Expert Knowledge in Intelligence Assessments

Bird Flu and Bioterrorism

Kathleen M. Vogel

In September 2011, scientists in the Netherlands announced new experimental findings that would not only threaten the conduct and publication of influenza research, but would have significant policy and intelligence implications. Ron Fouchier, an influenza virologist at the Erasmus Medical Center in Rotterdam, declared at the Fourth European Scientific Working Group on Influenza in Malta that his research group had created a modified variant of the H5N1 avian influenza virus (hereafter the H5N1 virus) that was transmissible via aerosol between ferrets. Until that point, the H5N1 virus, which can be lethal to humans, was known to be transmissible only through direct, physical contact with infected animals.[1]

Given that the World Health Organization has estimated that H5N1 infections in humans, although rare, have been nearly 60 percent fatal, Fouchier's findings suggested a worrisome possibility: the existence of a new, airborne-transmissible, highly lethal H5N1 virus that could cause a deadly global pandemic.[2] Reflecting on his findings, Fouchier concluded, "This is very bad news, indeed."[3] Within a month of Fouchier's announcement, a virologist at the University of Wisconsin, Yoshihiro Kawaoka, revealed that members of his

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1. World Health Organization, "FAQs: H5N1 Influenza," http://www.who.int/influenza/human_animal_interface/avian_influenza/h5n1_research/faqs/en/.
2. The first case of human infection with the H5N1 virus occurred in 1997 in Hong Kong. Eighteen people became ill, and six of them died. Hoping to stamp out the virus and prevent a pandemic, the Hong Kong government destroyed the country's entire poultry industry in just a few days. Since 1997, outbreaks of the H5N1 virus have occurred in other parts of Asia, Europe, and Africa. In these outbreaks, about 600 people have been infected; more than half of those infected (~60 percent) have died. See A. Amendola et al., "Is Avian Influenza Virus A(H5N1) a Real Threat to Human Health?" *Journal of Preventative Medicine and Hygiene*, Vol. 52 (2011), pp. 107–110. For a discussion of popular concerns about an H5N1 pandemic, see Jerry Adler, "The Fight against the Flu," *Newsweek*, October 30, 2005, p. 22.
3. "Scientists Provide Strong Evidence for Pandemic Threat," *Influenza Times*, http://www.eswiconference.org/Downloads/FEIC_news_1.aspx.

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laboratory had also created a different kind of mutated, air-transmissible H5N1 virus. Locked in a tight race for credit for their scientific discoveries, Fouchier and Kawaoka announced that they had submitted manuscripts to the journals *Nature* and *Science* for publication. Soon, government officials and the media were raising alarms about the wisdom of publishing such experimental methods and results in the open scientific literature. Their concerns sparked a large public controversy about these experiments and whether they should be published at all.

As news of Fouchier's and Kawaoka's experiments spread, U.S. intelligence analysts began assessing the potential security implications of their pending publication. They wrestled with questions such as: How much of a threat do scientific publications such as these pose for bioterrorism? Could a terrorist, criminal, or state easily replicate these experiments and create mutated viruses for bioweapons use? These questions are not necessarily new; the U.S. government has been worried about emerging bioweapons threats for decades.[4] The 2001 anthrax attacks and the pace and proliferation of developments in the life sciences, however, have brought new attention within the U.S. government to how intelligence analysts can stay abreast of cutting-edge science and its potential for misuse.[5] As the Barack Obama administration's 2009 *National*

4. For sources discussing historical bioweapons concerns in the United States, see Jeanne Guillemin, *Biological Weapons: The History of State-Sponsored Programs and Contemporary Bioterrorism* (New York: Columbia University Press, 2005); Susan Wright, "Terrorists and Biological Weapons: Forging the Linkage in the Clinton Administration," *Politics and the Life Sciences*, Vol. 25, Nos. 1–2 (March/September 2006), pp. 57–115; Milton Leitenberg, *Assessing the Biological Weapons and Bioterrorism Threat* (Carlisle Barracks, Pa.: Strategic Studies Institute, U.S. Army War College, 2005); and Greg D. Koblentz, *Living Weapons: Biological Warfare and International Security* (Ithaca, N.Y.: Cornell University Press, 2009).

5. National Security Council, *National Strategy for Countering Biological Threats*, November 2009, http://www.whitehouse.gov/sites/default/files/National_Strategy_for_Countering_BioThreats.pdf; Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, *Report to the President of the United States* (Washington, D.C.: Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, 2005), http://www.gpo.gov/fdsys/search/pagedetails.action?granuleId=&packageId=GPO-WMD&fromBrowse=true www.ise.gov/sites/default/files/wmdreport0.pdf; U.S. House of Representatives Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, Hearing on Bioscience and the Intelligence Community, 109th Cong., 1st and 2nd sess., November 3, 2005 and May 4, 2006, http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/pdf/CHRG-109hhrg35695.pdf; 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; James B. Petro, "Intelligence Support to the Life Science Community: Mitigating Threats from Bioterrorism," *Studies in Intelligence*, Vol. 48, No. 3 (2004), pp. 57–68, https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/vol48no3/article06.html; James B. Petro and David A. Relman, "Understanding Threats to Scientific Openness," *Science*, December 12, 2003, p. 1898; U.S. Central

Strategy for Countering Biological Threats emphasizes, "(1) the risk is evolving in unpredictable ways; (2) advances in the enabling technologies will continue to be globally available; and (3) the ability to exploit such advances will become increasingly accessible to those with ill intent as the barriers of technical expertise and monetary costs decline."[6] In recent years, several controversies have developed in the scientific and policymaking communities regarding threat assessments of emerging biotechnologies and dual-use research.[7] Publication of the Fouchier and Kawaoka H5N1 manuscripts is a recent (and recurrent) example of the ongoing challenges that intelligence analysts face in trying to keep pace with advances in the life sciences.

In contrast to most commentaries on the H5N1 publication controversy, the focus of this article is not on Fouchier or Kawaoka or on the U.S. policy officials and science advisers involved in the controversy. Instead, it examines how U.S. intelligence analysts, invisible in public accounts of the controversy, sought to assess the potential security threat posed by the publication of the H5N1 experiments. The study yields three important findings. First, U.S. intelligence analysts do not have adequate social and material resources to identify and evaluate the tacit knowledge, or know-how, that underpins dual-use experiments such as those in the H5N1 case. Second, they lack dedicated structures and methods to sort through the politics that characterize the use of technical expertise in such controversial biosecurity issues. Third, they require new types, structures, and assessments of expert knowledge to enable them to make more informed and balanced judgments of biosecurity threats.

Intelligence Agency, "The Darker Bioweapons Future," November 3, 2003, pp. 1–2, www.fas.org/irp/cia/product/bw1103.pdf; Gregory D. Koblentz, "Biosecurity Reconsidered: Calibrating Biological Threats and Responses," *International Security*, Vol. 34, No. 4 (Spring 2010), pp. 96–132; and Institute of Medicine and National Research Council, *Globalization, Biosecurity, and the Future of the Life Sciences* (Washington, D.C.: National Academies Press, 2006).

6. National Security Council, *National Strategy for Countering Biological Threats*, p. 2.

7. Dual-use research of concern is defined here as information or technologies that have the potential to both help and harm society. For examples of recent dual-use controversies, see 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; Ariella M. Rosengard et al., "Variola Virus Immune Evasion Design: Expression of a Highly Efficient Inhibitor of Human Complement," *Proceedings of the National Academy of Sciences*, June 25, 2002, pp. 8808–8813; Jeronomio Cello, Aniko V. Paul, and Eckhard Wimmer, "Chemical Synthesis of Poliovirus cDNA: Generation of Infectious Virus in the Absence of Natural Template," *Science*, August 9, 2002, pp. 1016–1018; Hamilton O. Smith et al., "Generating a Synthetic Genome by Whole Genome Assembly: phiX174 Bacteriophage from Synthetic Oligonucleotides," *Proceedings of the National Academy of Sciences*, December 23, 2003, pp. 15440–15445; and Terence M. Tumpey et al., "Characterization of the Reconstructed 1918 Spanish Influenza Pandemic Virus," *Science*, October 7, 2005, pp. 77–80.

In their assessments, intelligence analysts and policy practitioners concerned about biological weapons and dual-use biological threats have focused their attention and resources on the acquisition and use of technical expertise.[8] This focus, however, fails to take into account other important types of social science methods and knowledge that can be better used to evaluate important experimental factors such as tacit knowledge. Current intelligence and policy attention also fails to address other epistemic problems with the acquisition and use of expert knowledge. Few studies have devoted attention to examining this kind of knowledge at the micro level, and why explicating this knowledge is necessary to understanding the formulation of security threats and policymaking.[9] The current study aims to address this critical gap.

The article examines how analysts in one particular U.S. intelligence unit identified, drew on, and critiqued particular kinds of expertise to assess the potential security threat from the H5N1 experiments. In doing so, it explains how intelligence officials and policymakers can address problems associated with the use of such expertise to improve their analyses. In research for this article, I used a case study approach that employed different sets of ethnographic and empirical materials based on open source (i.e., unclassified) materials on the H5N1 controversy and interviews in the spring of 2012 with the unit's analysts involved in assessing the H5N1 experiments. Ethnography derives its analytic and empirical power from its ability to localize and contextualize, thus revealing the complex interconnections in relationships

8. For a recent discussion of this in the context of the H5N1 controversy, see National Research Council and Institute of Medicine, *Perspectives on Research with H5N1 Avian Influenza: Scientific Inquiry, Communication, Controversy: Summary of a Workshop* (Washington, D.C., National Academies Press, 2013), pp. 13–14. See also Kenneth Brill to the U.S. House of Representatives Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, Hearing on Bioscience and the Intelligence Community (Part II): Closing the Gap, 109th Cong., 2nd sess., May 4, 2006, http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/pdf/CHRG-109hhrg35695.pdf; James B. Petro, "Intelligence Support to the Life Science Community"; James B. Petro, and W. Seth Carus, "Biological Threat Characterization Research: A Critical Component of National Biodefense," *Biosecurity and Bioterrorism: Biodefense, Strategy, Practice, and Science*, Vol. 3, No. 4 (December 2005), pp. 295–308; David A. Relman to the U.S. House of Representatives Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, *Hearing on Bioscience and the Intelligence Community (Part II): Closing the Gap*, 109th Cong., 1st sess., November 3, 2005, http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/pdf/CHRG-109hhrg35695.pdf; and Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, *Report to the President of the United States*.

9. For a few studies that do have this focus, see T.V. Berling and C. Bueger, eds., *Capturing Security Expertise: Practice, Power, Responsibility* (Cambridge: Cambridge University Press, forthcoming). See also Benoît Pelopidas, "The Oracles of Proliferation: How Experts Maintain a Biased Historical Reading That Limits Policy Innovation," *Nonproliferation Review*, Vol. 18, No. 1 (March 2011), pp. 297–314.

and processes that yield a rich, in-depth understanding of the "why" and "how" of a particular case. It also highlights the important linkage between in-depth qualitative explanation and causation.[10] For my analysis, I drew on literature in constructivist security studies and science and technology studies (S&TS) that seeks to explain (1) the processes and practices involved in acquiring expertise in technical security issues and the ability to use it, (2) how experts contextualize security, and (3) the political and policy consequences that can result.[11]

I begin with an overview of the controversy surrounding publication of the findings of the Fouchier and Kawaoka H5N1 experiments and then describe how intelligence analysts assessed the potential security threat. Following this, I discuss how problems in the types and structure of expert knowledge and the practices of the experts involved in the H5N1 case became critical challenges for intelligence analysts in producing accurate assessments. I then offer several policy recommendations to help address these problems.

