

Biosecurity Reconsidered

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Calibrating Biological Threats and Responses

On January 10, 2000, the United Nations (UN) Security Council held an unprecedented meeting to discuss a new threat to international peace and security. The sole purpose of the meeting was to examine the impact of Human Immunodeficiency Virus (HIV) and acquired immunodeficiency syndrome (AIDS) on Africa. For the first time in the forty-five-year history of the United Nations, the Security Council addressed a health issue as a threat to international security. In justifying the Security Council's attention to this nonmilitary issue, UN Secretary-General Kofi Annan pointed out that although violent conflict in Africa had killed 200,000 the previous year, HIV/AIDS had killed more than 2.2 million people in the same year.¹ When U.S. Vice President Al Gore addressed the council, he stated that "the HIV/AIDS epidemic in sub-Saharan Africa is not just a humanitarian crisis. It is a security crisis because it threatens not just individual citizens, but the very institutions that define and defend the character of a society."² Six months later, the Security Council approved a resolution recognizing that "the spread of HIV/AIDS can have a uniquely devastating impact on all sectors and levels of society" and, "if unchecked, may pose a risk to stability and security."³

In February 2000, the U.S. National Security Council designated HIV/AIDS a national security threat, the first time a disease had been so labeled.⁴ This designation was based in part on an influential intelligence report on the national security implications of infectious disease. According to the assessment, "New and reemerging infectious diseases will pose a rising global health threat and will complicate US and global security over the next 20 years. These diseases will endanger US citizens at home and abroad, threaten US armed forces deployed overseas, and exacerbate social and political instability in key

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1. United Nations Security Council, "Security Council Holds Debate on Impact of AIDS on Peace and Security in Africa," press release, SC/6781, January 10, 2000.
 2. United Nations Security Council, "The Situation in Africa: The Impact of AIDS on Peace and Security in Africa," verbatim record of the 4,087th meeting, S/PV.4087, January 10, 2000, p. 6.
 3. United Nations Security Council, Resolution 1308, S/RES/1308, July 17, 2000.
 4. Barton Gellman, "AIDS Is Declared Threat to Security," *Washington Post*, April 30, 2000.
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countries and regions in which the United States has significant interests.”⁵ This report has been described as a “watershed in U.S. foreign policy” for expanding the purview of the U.S. national security community into the realm of public health.⁶

The year 2000 marked a turning point in the consideration of health and disease as an international security issue, but it was not a onetime affair. In 2001 and 2002, a series of events—including the terrorist attacks of September 11, 2001, the 2001 anthrax letter attacks, the lead-up to the 2003 U.S. invasion of Iraq, and high-profile experiments that highlighted the potential for advances in the life sciences to be misused—catapulted the threat of man-made diseases onto the international security agenda. The threat of naturally occurring infectious diseases, in the form of Severe Acute Respiratory Syndrome (SARS) and H5N1 avian influenza, returned with a vengeance in 2003. As a result of these events, the dangers posed by natural and man-made biological threats have featured prominently in recent reviews of national and international security. In 2004 the UN’s High-Level Panel on Threats called for a greater effort against biological security challenges such as infectious disease and biological terrorism.⁷ In 2005 UN Secretary-General Annan pledged to use his authority to “call to the attention of the Security Council any overwhelming outbreak of infectious disease that threatens international peace and security.”⁸ In 2006 the U.S. National Security Strategy included pandemic disease as a threat to national security in the same category as terrorist acquisition of nuclear, biological, and chemical weapons.⁹

The rise of biosecurity on the international security agenda has engendered a number of debates. These debates center around questions of securitization, risk assessment, and policy responses. Are naturally occurring infectious diseases a security threat? Do laboratory accidents or advances in biotechnology pose security threats? What are the costs of the securitization of public health and biology? What is the risk of terrorists causing mass casualties with a biological weapon? What is the proper balance in the life sciences between the need for openness and the need for security? How much emphasis should

5. National Intelligence Council (NIC), *The Global Infectious Disease Threat and Its Implications for the United States*, NIE 99-17D (Washington, D.C.: NIC, January 2000), p. 5.

6. Jennifer Brower and Peter Chalk, *The Global Threat of New and Reemerging Infectious Diseases: Reconciling U.S. National Security and Public Health Policy* (Santa Monica, Calif.: RAND, 2003), p. 61.

7. United Nations, *A More Secure World: Our Shared Responsibility: Report of the Secretary-General’s High-Level Panel on Threats, Challenges, and Change* (New York: United Nations, 2004), p. viii.

8. Kofi Annan, *In Larger Freedom: Towards Development, Security, and Human Rights for All*, A/59/2005 (New York: United Nations, 2005), p. 29.

9. George W. Bush, *The National Security Strategy of the United States of America* (Washington, D.C.: White House, 2006), p. 44.

governments place on preparing and responding to biological weapons threats versus naturally occurring diseases? The purpose of this article is not to settle these debates, but to provide a framework for addressing them in a systematic fashion.

This article has three goals. The first goal is to explain how biosecurity emerged as a key issue on the international security agenda in recent years. The rise of biosecurity resulted from a growing acceptance of a broader definition of security in the post-Cold War era and four trends that have increased the risks posed by biological threats to international security: advances in science and technology, the emergence of new diseases, globalization, and the changing nature of conflict.

The second goal is to examine the competing definitions and conceptualizations of biosecurity that have emerged in recent years. Academics, think tanks, and governments have put forward a growing number of proposals to counter biological threats under the rubric of biosecurity. Assessing these proposals is complicated by the lack of agreement on the definition of biosecurity, the diverse range of biological threats these proposals seek to address, and competing perspectives on the most pressing biological threats. I argue that a comprehensive definition of biosecurity that covers both naturally occurring and man-made biological threats provides an umbrella for engaging in multidisciplinary research, risk assessment, and strategy development.

The third goal of the article is to sharpen the debate on biosecurity by presenting a taxonomy of naturally occurring and man-made biological threats to international security. The taxonomy uses a levels-of-analysis approach that categorizes threats based on the source of the threat and the group most at risk from the threat. The taxonomy includes three potential sources of biological threats: states; nonstate actors including terrorists, criminals, and scientists; and nature.¹⁰ The taxonomy also distinguishes between threats that directly affect the security of states and those that primarily affect individuals, communities, and societies. This taxonomy provides a framework for organizing the ongoing debate about the likelihood and consequences of different biological threats to international security and the best strategies for reducing these threats. The taxonomy also provides a basis for discussing the relationship between these threats and the trade-offs of using different paradigms to respond to different threats. A clear understanding of the range of biological

10. The label "nature" is a misnomer, because even naturally occurring diseases are heavily influenced by human behavior. See Mark S. Smolinski, Margaret A. Hamburg, and Joshua Lederberg, eds., *Microbial Threats to Health: Emergence, Detection, and Response* (Washington, D.C.: National Academies Press, 2003), pp. 53–148.

threats to international security is also a prerequisite for evaluating proposed strategies for enhancing biosecurity. The goal of this taxonomy is to provide a foundation for future analyses of biological threats and biosecurity strategies.

The article is organized into five sections. The first section describes the rise of biosecurity on the international security agenda. The second section discusses the concept of biosecurity and its utility in assessing the risks posed by biological threats. The third section presents the taxonomy of biological threats to international security and describes how different biological threats fit into the taxonomy. The fourth section discusses implications of this taxonomy for evaluating biological threats to international security and devising biosecurity strategies. The concluding section offers suggestions on future research directions in this field.

The Rise of Biosecurity

Throughout history, disease has had a powerful but overlooked influence on international security.¹¹ Aside from the threat posed by states armed with biological weapons, however, disease had not been viewed as a threat to international security until the dawn of the twenty-first century. Traditionalists in favor of a strict definition of security have argued on principle against the inclusion of disease as a security threat.¹² The rise of health issues as a key topic in international security was enabled by a growing acceptance among national governments and international organizations of a definition of security beyond external military threats posed by states. Three conceptual changes paved the way for health issues to become part of the international security agenda. The first change was the redefinition of security to include non-military threats such as environmental degradation, climate change, organized crime, refugee flows, and terrorism.¹³ The second change was an acknowledgment that the sources of these threats are primarily not nation-states, but transnational or nonstate actors.¹⁴ The third change was a new focus on the security of individuals and groups within states, not just the states

11. Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies* (New York: W.W. Norton, 1999), pp. 195–214; William H. McNeill, *Plagues and Peoples* (New York: Anchor, 1998); and Hans Zinsser, *Rats, Lice, and History* (New York: Little, Brown, 1963).

12. Stephen M. Walt, "The Renaissance of Security Studies," *International Studies Quarterly*, Vol. 35, No. 2 (June 1991), pp. 211–239; and Lawrence Freedman, "International Security: Changing Targets," *Foreign Policy*, No. 110 (Spring 1998), pp. 48–63.

13. Richard H. Ullman, "Redefining Security," *International Security*, Vol. 8, No. 1 (Summer 1983), pp. 129–153; and Barry Buzan, *People, States, and Fear: The National Security Problem in International Relations* (Brighton, U.K.: Harvester Wheatsheaf, 1983).

14. Jessica T. Matthews, "Power Shift," *Foreign Affairs*, Vol. 76, No. 1 (January/February 1997), pp. 50–66; and Michael E. Brown, "Security Problems and Security Policy in a Grave New World,"

themselves.¹⁵ The emergence of the field of human security, with its emphasis on nontraditional threats and on the security of individuals, communities, and societies, played a key role in this process. Even academics who championed a broader definition of security neglected to include diseases in their list of non-military security threats.¹⁶ In contrast, human security explicitly includes health security as a key component.¹⁷ Health security also resonated with members of the public health community, given their shared focus on community-level populations.¹⁸ As a result, the field of health security has evolved beyond being a component of human security into its own nascent discipline.¹⁹

This broader conceptualization of security interacted with four trends that have increased the risks posed by biological threats: advances in science and technology, the emergence of new diseases, globalization, and the changing nature of conflict. Although each trend represents distinct challenges to international security, it is the convergence of these trends that has propelled biological threats onto the international agenda.

ADVANCES IN SCIENCE AND TECHNOLOGY

The first trend is the accelerating pace of innovation in biotechnology and the life sciences. Gene sequencing and synthesizing technologies, which are good benchmarks for measuring the ability of scientists to manipulate genomes, are advancing at a rate comparable to that experienced by the computer industry for the past few decades while costs continue to decrease.²⁰ Although the Human Genome Project required thirteen years to map the first human genome at a cost of \$3 billion, a private firm in 2007 sequenced the genome of James Watson, the Nobel Laureate who codiscovered the structure of DNA, in two months at a cost of about \$200,000.²¹ Breakthroughs in the life sciences

in Brown, ed., *Grave New World: Security Challenges in the 21st Century* (Washington, D.C.: Georgetown University Press, 2003), pp. 305–327.

15. Buzan, *People, States, and Fear*; and United Nations Development Programme (UNDP), *Human Development Report, 1994* (New York: UNDP, 1994), pp. 22–40.

16. Buzan, *People, States, and Fear*; Ullman, “Redefining Security”; and Brown, “Security Problems and Security Policy in a Grave New World.”

17. Commission on Human Security, *Human Security Now: Protecting and Empowering People* (New York: United Nations, 2003), chap. 6.

18. Colin McInnes, “Health and Security Studies,” in Alan Ingram, ed., *Health, Foreign Policy, and Security: Towards a Conceptual Framework for Research and Policy* (London: Nuffield Trust, 2004), p. 53.

19. Lincoln Chen, Jennifer Leaning, and Vasant Narasimhan, eds., *Global Health Challenges for Human Security* (Cambridge, Mass.: Harvard University Press, 2003); and Ingram, *Health, Foreign Policy, and Security*. For a critique of the field, see William Aldis, “Health Security as a Public Health Concept: A Critical Analysis,” *Health Policy and Planning*, Vol. 23, No. 6 (November 2008), pp. 369–375.

20. Robert Carlson, “The Pace and Proliferation of Biological Technologies,” *Biosecurity and Bioterrorism*, Vol. 1, No. 3 (September 2003), pp. 1–12.

