H5N1
Timeline of Select Episodes and their Significance

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In September 2011 researchers from the Erasmus Medical Center in Rotterdam, The Netherlands led by Ron Fouchier announced that they had successfully engineered a mutant form of influenza H5N1, “avian influenza,” that is transmissible by respiratory route between mammals (ferrets). Given that ferrets’ immune response to influenza is considered to be similar to the response in humans, the studies suggest that the engineered H5N1 is likely transmissible human-to-human as well. The researchers suggested that the transmissible flu they had created remained as lethal as the original strain on which their work had been carried out, a strain estimated to be fatal in ~30-60% of cases in humans. Several months later it became widely known that a second research group, led by University of Tokyo and University of Wisconsin professor Yoshihiro Kawaoka, similarly had engineered a mammal-to-mammal transmissible form of H5N1. The conduct of the work, the handling of its announcement, and the political turmoil set into motion by the prospect of its publication have raised serious questions about the limits of free inquiry and the regulation of research with dangerous organisms. It has also raised serious questions about the terms under which such research should be organized, justified, and critiqued.

In the table that follows I provide a timeline of the key episodes in the unfolding of this event, with an explanation of how each episode is significant. I pay particular attention to how the story being told about the research and importance had changed, and how its political framing has led to a game of justification and counter justification in which the account of the science and how it should be interpreted has become formed by the polemics which have taken hold. Where possible the table provides links to the primary documents or presentations referenced as part of the timeline. I have also included a second table with a list of the primary individuals involved in this event, with a short introductory bio on each. The materials in this second table have been extracted from longer biographies available online. The material in this timeline was developed in close conversation with Roger Brent and Meg Stalcup, and with the assistance of Desmond Huynh, of the Center for Biological Futures.

Date	Episode and its Significance

February 2011	The Center for Disease Control (CDC) conducts its regular inspection of the BSL3+ virology facilities at Erasmus Medical Center, Rotterdam, facilities which Erasmus influenza PI Ron Fouchier describes as specifically designed for work on the transmissibility of H5N1 by respiratory routes. The inspection will play a small, but important, role in the exchange of criticisms and justifications that will characterize the unfolding of events connected with the Fouchier and Yoshihiro Kawaoka groups' success in making H5N1 transmissible between mammals. In the most systematic defense of his work, which will be published by *ScienceInsider* in January 2012, Fouchier and colleagues will make the case, contrary to conclusions drawn by the National Science Advisory Board for Biosecurity (NSABB), that their work poses no "dual-use" threat. They attempt to make this case by strongly asserting that their research was conducted in strict compliance with the security and safety procedures characteristic of BSL3 facilities, and of anyone doing work on deadly viruses under an NIAID Centers for Excellence in Influenza Research (CEIR) sub-contract. Fouchier et al.'s insistence that the work was conducted within safe CDC-approved facilities stands in tension with their insistent commitment to publishing their research findings in full, however. If their argument against "dual-use" is that their facilities protect against accidental or intentional release of the virus they have created, then it would seem to follow that full publication undercuts that protection. Fouchier, Kawaoka and other will try to reconcile this apparent tension by simultaneously claiming that they did not use any new methods, and hence that redacting their publications won't keep malicious actors from reproducing their work, while also claiming that what they've done requires highly specialized facilities and can only be reproduced by a select number of experts worldwide. At no point do they address the question of how much easier making deadly flu becomes once the specific mutations are known and others no longer have to engineer the strain by passing it between ferrets. The CDC inspection also throws into doubt claims that Anthony Fauci, the head of the National Institutes of Allergy and Infectious (NIAID) disease who funded the research, will make stating that the transmissibility work "blind-sided" the NIAID. At least one member of the NSABB will ask the question of when Fouchier's team was ultimately successful in its efforts to make H5N1 transmissible by air between mammals and whether or not at this point his team had crossed a threshold from work appropriate in a BSL3 facility to work that requires BSL4 certification.