Overview of the H5N1 Virus Experiments and Controversy

With funding from the U.S. National Institutes of Health (NIH), independent teams under the leadership of Ron Fouchier and Yoshihiro Kawaoka created modified variants of the H5N1 virus that do not currently exist in nature.[12]

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10. For other examples of microlevel ethnographic analyses of biosecurity issues, see Sonia Ben Ouagrham-Gormley, "Barriers to Bioweapons: Intangible Obstacles to Proliferation," *International Security*, Vol. 36, No. 4 (Spring 2012), pp. 80–114; Brian Rappert, *Biotechnology, Security, and the Search for Limits: An Inquiry into Research and Methods* (New York: Palgrave McMillan, 2007); Filippa Lentzos, "Countering Misuse of Life Sciences through Regulatory Multiplicity," *Science and Public Policy*, Vol. 35, No. 1 (February 2008), pp. 55–64; Carlo Caduff, "The Semiotics of Security: On the Biopolitics of Informational Bodies in the United States," *Cultural Anthropology*, Vol. 27, No. 2 (May 2012), pp. 333–357; and Kathleen M. Vogel, *Phantom Menace or Looming Danger? A New Framework for Assessing Bioweapons Threats* (Baltimore, Md.: Johns Hopkins University Press, 2013).

11. For examples of relevant literature, see Barry Buzan, Jaap de Wilde, and Ole Waever, *Security: A New Framework for Analysis* (Boulder, Colo.: Lynne Rienner, 1998); Berling and Bueger, "Capturing Security Expertise"; Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge, Mass.: MIT Press, 1993); Trine Villumsen Berling and Christian Bueger, "Practical Reflexivity and Political Science: Strategies for Relating Scholarship and Political Practice," *PS: Political Science & Politics*, Vol. 46, No. 1 (January 2013), pp. 115–119; Donald MacKenzie, and Graham Spinardi, "Tacit Knowledge, Weapons Design, and the Uninvention of Nuclear Weapons," *American Journal of Sociology*, Vol. 101, No. 1 (July 1995), pp. 44–99; Rebecca Slayton, *Arguments That Count: Physics, Computing, and Missile Defense, 1949–2012* (Cambridge, Mass.: MIT Press, 2013); and Vogel, *Phantom Menace*.

12. The account in this section is not comprehensive, and readers are encouraged to consult other chronologies for additional details on the H5N1 controversy. For a more detailed chronology of the entire controversy, see Gaymon Bennett, "H5N1: Timeline of Select Episodes and their Sig-

Both teams conducted experiments to determine whether the H5N1 virus could achieve sustainable airborne transmission (via aerosol or respiratory droplet) in mammals. Despite using different experimental methodologies, both laboratories succeeded in creating novel, air-transmissible variants of the H5N1 virus in the summer of 2011.[13] In August 2011, Fouchier submitted a manuscript with his team's findings to the prestigious journal *Science*. The same month, Kawaoka sought publication of a manuscript detailing his laboratory's results in *Nature*.

In September 2011, Fouchier revealed his team's findings at the Fourth European Scientific Working Group on Influenza Conference in Malta. According to Fouchier, the team's mutated H5N1 virus was shown to be "airborne

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nificance," http://labs.fhcrc.org/cbf/H5N1TimelineofEventsandEpisodesv3.docx.pdf. See also see Gigi Kwik Gronvoll, "H5N1: A Case Study for Dual-Use Research" (New York: Council on Foreign Relations, July 2013), http://www.upmchealthsecurity.org/website/resources/publications/2013/pdf/2013-07-15-h5n1_dual-use_research.pdf; and Frank Grotton and Dana A. Shea, "Publishing Scientific Papers with Potential Security Risks: Issues for Congress," Congressional Research Service (March 18, 2013), http://www.fas.org/sgp/crs/secrecy/R42606.pdf.

13. In the Netherlands, Fouchier's team initially used the technique of site-directed mutagenesis to introduce three mutations into the H5N1 viral genome of a naturally occurring strain of the virus. Site-directed mutagenesis is a molecular biology technique in which a mutation is created at a specific, defined site in a piece of DNA. Fouchier's team inoculated the nasal cavities of laboratory ferrets with this mutated virus and the ferrets were subsequently monitored. When this approach failed to result in aerosol transmission of the mutated virus to uninfected ferrets in adjacent cages, Fouchier's team tried a follow-on set of experiments. They collected nasal secretions from each ferret infected with the mutated virus. Then, they inoculated the nasal cavities of a new set of ferrets with these infected nasal secretions. They repeated this procedure in different ferrets ten times. This repetition consisted of a virology technique called "passaging," which involves infecting an animal, such as a ferret, with a virus. The virus is allowed to incubate in the ferret. Then, secretions from the infected ferret are harvested and these secretions are used to infect another, healthy ferret. This process of passing the virus from one animal to another can continue indefinitely. This sequential passage of the virus between different animals is known to lead to natural mutations in the virus. After passaging, Fouchier's team isolated a newly modified H5N1 virus that had five significant mutations (consisting of the three mutations created by their original use of site-directed mutagenesis plus two additional mutations resulting from the repeated inoculation of this virus between ferrets). This mutated virus was shown to be transmitted via aerosol to uninfected ferrets. For more details, see Sander Herfst et al., "Airborne Transmission of Influenza A/H5N1 Virus between Ferrets," *Science*, June 22, 2012, pp. 1534–1541. In his laboratories in Madison, Wisconsin, and Tokyo, Japan, Kawaoka's research team created their laboratory-modified virus through an approach distinct from that of the Fouchier laboratory. Kawaoka's experimental work involved generation of a hybrid virus by using a mutated gene (consisting of four mutations) from an H5N1 viral strain and combining it with the remaining genes from a pandemic 2009 H1N1 influenza virus. Kawaoka's researchers then inoculated this hybrid, mutated virus into the nasal cavities of ferrets. These infected ferrets were then housed in cages next to uninfected ferrets; the cages were designed to prevent contact between the animals, but to allow the virus to spread through the air. Kawaoka's team showed that the mutated virus was able to spread between infected and uninfected ferrets via respiratory droplets. See Masaki Imai et al., "Experimental Adaptation of an Influenza H5HA Confers Respiratory Droplet Transmission to a Reassortant H5 HA/H1N1 Virus in Ferrets," *Nature*, June 21, 2012, pp. 420–428.

and as efficiently transmitted as the seasonal virus."[14] In a subsequent press interview, he stated, "This is a very dangerous virus."[15] Upon receiving copies of the Fouchier and Kawaoka manuscripts, NIH officials grew concerned about the security implications if the results were published and asked the National Science Advisory Board for Biosecurity (NSABB) to review both papers.[16] Throughout October 2011, a special NSABB subcommittee studied the manuscripts and spent hours in teleconference calls deciding how to proceed.[17]

On November 30, 2011, the NSABB made a formal recommendation about the manuscripts to the Department of Health and Human Services (HHS), the oversight authority for the NIH.[18] By unanimous vote, the NSABB recommended that "the [two papers'] general conclusions highlighting the novel outcome be published, but that the manuscripts not include the methodological and other details that could enable replication of the experiments by those who would seek to do harm."[19] This was the first time the NSABB had recommended restrictions on scientific publications in the life sciences.[20] Some of its

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14. "Scientists Provide Strong Evidence for Pandemic Threat," http://www.eswiconference.org/Downloads/FEIC_news_1.aspx/. No recording or transcript of Fouchier's Malta presentation is available. See also Nicole M. Bouvier, "The Science of Security versus the Security of Science," *Journal of Infectious Diseases*, June 1, 2012, pp. 1632–1635.

15. Quoted in Katherine Harmon, "What Really Happened in Malta This September When Contagious Bird Flu Was First Announced," *Scientific American* blog, September 30, 2011, http://blogs.scientificamerican.com/observations/2011/12/30/what-really-happened-in-malta-this-september-when-contagious-bird-flu-was-first-announced/. In late September, an article in *New Scientist*, a weekly science and technology news magazine, also first reported that Fouchier's modified H5N1 virus was lethal to the ferrets in the experiments. See Debora MacKenzie, "Five Easy Mutations to Make Bird Flu a Lethal Pandemic," *New Scientist*, September 26, 2011, http://www.newscientist.com/article/mg21128314.600-five-easy-mutations-to-make-bird-flu-a-lethal-pandemic.html.

16. The NSABB is an independent federal scientific committee that advises U.S. federal agencies on matters of biosecurity. The NSABB consists of appointed, voting members, as well as nonvoting, ex officio members from the U.S. government. See http://oba.od.nih.gov/biosecurity/about_nsabb.html.

17. Brendan Maher, "Bird-Flu Research: The Biosecurity Oversight," *Nature*, May 24, 2012, p. 431, http://www.nature.com/polopoly_fs/1.10695!/menu/main/topColumns/topLeftColumn/pdf/485431a.pdf; and Jon Cohen and David Malakoff, "On Second Thought, Flu Papers Get Go-Ahead," *Science*, April 6, 2012, p. 20, http://www.sciencemag.org/content/336/6077/19.full.pdf.

18. The NSABB released its recommendation to the public in December 2011. Kathy Wren, "Science: Editor-in-Chief Bruce Alberts on Publication of H5N1 Avian Influenza Research," December 20, 2011, http://www.aaas.org/news/releases/2011/media/1220herfst_statement.pdf. The NSABB has no legal authority to compel the NIH, journal editors, or scientists to comply with its recommendations.

19. U.S. Department of Health and Human Services, "Press Statement on the NSABB Review of H5N1 Research," *NIH News*, December 20, 2011, http://www.nih.gov/news/health/dec2011/od-20.htm. See also Kathy Wren, "Science."

20. Prior NSABB reviews of controversial scientific experiments had concluded with the NSABB's recommendation for full scientific publication. See Terence M. Tumpey et al., "Characterization of

members provided statements to media outlets explaining the recommendation.[21] As the number of reports on the experiments grew, so too did attention to the security and safety implications of the experimental findings.[22]

Critics of the experiments expressed concern over the supposed ease of making the mutated H5N1 viruses. Proponents argued for full disclosure

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the Reconstructed 1918 Spanish Influenza Pandemic Virus"; and Philip A. Sharp, "1918 Flu and Responsible Science," *Science*, October 7, 2005, p. 17.