21. Jon Cohen, “Sequencing in a Flash,” *Technology Review*, May/June 2007, p. 72.

have heightened fears that humanity's ability to create and manipulate life is outpacing its capability to prevent this technology from being misused. Biology and biotechnology are subject to a powerful dual-use dilemma: the skills, materials, and technology to conduct civilian activities such as biomedical research and pharmaceutical production can also be used to produce biological weapons. Molecular biology, synthetic biology, bioregulators, and advanced biotechnologies provide numerous ways to modify organisms to be more virulent, resistant to antibiotics and vaccines, and better able to avoid detection and diagnostic systems.²² Two high-profile experiments demonstrated the potential for advances in the life sciences to be misused and focused new attention on the security implications of biotechnology.²³ In 2001 an experiment with mousepox demonstrated a possible method for engineering a highly virulent and vaccine-resistant form of variola, the virus that causes smallpox.²⁴ A year later, scientists synthesized a virus—the poliovirus—from scratch for the first time, raising the prospect that more complex viruses, such as variola, could be synthesized in the future.²⁵ The emergence of the “do-it-yourself biology” movement, amateur biologists who engage in molecular biology and synthetic biology research outside of an institutional laboratory setting, adds another dimension to the safety and security concerns generated by the biotechnology revolution.²⁶

EMERGING INFECTIOUS DISEASES

The second trend is the continuous evolution of microorganisms, which has resulted in the growth of microbial threats to human health. Since 1973 more than thirty previously unknown infectious disease agents, such as HIV, Ebola, and SARS, have been identified. At least twenty more well-known diseases, such as malaria, tuberculosis, and cholera, have reemerged and/or spread geographically since that time, often in more lethal and drug-resistant forms.²⁷

22. Steven M. Block, “Living Nightmares: Biological Threats Enabled by Molecular Biology,” in Sidney D. Drell, Abraham D. Sofaer, and George D. Wilson, eds., *The New Terror: Facing the Threat of Biological and Chemical Weapons* (Stanford, Calif.: Hoover Institution Press, 1999), pp. 39–75; and U.S. Department of Defense, *Advances in Biotechnology and Genetic Engineering: Implications for the Development of New Biological Warfare Agents* (Washington, D.C.: Department of Defense, June 1996).

23. National Research Council, *Biotechnology Research in an Age of Terrorism* (Washington, D.C.: National Academies Press, 2004).

24. Ronald J. Jackson et al., “Expression of Mouse Interleukin-4 by a Recombinant Ectromelia Virus Suppresses Cytolytic Lymphocyte Responses and Overcomes Genetic Resistance to Mousepox,” *Journal of Virology*, Vol. 75, No. 3 (February 2001), pp. 1205–1210.

25. Jeronimo Cello, Aniko V. Paul, and Eckard Wimmer, “Chemical Synthesis of Poliovirus cDNA: Generation of Infectious Virus in the Absence of Natural Template,” *Science*, August 9, 2002, pp. 1016–1018.

26. Gaymon Bennett et al., “From Synthetic Biology to Biohacking: Are We Prepared?” *Nature Biotechnology*, Vol. 27, No. 12 (December 2009), pp. 1109–1111.

27. NIC, *The Global Infectious Disease Threat and Its Implications for the United States*, p. 5.

The rise in these emerging and reemerging infectious diseases (ERIDs) is the result of a complex interaction between genetic and biological factors; environmental and ecological factors; and social, political, and economic factors.²⁸

The most dramatic examples of these ERIDs in the twenty-first century are SARS and influenza. The 2003 SARS outbreak caused more than 8,000 infections in twenty-nine countries, killed 774 people, and imposed significant economic costs by disrupting trade, travel, and tourism in the Asia-Pacific region.²⁹ H5N1 avian influenza, which also causes a highly lethal disease in humans, reemerged in Southeast Asia in 2003 and began spreading throughout the world. By 2005 the geographic spread of the virus and the growing number of human cases triggered widespread concern that the world was on the brink of another influenza pandemic.³⁰ These outbreaks demonstrated the potential for new diseases to spread quickly and highlighted weaknesses in the global public health system.³¹ In 2009 a novel swine-origin influenza A (H1N1) virus emerged in North America and triggered the first influenza pandemic in forty-one years. As of November 2009, the World Health Organization (WHO) had reported more than 620,000 cases and at least 7,800 deaths caused by the pandemic.³²

GLOBALIZATION

The third major trend is globalization. The U.S. National Intelligence Council has identified the “growing interconnectedness reflected in the expanded flows of information, technology, capital, goods, services, and people throughout the world as an overarching ‘mega-trend,’ a force so ubiquitous that it will substantially shape all the other major trends in the world of 2020.”³³ The globalization of the pharmaceutical and biotechnology industries and the diffusion of information about the life sciences are making the ingredients necessary to develop biological weapons—knowledge, expertise, equipment, and materials—more widely available.³⁴

Globalization has also facilitated the spread of infectious diseases. Reduc-

28. Smolinski, Hamburg, and Lederberg, *Microbial Threats to Health*.

29. World Health Organization (WHO), *SARS: How a Global Epidemic Was Stopped* (Geneva: WHO, 2006).

30. World Health Organization, *Avian Influenza: Assessing the Pandemic Threat* (Geneva: WHO, 2005).

31. Elizabeth M. Prescott, “SARS: A Warning,” *Survival*, Vol. 45, No. 3 (Autumn 2003), pp. 207–226.

32. In July 2009, the World Health Organization stopped requiring countries to test and report individual cases to the WHO; so the number of reported cases significantly understates the real number of cases. World Health Organization, “Pandemic (H1N1) 2009: Update 76,” November 27, 2009, http://www.who.int/csr/don/2009_11_27a/en/index.html.

33. National Intelligence Council, *Mapping the Global Future: Report of the National Intelligence Council's 2020 Project*, NIC 2004-13 (Washington, D.C.: NIC, December 2004), p. 10.

34. Institute of Medicine and National Research Council, *Globalization, Biosecurity, and the Future of the Life Sciences* (Washington, D.C.: National Academies Press, 2006), pp. 79–112.

tions in trade barriers and transportation costs have led to the creation of a global agricultural supply chain that has introduced more pathways for pathogens to cross borders and cause food-borne illnesses. The growth in international travel, tourism, and immigration also increases the risk that a local outbreak will affect multiple countries.³⁵ Once SARS emerged from rural China in February 2003, it spread to five countries within twenty-four hours and another twenty countries on five continents within two months.³⁶ In 2009 the H1N1 influenza pandemic spread as far in six weeks as previous pandemics had spread in six months.³⁷

CHANGING NATURE OF CONFLICT

The nature of conflict has changed in two ways that increase the risk of biological threats. The first change is the replacement of war between states by war within states as the main source of armed conflict.³⁸ Although modern armies have all but eliminated disease as a major cause of casualties, one of the more pernicious effects associated with internal conflict is the spread of infectious disease.³⁹ Infectious diseases such as HIV/AIDS, malaria, tuberculosis, and other respiratory diseases are the primary causes of civilian death and disability generated by civil war.⁴⁰ Internal conflicts facilitate disease outbreaks by destroying a nation's medical and public health infrastructure, generating large volumes of displaced persons who lack adequate food, shelter, sanitation, and medical care, and by impeding assistance by international public health and humanitarian organizations.⁴¹

35. Stanley Knobler, Adel Mahmoud, and Stanley Lemon, eds., *The Impact of Globalization on Infectious Disease Emergence and Control: Exploring the Consequences and Opportunities* (Washington, D.C.: National Academies Press, 2006); and Ann Marie Kimball, *Risky Trade: Infectious Disease in the Era of Global Trade* (Aldershot, U.K.: Ashgate, 2006).

36. World Health Organization, "Summary of Probable SARS Cases with Onset of Illness from 1 November 2002 to 31 July 2003," April 21, 2004, http://www.who.int/csr/sars/country/table2003_09_23/en/.

37. World Health Organization, "Changes in Reporting Requirements for Pandemic (H1N1) 2009 Virus Infection," Pandemic (H1N1) 2009 Briefing Note 3 (Revised), July 16, 2009, http://www.who.int/csr/disease/swineflu/notes/h1n1_surveillance_20090710/en/index.html.

38. Between 1995 and 2005, 95 percent of armed conflicts took place within states. Human Security Centre, *Human Security Report, 2005: War and Peace in the 21st Century* (Oxford: Oxford University Press, 2005), p. 18.

39. Michael Moodie and William J. Taylor Jr., *Contagion and Conflict: Health as a Global Security Challenge* (Washington, D.C.: Chemical and Biological Arms Control Institute and Center for Strategic and International Studies, 2000), pp. 28–35; and Andrew T. Price-Smith, *Contagion and Chaos: Disease, Ecology, and National Security in the Era of Globalization* (Cambridge, Mass.: MIT Press, 2009), pp. 184–187.

40. Hazem Adam Ghobarah, Paul Huth, and Bruce Russett, "Civil Wars Kill and Maim People—Long after the Shooting Stops," *American Political Science Review*, Vol. 97, No. 2 (May 2003), pp. 189–202.

41. Michelle Gaye, Dominique Legros, Pierre Formenty, and Maire A. Connolly, "Conflict and Emerging Infectious Diseases," *Emerging Infectious Diseases*, Vol. 13, No. 11 (November 2007), pp. 1625–1631.

The second change is the emergence of terrorist groups interested in causing mass casualties and acquiring nuclear, biological, and chemical weapons. This threat emerged as a major security issue in the mid-1990s, after the Japanese cult Aum Shinrikyo tried to obtain nuclear and biological weapons and used sarin nerve gas to attack the Tokyo subway system.⁴² After al-Qaida's attacks on New York City and Washington, D.C., on September 11, 2001, the United States elevated terrorism as the primary issue on the international security agenda. The anthrax letter attacks later that fall, which killed five people, disrupted the U.S. Postal Service, and temporarily shut down the U.S. Senate, illustrated the impact that even a small bioterrorism incident could have. The combination of September 11 and the anthrax letter attacks brought together the twin dangers of mass casualty terrorism and biological weapons in a frightening new way and propelled biological terrorism to the forefront of the public health and security communities' agendas.⁴³

Defining Biosecurity

Biosecurity has become the new buzzword among public health officials, national security experts, and biologists in government, academia, and think tanks. Nonetheless, "the terrain of biosecurity policy is a conceptual and practical minefield."⁴⁴ The term "biosecurity" has gained specific meanings within different disciplines, which has resulted in four competing definitions of the word. In addition, biosecurity is sometimes used interchangeably with the term "biosafety," despite important differences in these terms.⁴⁵ A further complication is that the term "biosecurity" translates poorly into other languages, and in some languages, there is only word denoting both biosecurity

42. Richard A. Falkenrath, Robert D. Newman, and Bradley A. Thayer, *America's Achilles' Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack* (Cambridge, Mass.: MIT Press, 1998); and Jessica Stern, *The Ultimate Terrorists* (Cambridge, Mass.: Harvard University Press, 1999).

43. Gregory D. Koblenz, "Biological Terrorism: Understanding the Threat and America's Response," in Arnold M. Howitt and Robyn L. Pangi, eds., *Countering Terrorism: Dimensions of Preparedness* (Cambridge, Mass.: MIT Press, 2003), pp. 97–173.

44. David P. Fidler and Lawrence O. Gostin, *Biosecurity in the Global Age: Biological Weapons, Public Health, and the Rule of Law* (Stanford, Calif.: Stanford University Press, 2008), p. 6.

45. "Laboratory biosafety" is defined as measures to prevent the transmission of biological agents to researchers, the community, and the environment. A simple formulation that helps to distinguish between biosafety and biosecurity in the laboratory context is that biosafety protects people from germs, whereas biosecurity protects germs from people. In addition, for the community concerned with ecological and environmental protection, biosafety is associated with "the transboundary movements, transit, handling and use of all living modified organisms that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health." "Cartagena Protocol on Biosafety to the Convention on Biological Diversity," January 29, 2000, <http://www.cbd.int/biosafety/protocol.shtml>. This issue is also included in the first definition of biosecurity described below.

and biosafety.⁴⁶ This section describes the multiple definitions of biosecurity, examines the utility of using a comprehensive definition of the term to denote a broad category of research and policy that addresses natural and man-made biological threats, and critiques previous attempts to operationalize this broad conception of biosecurity.