March 2011	Researchers in Fouchier's group are co-authors on a paper published in the *Journal of General Virology* which suggests that mice which have been exposed to human seasonal H3N2 influenza have some immune resistance to 2009 pandemic H1N1 influenza . On 29 February 2012, nearly a year later, while explaining his H5N1 work at the "Biodefense and Emerging Diseases Meeting" of the American Society for Microbiology (ASM) Fouchier will cite the work reported in this paper as evidence that the mutant strains of H5N1 which his lab has created are unlikely to be lethal in humans who have had any prior exposure to the seasonal flu. In the ASM talk Fouchier fails to note that the "cross-protection" work was done on mice, and that the animals were not H5N1. The claim that the exposed ferrets likely benefited from "immunological cross-protection" is made as part of an ensemble of arguments put forward to clarify ostensible "misconceptions" regarding the lethality and transmissibility of the strain of H5N1 his group has created. Prior to the ASM event it is widely assumed that the mutant strain of H5N1 that the Fouchier group has created is not only transmissible, but also lethal. Indeed, prior to the ASM talk, Fouchier and his supporters will index the public health significance of his work to the fact that H5N1 is highly dangerous. The suggestion that it is not lethal thus constitutes a surprising change in Fouchier's rhetoric and self-presentation.
16 August 2011	Fouchier's group publishes a paper in *Current Opinion in Virology* in which they report on ongoing efforts to identify the genetic bases underlying the set of mechanisms needed for any non-pandemic strain of flu to become "airborne" and transmissible in human populations. The ultimate goal in identifying these genetic bases would be to predict the emergence of new pandemics by detecting flu strains which are beginning to evolve them. Specifically, study aimed at identify genetic bases for the mechanisms of (1) efficient virus attachment to (upper) respiratory tissues, (2) replication to high titers in these tissues, and (3) release and aerosolization of single virus particles will allow for prediction of future pandemics. The paper, however, also reveals the fact that their attempt to identify the genetic bases of interest in existing samples of known pandemic strains of the flu has not been successful. It therefore provides some indication of why the group may have decided to simply evolve a pathogen in a host organism until it develops the mechanisms of interest, so as to then to simply compare that mutant strain to the original. This difference in research strategy becomes significant over the coming months insofar as Fouchier and his supporters will defend the creation of the mammalian-transmissible form of H5N1 by claiming that, armed with knowledge of the specific mutations needed for H5N1 to become airborne, public health officials will be able to refine influenza surveillance efforts. As critics of the work will point out, however, there is no reason to assume that a naturally occurring strain of H5N1, which evolves to become transmissible in mammals, will have the same mutations as the mutant strain created by Fouchier.

11-14 September 2011	Fouchier gives a keynote presentation on his H5N1 work at the Fourth ESWI (European Scientific Working Group on Influenza) Influenza Conference held in Malta. The conference newsletter *The Influenza Times* reports that Fouchier's presentation begins with a report on the recent rise in fatal cases of H5N1 in Indonesia. According to the newsletter, Fouchier stresses the fact that the failure to curtail outbreaks is allowing for the accelerated evolution of the virus such that existing vaccine strains may become ineffectual. Fouchier then makes the announcement which sets off the cascade of events outlined in this timeline: he reports that his research group has successfully evolved a strain of the H5N1 that is transmissible by respiratory route in ferrets and is thus likely transmissible in humans. He explains that they did this by rationally engineering three mutations into the wild-type H5N1, then using a nasal wash to pass that engineered virus between ferrets until it became airborne. Fouchier concludes that this is "very bad news indeed," given how lethal H5N1 has proven to be. Fouchier suggests that the strain he has evolved is not only transmissible in humans, but also lethal, retaining the pathogenic character of the non-mutated strain, according to an article in *Scientific American* which is published several days later. Fouchier admits doubts about the wisdom of having conducted the work saying that the experiment in creating transmissible H5N1 was only undertaken when "someone finally convinced [him] to do something really, really stupid." Fouchier's stress on the lethal character of H5N1 will prove deeply consequential in the months that come. By strongly underscoring the virus's pathogenic character, and therewith the gravity of the fact that he has made the virus airborne, Fouchier is able to advance an forceful strong "public health" justification for his work. As an Erasmus Medical Center press release will put it two months later: "The discovery will enable scientists to recognize in time when a virus becomes a threat to public health, thereby possibly preventing a pandemic." The deadliness of the mutant virus is made equivalent to its value for human health. A certain measure of rhetorical and strategic confusion will thus ensue in late February 2012 when Fouchier insists, in rebuttal of a "dual-use" framing of his work, that the virus he has made is not as dangerous as it is being made out to be and that he and his work has been "misperceived." This assertion and change of rhetorical strategy has the corollary affect of compromising the strongest claims he and his supporters have been making with regard to how useful his mutated virus will be in helping to prevent a future pandemic. Largely overlooked, Sander Herfst, a lead post-doc on the H5N1 transmissibility study, also makes a presentation on the H5N1 work at the same EWSI meeting, a presentation titled ""Why is HPAI H5N1 virus not transmissible via aerosol? An extensive mutational and phenotypic analysis of mutant and reassortment H5N1 viruses." Herfst's talk is awarded best oral presentation.
19 September 2011	Five days after the Malta conference Katherine Harmon of *Scientific American* reports on Fouchier's work. Her report extends Fouchier's own framing of his endeavors as a matter of public health; the sub-heading of Harmon's article stresses this "salvific" framing of Fouchier's work: "Predicting pandemics might still be impossible, but with millions of lives at stake, researchers are using the latest science and lessons from history to best prepare for the next big one." The article introduces Fouchier's work by connecting it to the 60% case fatality rate (CFR) reported by the World Health Organization (WHO) in clinically confirmed cases of H5N1 infection. Reference to the WHO's H5N1 case fatality rate will become the common strategy used by advocates and critics for introducing Fouchier's work and for assessing its significance.