21. Denise Grady and William J. Broad, "Seeing Terror Risk, U.S. Asks Journals to Cut Flu Study Facts," *New York Times*, December 20, 2011, http://www.nytimes.com/2011/12/21/health/fearing-terrorism-us-asks-journals-to-censor-articles-on-virus.html?pagewanted=all. See also Vincent R. Racaniello, "A Bad Day for Science," *Virology* blog, December 20, 2011, http://www.virology.ws/2011/12/20/a-bad-day-for-science/; and Heidi Ledford, "Call to Censor Flu Studies Draws Fire," *Nature*, January 3, 2012, pp. 9–10, http://www.nature.com/polopoly_fs/1.9729!/menu/main/topColumns/topLeftColumn/pdf/481009a.pdf; Paul S. Keim, "Q&A: Reasons for Proposed Redaction of Flu Paper," *Nature*, February 9, 2012, p. 156, http://www.nature.com/nature/journal/vaop/ncurrent/pdf/482156a.pdf; Michael T. Osterholm and Donald A. Henderson, "Life Sciences at Crossroads: Respiratory Transmissible H5N1," *Science* Express, January 19, 2012, pp. 801–802, http://www.sciencemag.org/content/335/6070/801.full.pdf; Ron A.M. Fouchier, Sander Herfst, and Albert D.M.E. Osterhaus, "Restricted Data on Influenza H5N1 Virus Transmission," *Science* Express, January 19, 2012, http://www.sciencemag.org/content/335/6069/662.full.pdf; Ron A.M. Fouchier et al., "Pause on Avian Flu Transmission Research," *Science* Express, January 27, 2012, pp. 400–401, http://www.sciencemag.org/site/feature/data/hottopics/biosecurity/Fouchier.Express.pdf; Martin Enserink, "Flu Researcher Ron Fouchier: 'It's a Pity That It Has to Come to This,'" *ScienceInsider*, January 20, 2012, http://news.sciencemag.org/scienceinsider/2012/01/flu-researcher-ron-fouchier-its.html; Yoshihiro Kawaoka, "H5N1: Flu Transmission Work Is Urgent," *Nature*, February 9, 2012, p. 155, http://www.nature.com/nature/journal/vaop/ncurrent/pdf/nature10884.pdf; and Donald G. McNeil, Jr., "Scientist Plays Down Danger of Flu Strain," *New York Times*, January 25, 2012, http://www.nytimes.com/2012/01/26/health/wisconsin-scientist-says-h5n1-flu-strain-he-created-is-less-dangerous.html.

22. Debora MacKenzie, "Bioterror Fears Could Block Crucial Flu Research," *New Scientist*, November 21, 2011, http://www.newscientist.com/article/dn21195-bioterror-fears-could-block-crucial-flu-research.html; Martin Enserink, "Scientists Brace for Media Storm," *ScienceInsider*, November 23, 2011, http://news.sciencemag.org/2011/11/scientists-brace-media-storm-around-controversial-flu-studies; Laurie Garrett, "The Bioterrorist Next Door," *Foreign Policy*, December 15, 2011, http://www.foreignpolicy.com/articles/2011/12/14/the_bioterrorist_next_door; Thomas V. Inglsby, Anita Cicero, and D.A. Henderson, "The Risk of Engineering a Highly Transmissible H5N1 Virus," *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, December 15, 2011, http://www.upmc-biosecurity.org/website/resources/publications/2011/2011-12-15-editorial-engineering-H5N1; Martin Enserink, "Controversial Studies Give a Deadly Flu Virus Wings," *Science*, December 2, 2011, pp. 1192–1193; "'Too Late' to Contain Research into Deadly Bird Flu Strain, Warn Scientists," *Telegraph*, December 22, 2011, http://www.telegraph.co.uk/science/science-news/8972226/Too-late-to-contain-research-into-deadly-bird-flu-strain-warn-scientists.html; Declan Butler, "Fears Grow over Lab-Bred Flu," *Nature*, December 20, 2011, pp. 421–422, http://www.nature.com/polopoly_fs/1.9692!/menu/main/topColumns/topLeftColumn/pdf/480421a.pdf; William J. Broad, "Science and Censorship: A Duel Lasting Centuries," *New York Times*, December 26, 2011, http://www.nytimes.com/2011/12/27/science/science-and-censorship-a-duel-lasting-centuries.html?pagewanted=all; Heidi Ledford, "Call to Censor Flu Studies Draws Fire"; Laurie Garrett, "Flu Season," *Foreign Policy*, January 5, 2012, http://www.foreignpolicy.com/articles/2012/01/05/flu_season; "An Engineered Doomsday," editorial, *New York Times*, January 7, 2012, http://www.nytimes.com/2012/01/08/opinion/sunday/an-

of the experiments' details in an effort to promote more beneficial, public health research on the virus. Other scientific and biosecurity experts raised questions and offered critiques about how to interpret and extrapolate the Fouchier and Kawaoka data.

In January 2012, a prominent group of virologists wrote to the NSABB asking it to reconsider its recommendation.[23] In response, the board published a further explanation and defense of its recommendation in *Science* and *Nature*,[24] emphasizing that its primary reason for redaction was that "publishing these experiments in detail would provide information to some person, organization, or government that would help them develop similar mammal-adapted influenza A/H5N1 viruses for harmful purposes."[25] Media reports and a variety of publications covered the growing debate among virology experts about the potential dangers posed by the H5N1 experiments.[26]

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engineered-doomsday.html; Peter Palese, "Don't Censor Life-Saving Science," *Nature*, January 11, 2012, p. 115, http://www.nature.com/polopoly_fs/1.9777!/import/pdf/481115a.pdf; Vincent R. Racaniello, "Science Should Be in the Public Domain," *mBio*, Vol. 3, No. 1 (January/February 2012), pp. 1–2, http://mbio.asm.org/content/3/1/e00004-12.full.pdf+html; Peter Palese and Taia T. Wang, "H5N1 Influenza Viruses: Facts, Not Fear," *Proceedings of the National Academy of Sciences*, January 25, 2012, pp. 1–3, http://www.pnas.org/content/early/2012/01/24/1121297109.full.pdf; Andrew T. Pavia, "Laboratory Creation of a Highly Transmissible H5N1 Influenza Virus: Balancing Substantial Risks and Real Benefits," *Annals of Internal Medicine*, March 20, 2012, http://annals.org/article.aspx ?articleid=1090737; Robert G. Webster, "Mammalian-Transmissible H5N1 Influenza: The Dilemma of Dual-Use Research," *mBio*, Vol. 3, No. 1 (January/February 2012), pp. 1–2, http://mbio .asm.org/content/3/1/e00005-12.full.pdf+html; Thomas V. Inglesby, "Engineered H5N1: A Rare Time for Restraint in Science," *Annals of Internal Medicine*, March 20, 2012, pp. 460–462, http://annals.org/article.aspx?articleid=1090738; Fouchier, Herfst, and Osterhaus, "Restricted Data on Influenza H5N1 Virus Transmission"; Jeffrey Kofman, "Researchers Pause Work on Bird Flu That Could Kill Hundreds of Millions," *ABC News*, January 20, 2012, http://abcnews.go.com/Health/inside%20lab%20scientists%20created%20deadly%20bird%20flu%20virus/story?id=15371697; and Kawaoka, "H5N1: Flu Transmission Work Is Urgent," p. 10884.

23. David Malakoff, "Prominent Virologists Want U.S. Advisory Board to Take a Second Look at Controversial Flu Papers," *ScienceInsider*, January 20, 2012, http://news.sciencemag.org/scienceinsider/2012/01/prominent-virologists-want-us.html.

24. Kenneth I. Berns et al., "Adaptations of Avian Flu Virus Are a Cause for Concern," *Science*, February 10, 2012, pp. 660–661, http://www.sciencemag.org/content/335/6069/660.figures-only; and Kenneth I. Berns et al., "Policy: Adaptations of Avian Flu Virus Are a Cause for Concern," *Nature*, February 9, 2012, http://www.nature.com/nature/journal/v482/n7384/full/482153a.html.

25. Berns et al., "Policy: Adaptations of Avian Flu Virus Are a Cause for Concern," p. 154.

26. Declan Butler, "Death-Rate Row Blurs Mutant Flu Debate," *Nature*, February 13, 2012, p. 289, http://www.nature.com/polopoly_fs/1.10022!/menu/main/topColumns/topLeftColumn/pdf/482289a.pdf; Lisa Schnirring, "Debate on H5N1 Death Rate and Missed Cases Continues," Center for Infectious Disease Research and Policy, February 24, 2012, http://www.cidrap.umn.edu/cidrap/content/influenza/panflu/news/feb2412seroprev.html. Fouchier and his colleagues also published additional commentary explaining and justifying the experiments and the need for full publication of the work. See Fouchier, Herfst, and Osterhaus, "Restricted Data on Influenza H5N1 Virus Transmission." Scientific experts' debate over the case fatality rate predated the Fouchier

In mid-February 2012, the World Health Organization (WHO) convened a technical consultation on the Fouchier and Kawaoka H5N1 experiments. At the meeting, Fouchier and Kawaoka presented new data related to the manuscripts, with Fouchier clarifying data from his team's original submission. Many of the twenty-two experts at the meeting argued that the H5N1 papers should be published in full. The WHO, however, reached consensus that a temporary moratorium be placed on the research and that publication be delayed to more fully address public concerns.[27] NIH Director Anthony Fauci and other members of the WHO group recommended that Fouchier and Kawaoka revise their manuscripts to include the new details provided at the WHO meeting and submit their revisions to the NSABB for a second security review.

On February 29, the American Society for Microbiology sponsored a panel discussion in Washington, D.C., on the H5N1 controversy. Fouchier presented an overview of his experiments that differed significantly from past accounts. He stated that his team's mutated virus was not lethal when inhaled by ferrets and would not spread "like wildfire" through the air; in fact, such transmission would not be easy.[28] He also said that most of the ferrets that had contracted the virus via aerosol transmission had hardly become sick, and none had died. He clarified, however, that the mutated virus did cause disease when injected in very high concentrations into the lower respiratory tract of

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and Kawaoka papers. In 2006, *Nature* published an article that argued that the WHO 59 percent lethality rate did not take into account undetected human cases or asymptomatic infections. See Declan Butler, "Yes, But Will it Jump?" *Nature*, January 12, 2006, pp. 124–125. Other articles published in 2011 discussed the low seroprevalence rate of H5N1 infection in humans. See B.P. Khuntirat et al., "Evidence for Subclinical Avian Influenza Virus Infections among Rural Thai Villagers," *Clinical Infectious Diseases*, Vol. 53, No. 8 (October 2011), pp. 107–116; M.D Van Kerkhove et al., "Highly Pathogenic Avian Influenza (H5N1): Pathways of Exposure at the Animal/Human Interface, a Systematic Review," *PLoS One*, Vol. 6, No. 1 (January 2011), pp. 1–8; Jon Cohen, "The Limits of Avian Flu Studies in Ferrets," *Science*, February 3, 2012, p. 512, http://www.sciencemag.org/content/335/6068/512.full.pdf; Palese and Wang, "H5N1 Influenza Viruses"; and Jon Cohen and David Malakoff, "NSABB Members React to Request for Second Look at H5N1 Flu Studies," *ScienceInsider*, March 2, 2012, http://news.sciencemag.org/scienceinsider/2012/03/nsabb-members-react-to-request.html.