THE FOUR FACES OF BIOSECURITY

The agricultural and environmental communities were the first to use the term “biosecurity.” Biosecurity was originally used to describe an approach designed to prevent or decrease the transmission of naturally occurring infectious diseases and pests in crops and livestock. The definition was subsequently expanded to include threats posed to the economy and the environment by invasive alien organisms. Nations such as Australia and New Zealand have enshrined this conception of biosecurity in legislation.⁴⁷ The Food and Agriculture Organization’s definition of biosecurity covers “the introduction of plant pests, animal pests and diseases, and zoonoses, the introduction and release of genetically modified organisms (GMOs) and their products, and the introduction and management of invasive alien species and genotypes.”⁴⁸ This definition of biosecurity is concerned primarily with threats to animal and plant health and to biodiversity, which might have an indirect impact on human health, but no direct effect.

A second definition of biosecurity arose in the late 1990s in response to the threat of biological terrorism. In this context, biosecurity is defined as “the protection of microbial agents from loss, theft, diversion or intentional misuse.”⁴⁹ Similar definitions of laboratory biosecurity are used by the WHO and the Organization for Economic Cooperation and Development.⁵⁰ Discussions of

46. Marc L. Ostfield, “Global Progress on Biosecurity: U.S. Vision and International Efforts,” remarks to the Partnership for Global Security, Carnegie Endowment for International Peace, Washington, D.C., March 6, 2007, <http://2001-2009.state.gov/g/oes/rls/rm/2007/81611.htm>.

47. Laura A. Meyerson and Jamie K. Reaser, “Biosecurity: Moving toward a Comprehensive Approach,” *BioScience*, Vol. 52, No. 7 (July 2002), pp. 593–594.

48. Food and Agriculture Organization Committee on Agriculture, “Biosecurity in Food and Agriculture,” 17th sess., Rome, Italy, March 31–April 4, 2003, p. 1, <ftp://ftp.fao.org/unfao/bodies/coag/coag17/Y8453e.doc>.

49. Department of Health and Human Services (HHS), *Biosafety in Microbiological and Biomedical Laboratories*, (BMBL), 5th ed. (Washington, D.C.: Government Printing Office, 2007), sec. 6.

50. According to the World Health Organization, “laboratory biosecurity” refers to institutional and personal security measures designed to prevent the loss, theft, misuse, diversion, or intentional release of pathogens and toxins. World Health Organization, *Laboratory Biosafety Manual*, 3d ed. (Geneva: WHO, 2004), pp. 47–48. The Organization for Economic Cooperation and Development (OECD) defines biosecurity as “institutional and personal security measures designed to prevent the loss, theft, misuse, diversion or intentional release of pathogens, or parts of them, toxin-producing organisms, as well as such toxins that are held, transferred and/or supplied by

biosecurity in the context of the 1972 Biological Weapons Convention (BWC), which prohibits the development or possession of biological weapons, have also focused principally on laboratory biosecurity.⁵¹ Implementation of this version of biosecurity has concentrated on ensuring the physical security of a designated list of dangerous pathogens (called “select agents” in the United States). In the wake of the Federal Bureau of Investigation’s (FBI’s) conclusion that a scientist at the U.S. Army Medical Research Institute of Infectious Disease (USAMRIID), the military’s premier biodefense research facility, was responsible for the 2001 anthrax letter attacks, greater attention is now being paid to ensuring the reliability of personnel with access to these pathogens.⁵²

A third definition of biosecurity revolves around the oversight of dual-use research. The role of the National Science Advisory Board on Biosecurity, created in 2004, is to provide “advice, guidance and leadership regarding biosecurity oversight of dual-use research, defined as biological research with legitimate scientific purpose that may be misused to pose a biological threat to public health and/or national security.”⁵³ This definition extends the concept of biosecurity beyond the pathogenic organisms that are the focus of the previous definitions to encompass techniques and technologies that can be used to create new pathogenic organisms or biologically active compounds. Emerging fields such as synthetic biology, systems biology, gene therapy, and RNA interference, as well as deeper understandings of genomics, neurobiology, and immunology, are creating new opportunities for the design of advanced biological weapons.⁵⁴ The growing ability of scientists to synthesize pathogens from scratch threatens to undermine laboratory biosecurity measures designed to prevent unauthorized access to stocks of dangerous pathogens.⁵⁵ This conception of biosecurity places greater emphasis on the role of

BRCs [Biological Resource Centers].” OECD, *OECD Best Practice Guidelines on Biosecurity for BRCs* (Paris: OECD, 2007), p. 8.

51. In the context of the BWC, the term “biosecurity” refers to “the protection, control and accountability measures implemented to prevent the unauthorized access, retention, loss, theft, misuse, transfer, diversion or intentional release of biological agents and toxins.” Georgi Avramchev, “Synthesis of Considerations, Lessons, Perspectives, Recommendations, Conclusions, and Proposals Drawn from the Presentations, Statements, Working Papers, and Interventions on the Topics under Discussion at the Meeting of Experts,” October 10, 2008, [http://www.unog.ch/80256EDD006B8954/\(httpAssets\)/C0981350151BD96AC12574E30035A817/\\$file/Synthesis?Paper?distrib?10?Oct.pdf](http://www.unog.ch/80256EDD006B8954/(httpAssets)/C0981350151BD96AC12574E30035A817/$file/Synthesis?Paper?distrib?10?Oct.pdf).

52. National Science Advisory Board for Biosecurity (NSABB), “Enhancing Personnel Reliability among Individuals with Access to Select Agents” (Bethesda, Md.: NSABB, May 2009), <http://oba.od.nih.gov/biosecurity/meetings/200905T/NSABB%20Final%20Report%20on%20PR%205-29-09.pdf>.

53. Secretary of Health and Human Services, “Charter of the National Science Advisory Board for Biosecurity” (Washington, D.C.: U.S. Department of Health and Human Services, March 16, 2006).

54. Institute of Medicine and National Research Council, *Globalization, Biosecurity, and the Future of the Life Sciences*.

55. Michele S. Garfinkel et al., *Synthetic Genomics: Options for Governance* (Rockville, Md., and

scientists—and the knowledge and technology that their research generates—as potential sources of biological threats and on their responsibilities to prevent the misuse of this knowledge.⁵⁶

The fourth definition of biosecurity that has emerged is the most comprehensive. The National Academies of Science defines biosecurity as “security against the inadvertent, inappropriate, or intentional malicious or malevolent use of potentially dangerous biological agents or biotechnology, including the development, production, stockpiling, or use of biological weapons as well as outbreaks of newly emergent and epidemic disease.”⁵⁷ This definition is characterized by the inclusion of both deliberate and natural sources of disease outbreaks, the threats posed by pathogens as well as biotechnology, and the vulnerability of humans, plants, and animals to biological threats.⁵⁸ This conceptualization of biosecurity, with its inclusion of naturally occurring threats to human health, has much in common with the field of health security.

UTILITY OF A COMPREHENSIVE DEFINITION OF BIOSECURITY

The National Academies of Science’s comprehensive definition of biosecurity has several drawbacks. It is unlikely to supplant the other definitions of biosecurity, which are now embedded in various professional communities. This problem could be ameliorated by the proper usage of adjectives to describe the narrower definitions of biosecurity (e.g., agricultural biosecurity and laboratory biosecurity). Nonetheless, the lack of a well-bounded and widely agreed-upon definition of biosecurity raises the prospect that biosecurity will fall victim to the same pitfall encountered by fields such as human security and sustainable development where “everyone is for it, but few people have a clear idea of what it means.”⁵⁹ Andrew Price-Smith warns that “excessively broad categorizations wherein all pathogens are designated as threats to national security must be eschewed because they obfuscate coherent analysis,

Cambridge, Mass.: J. Craig Venter Institute, Center for Strategic and International Studies, and Massachusetts Institute of Technology, October 2007).

56. National Science Advisory Board for Biosecurity, “Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information” (Bethesda, Md.: NSABB, 2007); and John Steinbruner et al., *Controlling Dangerous Pathogens: A Prototype Protective Oversight System* (College Park: Center for International and Security Studies, University of Maryland, March 2007).

57. Institute of Medicine and National Research Council, *Globalization, Biosecurity, and the Future of the Life Sciences*, p. 32.

58. See Christopher F. Chyba, “Towards Biological Security,” *Foreign Affairs*, Vol. 81, No. 3 (May/June 2002), p. 122; Andrew J. Grotto and Jonathan B. Tucker, *Biosecurity: A Comprehensive Action Plan* (Washington, D.C.: Center for American Progress, June 2006); and Fidler and Gostin, *Biosecurity in the Global Age*, p. 4.

59. Roland Paris, “Human Security: Paradigm Shift or Hot Air?” *International Security*, Vol. 26, No. 2 (Fall 2001), p. 88.

and because they undermine the credibility of the argument."⁶⁰ A comprehensive definition of biosecurity also runs the risk of biosecurity being viewed the same way as human security, which has been accused of being "too broad and vague a concept to be meaningful for policymakers, as it has come to entail such a wide range of different threats on one hand, while prescribing a diverse and sometimes incompatible set of policy solutions to resolve them on the other."⁶¹ By encompassing a diverse range of biological risks, the National Academies of Science's definition may make it harder for policymakers to prioritize among them and allocate resources accordingly. Biosecurity policy could also become paralyzed by the competing demands of too many different constituencies or fall victim to lowest-common-denominator solutions.

At the same time, this comprehensive definition of biosecurity also serves several useful purposes. First, it offers an overarching concept for an otherwise fragmented field. This conceptualization of biosecurity can prove useful as a label for a broad category of research and policy that is primarily concerned with biological threats to the security of individuals, groups, societies, and states.⁶² Second, a broad definition of biosecurity provides an umbrella under which scholars and practitioners from a wide array of disciplines, agencies, sectors, organizations, and countries can work together to develop strategies for preventing, preparing for, and responding to both naturally occurring and man-made disease outbreaks. Third, this definition offers a framework for assessing and comparing the dangers posed by different types of biological threats. By encompassing the full range of biological threats instead of focusing on each one independently, a comprehensive definition of biosecurity can help to identify strategies that are effective at reducing the likelihood or consequences of multiple biological threats. In addition, this approach can be used to make explicit what would otherwise be implicit trade-offs that reduce the risk of one type of biological threat while increasing the risk of another. A comprehensive approach could also help to identify neglected issues that require additional research or increased attention from policymakers.

OPERATIONALIZING BIOSECURITY

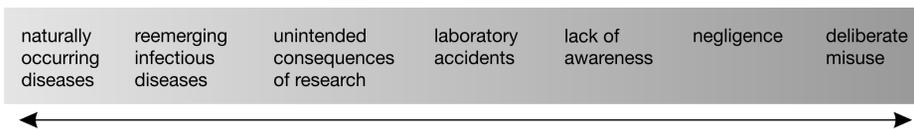
Previous attempts to operationalize this broad conception of biosecurity, however, have not been successful. One of the more common ways to think about

60. Price-Smith, *Contagion and Chaos*, p. 208.

61. Heather Owens and Barbara Arneil, "The Human Security Paradigm Shift: A New Lens on Canadian Foreign Policy? Report of the University of British Columbia Symposium on Human Security," *Canadian Foreign Policy*, Vol. 7, No. 1 (Fall 1999), p. 2.

62. For a similar argument about how to conceptualize human security, see Paris, "Human Security," pp. 96–97.

Figure 1. Spectrum of Biological Threats



SOURCE: Terence Taylor, "Safeguarding Advances in the Life Sciences," *EMBO Reports*, Vol. 7 (July 2006), pp. S61–S64.

biosecurity is as a spectrum of threats posed by naturally occurring infectious disease, accidental or inadvertent harm generated by research, and the deliberate use of disease as a weapon (see figure 1).