26 September 2011	A week after the *Scientific American* article, Debora Mackenzie of *New Scientist* provided another account of the Fouchier group's work. Rather than framing the significance of the research as a ratio between the virus' natural lethality and possible goods to public health, Mackenzie frames things in terms of how the work provides a simple means by way of which an H5N1 pandemic could be intentionally engineered. She foregrounds the fact that Fouchier's engineered strain only requires five mutations to make it transmissible and reports that "the virus is just as lethal despite the mutations." Several biosecurity experts are quoted in her piece describing the work as "scary," thereby introducing the elements that will serve as a rival narrative to Fouchier's "public health" account of his work. The piece also introduces the views of Peter Palese, who expresses doubts that Fouchier's work will be transmissible or dangerous in humans just because it appears to be so in ferrets. Palese will later appear as a major supporter of the open circulation of Fouchier's findings, advancing a series of arguments claiming that the engineered H5N1 is likely not as dangerous as most advocates and critics assume.
September 2011	Fouchier submits a paper on his H5N1 transmissibility work to *Science* for publication. This paper and the question of its circulation, along with a paper submitted to *Nature* by Yoshihiro Kawaoka's groups at Tokyo and Wisconsin also reporting to have made H5N1 transmissible via the respiratory route, will become the centerpiece of the unfolding controversy.
September 2011	In later statements Fouchier will state that in late September he informs the National Institutes of Health (NIH) and the Dutch government that he has submitted his work for publication, knowing that there is likely to be a strong political and press reaction to his findings. Statements made later by others involved will suggest that the NIH learned of the paper, and of the paper submitted by Kawaoka, when alerted by the editors of the two journals.
October 2011	The NIH asks the National Scientific Advisory Board for Biosecurity (NSABB) to review the manuscripts submitted by Fouchier and Kawaoka and to make a recommendation as to how publication of the two papers should be handled. Michael Osterholm, a voting member of the NSABB and a leading figure in the influenza community, will later describe the NSABB's mandate as "advising the government on whether or not new work in science could be 'misused' to cause harm to public health and safety and environment." The key figure of speech for the NSABB is "dual-use"; the NSABB will assess Fouchier's and Kawaoka's work in terms of the extent to which it constitutes "Dual-Use Research of Concern." This turn of phrase, and means of framing the research, which will have significant determinative affects on how the research will be critiqued and justified. Defending the NSABB's approach, Osterholm will become a major figure in how the controversy unfolds.