27. World Health Organization, "Technical Consultation on H5N1 Research Issues—Consensus Points," February 16–17, 2012, http://www.who.int/influenza/human_animal_interface/consensus_points/en/index.html; and World Health Organization, "Public Health, Influenza Experts Agree H5N1 Research Critical but Extend Delay," February 17, 2012, http://www.who.int/mediacentre/news/releases/2012/h5n1_research_20120217/en/index.html.

28. "Discussion of NSABB's Publication Recommendations for the NIH-Funded Research on the Transmissibility of H5N1," American Society for Microbiology Biodefense and Emerging Diseases Research meeting, Washington, D.C., February 29, 2012, http://mediasuite.multicastmedia.com/player.php?p=rxmwj814.

ferrets. In addition, he indicated having written a revised manuscript further describing these results.

In early March 2012, the NIH asked the NSABB to read the revised versions of the Fouchier and Kawaoka manuscripts.[29] The request surprised some of its members, who then made statements to the press about their continued concern over the experiments' results.[30] NSABB member Michael Imperiale voiced concern that "what Ron [Fouchier] is saying now is not what was in the [original] paper. We were led to believe by the paper that aerosol transmission is also lethal."[31] Imperiale also stated that he was surprised to hear that the mutated virus did not spread between ferrets via aerosol as readily as seasonal flu strains. Also in March, NSABB members Michael Osterholm and David Relman published an online scientific paper reiterating their view that concerns over dual use should prevent full publication of the experiments.[32] Other published scientific papers, however, used technical arguments to dispute these assertions.[33]

On March 29, the NSABB convened to examine the revised Fouchier and Kawaoka papers and to question Fouchier and Kawaoka in person.[34] It also

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29. Cohen and Malakoff, "NSABB Members React to Request for Second Look at H5N1 Flu Studies."

30. Ibid. NSABB members David Relman and Arturo Casedevall emphasized that the ability to transmit the mutated virus by aerosol was their key security concern. NSABB member Susan Ehrlich emphasized the extension of the host range of the mutated virus (from birds to ferrets) as being of primary concern. NSABB members Stanley Lemon, Lynn Enquist, and Michael Osterholm also emphasized both of these concerns in their public statements.

31. Quoted in ibid.

32. Michael T. Osterholm and David A. Relman, "Creating a Mammalian Transmissible A/H5N1 Influenza Virus: Social Contracts, Prudence, and Alternative Perspectives," *Journal of Infectious Diseases*, June 1, 2012, pp. 1636–1638, http://jid.oxfordjournals.org/content/early/2012/03/22/infdis.jis259.abstract. In the same journal, Fouchier and colleagues published a paper arguing against Osterholm and Relman. In March 2012, Osterholm and a University of Minnesota colleague subsequently published a paper in which they argued that the existing scientific data supported the high WHO case fatality rate for H5N1 infection in humans, and that existing medical treatments for H5N1 infection were not likely sufficient or effective against a mutated H5N1 virus or in the event of a pandemic.

33. Lisa N. Murillo, "Ferret-Transmissible Influenza A (H5N1) Virus: Let Us Err on the Side of Caution," *mBio*, Vol. 3, No. 2, (March/April 2012), pp. 1–3, http://mbio.asm.org/content/3/2/e00037-12.full.pdf+html. Peter Palese and colleagues published a paper outlining the case for mild or subclinical infections of H5N1, based on serological evidence of H5N1 infections in humans reported previously in the scientific literature. They argued that this evidence indicated that mild or asymptomatic cases of H5N1 infection were not being taken into account in the WHO fatality rates. See Taia T. Wang, Michael K. Parides, and Peter Palese, "Seroevidence for H5N1 Influenza Infections in Humans: Meta-Analysis," *Science*, March 23, 2012, p. 1463, https://www.sciencemag.org/content/335/6075/1463.full.

34. National Science Advisory Board for Biosecurity, "Meeting of the National Science Advisory Board for Biosecurity to Review Revised Manuscripts on Transmissibility of A/H5N1 Influenza

received a classified briefing from U.S. intelligence officials, as well as information from the international public health and research community about the risks and benefits of the Fouchier and Kawaoka research. At the end of the meeting, the NSABB unanimously recommended publication of Kawaoka's revised paper, with full details of his laboratory's experiments. In contrast, only a two-thirds majority recommended publication of all of the data, methods, and conclusions contained in the revised Fouchier paper. The one-third who disagreed remained concerned about the potential security threat posed by full publication.

In making its recommendations, the NSABB stated that it supported open publication of scientific research unless that information "could be directly misused to pose a significant and immediate risk to public health and safety."[35] The board explained that "the data described in the revised manuscripts do not appear to provide information that would immediately enable misuse of the research in ways that would endanger public health or national security."[36] In a press interview, NSABB Chair Paul Keim stated that the revised manuscripts clarified that the experiments were not as dangerous as they originally appeared and that the benefits of the research were greater than any possible security threat.[37] He further explained that the new recommendations were not a reversal, because the revised manuscripts were very different from the originals. "Had these [later] versions been presented originally," said Keim, "the board would not have recommended withholding any details."[38]

In April 2012, NSABB members continued to speak to the media about the board's latest recommendations. In describing the differences between the original and revised papers, board member Lynn Enquist stated that "the original papers were typical *Science* and *Nature* papers: very brief, short on detailed discussion, little to no information on biosafety/biosecurity/mitigation, and perhaps even a little sensational."[39] Some board members, however, remained concerned about publication of the Fouchier paper. Regarding the

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Virus," Washington, D.C., March 29–30, 2012, http://oba.od.nih.gov/oba/biosecurity/PDF/NSABB_Statement_March_2012_Meeting.pdf.

35. Ibid.

36. Ibid.

37. Denise Grady, "Panel Says Flu Research Is Safe to Publish," *New York Times*, March 30, 2012, http://www.nytimes.com/2012/03/31/health/h5n1-bird-flu-research-is-safe-to-publish-panel-says.html.

38. Quoted in ibid. The board also said that its deliberations were guided by the newly released "United States Government Policy for Oversight of Life Sciences Dual Use Research of Concern," March 29, 2012, http://oba.od.nih.gov/oba/biosecurity/PDF/United_States_Government_Policy_for_Oversight_of_DURC_FINAL_version_032812.pdf.

39. Quoted in Cohen and Malakoff, "On Second Thought, Flu Papers Get Go-Ahead," p. 19.

original manuscript, Relman noted that "data Ron Fouchier presented to us were confusing, contradictory, and poorly done."[40] He also commented that he did not find Fouchier's new revision reassuring: "There were no new data that for me diminished the evidence for mammal-to-mammal transmissibility and no data that convinced me that the virulence was any less in his mutant viruses than it was in the wild-type parental H5N1 strains."[41]

Also in April 2012, Osterholm submitted a letter to Amy Patterson, then associate director for science policy at the NIH Office of Science Policy and at the time responsible for providing NIH administrative oversight to the NSABB. In his letter, which was leaked to *Science* and *Nature*, Osterholm criticized the March 2012 NSABB recommendations, arguing that the revised Fouchier manuscript should have been redacted. He noted that members at the March meeting did not fully discuss the continued risks from the Fouchier experiments and that the board did not invite "disinterested subject matter experts" who could discuss these risks and provide additional technical advice. Osterholm claimed that invitees to the March meeting (as well as to the February 2012 WHO meeting) had a conflict of interest, because they were influenza virologists doing work similar to that of the Fouchier and Kawaoka laboratories. They therefore had a personal and professional stake in promoting publication of the papers. In drawing on expertise from his own network of influenza specialists with a different perspective on the risks of mutated H5N1 strains, Osterholm argued that data in the revised manuscripts were "immediately and directly enabling" for terrorism and a "pretty complete cookbook" for causing harm.[42]

On May 2, 2012, *Nature* published the Kawaoka H5N1 paper.[43] In comments, the journal's editor, Philip Campbell, critiqued the NSABB's evaluation of the manuscript, stating that "[t]he process was too closed. People were having conversations only by phone and there was insufficient consultation of the researchers and other experts."[44] On June 22 of the same year, Fouchier's paper was published in *Science*.

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40. Quoted in ibid., p. 20.
41. Quoted in Maher, "Bird Flu Research," p. 434.
42. Letter from Michael T. Osterholm, director of the Center for Infectious Disease Research and Policy, to Amy P. Patterson, associate director for science policy, National Institutes of Health, April 12, 2012, http://labs.fhcrc.org/cbf/Papers/H5N1_docs/Osterholm_Letter_April_2012.pdf.
43. Imai et al., "Experimental Adaptation of an Influenza H5 HA Confers Respiratory Droplet Transmission to a Reassortant H5 HA/H1N1 Virus in Ferrets."
44. Quoted in Pallab Ghosh, "H5N1 Research Censorship 'Problematic,'" BBC News, May 2, 2012, http://www.bbc.co.uk/news/health-17914706.

An Intelligence Analytic Unit Working amid the Controversy

From the beginning, U.S. intelligence analysts had followed the H5N1 controversy. One particular intelligence unit began focusing on the H5N1 experiments in November 2011.[45] Among the members of this unit whom I interviewed for this article were a senior analyst with a Ph.D. and extensive intelligence experience in bioweapons issues, as well as four junior analysts, all holders of bachelor's and master's degrees in the life sciences but with limited bioweapons intelligence expertise. At the time, the unit's interest in the controversy centered on the emerging policy and press attention swirling around the Fouchier and Kawaoka experimental findings; the analysts were also aware that the NSABB was conducting a review of the manuscripts.[46] In addition, they were seeking to respond to inquiries about the H5N1 research from their managers, who had been following the press and policy interest in the case. The possibility that Fouchier's and Kawaoka's research posed a possible security threat provided "a good national security hook" for intelligence reporting.[47] As one interviewee explained, intelligence analysts are driven to produce assessments of possible threats for their customers, especially in the event of a perceived threat to U.S. persons or interests.[48]

In their assessments, these analysts sought answers to a series of critical questions about the Fouchier and Kawaoka experiments, among them: Would publication of the manuscripts pose a security threat? Who could use the papers' findings to inflict harm? What kinds of skills and expertise would they need? Could the experiments be conducted in a rudimentary facility or would an insider with substantial resources be required? Although the analysts were used to fielding these kinds of questions for other types of bioweapons threats, the H5N1 case was unique in that the mechanism and information sources for this assessment did not draw on traditional clandestine means (e.g., classified

45. In this article, I have obscured the details of this particular analytic unit to protect the identities of those interviewed; all of my interviewees requested anonymity. My decision to focus on the H5N1 case in interviews with these analysts emerged from a broader discussion I had with them a month earlier about incorporating science and technology studies literature into methodologies of intelligence analysis. In this discussion, the analysts proposed that it would be interesting to consider the H5N1 case, because they were currently working to assess that case and believed they would benefit from outside perspectives. I conducted five separate in-person interviews (consisting of individual and group interviews), as well as email follow-ups during the spring and summer of 2012. The interviews were open-ended.

46. This is a normal response for intelligence analysts who produce daily intelligence reports. For a discussion of this, see Vogel, *Phantom Menace*, pp. 183–215.