This spectrum is useful for listing the major areas of concern in biosecurity, but it does not provide a helpful analytical framework. This characterization of biosecurity does not differentiate among the different types of actors responsible for different types of threats, making it difficult to develop strategies to address these threats. In addition, there is not as much continuity between the threats to biosecurity as figure 1 seems to indicate. Furthermore, lumping all naturally occurring diseases into a single category is unhelpful. This approach fails to take into consideration whether the impact of specific infectious diseases have direct or indirect effects on security and the magnitude of such effects.⁶³ Combining all deliberate misuses of biology into a single category is also unhelpful. Barry Kellman coined the term "bioviolence" to describe "the infliction of harm by the intentional manipulation of living micro-organisms or their natural products for hostile purposes."⁶⁴ This label, however, obscures important differences between the capabilities and intentions of states, terrorists, and criminals to acquire and use biological weapons.⁶⁵ Although states are highly capable of developing biological weapons that can cause mass casualties, they have the least interest in using these weapons given normative concerns, operational uncertainties, and the fear of retaliation. Criminals have virtually no capability or interest in causing mass casualties. Some terrorist groups have an interest in using biological weapons to cause mass casualties, but so far they have not demonstrated the capability of doing so.

63. Marc A. Levy has identified a similar weakness in the environmental security literature. See Levy, "Is the Environment a National Security Issue?" *International Security*, Vol. 20, No. 2 (Fall 1995), pp. 36–37.

64. Barry Kellman, *Bioviolence: Preventing Biological Terror and Crime* (Cambridge: Cambridge University Press, 2007), p. 1.

65. Reynolds M. Salerno et al., "A BW Risk Assessment: Historical and Technical Perspectives," *Nonproliferation Review*, Vol. 11, No. 3 (Autumn 2004), pp. 25–55.

These definitional, conceptual, and practical difficulties have led several analysts to reject the value of a unified view of biosecurity.⁶⁶ For the comprehensive definition of biosecurity to be analytically useful, it is necessary to clearly identify the sources of biological threats to international security and the groups most at risk from these threats, as well as assess the likelihood and consequences of these threats to these groups.

A Biosecurity Taxonomy

In this section, I present a taxonomy of biological threats to international security as the first step in developing an integrated approach to biosecurity. The goal of this taxonomy is to provide an overarching framework for rigorous analysis that will yield sound policy prescriptions. The taxonomy is based on a level-of-analysis approach that identifies both the source of the threat and the group considered most at risk. The interaction between these two variables is central to how these biological threats are perceived and what strategies are used to prevent and respond to them. This interaction is depicted in figure 2, which provides a taxonomy of biosecurity threats based on these two levels of analysis.⁶⁷

The first level of analysis identifies the type of actor responsible for posing the threat: states; nonstate actors including terrorists, criminals, and scientists; and nature.⁶⁸ Historically, state-based biological warfare programs have been viewed as posing the only biological threat to international security. More recently, nonstate actors such as terrorists and criminals have also demonstrated an interest in acquiring and using biological agents as weapons. Scientists engaged in research on infectious disease and biotechnology are increasingly capable of posing two different types of biological risks: through the accidental release of a pathogen outside of the laboratory and the generation of dual-use knowledge or technology that could be misused for malicious purposes. Finally, the natural and human-influenced process of microbial evolution is a never-ending source of biological threats. A subset of infectious diseases,

66. Kathryn Baker, "The Meaning and Practice of Biosecurity," *International Journal of Risk Assessment and Management*, Vol. 12, Nos. 2/3/4 (May 2009), p. 121; and Anna Zmorzynska and Iris Hunger, "Restricting the Role of Biosecurity," *Bulletin of the Atomic Scientists* (web edition), December 19, 2008, <http://www.thebulletin.org/web-edition/op-eds/restricting-the-role-of-biosecurity>.

67. This figure borrows from Roland Paris's conceptualization of how human security fits into the broader field of security studies and Michael Brown's framework for the new security landscape. See Paris, "Human Security," p. 98; and Brown, "Security Problems and Security Policy in a Grave New World," p. 312.

68. This categorization is similar to the one used in Christian Enemark, *Disease and Security: Natural Plagues and Biological Weapons in East Asia* (New York: Routledge, 2007).

Figure 2. Taxonomy of Biological Threats

At-Risk Group	Source of Threat		
	State	Nonstate Actors	Nature
State	<u>Cell 1</u> Biological warfare (e.g., former Soviet and Iraqi biological weapons program)	<u>Cell 3a</u> Biological terrorism (e.g., Aum Shinrikyo, al-Qaida, and 2001 anthrax letter attacks)	<u>Cell 5</u> Pandemics (e.g., HIV/AIDS and pandemic influenza)
		<u>Cell 3b</u> Dual-use research (e.g., genetic engineering and synthetic biology)	
Individual, Community, or Society	<u>Cell 2</u> Biological warfare (e.g., South Africa's apartheid-era biological weapons program)	<u>Cell 4a</u> Biocrimes (e.g., puffer fish toxin case)	<u>Cell 6</u> Endemic and epidemic diseases (e.g., SARS, cholera, and West Nile virus)
		<u>Cell 4b</u> Laboratory accidents (e.g., Sverdlovsk and Pirbright)	

called pandemics, have the potential to pose direct threats to national and international security through a combination of their prevalence, transmissibility, virulence, and lethality.

The second level of analysis addresses who is at risk from these biological threats. In the words of Barry Buzan, what is the “referent object” for biosecurity?⁶⁹ Is it states or individuals and groups within states? Scholars such as Andrew Price-Smith, Stefan Elbe, and Christian Enemark have argued that infectious diseases pose direct and indirect threats to national and international security.⁷⁰ Another set of scholars has looked at biological threats through the lens of the human security paradigm, which focuses on the security of individuals, groups, and societies.⁷¹

69. Buzan, *People, States, and Fear*, p. 26.

70. Andrew T. Price-Smith, *The Health of Nations: Infectious Disease, Environmental Change, and Their Effects on National Security and Development* (Cambridge, Mass.: MIT Press, 2002); Stefan Elbe, *Strategic Implications of HIV/AIDS*, Adelphi Papers, No. 357 (Oxford: Oxford University Press, 2003); and Enemark, *Disease and Security*. For a useful review of the literature on the nexus between disease and security, see Price-Smith, *Contagion and Chaos*, pp. 189–206.

71. Chen, Leaning, and Narasimhan, *Global Health Challenges for Human Security*.

Determining when a particular risk poses a threat to security—and whether national security or human security is the more appropriate paradigm for addressing that threat—is an inexact science. According to Buzan, a threat has been securitized when it is successfully portrayed as an existential threat that requires emergency measures outside of the normal political process.⁷² Colin McInnes refines the criteria for securitization to include threats that pose an extreme—not just existential—danger.⁷³ Building on Buzan and McInnes, Enemark adds the requirement that the threat represent a “dreaded” risk that evokes disproportionate fear and anxiety. The dread of acute infectious disease outbreaks, whether natural or man-made, is crucial for these outbreaks to be successfully portrayed not just as health risks but also as security threats.⁷⁴ Price-Smith has proposed a set of objective economic and demographic criteria for determining when a disease poses a security threat.⁷⁵ There are also skeptics who downplay the link between disease and national security.⁷⁶

Figure 2 offers a descriptive representation of the dominant views of how these biological threats are categorized. It is not meant to convey the impression that a consensus exists among academics or policymakers on the nature and scope of biosecurity. Furthermore, the taxonomy is not meant to prescribe which actor(s) in the international system represent appropriate rallying points for addressing the threat. Nongovernment organizations, governments, international organizations, and the private sector have valuable roles to play in preventing, preparing for, and responding to all of these threats. One of the goals of this taxonomy is to stimulate debate about the appropriate scope of biosecurity, the risks posed by different types of biological threats, the extent to which these threats are or should be securitized, and how these threats should be prioritized in terms of political attention and resources. The rest of the section provides background information for each of these threats and its relationship to international security.

CELLS 1 AND 2: BIOLOGICAL WARFARE

Throughout the twentieth century, biological threats to international security were conceived of principally in terms of the use of biological weapons by

72. Barry Buzan, Ole Waever, and Japp de Wilde, *Security: A New Framework for Analysis* (Boulder, Colo.: Lynne Rienner, 1997), pp. 23–24.

73. McInnes, “Health and Security Studies,” pp. 53–54.

74. Enemark, *Disease and Security*, pp. 6–15.

75. Price-Smith would designate a disease as a security threat if it causes at least 1 percent annual gross domestic product loss per year, at least 1 percent annual mortality of the adult population, and/or severe debilitation of 10 percent of the adult population per year. Price-Smith, *Contagion and Chaos*, p. 206.

76. Susan Peterson, “Epidemic Disease and National Security,” *Security Studies*, Vol. 12, No. 2 (Winter 2002/03), pp. 43–81; and Colin McInnes, “HIV/AIDS and National Security,” in Nana K.

states against other states (cell 1). Although biological weapons do not have military utility at the tactical level on the battlefield, a number of nations have developed these weapons for use at the operational and strategic levels of warfare.⁷⁷ The Soviet Union developed a vast biological weapons complex, which included large stockpiles of biological warfare agents, enormous production facilities, and a network of laboratories dedicated to creating genetically engineered agents.⁷⁸ Iraq had an ambitious biological weapons program that culminated in the deployment of missile warheads and aerial bombs filled with biological warfare agents during the 1991 Persian Gulf War.⁷⁹ According to a 2005 State Department report, six nations are suspected of developing biological weapons in violation of the BWC: China, Cuba, Iran, North Korea, Russia, and Syria.⁸⁰

A combination of normative, operational, and strategic restraints has made the use of biological weapons in interstate warfare extremely rare.⁸¹ When states have employed biological weapons in modern times, they have not done so against other states, but against individuals and opposition groups. Thus, these attacks fall into cell 2. In the late 1970s, Rhodesia used biological weapons against rebel groups, and in the 1980s South Africa used them against rebels and anti-apartheid activists.⁸² In 1978 Bulgaria, with Soviet assistance, targeted two dissidents living in the West with assassination by ricin.⁸³ In each of these cases, states engaged in biological warfare as a means of counterinsurgency or assassination against opponents unable to retaliate in kind.

Poku, Alan Whiteside, and Bjorg Sandkjaer, eds., *AIDS and Governance* (Burlington, Vt.: Ashgate, 2007), pp. 93–111.

77. Gregory D. Koblenz, *Living Weapons: Biological Warfare and International Security* (Ithaca, N.Y.: Cornell University Press, 2009).

78. Anthony Rimmington, "The Soviet Union's Offensive Program: The Implications for Contemporary Arms Control," in Susan Wright, ed., *Biological Warfare and Disarmament: New Problems/New Perspectives* (Lanham, Md.: Rowman and Littlefield, 2002), pp. 103–150.

79. United Nations Monitoring, Verification, and Inspection Commission, *Compendium of Iraq's Proscribed Weapons Programmes in the Chemical, Biological, and Missile Areas* (New York: United Nations, 2007), pp. 765–1030.

80. U.S. Department of State, *Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* (Washington, D.C.: Bureau of Verification and Compliance, U.S. Department of State, 2005), pp. 17–31.

81. Koblenz, *Living Weapons*, pp. 48–51. The only confirmed cases of such use are Germany's sabotage campaign aimed at draft animals bound for the Allies during World War I, and Japan's repeated biological attacks on military and civilian targets in the Republic of China between 1939 and 1942. *Ibid.*, pp. 12–13.

82. On the Rhodesia case, see Marlène Burger and Chandré Gould, *Secrets and Lies: Wouter Basson and South Africa's Chemical and Biological Warfare Programme* (Cape Town, S.A.: Zebra Press, 2002), pp. 15–16, 221–222. On the South African case, see *ibid.*, pp. 31–36, 53–77; and Chandré Gould and Peter Folb, *Project Coast: Apartheid's Chemical and Biological Warfare Programme* (Geneva: United Nations, 2002), pp. 86–99, 103–104, 115–116, 159–167.