October – November 2011	The NSABB appoints a sub-committee for initial review of papers. The sub-committee, consisting of voting members of the NSABB and *ex officio* members from the White House and the National Institute of Allergies and Infectious Disease (NIAID), reportedly spends "hundreds of hours" in conference calls debating what recommendations to make regarding the publication of the research. The NSABB conducts phone interviews with both Fouchier and Kawaoka in order to clarify the data reported in the two papers and its significance, as well as to hear the researchers' own view of the work. The fact that this deliberation is extensive and informed will prove significant in the unfolding game of critique-and-justification which ensues following release of the NSABB's recommendations. Fouchier and others will consistently try to frame criticism of the research as "misconceptions" promulgated by "the media" and non-specialists who do not have access to his paper and data. Several of members of the NSABB and the *ad hoc* sub-committee will become principal public critics of the work.
21 and 23 November 2011	Additional reports on Fouchier's work in *New Scientist* and *ScienceInsider* serve to significantly expand the number of scientists and non-scientists who know about the controversial H5N1 research and who begin following and participating in debates about the significance of Fouchier's and Kawaoka's work. This is the first time Kawaoka's name and research is connected to Fouchier's in media reports. The two principle framings of the research which have been articulated—that it's significant turns on its "public health" potential and that it's significant is determined by the security threat it poses—are further solidified and consistently contrasted. Several of the key tropes that will continue to be used to justify and criticize the work are introduced or underscored in these articles. Fouchier again underscores the lethality of H5N1 per se, connecting those claims to the virus he has engineered; he is quoted as saying that his is "probably one of the most dangerous viruses you can make." Paul Keim, the chair of the NSABB, is quoted as saying that Fouchier's virus is "scarier" than anthrax, which he works with. Thomas Inglsby, who in December will write the first extensive critique of the research by someone closely connected to the security establishment, asserts that the benefits of the work are outweighed by the dangers posed by accidental release or malicious use. Michael Osterholm is the first introduces the distinction between being in support of the research per se and being against its dissemination. He suggests that Fouchier and Kawaoka have the support of the "entire influenza community." Later, however, as he takes up a more forcefully critical position, he will insist that the work should never have been done. Peter Palese asserts that the "public health" framing of the dangers of the work by claiming that a transmissible form of H5N1 emerging in nature is "much more likely" than a dangerous form being circulated by humans. Claims about the relative likelihood of a naturally arising pandemic versus a pandemic created by either malicious or accidental release of Fouchier's engineered virus will become a common feature of the debates about the research and its dissemination. These claims frequently left unexplained and therefore their affects are almost always polemical. Michael Osterholm's commentaries will be perhaps the only exception.

November – December 2011	Guided by the findings of the sub-committee, the full NSABB meets to formulate its recommendations concerning what should be done about the imminent publication of the two papers, which now have been accepted by *Science* and *Nature*. After significant deliberation NSABB members reach consensus about the need to restrict access to the full findings of the two studies. Several committee members will report that they are committed to the free circulation of research findings as a definitional characteristic of science, but that the dangers associated the methods and findings of this research were uniquely grave and warranted redaction. The NSABB's recommendation cannot be enforced as they are only an advisory body. Their recommendation will thus require the cooperation of the editors of the publishing journals, Philip Campbell (*Nature*) and Bruce Alberts (*Science*). The NSABB makes its recommendations to the NIH/NIAID, who will release the recommendations on December 20 after having communicated with the researchers and the editors of the journals.
30 November 2011	The Department of Health and Human Services (DHHS) conveys the NSABB's recommendations to the paper authors and the two journals
30 November 2011	The WHO publishes a document which makes it clear that its position at this point favors some form of limited release of the H5N1 research. The opening lines suggest that WHO considers this research to be an issue of dual use, stating that they are "deeply concerned about the potential negative consequences [of the research]." They then follow with a discussion of the high mortality of the pathogen, underlining these dangers. The piece is then steered toward the topic of the Pandemic Influenza Preparedness(PIP) program, a program instituted by the WHO in May of 2011 which aims to "improve the sharing of influenza viruses with pandemic potential, and to achieve more predictable, efficient, and equitable access for countries in need, to life saving vaccines and medicines during future pandemics." The WHO returns to the framework of dual use and poses that the PIP is the "white hat" entity in this dichotomy. The document then reasserts that the H5N1 research is dangerous and needs to be limited in its distribution, making the claim that the PIP is the best way in which to effect this limited release. The publication goes on to make a claim on the H5N1 research itself, stating that the Fouchier and Kawaoka labs received their initial influenza samples from the late GISN(Global Influenza Surveillance Network). When active, the GISN was independent of the regulations of the PIP as the GISN was active prior to the PIP's inception. When the PIP was instituted, the former GISN was replaced by a similar program the GISRS(Global Influenza Surveillance and Response System) one of the tenets of which is to obey the guidelines of the PIP. WHO claims that that these changes constituted by the GISRS are retroactive and that any research under the GISN is subject to the regulations of the GISRS and PIP. The release ends by stating that failure to manage the H5N1 as described by these guidelines could undermine the PIP.

