Services, "Protecting Americans: Smallpox Vaccination Program—Smallpox Q&A," December 13, 2002, <http://www.smallpox.gov/VaccinationProgramQA.html>.

[39] 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.

[40] "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.

[41] 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.

[42] 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, T*errorism and US Foreign Policy*.

[43] Gigi Kwik, et al., "Biosecurity"; Veronique de Rugy and Charles V. Peña, "Responding to the Threat of Smallpox Bioterrorism: An Ounce of Prevention Is Best Approach," The Cato Institute, April 18, 2002, <http://www.cato.org/pubs/pas/pa434.pdf>; and Greg Seigle, "Bioterror Expert Criticizes CDC, NIH for Poor Communication," *Global Security Newswire*, February 7, 2002, <http://www.nti.org/d_newswire/issues/thisweek/2002_2_7_biow.html>.

[44] Office of Homeland Security, "National Strategy for Homeland Security."