83. Shlomo Shpiro, "Poisoned Chalice: Intelligence Use of Chemical and Biological Weapons," *International Journal of Intelligence and Counterintelligence*, Vol. 22, No. 1 (March 2009), pp. 5–6.

CELL 3A: BIOLOGICAL TERRORISM

The prospect of a terrorist group acquiring and using biological weapons has become one of the most feared threats to international security. Writing in 2006, UN Secretary-General Annan warned, “The most important under-addressed threat relating to terrorism, and one which acutely requires new thinking on the part of the international community, is that of terrorists using a biological weapon.”⁸⁴ In 2008 the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism judged that it was more likely than not that a biological terrorist attack would take place within five years.⁸⁵ Biological terrorism is included in cell 3a of the figure, given that the purpose of such attacks—to achieve political change through the use of violence—threatens the institutions, policies, and legitimacy of a state.

The threat of bioterrorism, however, may not be as severe as some have portrayed it to be. Few terrorist groups have attempted to develop a biological weapons capability, and even fewer have succeeded. Prior to the anthrax letter attacks in 2001, only one group, the disciples of guru Bhagwan Shree Rajneesh in Oregon, managed to cause any casualties with a biological agent.⁸⁶ The U.S. intelligence community estimates that of the fifteen terrorist groups that have expressed an interest in acquiring biological weapons, only three have demonstrated a commitment to acquiring the capability to cause mass casualties with these weapons.⁸⁷ Groups such as Japan’s Aum Shinrikyo and al-Qaida have demonstrated the desire to cause mass casualties and an interest in using disease as a weapon. Despite concerted efforts by both groups to produce deadly pathogens and toxins, however, neither has caused any casualties with such weapons, let alone developed a weapon capable of causing mass casualties. The failures experienced by these groups illustrate the significant hurdles that terrorists face in progressing beyond crude weapons suitable for assassination and the contamination of food supplies to biological weapons based on aerosol dissemination technology that are capable of causing mass casualties.⁸⁸

For these reasons, the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism warned that “the United States should

84. Kofi Annan, *Uniting against Terrorism: Report of the Secretary-General*, A /60/825 (New York: United Nations, 2006), p. 11.

85. Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism, *World at Risk: The Report of the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism* (New York: Vintage, 2008), p. xv.

86. The cult sickened 750 residents of a small town in Oregon by contaminating local salad bars with *Salmonella* Typhimurium, a common cause of food poisoning. Milton Leitenberg, *Assessing the Biological Weapons and Bioterrorism Threat* (Carlisle Barracks, Pa.: Strategic Studies Institute, U.S. Army War College, 2005), pp. 20–21.

87. Senior U.S. intelligence official, interview by author, Washington, D.C., May 2008.

88. Koblenz, *Living Weapons*, pp. 200–227.

be less concerned that terrorists will become biologists and far more concerned that biologists will become terrorists.”⁸⁹ The growth of biodefense programs in the United States and around the world has increased the risk of the insider threat: a scientist who uses his or her knowledge and access to pathogens or toxins for malicious purposes. In August 2008, the Federal Bureau of Investigation announced that Bruce Ivins, a scientist at USAMRIID, was the sole perpetrator of the 2001 anthrax letter attacks. Tragically, Ivins committed suicide before he could be indicted for the attacks. If, as alleged by the FBI, Ivins was responsible for the anthrax letter attacks, he possessed a level of experience, set of skills, and access to specialized resources that could be found only in an individual affiliated with a state-run program. Ivins was a Ph.D. microbiologist with more than twenty years of experience working with *B. anthracis* and was considered an expert in the growth, sporulation, and purification of the bacteria. Ivins’s employment at USAMRIID also afforded him access to a highly virulent strain of *B. anthracis*, a well-equipped biocontainment laboratory, experience working in such a lab, immunization against anthrax, and knowledge of decontamination procedures.⁹⁰ These are resources that a terrorist group would find extremely difficult to acquire on its own. Many of these material resources and sociotechnical enablers, however, are now available to more than 14,000 laboratory workers in more than 1,300 high-biocontainment laboratories in the United States.⁹¹

CELL 3B: DUAL-USE RESEARCH

The life sciences and biotechnology are characterized by a dual-use dilemma: the facilities, material, and knowledge used for peaceful purposes such as biomedical research and pharmaceutical production can also be used for hostile purposes such as biological warfare and bioterrorism.⁹² The rapid pace of innovation in the life sciences and the globalization of knowledge and technology have exacerbated this dilemma.⁹³ These trends are widely seen as having two effects on the threats posed by biological warfare and biological terrorism. First, the global diffusion of dual-use biotechnology makes the material and

89. Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism, *World at Risk*, p. 11.

90. Thomas F. Dellafera, “Affidavit in Support of Search Warrant,” Search Warrant 07-524-M-01, October 31, 2007, <http://www.usdoj.gov/amerithrax>.

91. U.S. General Accounting Office (GAO), *High-Containment Laboratories: National Strategy for Oversight Is Needed*, GAO-09-574 (Washington, D.C.: GAO, September 2009), pp. 20–21, 25–26, 29.

92. Ronald M. Atlas and Malcolm Dando, “The Dual-Use Dilemma for the Life Sciences: Perspectives, Conundrums, and Global Solutions,” *Biosecurity and Bioterrorism*, Vol. 4, No. 3 (September 2006), pp. 276–286.

93. Institute of Medicine and National Research Council, *Globalization, Biosecurity, and the Future of the Life Sciences*.

knowledge necessary to produce biological weapons more accessible to a wider range of actors. Second, these dual-use technologies enable states and terrorists to develop genetically engineered biological agents that are more lethal as well as harder to detect, protect against, and treat.⁹⁴

The growth in dual-use research has also raised a number of biosafety concerns. One concern is that genetically engineered pathogens might escape a laboratory. Scientists have re-created the influenza virus that caused the 1918–19 pandemic, which killed 50 million people around the world, and used genes from this virus to make contemporary influenza viruses more virulent.⁹⁵ Some scientists have criticized these experiments for being conducted with inadequate biosafety procedures; others have stated that they should not have been done at all.⁹⁶ The burgeoning field of synthetic biology raises the conundrum of determining the proper biosafety level for experiments with artificially created organisms that have no naturally occurring analogue.⁹⁷

Analyses of the security implications of dual-use research frequently suffer from three flaws that serve to exaggerate the severity of the threat. First, they conflate the ability of states to conduct such research with those of terrorist groups that have much more limited scientific, technical, and financial resources. Given the difficulty that terrorists have faced in carrying out even crude biological attacks with toxins, let alone developing a sophisticated capability based on an aerosolized weapon, it is unlikely that they are capable of developing a genetically engineered pathogen. According to Charles Allen, head of intelligence for the Department of Homeland Security, “In general, we see terrorists in the early stages of biological capabilities, and we do not anticipate a rapid evolution to include sophisticated methods that will enable the creation of new organisms or genetic modification to enhance virulence.”⁹⁸

94. James B. Petro, Theodore R. Plasse, and Jack A. McNulty, “Biotechnology: Impact on Biological Warfare and Biodefense,” *Biosecurity and Bioterrorism*, Vol. 1, No. 3 (September 2003), pp. 161–168; and Christopher F. Chyba and Alexander L. Greninger, “Biotechnology and Bioterrorism: An Unprecedented World,” *Survival*, Vol. 46, No. 2 (Summer 2004), pp. 143–162.

95. Terrence M. Tumpey et al., “Characterization of the Reconstructed 1918 Spanish Influenza Pandemic Virus,” *Science*, October 7, 2005, pp. 77–80; and Darwyn Kobasa et al., “Enhanced Virulence of Influenza A Viruses with the Haemagglutinin of the 1918 Pandemic Virus,” *Nature*, October 7, 2004, pp. 703–707.

96. Jocelyn Kaiser, “1918 Flu Experiments Spark Concerns about Biosafety,” *Science*, October 22, 2004, p. 591; and Kerri Smith, “Concern as Revived 1918 Flu Virus Kills Monkeys,” *Nature*, January 18, 2007, p. 237.

97. Jonathan B. Tucker and Raymond A. Zilinskas, “The Promise and Perils of Synthetic Biology,” *New Atlantis*, No. 12 (Spring 2006), pp. 32–34.

98. Charles Allen, chief intelligence officer, Department of Homeland Security, in “Bioscience and the Intelligence Community,” hearing before the House Committee on Homeland Security, 109th Cong., 1st and 2d sess., November 3, 2005, and May 4, 2006, p. 47.

Second, these assessments focus on the scientific and technical possibilities but typically ignore the issue of motivation. There is no known case of a terrorist group even attempting to develop such a capability.⁹⁹ As the anthrax letter attacks showed, even small-scale attacks with an unmodified biological agent can have dramatic effects. Thus, terrorists may have little incentive to develop genetically engineered pathogens, given the opportunity costs involved and the demonstrated ability of natural pathogens to evoke dread. Third, the “technological determinism” implicit in much of the discussion of the dual-use dilemma may be overstated. Kathleen Vogel argues that successfully using biotechnology requires having access not only to the right equipment and scientific publications, but also to sociotechnical enablers such as laboratory skills, tacit knowledge, and interdisciplinary teams. These enablers are not easily developed via the internet or outside of long-standing scientific communities of practice.¹⁰⁰

CELL 4A: BIOCRIMES

Not all nonstate actors who use disease as a weapon are terrorists. Whereas terrorists use violence to bring about political change, criminals are motivated by personal gains (usually material but sometimes psychological).¹⁰¹ The most common motives for biocriminals have been murder and extortion.¹⁰² In 2009 a Chicago-area man was indicted for illegally obtaining Tetrodotoxin (puffer fish toxin) with the intent of killing his wife and collecting \$20 million in life insurance.¹⁰³ Biocriminals are included in cell 4a of the figure because they pose a threat primarily to individuals or small groups of specifically chosen victims. There have been a few cases of biocriminals causing large numbers of casualties, but these have been accomplished through multiple small-scale attacks on discrete groups using crude means of dissemination as opposed to large-scale indiscriminant attacks.¹⁰⁴

99. Reports that Aum Shinrikyo conducted genetic engineering are apocryphal. Milton Leitenberg, “Aum Shinrikyo’s Efforts to Produce Biological Weapons: A Case Study in the Serial Propagation of Misinformation,” *Terrorism and Political Violence*, Vol. 11, No. 4 (Winter 1999), pp. 154–156.

100. Kathleen M. Vogel, “Framing Biosecurity: An Alternative to the Biotech Revolution Model?” *Science and Public Policy*, Vol. 35, No. 1 (February 2008), pp. 45–54.

101. Bruce Hoffman, *Inside Terrorism* (New York: Columbia University Press, 2006), p. 36.

102. W. Seth Carus, *Bioterrorism and Biocrimes: The Illicit Use of Biological Agents since 1900* (Washington, D.C.: National Defense University, February 2001), pp. 7–8.

103. “Man Found with Deadly Puffer Fish Toxin Indicted on Charges of Plotting to Kill His Wife,” Associated Press, June 16, 2009.

104. Carus, *Bioterrorism and Biocrimes*, pp. 17–20.

CELL 4B: LABORATORY ACCIDENTS

Laboratory accidents with dangerous pathogens pose the greatest risks to individual researchers.¹⁰⁵ The risk to local communities from laboratory accidents, however, is increasing as a result of the global proliferation of high biocontainment laboratories around the world. Thus, this threat is included in cell 4b.