7 December 2011	Secretary of State Hillary Clinton travels to Geneva to address the United Nations Biological Weapons Convention Review, a highly unusual occurrence, which is clearly occasioned by the work of the Fouchier and Kawaoka groups. In her address Clinton reportedly warns that the threat of biological weapons cannot be ignored, given the "warning signs" and "evidence in Afghanistan" that al-Qaida in the Arabian Peninsula is calling for "brothers with degrees in microbiology or chemistry to develop a weapon of mass destruction." Evoking the specter of easy-access and garage bioterrorism Clinton states that "crude but effective" terrorist weapons can be made by using "widely available pathogens, inexpensive equipment, and college-level chemistry and biology." Clinton's visit, reference to al-Qaida, and claims about the ease within which biology can be made into a weapon confirms that questions of security and "dual-use" will frame the US Government's deliberations about these events.
15 December 2011	Writing in *Foreign Policy,* Laurie Garrett provides the most thoroughgoing account to date of Fouchier's and Kawaoka's work in an article entitled "The Bioterrorist Next-Door". The article elaborates the broader biosecurity context within which the dangers of the current research might be estimated. The article, which introduces the H5N1 research by stating "man-made killer bird flu is here," portrays the research as exceptionally dangerous and easily reproduced by a malicious actor with minimal skills in biological engineering. Although written in the style of journalistic neutrality, given this double emphasis, Garrett's piece has the narrative effect of making it seem that Fouchier and Kawaoka have brought about a worst-case-scenario. This double emphasis on danger and easy reproduction will become a repeated talking point, and thereby will become a point contentious claim and counterclaim in the coming months. Fouchier in particular will take up an uneasy stance toward both parts of Garrett's claim. He will argue that his work should be published in full because there is nothing really novel about what he has done and that his work could be reproduced by anyone familiar with existing scientific literature. He will also argue that his work is not easy to perform and that only a handful of labs worldwide would be able to pull off what he has accomplished. Similarly he will continue indexing the importance of the work to WHO case fatality rates for H5N1, while eventually arguing that the mutant strains he has created are not particularly lethal.
15 December 2011	Thomas Inglsby with his colleagues Anita Cicero and D.A. Henderson at the Center for Biosecurity at the University of Maryland publish a statement on the dangers of creating a transmissible form of the H5N1 virus. The piece is the first published statement by a group close to the biosecurity establishment which makes asserts that the possible dangers associated with the research should be considered as more significant than the possible benefits. Inglsby et al., in a fashion similar to many other commentaries which will eventually be written, begin their editorial by referencing the high rates of fatality in confirmed cases of H5N1 infection in humans. They thereby underscore the gravity of the fact that the research groups have made this virus transmissible via respiratory routes. They assert that although they are not opposed to research with deadly viruses being conducted in secure facilities, they do not think it is ever necessary to engineer lethal strains so as to make them transmissible between humans. They do not explain this assertion, other than to stress that all possibility that accidental or intentional release of deadly viruses must be eliminated. The only possible way to realize such a zero-possibility is to simply not do the work in the first place. Given that the engineering of H5N1 has already taken place, Inglsby et al. conclude by calling for a redaction of the published work and demand that the NIH make public its justifications for funding the research.

20 December 2011	The NIH emits a press release announcing the NSABB's recommendations. The press release explains that on the NSABB's advice the DHHS has asked the authors and the editors to redact the manuscripts such that methodological and other details be removed that could enable "those who would see to do harm" to replicate the experiments. Acknowledging the potential public health benefits of influenza research, the press release states that "the US Government is working" to create a mechanism whereby those "with a legitimate need" for the findings for further research or for improving public health will be able to gain access to the full details of the studies. It is later acknowledged that the NIH/DHHS has also asked the researchers to accept a voluntary moratorium on their ongoing research while this mechanism for dissemination is sorted out. The NSABB's recommendations are framed and presented in a fashion which becomes important to how the debate about the research will unfold. The NIH's press release begins by emphasizing the US Government's commitment to pandemic detection and response—strengthening flu surveillance technologies and developing vaccines. In fact more than half of the one-page press release is devoted to underscoring this commitment, with stress on the importance of transmissibility research generally and H5N1 research in particular. This emphasis on a commitment to influenza research confirms and effectively backs the claims being made by the researchers in their self-presentation. The claim that this research will enable better disease surveillance and vaccine development will be elaborated, defended, and examined in exhaustive detail in the coming weeks. Only having stated the case for H5N1 research does the press release then explain that the NIH has asked the NSABB to review the two papers in question in order to determine the extent to which this "beneficial" research might also have "the potential to be misused for harmful purposes." It then reports that the NSABB recommends redaction and the implementation a system of limited access, so as to keep the technical specifications of the research from malicious actors to the extent possible. The press release opens up a measure of rhetorical and conceptual distance, and therefore of political inconsistency, between the NSABB's and NIH's framing of the significance of the H5N1 work. The NSABB frames the research as a question of "dual-use," a framing in which the gravity of possible dangers ultimately outweigh whatever goods might otherwise come of unrestricted access to the research findings. The NIH/NIAID's emphasis on "public health" frames the significance as a matter of disease surveillance and the production of antiviral counter-measures. Although there are those who will try to join these two ways of figuring the situation, the two framings will ultimately serve to structure an increasingly polemical response to the situation. Crucially, given these polemics, the two frameworks will circumscribe the range of claims that will be taken seriously. They will delimit the terms according to which the researchers and the critics alike will be asked to justify themselves and their work, and therefore put into motion a game of claim and counter claim concerning the relative goods and dangers of the research.