47. Interview with U.S. intelligence analyst, Washington, D.C., June 14, 2012.

48. Email communication with U.S. intelligence analyst, July 3, 2012.

systems, spies, and foreign intelligence). Instead, the H5N1 experiments were unclassified, and the work was conducted within the open U.S. and international scientific community, not in classified defense laboratories or covert facilities. Also, the analysts did not have specific classified threat information about an adversary who had explicitly stated an interest in using these H5N1 experimental findings to inflict harm. Instead, they had to consider the hypothetical misuse of these findings by an unknown actor.

The analysts relied exclusively on open source information, gathering information about the experiments from scientific society meetings, blogs, newspapers, journal publications, discussions with experts, official government press releases, the NSABB, and other scientific outlets—essentially, information that any other government or nongovernment analyst might use. Their unclassified assessments were not made public, however, and their managers maintained some control over their access and distribution. These analysts never had access to, and were never asked to review, the Fouchier or Kawaoka manuscripts prior to publication, although they nonetheless had to make judgments about the controversy.[49]

During the fall of 2011, the analysts concluded that the H5N1 experiments were not a likely state-level bioweapons threat: no present or past indication of intentional use of influenza as a weapon by a state existed; in addition, the influenza virus is too unstable, unpredictable, and uncontrollable to be useful as a weapon.[50] One analyst noted that some informal discussions of the controversy had occurred across the interagency intelligence community. Most intelligence agencies and units at the time, however, had no interest in the controversy, having largely categorized it a public health issue. Traditionally, these agencies devote their attention and resources to assessing bioweapons threats that have immediacy, coming from known states, terrorists, or criminal groups. Because no state or nonstate actors had used or possessed influenza as a weapon, the U.S. intelligence community gave low priority to evaluating the H5N1 experiments during the fall of 2011 and spring of 2012.[51] As one interviewee explained, "The [intelligence] community is driven by [intelligence] reporting. If there is no reporting, then no resources are devoted to that."[52] Another commented, however, that because his boss was an "interested cus-

49. One of these analysts also indicated that s/he did not think that other analysts within the U.S. intelligence community had copies of these manuscripts either, or they possessed only "bootlegged" copies not given to those analysts for official review and assessment.
50. Interview with U.S. intelligence analyst, Washington, D.C., June 14, 2012.
51. Ibid.
52. Ibid.

tomer" for information on the controversy, his unit followed it on a daily basis.[53] According to these analysts, an unofficial consensus began to form within the intelligence community in the fall of 2011 that the H5N1 experiments were not likely to pose a serious bioweapons threat. Surprisingly, my interviewees revealed that, as far as they knew, neither the NSABB nor any other U.S. government entity had requested intelligence consultations on the H5N1 experiments in their fall 2011 deliberations on the manuscripts.[54]

In addition to the behind-the-scenes activity in the U.S. intelligence community, there were U.S. interagency policy discussions about the H5N1 controversy. The discussions, which occurred before the NSABB had made public its initial recommendation, yielded several questions, including: Were the experiments valid? Could they be replicated? Under what conditions were they conducted? For years, similar experiments had failed, so how might this affect the ease of replication? Are ferrets reliable as animal models? What was the method of their exposure to the virus? Policy officials present at these discussions stated that they needed more details on how the experiments were conducted before they could answer these questions. Similar to my interviewees, none of these policy officials claimed to have had access to the Fouchier or Kawaoka manuscripts.[55] It appears, therefore, that both manuscripts were tightly held by the NSABB.

When the NSABB made public its recommendations about the manuscripts, my intelligence interviewees took them "seriously," although they remained unconvinced about the manuscripts' supposed security threat.[56] Regarding the February 2012 American Society for Microbiology meeting, when Fouchier seemed to backtrack from his earlier statements about the danger of his work, my interviewees found his comments "surprising."[57] At the same time, they were hearing from some academic scientific experts that Fouchier did not have a good academic lineage or reputation.[58] These analysts were aware, however, that because scientists can engage in "trash talk" and gossip about one another, they needed to evaluate and filter what was being said about Fouchier.

53. Ibid.
54. Another anonymous U.S. government informant with whom I communicated also related that s/he "didn't hear anything about their [the intelligence community's] role in any of the NSABB deliberations," although "the IC gave a classified brief to the NSABB at the Spring 2012 meeting." Email communication with U.S. government official, June 12, 2013.
55. Interview with U.S. intelligence analyst, Washington, D.C., June 14, 2012.
56. Ibid.
57. Ibid.
58. Ibid.

The NSABB's credibility among my interviewees and their superiors was already strained when the board issued its revised recommendations to publish the papers in full. In a briefing about the decision, one analyst said that his boss had asked, "OK, so who's lying?"[59] As a result of this controversy and how it played out within the NSABB, one lesson learned among these analysts is that "it may be harder to convince people around the table next time that something is a threat."[60] Therefore, although the NSABB was established as a federal advisory committee to provide independent advice, guidance, and leadership regarding biosecurity oversight of potentially harmful research, my interviewees found its expert judgments lacking, if not suspect, as the H5N1 controversy unfolded.

Identifying, Acquiring, and Using Expert Knowledge

This section examines why U.S. intelligence analysts do not have adequate social and material resources to identify and evaluate the tacit knowledge, or know-how, that underpins dual-use experiments such as those in the H5N1 case. I learned from my interviews that (1) there were limits on the kinds of experts whom they could consult; and (2) they lacked dedicated structures and methods to navigate the politics associated with consulting technical experts involved with biosecurity issues.

Assessing Tacit Knowledge in Scientific Work

In assessing the potential security threat from the H5N1 experiments, my interviewees had to evaluate the ease with which an individual, group, or state could take information from the Fouchier and Kawaoka manuscripts and replicate it to produce the mutated H5N1 viruses. In essence, they had to assess the role of tacit versus explicit knowledge in scientific work. Tacit knowledge is not written down, but transmitted by word of mouth, observation, and/or hands-on training by scientists working in a laboratory.[61] In the H5N1 case, this might have involved skills such as how the Fouchier or Kawaoka teams handled ferrets for their inoculations or how they used or adapted different molecular biology techniques to produce mutations in the virus.

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59. Ibid.
60. Ibid.
61. In contrast, explicit scientific knowledge consists of information that can be reduced to a written form, such as a list of materials used for an experiment or the sequential steps of an experiment found in laboratory notebooks or journal articles.

One analyst noted that several scientific experts (including those at the NSABB) had dismissed the importance of tacit knowledge in the emerging life sciences and in the H5N1 experiments, in particular. To these scientific experts, the growing ease and diffusion of biotechnology facilitated acquisition of the laboratory skills behind the experiments. In discussions with one such expert, an analyst recounted, "X [name removed for anonymity] said it is so easy that a child could do this. He is unwilling to entertain a role for tacit knowledge. He said that even though the [first Fouchier and Kawaoka] manuscripts were not made public, just the vague hints in the media about the experiments and the results that were obtained were enough such that people could explore the right pathway to get similar results."[62] Overall, my interviewees expressed frustration with the unwillingness of this scientific expert to explore the role of tacit knowledge in the H5N1 experiments.

For the interviewees, the role of tacit knowledge in new biological developments remained an open question. As one analyst noted regarding the H5N1 experiments, a more accurate assessment would require answering careful, nuanced questions such as: "Who exactly could replicate this experiment? Could it be done in a rudimentary facility in Pakistan or Indonesia versus an insider with well-resourced equipment?"[63] Based on available descriptions of the work involved, unit analysts concluded that the H5N1 experiments did not appear to have been too technically difficult. Still, they were unsure how to evaluate whether or how someone could replicate them, and under what conditions.[64]

Unit analysts could have consulted scholars in the field of science and technology studies to obtain a better understanding of the role of tacit knowledge in the H5N1 experiments. S&TS scholars have developed a considerable body of work that discusses the differences between tacit and explicit knowledge, as well as how to analyze the tacit dimensions of scientific practice. Research in the S&TS field has shown that social scientists can identify and measure different kinds of tacit knowledge in technical work. It has also shown how some kinds of tacit knowledge are more difficult than others to acquire or transfer, as well as how the absence of such knowledge can prevent the use of explicit in-

62. Ibid. This analyst's conversation with the scientific expert reveals how "scientists come to accept their own assumptions as natural and not open to question." See Sheila Jasanoff and Brian Wynne, "Science and Decisionmaking," in Steve Rayner and Elizabeth L. Malone, eds., *Human Choice and Climate Change*, Vol. 1: *The Societal Framework* (Columbus: Batelle, 1998), p. 25.
63. Interview with U.S. intelligence analyst, Washington, D.C., May 15, 2012.
64. Interview with U.S. intelligence analyst, Washington, D.C., June 14, 2012.

formation, making it difficult to repeat previously successful experiments even by experienced individuals.[65] By examining laboratory practices in detail, it is possible to determine the tacit dimensions of how scientific skills are developed, transferred, and replicated at the local level.

Through in-depth research, S&TS scholars have found that scientists and other technical experts often forget (or lose sight of the fact) that successful experiments are ordered and prepared in particular ways in specific laboratory contexts, and that these experts possess a variety of skill sets that frequently consist of taken-for-granted laboratory practices.[66] Many technical specialists overlook these tacit dimensions of scientific practice, and special analytic work is required to elucidate particular skills of laboratory workers. This research and analysis on tacit skills is not typically carried out by the scientists doing the work, given their own blind spots on these issues, but by others who can observe and document the laboratory skills and work practices with a fresh eye.

In contrast to popular understandings of science and how the NSABB and other technical experts assessed the H5N1 experiment, S&TS research shows that it is impossible to evaluate tacit knowledge in an experiment merely by reading a scientific manuscript (no matter how carefully or how many times) or by talking only to the principal investigators. Instead, S&TS research on tacit knowledge shows that activities in the laboratory and in specific experiments must be closely analyzed, with a detailed understanding of the local, often messy, laboratory practices of "science-in-the-making" and of the bench researchers themselves. None of these details are documented in scientific journal articles or scientific protocols. S&TS forms of analysis require the use of social science qualitative research methods, in which data collection involves participant observation and interviews of scientists in their laboratories.

An S&TS analytic approach that I used in an earlier study reveals the importance of tacit knowledge in evaluating the security threat from new develop-

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65. For a few examples, see H.M. Collins, "Tacit Knowledge, Trust, and the Q of Sapphire," *Social Studies of Science*, Vol. 31, No. 1 (February 2001), pp. 71–85; H.M. Collins, *Changing Order: Replication and Induction in Scientific Practice* (Chicago: University of Chicago Press, 1985); Kathleen Jordan and Michael Lynch, "The Sociology of a Genetic Engineering Technique: Ritual and Rationality in the Performance of a 'Plasmid Prep,'" in Adele E. Clarke and Joan H. Fujimura, eds., *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences* (Princeton, N.J.: Princeton University Press, 1992), pp. 77–114.