Historically, the greatest risks of laboratory accidents have been posed by state-run biological weapons (BW) programs that produced large quantities of dangerous pathogens, conducted particularly hazardous laboratory activities such as aerosolization studies, and engaged in field testing of biological weapons. The Soviet BW program suffered at least two major accidents. In 1971 a field test of variola virus at its BW test site on Vozrozhdeniye Island in the Aral Sea resulted in a small outbreak of smallpox that required extraordinary public health measures to contain.¹⁰⁶ In April 1979, an accident at a military BW facility in Sverdlovsk (now Yekaterinburg, Russia) released a plume of *B. anthracis* spores, which caused an outbreak of inhalation anthrax that killed at least sixty-six individuals.¹⁰⁷

The threats of emerging infectious disease and bioterrorism and the economic opportunities presented by the biotechnology revolution have triggered a construction boom in high biocontainment laboratories in the United States and around the world.¹⁰⁸ In 2009 the United States possessed seven biosafety level-four (BSL-4) laboratories, with another seven under construction and more than 1,300 BSL-3 laboratories registered to work with dangerous human, plant, or animal pathogens.¹⁰⁹ In addition, there are at least twenty-four BSL-4 laboratories in operation outside the United States.¹¹⁰ The number of countries with declared biodefense programs has also increased dramatically, from thirteen in 1993 to twenty-five in 2007.¹¹¹

105. Tjeerd G. Kimman, Eric Smit, and Michèl R. Klein, "Evidence-Based Biosafety: A Review of the Principles and Effectiveness of Microbiological Containment Measures," *Clinical Microbiology Reviews*, Vol. 21, No. 3 (July 2008), pp. 403–425.

106. Jonathan B. Tucker and Raymond A. Zilinskas, eds., *The 1971 Smallpox Epidemic in Aralsk, Kazakhstan, and the Soviet Biological Warfare Program*, Occasional Paper, No. 9 (Monterey, Calif.: Center for Nonproliferation Studies, 2002).

107. Jeanne Guillemin, *Anthrax: The Investigation of a Deadly Outbreak* (Berkeley: University of California Press, 1999), pp. 233–237.

108. High biocontainment laboratories include those with biosafety levels (BSL) 3 and 4. Work in BSL-3 laboratories involves agents such as *Francisella tularensis* (tularemia), SARS coronavirus, and West Nile virus that may cause serious and potentially lethal infection although vaccines or effective treatments may be available. Work in BSL-4 laboratories involves the most dangerous agents for which there are no effective vaccines or treatments available, such as Ebola, Marburg, and variola virus (smallpox). HHS, *Biosafety in Microbiological and Biomedical Laboratories*.

109. GAO, *High-Containment Laboratories*, pp. 20–21, 25–26.

110. Gigi Kwik Gronvall and Nidhi Bouri, "Biosafety Laboratories," *Biosecurity and Bioterrorism*, Vol. 6, No. 4 (December 2008), p. 300.

111. Filippa Lentzos, *Preparing the Ground for the CBM Content Debate: A Study on the Information*

Although BSL-4 laboratories in the United States have an excellent safety record, several BSL-4 laboratories outside the United States have experienced lethal laboratory-acquired infections and secondary transmission of a disease from a researcher to individuals outside of the laboratory.¹¹² BSL-3 laboratories in the United States have also experienced several high-profile accidents in recent years.¹¹³ A major biosafety concern with implications for public health is that a laboratory accident could reintroduce a contagious disease that has already been eradicated or otherwise contained. The last known cases of smallpox and SARS were both caused by laboratory exposures, and both viruses were able to spread from infected researchers to a small number of individuals outside of the laboratory.¹¹⁴ In 2007 a breach of containment at the Pirbright BSL-4 laboratory in the United Kingdom caused an outbreak of foot-and-mouth disease at several local farms. A 2001 epidemic of this highly infectious disease in the United Kingdom cost taxpayers more than £3 billion.¹¹⁵

CELL 5: PANDEMIC DISEASES

Pandemics are disease outbreaks that occur over a wide geographic area, such as a region, continent, or the entire world, and infect an unusually high proportion of the population. Two pandemic diseases are widely cited as having the potential to pose direct threats to the stability and security of states: HIV/AIDS and influenza.

HIV/AIDS. Since it was first identified in 1981, HIV is estimated to have killed more than 25 million people worldwide. According to the Joint UN Program on HIV/AIDS (UNAIDS), the percentage of the global population with HIV has stabilized since 2000, but the overall number of people living with HIV (33 million in 2007) has steadily increased. Sub-Saharan Africa continues to bear a disproportionate share of the global burden of HIV with

Exchange That Builds Confidence between States Parties to the Biological and Toxin Weapons Convention (BTWC) (London: BIOS Centre, London School of Economics, 2008), p. 11.

112. Karl M. Johnson, "Biosafety at BSL-4: More than 20 Years Experience at Three Major Facilities," in National Institutes of Health (NIH), *Rocky Mountain Laboratory Integrated Research Facility Final Environmental Impact Statement* (Washington, D.C.: NIH, 2004), pp. D-5 to D-11; and David L. Heymann, R. Bruce Aylward, and Christopher Wolff, "Dangerous Pathogens in the Laboratory: From Smallpox to Today's SARS Setbacks and Tomorrow's Polio-free World," *Lancet*, May 15, 2004, pp. 1566–1568.

113. Jocelyn Kaiser, "Accidents Spur a Closer Look at Risks at Biodefense Labs," *Science*, September 28, 2007, pp. 1852–1854.

114. Heymann, Aylward, and Wolff, "Dangerous Pathogens in the Laboratory," pp. 1566–1568.

115. T. Hugh Pennington, "Biosecurity 101: Pirbright's Lessons in Laboratory Security," *BioSocieties*, Vol. 2, No. 4 (December 2007), pp. 449–453.

35 percent of new HIV infections, 75 percent of AIDS deaths, and 67 percent of all people living with HIV.¹¹⁶

Scholars have identified four ways that HIV/AIDS can affect security.¹¹⁷ First, the disproportionately high prevalence of HIV/AIDS in the armed forces of some nations, particularly in Southern Africa, may compromise the ability of those states to defend themselves from internal or external threats. Militaries with high rates of HIV infection may suffer losses in combat readiness and effectiveness as infected troops are transferred out of combat roles, units lose cohesion because of high turnover rates, middle management is “hollowed out” by the early death or disability of officers, and defense budgets are strained because of rising medical costs and the need to recruit and train replacements for sick soldiers.

The second threat is that HIV/AIDS will undermine the international peacekeeping system. Nations with militaries with high rates of HIV/AIDS will be unable to provide troops for international peacekeeping missions; nations with healthy militaries may be unwilling to commit troops to peacekeeping operations in nations with a high prevalence rate of HIV/AIDS; and war-torn nations may be unwilling to accept peacekeepers for fear they will spread the disease in their country.

The third threat is that a “second wave” of HIV/AIDS could strike large, strategically important countries such as China, India, and Russia. These states, which possess nuclear weapons and are important players in critical regions, also suffer from internal security challenges that could be aggravated by a severe AIDS epidemic and its attendant socioeconomic disruptions.

The fourth threat is that the high prevalence of HIV in less developed countries will cause political instability that could degenerate into internal conflict or spread into neighboring countries. Unlike most diseases, which affect primarily the poor, young, and old, HIV/AIDS strikes young adults and members of the middle and upper classes. By sickening and killing members of society when they should be their most productive, HIV/AIDS has inflicted the “single greatest reversal in human development” in modern history.¹¹⁸

Despite the global consensus that HIV/AIDS is the worst humanitarian cri-

116. Joint United Nations Program on HIV/AIDS (UNAIDS), *2008 Report on the Global AIDS Epidemic* (Geneva: UNAIDS, 2008), pp. 32, 39.

117. This section is based on Elbe, *Strategic Implications of HIV/AIDS*; and Harley Feldbaum, Kelley Lee, and Preeti Patel, “The National Security Implications of HIV/AIDS,” *PLoS Medicine*, Vol. 3, No. 6 (June 2006), pp. 775–777.

118. United Nations Development Programme, *Human Development Report, 2005: International Cooperation at a Crossroads: Aid, Trade, and Security in an Unequal World* (New York: UNDP, 2005), p. 3.

sis facing the world, there is still debate over whether the scope and severity of the crisis qualify it as a security threat. Contrary to earlier reports of extremely high HIV prevalence rates in the armed forces in certain African nations, these forces have been found to exhibit only slightly higher prevalence rates than the civilian populations in those nations.¹¹⁹ In addition, the threat of HIV/AIDS to international peacekeeping operations has not materialized. Between January 2000 and January 2009, the United Nations increased its peacekeeping forces from 18,000 soldiers, police, and observers to more than 90,000.¹²⁰ As Harley Feldbaum has noted, predictions of a “second wave” of HIV infections in China, India, and Russia now appear to be overly pessimistic.¹²¹ In addition, the social and political destabilization predicted for the most-affected nations has not occurred.¹²² The lack of empirical data supporting claims that HIV/AIDS is a threat to international security has even led an early supporter of this perspective to change his mind.¹²³

PANDEMIC INFLUENZA. If HIV/AIDS is nature’s version of attrition warfare, then pandemic influenza is its version of blitzkrieg. The most devastating influenza pandemic of the twentieth century, in 1918–19, is estimated to have killed upwards of 50 million people around the world, more than perished during World War I. According to the historian John Barry, “Influenza killed more people in a year than the Black Death of the Middle Ages killed in a century; it killed more people in twenty-four weeks than AIDS has killed in twenty-four years.”¹²⁴ The 1918 pandemic has become the touchstone for national and international pandemic planning and preparedness activities. A modern-day recurrence of a 1918-like influenza pandemic could cause an estimated 180–360 million deaths worldwide. Such a pandemic could also cause a drastic reduction in economic growth, given the lost productivity and trade

119. Laurie Garrett, “HIV and National Security: Where Are the Links? A Council on Foreign Relations Report” (New York: Council on Foreign Relations, 2005), pp. 25–29.

120. United Nations Department of Peacekeeping, “Monthly Summary of Contributors of Military and Civilian Police Personnel,” <http://www.un.org/Depts/dpko/dpko/contributors>.

121. Harley Feldbaum, “U.S. Global Health and National Security Policy: A Report of the CSIS Global Health Policy Center” (Washington, D.C.: Center for Strategic and International Studies, 2009), p. 4.

122. *Ibid.* Price-Smith attributes an important role to HIV/AIDS for the growing instability in Zimbabwe, but the multiplicity of factors at play makes it difficult to establish a causal link between the disease and that nation’s destabilization. Price-Smith, *Contagion and Chaos*, pp. 89–116.

123. Stefan Elbe now believes that HIV/AIDS is better thought of as a threat to human security rather than to national or international security. Compare Elbe, *Strategic Implications of HIV/AIDS*; and Elbe, *Virus Alert: Security, Governmentality, and the AIDS Pandemic* (New York: Columbia University Press, 2009), pp. 27–58.

124. John M. Barry, *The Great Influenza: The Epic Story of the Deadliest Plague in History* (New York: Viking, 2004), p. 5.

and travel restrictions that would disrupt the global just-in-time economy. Based on these human and economic costs, it is feared that a severe pandemic could also trigger widespread political and social instability, even in developed nations, as governments lose legitimacy, citizens panic, and security forces become weakened.¹²⁵ These concerns have led pandemic influenza to be viewed as a threat to national and international security.¹²⁶

Although the 2009 influenza pandemic has so far exhibited relatively low case fatality rates, several parallels with the 1918 pandemic have been noted. The H1N1 virus that caused the 2009 pandemic is a descendant of the H1N1 influenza virus that caused the 1918 pandemic.¹²⁷ In addition, the initial epidemiological characteristics of the H1N1 pandemic, including the emergence of the virus in the spring and a shift in disease severity to young adults, are similar to those witnessed in 1918.¹²⁸ It remains to be seen whether the 2009 pandemic will be relatively mild in severity or, in the words of WHO Secretary-General Margaret Chan, represents “the calm before the storm.”¹²⁹

Forecasting the behavior of influenza viruses is fraught with peril. Nonetheless, it is possible to identify four scientific and geopolitical factors that reduce the likelihood that the 2009 pandemic, or the next one, will be as deadly as the one in 1918.¹³⁰ First, unlike in 1918, we have advance warning of the threat of a highly lethal influenza pandemic and are preparing for it ahead of time. This advance warning stems from historical memory of the 1918 influenza pandemic, greater scientific understanding of influenza viruses, and recent disease outbreaks such as SARS and H5N1. Since 2003 the international community has taken advantage of this advance warning to pledge \$3 billion to enhance national preparedness capabilities. Second, we have a global health surveillance and response system that can provide early detection of a pandemic and

125. Michael T. Osterholm, “Preparing for the Next Pandemic,” *Foreign Affairs*, Vol. 84, No. 4 (July/August 2005), pp. 24–37; Laurie Garrett, “The Next Pandemic?” *Foreign Affairs*, Vol. 84, No. 4 (July/August 2005), pp. 3–23; Michael T. Osterholm, “Unprepared for a Pandemic,” *Foreign Affairs*, Vol. 86, No. 2 (March/April 2007), pp. 47–57; and Andrew Burns, Dominique van der Mensbrugghe, and Hans Timmer, “Evaluating the Economic Consequences of Avian Influenza” (Washington, D.C.: World Bank, updated September 2008).