20 December 2011	The NSABB recommendations initiate an intense debate about the rights of the scientific community to govern the dissemination of their work. This is linked to the question of whether Fouchier's and Kawaoka's work constitutes a matter of "dual-use" or "public health." These linked questions will quickly begin to circumscribe and intensify the range of subsidiary issues which are taken to count as a meaningful. Issues such as whether or not limited publication is feasible given the ubiquity of electronic communications, or what algorithms the WHO should use in calculating case fatality rates for H5N1 will be intensely debated in the attempt to defend positions taken on the broader questions. Crucially, if not surprisingly, the question of the right of researchers to circulate their research findings and of scientific self-determination more broadly will be cast as questions of "censorship" and "intellectual freedom." This way of narrating the situation will greatly expand the number of researchers paying close attention to the debate over the H5N1 work, thereby engaging them in the corollary questions over how to weigh goods and harms.
30 December 2011	Anthony Fauci the Director of the NIAID, Gary Nabel director of the Vaccine Research Center for NIAID, and Francis Collins the Director of the National Institutes of Health publish an op-ed piece in the Washington Post entitled "A flu risk worth taking," in which they strongly support the work of the two research groups. In a fashion consistent with the rhetorical strategy of the NIH press release, the op-ed piece frames the stakes of the H5N1 research as a matter of "public health" rather than primarily one of "dual-use." The editorial again emphasizes the high case fatality rate among humans who have become infected by avian flu. And once again this rate is cited as a means of underscoring what a boon influenza research can be to public health to the extent that it allows us to predict, detect, or respond to a "naturally occurring" H5N1 pandemic. The op-ed piece says almost nothing about the Fouchier and Kawaoka research programs specifically, and therefore does not address the question of whether these two instances of research will themselves contribute positively to public health. It only stresses the need to understand transmissibility and the emergence of new pandemics per se. The piece tacitly rejects the NSABB's dual-use framing, and makes only a passing reference to the question of whether this research might not have been worth doing given the dangers it poses in terms of malicious or accidental release. It states that work should be done in secure facilities. There is a nod to the NSABB's recommendations that circulation of the studies' findings be limited, though this too is tacit. Fauci et al.'s reframing thus effectively, if indirectly, works against the position taken by the NSABB. Despite a somewhat oblique caution that prudence is needed, the overriding tone and emphasis of the article is on the importance of transmissibility and pathogenesis studies of influenza, tacitly including the work of Fouchier and Kawaoka therein. As will be made more explicit in late February, Fauci and presumably others at the NIH, acknowledge the NSABB while nonetheless pushing for the research published in full. They will promote a rewriting (not a redaction) of the papers to the end of getting the NSABB to change its framing and its recommendations. These efforts introduce further discordancy into the "official" USG position on the research. The op-ed piece is the first major statement by government officials which takes the "public health" framing of the work as the key to understanding and justifying the research. This framing will continue to be used by other supporters of the work, especially by the researchers themselves during what might be called a "commentaries-war" in the major scientific journals, which begins in earnest in January and still continues.