66. David Gooding, "Mapping Experiment as a Learning Process: How the First Electromagnetic Motor Was Invented," *Science, Technology, and Human Values*, Vol. 15, No. 2 (Spring 1990), pp. 165–201.

ments in the life sciences. In 2002, virologists at the State University of New York, Stony Brook, created a synthetic poliovirus.[67] Because the experiment used commercially available DNA and open-source scientific information, the media and policymakers focused on how terrorists could easily replicate the experiment. My analysis of the experiment reveals, however, the importance of certain kinds of tacit knowledge in the preparation of cell cultures necessary for the experiment: if this know-how could not be mastered, it would prevent replication of the experiment as published.[68] Another recent study also illustrates the relevance of tacit knowledge to bioweapons development.[69]

How would a similar analytic approach have helped in evaluating the existence of a potential security threat in the H5N1 case? In simple terms, it would have involved asking and answering in a rigorous social science analytic study the questions "Who, What, Where, When, and How?" Neither the NSABB, nor intelligence analysts, nor others studying the controversy conducted such an in-depth study on the H5N1 laboratory practices—probably because S&TS expertise on tacit knowledge, and how to apply this knowledge to technical security issues, is not well known or relied on in the security policy community. The next section describes a compounding dilemma that intelligence analysts faced in seeking assistance in making their assessments.

The Politics of Expert Knowledge

A second major problem confronting intelligence analysts in assessing the H5N1 experiments was how to judge who the credible experts were, given that many of them had personal or institutional agendas. As one intelligence interviewee put it, "There isn't an impartial arbiter in the bio community. . . . Where are you going to find an outside voice who speaks without bias? Where is the balanced perspective? Who do you call on?"[70] In talking about the need for impartial arbiters, one analyst used the example of Walter Cronkite, the American television broadcast journalist who was often called "the most trusted man in America." This analyst lamented that there was no

67. Cello, Paul, and Wimmer, "Chemical Synthesis of Poliovirus cDNA: Generation of Infectious Virus in the Absence of Natural Template."
68. 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; Vogel, *Phantom Menace*, pp. 71–105; Shannon Fye also discusses the importance of tacit knowledge in contemporary synthetic genomics. See Fye, "Examination of Technical Difficulties and Contingencies among Gene Synthesis Companies," annual meeting of the American Political Science Association, Seattle, Washington, September 1–4, 2011, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1902950.
69. Ben Ouagrham-Gormley, "Barriers to Bioweapons."
70. Interview with U.S. intelligence analyst, Washington, D.C., March 23, 2012; and interview with U.S. intelligence analyst, Washington, D.C., March 15, 2012.

Cronkite-like figure in the scientific/policy community who could consult on biosecurity threat issues such as the H5N1 controversy.[71] Although this observation might seem naïve—one could doubt whether such a Cronkite-like expert has ever existed—the analyst reveals a real concern about what s/he sees as partiality among scientific experts and advisers on bioweapons issues and the need for greater diversity and credibility in experts on whom s/he can draw for assessments. Other members of the U.S. intelligence community have voiced similar concerns.[72] Governmental and nongovernmental reports focused on improving intelligence analysis on advances in the life sciences have so far failed to address this issue. Instead, they merely advocate increasing the number of technical experts available to the intelligence community.

One of my interviewees contrasted the challenge of finding reliable bioweapons experts today with the situation in the 1990s, when scientists appeared to offer nonpartial, trustworthy outside expertise to policymakers. At that time, s/he stated that disinterested scientists could be tapped to provide expertise that senior policymakers would respect. Biologist and Nobel laureate Joshua Lederberg, whose involvement in biosecurity issues is well known, was given as one such example.[73] Lederberg argued that bioweapons posed a

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71. Interview with U.S. intelligence analyst, Washington, D.C., May 12, 2012. The notion of scientists serving as impartial or disinterested arbiters reflects a view of science and scientific expertise that has long characterized American science policy. In this view, scientific knowledge is seen as objective and value free, and scientists are believed to operate under norms of disinterestedness; they do not seek personal gain, but act for the benefit of the public and scientific community. According to this perspective, the scientific expert's job is to provide technical input to policy problems, while remaining independent of political influences. S&TS scholar Sheila Jasanoff has described how the separation of science from politics is embodied in government institutions, policy processes, practices, and statements. She cites expert science advisory committees, as they are currently structured in the United States as a primary example of this split. Jasanoff writes that these advisory structures keep alive "the politically useful fiction that science is apolitical and that scientific advisors are capable of 'speaking truth to power.'" See Jasanoff, "Citizens at Risk: Cultures of Modernity in the U.S. and EU," *Science as Culture*, Vol. 11, No. 3 (September 2002), pp. 373–374. For additional references discussing the politics of science, see Wiebe E. Bijker, *The Paradox of Scientific Authority: The Role of Scientific Advice in Democracies* (Cambridge, Mass.: MIT Press, 2009); and Steven Shapin, "Trust, Honesty, and the Authority of Science," in Ruth Ellen Bulger, Elizabeth Meyer Bobby, and Harvey V. Fineberg, eds., *Society's Choices: Social and Ethical Decision Making in Biomedicine* (Washington, D.C.: National Academies Press, 1995), p. 390. Chandra Mukerji argues that science's cultural power—as an independent, objective, value-free enterprise for use by the state—was particularly ingrained during the Cold War period. See Chandra Mukerji, *A Fragile Power: Scientists and the State* (Princeton, N.J.: Princeton University Press, 1989).

72. For examples of some of these academic critiques, see Milton Leitenberg, *Assessing the Biological Weapons and Bioterrorism Threat*; and Wright, "Terrorists and Biological Weapons." I have also heard this complaint about partiality from other U.S. intelligence analysts. Email communication with U.S. intelligence analyst, Washington, D.C., August 18, 2010.

73. See Wright, "Terrorists and Biological Weapons," p. 67; and Judith Miller, Stephen Engelberg, and William Broad, *Germs: Biological Weapons and America's Secret War* (New York: Simon and

serious threat to U.S. national security, a view around which a consensus in the scientific and policy communities began to form in the 1990s.

Another analyst, however, commented that since the terrorist attacks of September 11, 2001, reaching a consensus about the biological weapons threat has become far more difficult. According to this analyst, with more defense money at stake since the attacks, there has been a proliferation of "competing agendas, rice bowls, and turfs within the biosecurity community."[74] The analyst offered the example of a teeter totter to illustrate the point, describing several science advisers, policy analysts, and policy officials favoring increased biodefense funding weighing heavily on one side and only one or two skeptics on the other.[75] According to this analyst, the debate lacks more "balancers" whose nuanced understanding of bioweapons threats could help build a more trustworthy consensus around the nature of the threat.[76]

Yet another analyst noted that some NSABB members were also members of other biosecurity-related advisory groups.[77] The analyst likened the situation to "a Venn diagram with some area of overlap."[78] Another attributed the overlap, in part, to the challenges of obtaining security clearances for nongovernment employees: "You can only get so many people cleared; therefore, the number of outside experts that are cleared is very small."[79] The result of this overlap in advisory board membership has been a decrease in the number of divergent perspectives available to intelligence analysts. According to my interviewees, scientists with overlapping advisory memberships who were in-

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Schuster, 2001), pp. 140, 156. Although not named by these analysts, there are other scientists who could also be considered influential experts on bioweapons issues. Harvard biologist Matthew Meselson is one example.

74. Interview with U.S. intelligence analyst, Washington, D.C., June 14, 2012.

75. Ibid.

76. Ibid.

77. Interview with U.S. intelligence analyst, Washington, D.C., May 15, 2012. In 1998 the U.S. Defense Intelligence Agency created a new science advisory group for the military called Bio-Chem 20/20. BioChem 20/20 was responsible for preparing a variety of classified technical intelligence studies for the agency on biological and chemical weapons issues. In November 2006, the National Counterproliferation Center within the Office of the Director of National Intelligence established the Biological Sciences Experts Group to improve the intelligence community's access to biological expertise. The group consists of a cadre of external life science and bioweapons experts from universities, private firms, and nongovernment organizations. See Biological Sciences Experts Group, "Charter," http://www.fas.org/irp/eprint/bseg-concept.pdf; and Institute of Medicine and National Research Council, *Globalization, Biosecurity, and the Future of the Life Sciences*, p. 237.

78. Interview with U.S. intelligence analyst, Washington, D.C., May 15, 2012. This comment has been made to me by other intelligence analysts who regularly attend NSABB, Bio-Chem 20/20, and BSEG meetings. See Vogel, *Phantom Menace*, p. 274.

79. Ibid.

volved in the H5N1 controversy, as well as several other experts who have made public comments on the H5N1 experiments, tend to have similar views about the increasing dangers of bioterrorism, with a focus on worst-case scenarios.[80] One analyst describe it as a catch-22: the partiality of these scientific experts makes it difficult to fully trust their expertise.[81]

Outside scientific experts and senior policy and intelligence officials do not share the analysts' perception of this problem of overlap within the NSABB. Rather, they see the NSABB as a "broadly constituted" group of experts.[82] In contrast, after NSABB member Osterholm wrote his critical letter to the NIH after the board supported publication of the revised Fouchier and Kawaoka papers, the analysts commented that the letter further reduced the credibility of the NSABB, because it complicated the ability of the analysts to know how to weigh conflicting voices on the board. As one analyst commented, "You had [NSABB Chair] Keim later on backtracking that he had said it was a doomsday virus, and then you had the Osterholm letter. It diminishes the credibility of the NSABB."[83] The individual and public means of airing different NSABB member perspectives on the experiments were troublesome to these analysts.

Another problem encountered by unit analysts was the lack of consensus within the broader scientific community on how to interpret the H5N1 experimental data. This difficulty reflects the absence of a forum or process within the intelligence and policy communities where experts and analysts can discuss technical differences in a constructive manner. During the H5N1 controversy, for example, scientific experts engaged in heated debates over issues

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80. For other scholarly discussions of this issue, see Wright, "Terrorists and Biological Weapons"; and Kathleen M. Vogel, "Necessary Interventions: Expertise and Experiments in Bioweapons Intelligence Assessments," *Science, Technology, and Innovation Studies*, Vol. 9, No. 2 (October 2013), pp. 61–88. This focus on worst-case scenarios is not an issue exclusively of concern for bioweapons assessments; it has been a concern in other types of weapons assessments as well. See Sharon Ghamari-Tabrizi, *The Worlds of Herman Kahn: The Intuitive Science of Thermonuclear War* (Cambridge, Mass.: Harvard University Press, 2005); and Herbert F. York, *Race to Oblivion: A Participant's View of the Arms Race* (New York: Simon and Schuster, 1970).

81. Interview with U.S. intelligence analyst, Washington, D.C., May 15, 2012.

82. Michael J. Imperiale, "Dual-Use Research after the Avian Influenza Controversy," *Bulletin of the Atomic Scientists*, July 11, 2012, http://thebulletin.org/dual-use-research-after-avian-influenza-controversy. See also Larry Kerr, "The H5N1 Influenza Controversy: Implications for Science Governance," paper presented at the Biological and Toxin Weapons Convention Meeting of Experts, Geneva, Switzerland, July 17, 2012, http://www.unog.ch/80256EDD006B8954/(httpAssets)/7C3D410083B582B0C1257A4F002AC7E4/$file/USG+Briefing+Slides+on+H5N1+Controversy+delivered+at+BWC+MXP+7-17-2012+LDK.pdf. As noted earlier, however, NSABB member Osterholm in his letter to the NIH criticized the NSABB for not inviting "disinterested subject matter experts" into its deliberations.