126. Christian Enemark, “Is Pandemic Flu a Security Threat?” *Survival*, Vol. 51, No. 1 (February–March 2009), pp. 191–214.

127. David M. Morens, Jeffrey K. Taubenberger, and Anthony S. Fauci, “The Persistent Legacy of the 1918 Influenza Virus,” *New England Journal of Medicine*, July 16, 2009, pp. 225–229.

128. Gerardo Chowell et al., “Severe Respiratory Disease Concurrent with the Circulation of H1N1 Influenza,” *New England Journal of Medicine*, August 13, 2009, pp. 674–679.

129. Margaret Chan, director-general, World Health Organization, “Concern Over Flu Pandemic Justified,” address to sixty-second World Health Assembly, May 18, 2009, http://www.who.int/dg/speeches/2009/62nd_assembly_address_20090518/en/index.html.

130. This section is based on Gregory D. Koblentz, “The Threat of Pandemic Influenza: Why Today Is Not 1918,” *World Medical and Health Policy*, Vol. 1, No. 1 (November 2009), pp. 71–84.

the broad adoption of measures to mitigate the impact of the disease. The WHO Global Influenza Surveillance Network, operating in ninety-seven countries, serves as a global alert mechanism for the emergence of influenza viruses with pandemic potential. WHO's Global Outbreak Alert and Response Network can call upon 140 institutions around the world to deploy multidisciplinary teams to investigate and respond to disease outbreaks of international public health importance. Third, there are also medical countermeasures such as vaccines, antivirals, and antibiotics that were not available in 1918. None of these is a "silver bullet," but together they hold significant potential for mitigating the consequences of an influenza pandemic. Finally, there is no global conflict such as World War I, which served as both incubator and vector for a highly virulent strain of influenza and as an impediment to the medical and public health responses to the pandemic. The overcrowded and unsanitary conditions characteristic of the trenches, barracks, and troop transports during World War I and the continuous infusion of new troops to replace those who were killed, injured, or ill created an environment that favored the emergence and spread of a highly virulent strain of influenza. In addition, national responses to the pandemic were hampered by the diversion of civilian health-care workers into the military and widespread censorship. The 1918 influenza pandemic is commonly known as "Spanish influenza" because Spain was neutral during the war and its press was one of only a few to openly report about the spread of the disease.

CELL 6: ENDEMIC AND EPIDEMIC DISEASES

Infectious diseases are a major cause of global morbidity and mortality. In 2004, of an estimated 58.7 million deaths worldwide, about 25 percent resulted from infectious diseases including respiratory infections, diarrheal diseases, neonatal infections, malaria, and tuberculosis.¹³¹ In addition to the direct effects on human health, these diseases have political and economic impacts. According to Yanzhong Huang, the Chinese authorities' botched response to the SARS outbreak caused the "most severe social-political crisis to the Chinese leadership since the 1989 Tiananmen crackdown."¹³² Price-Smith has argued persuasively that infectious diseases have a negative impact on state capacity. He has also hypothesized that the combination of relative deprivation and state weakness produced by, or exacerbated by, severe disease outbreaks can

131. In contrast, war and conflict accounted for only 0.3 percent of global deaths. World Health Organization, *The Global Burden of Disease: 2004 Update* (Geneva: WHO, 2008), pp. 72–74.

132. Yanzhong Huang, "The SARS Epidemic and Its Aftermath in China: A Political Perspective," in Stacey Knobler et al., eds., *Learning from SARS: Preparing for the Next Disease Outbreak* (Washington, D.C.: National Academies Press, 2004), p. 116.

generate instability and conflict.¹³³ This connection between endemic and epidemic diseases and conflict, however, remains unproven.¹³⁴ Instead, the impact of endemic and epidemic infectious diseases is borne primarily by individuals, communities, and societies and does not pose a direct threat to national or international security. Thus, these diseases are included in cell 6 of the taxonomy. This categorization places the study of these diseases and their impact within the domain of health security, which seeks to alleviate the burden of infectious and chronic diseases on populations.¹³⁵

The Future of Biosecurity

The future of biosecurity will depend in part on increasing coordination among national governments, international organizations, the private sector, and nongovernment organizations. Equally important will be greater information sharing, dialogue, and debate among the myriad of disciplines and professions that are necessary to develop and implement effective strategies to prevent and respond to natural and man-made biological threats. Achieving this level of cooperation requires a common framework for assessing the risks posed by biological threats and an understanding of the interconnectedness between these threats and the strategies put in place to counter them. The biosecurity taxonomy presented above raises several important implications for assessing the risks posed by biological threats and developing strategies to reduce them.

First, estimating the likelihood and consequences of most of these biological threats is extremely difficult. Aside from naturally occurring infectious diseases such as HIV/AIDS, these threats are rare. There are only a handful of cases of biological weapons being used by states, terrorists, or criminals; laboratory accidents that caused mass casualties; or influenza pandemics. Experts' understanding of why most of these events occurred is incomplete, as is our knowledge about what conditions or variables may contribute to a recurrence. When confronted with this level of uncertainty, many analysts fall back on labeling an uncertain but feared threat, such as bioterrorism or an influenza pandemic, as a "low probability, high consequence" threat.¹³⁶ This analytic crutch

133. Price-Smith, *The Health of Nations*, pp. 120–127.

134. Peterson, "Epidemic Disease and National Security"; and Price-Smith, *Contagion and Chaos*, p. 200.

135. Lincoln Chen and Vasant Narasimhan, "A Human Security Agenda for Global Health," in Chen, Leaning, and Narasimhan, *Global Health Challenges for Human Security*, pp. 3–12.

136. Richard A. Falkenrath, "Confronting Nuclear, Biological, and Chemical Terrorism," *Survival*, Vol. 40, No. 3 (Autumn 1998), pp. 43–65, at p. 44; and Garrett, "The Next Pandemic."

may be sufficient for flagging a new issue as an emerging threat, but it is not a sufficient long-term guide for research or policy. Although in many cases it is possible to quantify the potential consequences of an event, the reliability of many of these projections is open to doubt. Sanford Weiner has observed, “The greater the degree of uncertainty, the more room there is for spurious claims of expertise to be made, and for organizational and political agendas to dominate.”¹³⁷ Risk assessments that are not grounded in empirical data, do not present their methodology, and express a high degree of certainty about their conclusions should be considered suspect.

Second, properly assessing these risks requires a multidisciplinary approach.¹³⁸ Despite its limitations, a broad definition of biosecurity is valuable for providing a means for scholars, policymakers, and practitioners to bridge the gaps between the national security, life sciences, and public health communities. The biosecurity taxonomy presented in this article provides a framework for these different communities to discuss their assessments of different biological risks and exchange ideas on how best to prevent and respond to these risks.

Third, even if the likelihood and consequences of these risks could be measured reliably, the perception of risk will still play an important role in responding to the risk. Unfortunately, infectious diseases—whether spread by terrorists or by Mother Nature—represent a “dreaded” risk that evokes a disproportionate level of fear. Psychologists have found that individuals tend to be more fearful of “dreaded” risks that involve involuntary, indiscriminant, and invisible exposure; delayed or long-term effects; lack of understanding of the mechanism of harm; and difficulty predicting the number of people likely to be affected.¹³⁹ As a result, people tend to overestimate the frequency and severity of such risks and to overreact to them. This results in worst-case planning, which not only wastes resources but also distracts attention from other potential threats. While the global health community was focused on Asia, the H5N1 strain, and birds as the source of the next pandemic, insufficient attention was being paid to North America, H1N1, and swine—the actual source of the 2009 pandemic.¹⁴⁰

137. Sanford Weiner, *Projecting Pandemics* (Cambridge, Mass.: Center for International Studies, forthcoming).

138. Royal Society, *New Approaches to Biological Risk Assessments* (London: Royal Society, July 2009).

139. Jessica Stern, “Dreaded Risks and the Control of Biological Weapons,” *International Security*, Vol. 27, No. 3 (Winter 2002/03), pp. 89–123.

140. One indicator is that influenza genome sequence databases hold ten times as many sequences of avian influenza strains as swine influenza strains. Declan Butler, “Patchy Pig Monitoring May Hide Flu Threat,” *Nature*, June 18, 2009, p. 894.

Fourth, in light of this pervasive uncertainty, the optimal risk-reduction strategy is to emphasize policies that would have the greatest impact across the largest number or most likely threats. As David Fidler and Lawrence Gostin have pointed out, this “synergy thesis” is typically overstated.¹⁴¹ Achieving significant synergy is easier said than done, but it is nonetheless an important objective when conducting research and formulating policy. One of the most promising areas of investment that could have large and immediate payoffs for dealing with both man-made and natural biological threats is improving global disease surveillance capabilities. Enhancing national and international surveillance systems is crucial because early detection of disease outbreaks is the key to mitigating their consequences—regardless of whether the outbreak is intentional, accidental, or natural.¹⁴² Improving global disease surveillance is “triple imperative—as a means of fighting new emerging infectious disease, defending against the threat of biological terrorism and building effective, responsible States.”¹⁴³ The WHO’s 2005 International Health Regulations, which require states to develop core competencies in disease detection, represent an unprecedented opportunity to develop an integrated global disease surveillance system.¹⁴⁴

One way to encourage synergistic policies is to replace threat-specific responses with “all-hazard” strategies. In the laboratory context, the concept of biorisk management is a useful approach to integrating biosafety and biosecurity. Biorisk management uses a performance-based system management approach to assess risks, identify measures to reduce these risks, and develop processes to implement and review these risk-reduction measures.¹⁴⁵ Likewise, the concept of public health emergency preparedness, which encompasses defenses against bioterrorism as well as natural disasters and disease outbreaks, provides a sustainable model for improving the ability of the public health community to respond to extraordinary events, regardless of their cause.¹⁴⁶ If not formulated and implemented properly, however, such strategies can cause additional problems. In 2001 the U.S. military implemented a new biological surety program (also known as “biosurety”) for ensuring the physical security,

141. Fidler and Gostin, *Biosecurity in the Global Age*, pp. 147–188.

142. Institute of Medicine, *Global Infectious Disease Surveillance and Detection: Assessing the Challenges—Finding Solutions* (Washington, D.C.: National Academies Press, 2007).

143. United Nations, *A More Secure World*, p. 29.

144. Michael G. Baker and David P. Fidler, “Global Public Health Surveillance under New International Health Regulations,” *Emerging Infectious Diseases*, Vol. 12, No. 7 (July 2006), pp. 1058–1065.

145. World Health Organization, *Biorisk Management: Laboratory Biosecurity Guidance* (Geneva: WHO, 2006); and European Committee for Standardization (CEN), “Laboratory Biorisk Management Standard,” CEN Workshop Agreement 15793 (Brussels: CEN, 2008).