83. Interview with U.S. intelligence analyst, Washington, D.C., May 15, 2012.

such the reliability of ferrets as test animals, the collection and processing of ferret model data, the case fatality and seroprevalence rates, and the danger of H5N1 in the wild compared to the laboratory. As one interviewee reflected, "Each of the experts was at loggerheads over each of these issues, there was no traction, no winning but each side [of experts] takes a stance. The debate evolved, had a flow, but there was no traction on any of these issues. Instead, the debate would switch gears as they [experts] would move on to the next contentious issue, sort of like wrestling, where they try to throw each other off balance."[84]

According to this observer, the problem with such winner-take-all matches is that "[scientific experts] lose credibility . . . because they are seen to be biased and have agendas."[85] According to the analysts, the H5NI credibility problem extended to publicly available information, including a large amount of "obviously biased material" being published in the nongovernment literature.[86] To address this problem, intelligence analysts following the debate needed to "filter these open source documents from various scientific and biosecurity experts who were writing commentaries on these experiments, to weigh what are the valid arguments in the articles versus their own preconceptions of who is writing and their inherent biases on the issue."[87] While these statements may appear naïve, they reveal the struggles that senior and junior analysts faced in weighing what they heard from experts without having the appropriate structures and mechanisms to help them evaluate contrasting views.

Creating consensus on security issues, however, can result in the exclusion of important perspectives and limit the kinds of expert knowledge brought to bear on a problem. Consensus does not necessarily guarantee objectivity, lack of bias, or validity in the final outcome. For example, even if my interviewees might have considered the 1990s to have been a golden era of science advising, expertise on bioweapons policy issues at that time was "thin."[88] A smaller number of experts makes consensus easier, but it can also be a hindrance when seeking a range of opinions. Lederberg, who conducted a significant amount of work inside and outside the government to achieve consensus for increasing military and civilian biodefense funding, did not always recognize critical

84. Ibid.
85. Ibid.
86. Ibid.
87. Ibid.
88. Wright, "Terrorism and Biological Weapons," p. 102.

voices.[89] Thus, he, too, could be an example of a science adviser whose actions and end results intertwined with science and politics.

In response to concerns about the politics surrounding expert scientific knowledge, S&TS scholarship has sought to illustrate how this knowledge is produced, acquired, and used within specific social and political institutions and contexts.[90] This work shows how science and social context are always mutually constituted. In contrast to what my intelligence interviewees might prefer, separating science from politics is impossible in the real world.[91] Moreover, given the high level of contingency and low level of certainty in scientific controversies, Charles Thorpe argues that "trust in the advice depends heavily on trust in the advisor."[92] Thus, one cannot divorce the technical facts from those involved in their production and use. This fact points to the need for the U.S. government to create structures and mechanisms that can help intelligence analysts sort through the socially laden nature of scientific expertise.

Policy Recommendations

This detailed examination of the H5N1 controversy through the work of a U.S. intelligence analytic unit reveals inherent challenges in how expert knowledge

89. See ibid., pp. 65, 67–70, 80–91, 95, 101–102.

90. For examples of how science is co-produced within varying social contexts, see Sheila Jasanoff et al., eds. *The Handbook of Science and Technology Studies* (Thousand Oaks, Calif.: Sage; 1995); Edward J. Hackett et al., eds., *The Handbook of Science and Technology Studies*, 3rd ed. (Cambridge, Mass.: MIT Press, 2007). See also Sheila Jasanoff, "Breaking the Waves in Science Studies: Comment on H.M. Collins and Robert Evans, 'The Third Wave of Science Studies,'" *Social Studies of Science*, Vol. 33, No. 3 (June 2003), pp. 389–400; and Sheila Jasanoff, ed., *State of Knowledge: The Co-Production of Science and Social Order* (London: Routledge, 2004).

91. In his discussion of the role of scientific experts in the World Health Organization's oversight of smallpox research, Jonathan B. Tucker also finds that personal values and assumptions can influence scientific judgments. See Tucker, "Preventing the Misuse of Biology: Lessons from the Oversight of Smallpox Research," *International Security*, Vol. 31, No. 2 (Fall 2006), pp. 116–150. For broader critiques of the separation of science and politics, see Yaron Ezrahi, "The Political Resources of American Science," *Science Studies*, Vol. 1 (1971), pp. 117–133; Sheila Jasanoff, "(No?) Accounting for Expertise," *Science and Public Policy*, Vol. 30, No. 3 (June 2003), pp. 157–162; Dorothy Nelkin, "The Political Impact of Technical Expertise," *Social Studies of Science*, Vol. 5 (1975), pp. 35–54; Stephen Hilgartner, *Science on Stage: Expert Advice as Public Drama* (Palo Alto, Calif.: Stanford University Press, 2000); and Roger A. Pielke Jr., *The Honest Broker: Making Sense of Science in Policy and Politics* (Cambridge: Cambridge University Press, 2007). For a bioweapons-related example of the politics of scientific experts, see Brian Balmer, *Britain and Biological Warfare: Expert Advice and Science Policy, 1930–65* (Basingstoke, U.K.: Palgrave, 2001). See also Sheila Jasanoff, "Representation and Re-Presentation in Litigation Science," *Environmental Health Perspectives*, Vol. 116, No. 1 (January 2008), p. 124.

92. Charles Thorpe, "Disciplining Experts: Scientific Authority and Liberal Democracy in the Oppenheimer Case," *Social Studies of Science*, Vol. 32, No. 4 (August 2002), p. 530.

is identified, defined, acquired, and used in intelligence assessments on bioweapons threats. The case provides an opportunity to explore how intelligence analysts talk about experts and expert knowledge in ways that differ from public and official perspectives; it illuminates inherent difficulties in the kinds of expert knowledge that analysts can use in their assessments; and it offers useful lessons for how to intervene to remedy existing shortcomings. Two key sets of policy recommendations follow from this analysis.

develop new types of expert knowledge

The H5N1 case reveals that neither the NSABB nor intelligence analysts incorporated important sources of expert knowledge into their assessments. Although intelligence analysts recognized the importance of evaluating tacit knowledge in the experiments, they were unable to find experts who could use rigorous analytic methods to help them assess its significance. To rectify this problem, the intelligence community should tap scholars from the S&TS field. Applying S&TS ethnographic methods in the H5N1 case could have provided a new cache of knowledge to better evaluate the security threat that some believed the Fouchier and Kawaoka manuscripts posed. For example, Fouchier and Kawaoka were the only persons whom the NSABB or the Federal Bureau of Investigation interviewed in any detail. Neither of these individuals had participated directly in the experiments; in fact, as the principal investigators, they rarely set foot in the laboratories where the work was done. This is common in most cutting-edge, contemporary scientific laboratories; the principal investigator serves as "administrator" or "manager" of the laboratory, but does not typically participate in the day-to-day work conducted on the laboratory bench.[93] For years, both Fouchier and Kawaoka acted as administrators/managers of laboratories with research teams who worked day in and day out on the experiments. Yet, these research teams remained largely invisible as the controversy unfolded. As one media account notes, the main postdoctoral researcher, who led the experimental work for the Fouchier laboratory, Stefan Herfst, "stayed in the background, as did Ph.D. students Eefje Schrawuen and Martin Linster."[94] In addition to these three individuals, the Fouchier manuscript listed eight other researchers.[95] Similarly, Masato Hatta, Masaki Imai, and Tokiko Watanabke, key researchers on the Kawaoka team, remained

93. Martin Enserink, "For Young Scientists, A Wild Ride," *Science*, June 22, 2012, p. 1495.
94. Ibid.
95. See Herfst et al., "Airborne Transmission of Influenza A/H5N1 Virus between Ferrets."

invisible as the controversy around their team's experiments unfolded.[96] The Kawaoka manuscript listed fourteen other researchers. No government or nongovernment entity interviewed any of these postdoctoral researchers, graduate students, or related technicians using rigorous qualitative research methods to assess the microlevel laboratory practices.[97] As the controversy unfolded, Schrawuen commented, "It was clear that this was being discussed at a level where we didn't belong."[98]

In addition, the NSABB and members of the press largely conducted their interviews with Fouchier and Kawaoka offsite or in phone calls.[99] In contrast, ethnographies that are able to tease out tacit knowledge details in scientific work require multiple of hours of interviews and site visits to elucidate the minute, mundane, and important details of laboratory practices and the individuals who actually work in the laboratories. These details cannot be found in manuscripts and must be investigated separately. Detailed laboratory ethnographies of the Fouchier and Kawaoka laboratories could have been conducted. First, an analyst could have interviewed the research team members in both laboratories to obtain their expert knowledge about the actual laboratory practices involved in the experiments. Herfst, for example, was described briefly by Fouchier as having spent four years working on these experiments before achieving success. Detailed interviews with Herfst and others could have yielded a better understanding of the experimental challenges involved.[100] Second, consultations with a broader array of experts could have helped elucidate the work conducted in the Fouchier and Kawaoka laboratories and the technical challenges they confronted. To cross-check the teams' accounts of the experiments, the NSABB, media, and intelligence analysts could have conducted secondary interviews with the teams' scientific competitors who used similar techniques and practices. Third, scientists in the

96. See Imai et al., "Experimental Adaptation of an Influenza H5 HA Confers Respiratory Droplet Transmission to a Reassortant H5 HA/H1N1 Virus in Ferrets."
97. See also Sonia Ben Ouagrham-Gormley, "Dissuading Biological Weapons Proliferation," *Contemporary Security Policy*, Vol. 34, No. 3 (December 2013), pp. 9–10.
98. Quoted in Enserink, "For Young Scientists, A Wild Ride," p. 1495.
99. Steve Connor, "Controversial Bird Flu Research Set for Publication," *Independent*, April 2, 2012, http://www.independent.co.uk/life-style/health-and-families/health-news/controversial-bird-flu-research-set-for-publication-7608820.html.
100. Largely overlooked by early media reports, Herfst made a presentation on the H5N1 work to the September 2011 Fourth European Scientific Working Group on Influenza in Malta. His presentation, entitled "Why Is HPAI H5N1 Virus Not Transmissible via Aerosol? An Extensive Mutational and Phenotypic Analysis of Mutant and Reassortment H5N1 Viruses," won the award for best oral presentation at the conference. See http://www.eswiconference.org/.

U.S. academic and government communities with expert knowledge could have provided additional questions and perspectives about the laboratory work. Finally, interviews with former U.S. and Soviet bioweapons scientists who had spent much of their careers trying to aerosolize harmful pathogens could have offered a broader understanding of the technical challenges in aerosol transmission and virus infection.