146. Christopher Nelson et al., “Conceptualizing and Defining Public Health Emergency Preparedness,” *American Journal of Public Health*, Vol. 97, No. S1 (April 2007), pp. S9–S11.

safety, personnel reliability, and agent accountability of its biological research programs.¹⁴⁷ The military's application of this concept, which was borrowed from its program to ensure the safety and security of its nuclear weapons, to biological research has been criticized for overlooking important differences between the nuclear and biological domains. For example, material control and accounting is far more difficult for small quantities of self-replicating organisms than for man-made nuclear materials that are stable, measurable, and can be detected remotely by sensors.¹⁴⁸ In addition, the use of the term "bio-surety" has raised objections, because the concept originated in the U.S. nuclear weapons program and might be interpreted as implying that the United States has a biological weapons program in violation of the BWC or that the goal of U.S. biologists is to develop biological weapons.¹⁴⁹

Fifth, the cross-cutting nature of these threats may result in policymakers knowingly or unknowingly making trade-offs among them. Because man-made, accidental, and natural biological threats have long been considered in isolation from one another, decisionmakers may be "more prone to choose remedies that substitute new risks for old ones in the same population, transfer risks to new populations, or transform risks by creating new risks in new populations."¹⁵⁰ As states establish or expand biological defense research programs and high biocontainment laboratories to combat bioterrorism, other states may perceive these activities as threatening, thereby providing a justification for initiating or continuing a BW program. The shift from threat-based to science-based defensive research exacerbates this security dilemma by increasing the scope of potential agents that require investigation and the necessity of inventing new agents to develop defenses against them.¹⁵¹ By dramatically increasing the number of facilities and researchers working with dangerous pathogens, the recent biodefense research boom has also increased the risk of biological crimes and biological terrorism. A similar relationship exists between increased levels of research on naturally occurring infectious diseases and a heightened risk of laboratory accidents.¹⁵² Although new laboratory biosecurity regulations were adopted in 2002, there has not been similar

147. Kathleen Carr et al., "Implementation of Biosurety Systems in a Department of Defense Medical Research Laboratory," *Biosecurity and Bioterrorism*, Vol. 2, No. 1 (January 2004), pp. 7–16.

148. *Ibid.*, pp. 10–11.

149. NSABB, "Enhancing Personnel Reliability among Individuals with Access to Select Agents," p. 4.

150. Stern, "Dreaded Risks and the Control of Biological Weapons," pp. 91–92.

151. Jonathan B. Tucker, "Biological Threat Assessment: Is the Cure Worse Than the Disease?" *Arms Control Today*, Vol. 34, No. 8 (October 2004), pp. 13–19.

152. Lynn C. Klotz and Edward J. Sylvester, *Breeding Bio Insecurity: How U.S. Biodefense Is Exporting Fear, Globalizing Risk, and Making Us All Less Secure* (Chicago: University of Chicago Press, 2009).

attention paid to tightening biosafety regulations.¹⁵³ Finally, supporters of the dramatic increase in biodefense funding after 2001 have also been accused of distorting research priorities too heavily toward biodefense pathogens at the expense of diseases that pose public health threats every day around the world.¹⁵⁴

A sixth implication is that the nonsecurity benefits of a well-designed biosecurity strategy create positive externalities that are not generated by other national security programs. This complicates efforts to prioritize the allocation of resources among different programs. For example, developing improved sensors to detect nuclear materials or enhancing the security of fissile material in Russia is crucial for preventing nuclear smuggling, but this is the only objective that these investments serve. In contrast, improving public health surveillance systems and the safety and security of public health laboratories in the former Soviet Union provides ongoing benefits to the nations in which these systems and laboratories are located by improving their ability to prevent, detect, and contain disease outbreaks.¹⁵⁵ As a result, well-designed biosecurity initiatives can simultaneously serve both security and humanitarian purposes.

A seventh implication is that there are both costs and benefits to linking public health and national security. In January 1999, at the unveiling of President Bill Clinton's 2000 budget to combat terrorism, Secretary of Health and Human Services Donna Shalala stated, "This is the first time in American history in which the public health system has been integrated directly into the national security system."¹⁵⁶ At the time, this statement was a gross exaggeration of the extent of collaboration between the public health and national security communities, but it captured the growing securitization of public health. Public health practitioners have warned that the securitization of public health to address bioterrorism would have a negative impact on the ability of the public health community to fulfill its core mission.¹⁵⁷ The downsides of the securitization of public health became evident in 2003, when the public health community was put in charge of implementing a large-scale smallpox immu-

153. U.S. General Accounting Office, *Homeland Security: CDC's Oversight of the Select Agent Program*, GAO-03-315R (Washington, D.C.: GAO, November 22, 2002); and GAO, *High-Containment Laboratories*.

154. Sydney Altman et al., "An Open Letter to Elias Zerhouni," *Science*, March 4, 2005, pp. 1409–1410.

155. National Research Council, *Biological Science and Biotechnology in Russia: Controlling Diseases and Enhancing Security* (Washington, D.C.: National Academies Press, 2005).

156. Office of the Press Secretary, "Press Briefing by Attorney General Reno, Secretary of HHS Donna Shalala, and Richard Clarke, President's National Coordinator for Security, Infrastructure, and Counterterrorism" (Washington, D.C.: White House, January 22, 1999).

157. Victor W. Sidel, "Bioterrorism in the United States: A Balanced Assessment of Risk and Response," *Medicine, Conflict, and Survival*, Vol. 19, No. 4 (October 2003), pp. 318–325.

nization program for public health and health-care workers. The program was motivated by national security concerns stemming from the imminent invasion of Iraq and not by public health assessments of the benefits and risks of the vaccine. As a result, instead of immunizing 500,000 civilians, fewer than 40,000 received the vaccine and the program was ignominiously suspended.¹⁵⁸

Invoking national security as the justification for preparing for natural and man-made biological threats is an increasingly common strategy for elevating the prominence of a threat and mobilizing additional resources to address it. The success of this strategy, however, depends on whether one is dealing with a self-fulfilling or a self-denying prophecy. The designation of HIV/AIDS as a threat to international security was probably an example of a self-denying prophecy. According to Peter Piot, executive director of UNAIDS, the UN Security Council's action transformed the international community's response to the disease "because many now view AIDS as a threat to national security and stability rather than to development and public health alone."¹⁵⁹ This transformation saw the establishment of several new international programs, including the Global Fund for AIDS, Tuberculosis, and Malaria; the World Bank's Global HIV/AIDS program; and the President's Emergency Plan for AIDS Relief. These new initiatives helped to fuel the growth in international spending on AIDS response in developing nations from \$1.5 billion in 2000 to \$10 billion in 2007.¹⁶⁰ According to UNAIDS, this sixfold increase in funding has begun to bear fruit, and for the first time, progress in combating HIV/AIDS is being witnessed.¹⁶¹

Milton Leitenberg argues that the elevation of biological terrorism as a major national security threat in the late 1990s was a self-fulfilling prophecy. The Clinton administration's public efforts to highlight the threat posed by biological weapons sent the message that these weapons were desirable and easily obtained, and that their use on the battlefield or by terrorists was inevitable. According to Leitenberg, "None of these possibilities was necessarily the most likely outcome, and the way in which one portrays them is in fact likely to affect what that outcome will be."¹⁶² Leitenberg points to a memo written by Ayman al-Zawahiri, second-in-command of al-Qaida, as evidence of the self-

158. Alina Baciú et al., eds., *The Smallpox Vaccination Program: Public Health in an Age of Terrorism* (Washington, D.C.: National Academies Press, 2005).

159. Peter Piot, executive director, Joint UN Program on HIV/AIDS, "Statement to the United Nations Security Council," New York, New York, July 18, 2005.

160. Joint UN Program on HIV/AIDS, "Financial Resources Required to Achieve Universal Access to HIV Prevention, Treatment, Care, and Support" (Geneva: UNAIDS, 2007), p. 4.

161. UNAIDS, *2008 Report on the Global AIDS Epidemic*, p. 15.

162. Milton Leitenberg, *The Problem of Biological Weapons* (Stockholm: Swedish National Defence College, 2004), p. 41.

fulfilling nature of the Clinton administration's bioterrorism rhetoric. In the memo, recovered by U.S. forces after the invasion of Afghanistan, Zawahiri complained to another al-Qaida operative that the organization had been slow in realizing the potential utility of biological weapons, noting that "despite their extreme danger, we only became aware of them when the enemy drew our attention to them by repeatedly expressing concern that they can be produced simply."¹⁶³ The Clinton administration's efforts to highlight the threat posed by biological weapons attracted not only the attention of foreign extremists, but domestic ones as well. Between January 1998 and April 2000, 172 false anthrax threats were made in the United States, with about one-third sent to abortion clinics.¹⁶⁴

There is also a possible link between the elevated biodefense efforts begun in the late 1990s and the 2001 anthrax letter attacks. According to the FBI, one of Ivins's motives for mailing the anthrax letters in 2001 was his frustration with the slow pace of anthrax vaccine development. By the fall of 2001, both anthrax vaccine programs that Ivins had been working on had virtually ground to a halt, and he was reportedly growing increasingly aggravated by these delays.¹⁶⁵ Although Ivins's suicide precludes a definitive understanding of what his motive was, it is possible that after the September 11 attacks he feared that the next terrorist attack would involve biological weapons that could cause even greater harm. Ivins may have intended the anthrax letters as a warning to the nation about the dangers posed by biological weapons and the need for stronger defenses against these weapons.

Conclusion

This article has argued that the risks posed by biological threats are growing. Furthermore, the trends driving these increased risks are largely outside the control of individual states or even the international community. Indeed, globalization and advances in the life sciences are encouraged at the national and international levels for the material benefits they bring. National governments and international organizations will continue to face increasingly difficult challenges in managing the risks generated by these trends.

The rise of biosecurity on the international security agenda has created new opportunities for research and analysis. This article suggests a number of areas

163. *Ibid.*, pp. 123–124.

164. Erica Goode, "Anthrax Hoaxes Hinder Effort to Cope with Real Threats," *New York Times*, October 15, 2001.

165. Dellafera, "Affidavit in Support of Search Warrant," pp. 2, 12–14.

that require further research to better inform policymaking to enhance biosecurity. The most common but least studied aspect of biological warfare is the use of these weapons against internal opponents. How do considerations of regime security affect a state's decision to develop and use biological weapons? How can the international community deter the use of biological weapons in internal conflicts? Answering these questions has particular urgency given the prediction that advances in the life sciences—if used for hostile purposes—create “unprecedented opportunities for violence, coercion, repression, or subjugation.”¹⁶⁶

One of the most striking puzzles in the bioterrorism literature is the extremely small number of cases of bioterrorism attacks, given the ease with which such attacks are said to be possible. This paradox suggests either that few groups lack the motive to conduct such attacks, or the capability for doing so is harder to develop than commonly assumed, or both. How important are intangible factors such as tacit knowledge, organization, and intragroup dynamics to the ability of terrorists to develop a biological weapon capable of causing mass casualties? How can terrorists and criminals be dissuaded and deterred from acquiring and using biological weapons?

There is broad agreement among experts on the need for increased oversight of dual-use research in the life sciences, but no consensus on the best strategy for attaining this goal. What does the emergence of other dual-use technologies and measures to prevent their use for illicit purposes tell us about how to achieve this objective for biotechnology? How can life scientists be empowered to promote a culture of responsibility and participate in the development of national and international dual-use research oversight mechanisms?

Although the foreign policy and security implications of infectious disease have begun to receive increased attention from governments, scholars, and analysts, there is a great deal of work left to be done at the nexus between health and security. Why are some diseases designated as a security threat and not others? What are the costs and benefits of framing health issues as security threats? What is the best way to measure the public health and security benefits of synergistic biosecurity policies?

The biosecurity taxonomy presented in this article represents a first step toward a unified approach to biosecurity. Moving from debate to action requires not only a common framework for assessing risk, but improved methodologies for doing so. How can one measure the likelihood and consequences of risks that have never or rarely occurred? In the context of risk management,

166. Matthew Meselson, “Averting the Hostile Exploitation of Biotechnology,” *CBW Conventions Bulletin*, No. 48 (June 2000), p. 16.

what is the best way to compare such rare risks with those that occur on a daily basis? How can one minimize the influence of cognitive biases on such assessments?

Answering these questions will not be easy, but doing so is vital for improving understanding of the full spectrum of biological threats and for developing strategies to enhance biosecurity.