The consultations described above would have required focused research, data collection, and analysis. They could have been accomplished, however, with minimal time and personnel resources. Based on my prior research and on other related studies,[101] I estimate that with the proper training in science and ethnographic methods, one intelligence analyst or contractor working over a ten-day period could have gathered new, substantial information about the H5N1 experiments from site visits to the Fouchier and Kawaoka laboratories and from staff interviews. The analyst would have incurred travel, accommodation, and per diem expenses; for the interviews, s/he would have had to purchase a tape recorder and camera and/or video camera. Research assistants/interns could have transcribed and organized the interview data to expedite analysis. Although more lengthy research and interviews would have been ideal, a ten-day research visit to the laboratories would have yielded a wealth of new information about the experimental work that was not available merely by reading the manuscripts or interviewing Fouchier and Kawaoka. A U.S. government analyst could have conducted this type of research on the H5N1 case more efficiently than academic researchers, because the Fouchier and Kawaoka experiments were paid for with tax dollars. The U.S. government can compel such investigations, just as the Government Accountability Office, the Food and Drug Administration, and the National Institutes of Health fraud unit do.[102]

A second recommendation for evaluating controversial cases in the emerging life sciences and biotechnologies is to expand the pool of experts with knowledge of bioweapons threats and include some of these individuals on the advisory boards of the NSABB and other relevant groups. These experts

101. See Kathleen M. Vogel, "Bioweapons Proliferation: Where Science Studies and Public Policy Collide," *Social Studies of Science*, Vol. 36, No. 5 (October 2006), pp. 659–690; Vogel, "Framing Biosecurity"; and Vogel, *Phantom Menace*, pp. 59–130.

102. Alternatively, U.S. government scientists could have sought to replicate the H5N1 experiments. Given safety concerns about the mutated viruses, however, replication would have likely raised other controversies.

could also play a larger role in producing biosecurity assessments. The ability of analysts to call on outside expertise is limited, however—even if it is acknowledged to be important within the intelligence community. In July 2008 the Office of the Director of National Intelligence issued Intelligence Community Directive Number 205, "Analytic Outreach." This directive charges intelligence analysts to "leverage outside expertise as part of their work." To do so, the analyst is expected to know the leading experts in their focus areas and to engage openly with them to "explore ideas and alternative perspectives, gain new insights, generate new knowledge, or obtain new information."[103] Currently, however, the directive remains underutilized because, as one of these intelligence analysts explained, it is "pretty much an unfunded mandate."[104] Although the directive demonstrates high-level support for increased intelligence outreach, it leaves the implementation up to individual agencies and office units, which "few do given limited resources and some bureaucratic obstacles (e.g., security clearances, identifying and justifying suitable academics)."[105] Similar constraints emerged during the H5N1 controversy, which suggests a third recommendation: the U.S. government should make a greater financial and managerial commitment to support efforts at analytic outreach.

Other concerns within the intelligence community include analysts working closely with outside experts who do not possess security clearances. This relates to the culture of secrecy in intelligence work and the risks of revealing classified information or other U.S. security vulnerabilities. In the past, certain intelligence units at specific times found ways to deal with this problem successfully. For example, in the late 1990s, the Central Intelligence Agency (CIA) created an analytic unit called the Strategic Assessment Group, located within the Directorate of Intelligence's Office of Transnational Issues.[106] This group was established to conduct long-term, strategic assessments of specific security issues and a variety of forecasting studies. Analysts were given resources to consult with a range of outside experts. At the end of the research period, they typically produced a report for the CIA and often held an unclassified workshop with outside experts on the topic. This historical example leads to a fourth recommendation: the U.S. intelligence community should develop new

103. Office of the Director of National Intelligence, "Intelligence Community Directive 205: Analytic Outreach," July 16, 2008, http://www.fas.org/irp/dni/icd/icd-205.pdf.
104. Email communication with intelligence analyst, October 21, 2012.
105. Ibid.
106. Telephone interview with former CIA analyst, September 9, 2008.

institutional structures within intelligence analytic units (with high-level organizational backing) to support new forms of open source collection; long-term, in-depth analysis; and expert consultation.

create new structures and practices for using expert knowledge

As noted earlier, intelligence analysts interviewed for this article had no opportunity to review the Fouchier and Kawaoka H5N1 papers prior to publication. Overall, little information was available about how the NSABB conducted its assessments of the experiments and exactly how it modified its recommendations. As a result, intelligence analysts came to mistrust the NSABB and other experts. Also, despite several ad hoc, informal discussions between intelligence analysts and government officials on the H5N1 case throughout 2011 and 2012, no established structure or mechanisms existed that intelligence analysts, government officials, NSABB members, and other experts could use to exchange information or knowledge about the case. Therefore, creating more accurate assessments on bioweapons threats involves not only acquiring relevant facts and expertise, but also examining the fundamental nature of how knowledge is produced through such expert deliberations and consultations. This issue is important not only for biosecurity issues, but also for other types of technical security assessments.

In one of my interviews, I asked unit analysts why the NSABB did not request threat briefings from the intelligence community well before the March 2012 meeting. If the NSABB's mandate included evaluating the experiments from a security perspective, intelligence briefings should have been a part of their deliberations from the beginning (if intelligence analysts are presumably the experts on security threats). Additionally, a closer relationship between analysts and the NSABB would have given these intelligence analysts direct access to the manuscripts, which would have facilitated an ethnographic analysis. One intelligence analyst stated that, because the responsibility of the NSABB is to advise HHS on issues that it brings before the NSABB, the NSABB may not have had the authority to reach out directly to the intelligence community, although it could have asked that the HHS request briefings from the intelligence community.[107] The HHS cannot, however, task the intelligence community to provide such briefings.

In addition, intelligence analysts should develop an understanding of differ-

107. Interview with U.S. intelligence analyst, Washington, D.C., June 14, 2012.

ences in expert knowledge and view them as an opportunity to begin discussing fundamental assumptions, how issues are framed, and whether alternative assumptions or framings would improve their analyses. They should also examine areas of consensus to determine whether important perspectives have been excluded and the implications of this for their assessments. In the H5N1 case, this suggests that intelligence analysts should have been given the resources to seek out alternative perspectives and sources of expert knowledge with greater vigor, particularly given the overlap in membership between the NSABB and other biodefense- and science-related advisory groups.

The U.S. intelligence community should create a forum and set of expert practices to expand the openness of expert deliberations and increase opportunities for information exchange and discussion between experts and intelligence analysts. In these forums, a mediator or set of mediators could moderate the deliberations and identify strengths and weaknesses of various positions; one intelligence practitioner not involved in the H5N1 controversy described the growth in collaboration among intelligence analysts as complicating the ability of joint intelligence projects and creating a never-ending process of analysis and assessment, with participants having vested interests in what they have written before.[108] In such cases, two opposing analytic teams could use a mediator to help expose biases, understand the other's perspective, and resolve the conflict. Experimenting with new forms of expert engagement would facilitate exploration of alternative ways of acquiring and using expert knowledge. The National Intelligence Council and the Department of State's Global Futures Forum would be useful initial choices, because they have involved a range of scientific and social science experts in unclassified meetings with practitioners. Another possibility is the Office of the Director of National Intelligence's Biological Sciences Experts Group. A purely scientific advisory group for intelligence, the group could modify its composition to involve multidisciplinary forums of expertise. The group could also create classified and unclassified forums dedicated to mediating multiple perspectives on contentious biosecurity issues.[109] Government and nongovernment funds could be used to support more initiatives along these lines.

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108. Comment by intelligence practitioner at the "U.S.-U.K. Joint Workshop on Improving Intelligence Analysis for Emerging Biotechnology Threats," London, England, September 12–14, 2012. A brief description of this meeting can be found at http://www.genomicsnetwork.ac.uk/forum/events/pastevents/workshops/title,26429,en.html.

109. For some examples of alternative science advisory models that include different forms of expert knowledge, see Roland Bal, Wiebe E. Bijker, and Ruud Hendriks, "Democratisation of

Conclusion

Even with the NSABB recommendation to publish the Fouchier and Kawaoka manuscripts, questions linger about how much of a researcher's scientific methods in this kind of experimental work should be published.[110] With Fouchier and other virologists planning more mutation experiments on strains of the bird flu, more questions and controversies are likely to emerge.[111] There will continue to be a need for more rigorous assessments of the potential security threats that such scientific research may pose.

As this article has illustrated, a microlevel analysis of the problems faced by U.S. intelligence analysts during the 2011–12 H5N1 controversy highlights the importance of closely examining the epistemic practices and expert knowledge that laboratories and advisory groups rely on. This holds true for intelligence and policy practitioners as well. In addition, intelligence analysts must have access to a broader array of social, material, and intellectual resources that they can incorporate into their assessments of such life science controversies.

The omission of important information about tacit knowledge in assessments of the H5N1 case points out that in threat assessments on cutting-edge science, analysts and scientific experts need to move beyond a focus on written scientific texts and spend more time probing the technical practices and social relations in the laboratories where the scientific work is conducted.[112] Such findings are critical for policymaking because how intelligence analysts construct their assessments has implications for the implementation of new

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Scientific Advice," *British Medical Journal*, March 12, 2005, p. 602; and Wiebe E. Bijker, Paolo Volonte, and Cristina Grasseni, "Technoscientific Dialogues: Expertise, Democracy, and Technological Cultures," *Tecnoscienza*, Vol. 1, No. 2 (2010), p. 128. Sheila Jasanoff also notes that the British experience with mad cow disease resulted in the British government moving toward including a broader range of expertise in decisions concerning health, safety, and the environment. See Jasanoff, "(No?) Accounting for Expertise," p. 161.

110. Mark S. Frankel, "Regulating the Boundaries of Dual-Use Research" *Science*, June 22, 2012, pp. 1523–1525.

111. Ron A.M. Fouchier et al., "Transmission Studies Resume for Avian Flu," *Science*, February 1, 2013, pp. 520–521; and David Malakoff, "Critics Skeptical as Flu Scientists Argue for Controversial H7N9 Studies," *Science*, August 9, 2013, p. 601, http://www.sciencemag.org/content/341/6146/601.

112. This concern applies to other kinds of weapons assessments as well. See, for example, MacKenzie and Spinardi, "Tacit Knowledge, Weapons Design, and the Uninvention of Nuclear Weapons"; Laura McNamara, "Ways of Knowing about Weapons: The Cold War's End at the Los Alamos National Laboratory," Ph.D. dissertation, University of New Mexico, 2001; Alexander H. Montgomery, "Ringing in Proliferation: How to Dismantle an Atomic Bomb Network," *International Security*, Vol. 30, No. 2 (Fall 2005), pp. 153–187; and Dennis Gormley, *Missile Contagion: Cruise Missile Proliferation and the Threat to International Security* (Westport, Conn.: Praeger, 2008).

biosecurity policy responses to deal with these potential threats such as the control of scientific publications and materials (e.g., restricted access to research results and biological data, export controls, and outright censorship of scientific protocols and papers); increased oversight, safety, and security measures on scientists and laboratories; and restrictions on federal funding for biological research.

This study also opens up discussion on new approaches for how to improve the acquisition and use of expert knowledge on technical security issues. It also points to a need for better ways to make visible and explicit the social and political influences and stakes on expert advice in intelligence and policy-making. Intelligence analysts should examine and expand the types of expert knowledge that they use, and they need to have the resources, mechanisms, and structures to support this kind of work. In their book *Capturing Security Expertise*, Trine Villumsen Berling and Christian Bueger argue that our social and political institutions and public policies will become increasingly dependent on experts as a consequence of the growing ambivalence and uncertainties that societies face.[113] This suggests the need for greater analytic attention to explicating the diverse roles and character of experts and the knowledge they produce in the security domain.

113. Berling and Bueger, *Capturing Security Expertise: Practice, Power, Responsibility*.