December 2011	The two research groups and the editors of the two journals agree to comply with the NIH/NSABB recommendations.
5 January 2012	Laurie Garrett publishes a second article on the flu research in *Foreign Policy*, this time working to contextualize the H5N1 work relative to the existing state-of-play in the regulation of research with deadly viruses. Denouncing what she takes to be ineffectiveness of existing mechanisms, Garrett rejects the idea that the restriction of access to research findings is "the real issue" or that it will be in any way effective. Despite Garrett's rhetoric, it is not clear that restriction of access is the real issue for anyone closely involved in mitigating the possible negative outcomes of the research, not least the NSABB, for whom the recommendation to redact the manuscripts is offered as perhaps the only feasible security response available to the USG at this point. Further, Garrett connects the impossibility of effectively restricting access to a set of scientific-social dynamics which she portrays as the "democratization" of capacities for biological engineering, meaning that more and more people are able to conduct basic experiments in engineering living systems. Garrett's article offers a portrait of the situation in which that the proverbial wheels have now come off. She suggests that the US government (and others) will have to develop fundamentally new strategies for dealing with questions of biological security. She concludes her article by once again suggesting that it is easy to transform "garden-variety bird flu into a supercontagious mammalian killer." Whether or not this is the case, whether or not Fouchier has facilitated the easy creation of a supercontagious mammalian killer will become a question of intense scrutiny in the days and weeks following this article. In the meanwhile, the assumption that he has indeed brought something extremely dangerous into the world will persist as the basic assumption guiding the way in which the work is narrated and debated by supporters and critics alike.
7 January 2012	The NY Times editorial board publishes an opinion piece in which they articulate perhaps the most full throated opposition to the H5N1 research to date. The flat rejection of the worth of the research is striking, particularly in a setting which scientific research and its publication is almost always praised and defended, as the piece itself notes. The piece is titled "An Engineered Doomsday" and remains focuses tightly on the idea that the Fouchier and Kawaoka groups have created a virus which, if released, could potentially kill hundreds of millions of people. In a striking and uncompromising denunciation of the work, the editorial states that unless the US Government can justify doing otherwise, all samples of these engineered viruses should be destroyed and none of the results published, not even in a redacted form. The piece thus goes beyond the recommendations of NSABB, and even beyond the "dual-use" framing of the work. The question of "public health" does not enter in as any kind of counter-weight to their position. The piece immediately receives a series of rebuttals from writers identifying themselves as scientific experts, typified by a rebuke from noted flu expert Vincent Racaniello in his virology blog. These responses denounce the editors for taking an uncompromising position on an issue which they ostensible know very little about. This trope—that reasonable opinions can only be offered by scientific experts, and that such informed experts will inevitably support Fouchier's and Kawaoka's research—persists from this point forward. Fouchier will make the most use of the idea that his critiques are "in the media" and that they lack the insider's knowledge needed to formulate an informed position on his work. This appeal to expertise in support of the research, unsurprisingly, will elicit counter-responses from other scientific experts who will reiterate and provide more detailed formulations of the strongly critical position offered by the Times editorial board.

12 January 2012	Peter Palese, who had been quoted in several of the early reports on Fouchier's work, and who, from the outset, had expressed skepticism regarding the claim that Fouchier's strains are as deadly for humans as they are said to be for ferrets, publishes in *Nature* one of the first commentaries strongly against the NSABB's recommendations by a prominent member of the influenza research community. Palese introduces himself as the leader of the team who, in 2005, reconstructed the 1918 Spanish Flu in order to determine, genetically, why it was so lethal. Palese compares the Fouchier and Kawaoka work with this earlier experiment. He suggests that there is really little difference between them in terms of security risks, and notes that he too was criticized for bringing something dangerous into the world. This attempt to equate the two undertakings is the key to Palese's position: in this way he presumes to argue that the NSABB, who reviewed his work and recommended full publication, should endorse full publication in this case as well. Palese asserts that the NSABB's recommendation is tantamount to censorship and therefore stands against public health and science itself. If the NY Times editorial externalized any consideration of the health question, Palese uses discounts and externalizes the question of possible nefarious uses of the H5N1 work by reference to the fact that no nefarious outcomes have followed from the publication of his work. Palese ends his commentary by asserting again that the Fouchier experiments are likely not as dangerous as most critics make them out to be. And in fact, in subsequent commentaries, he will attempt to demonstrate this through a critical meta-analysis of the WHO formulas for calculating case fatality rates. Palese concludes with a kind of public health maxim, stating that the more dangerous a virus is the more important it is to study. He thus gives articulation to the rhetorical strategy that had been tacit in Fouchier's framing of his work from the outset.

19 January 2012	On 19 January *Sciencexpress* publishes two pieces in its Policy Forum which constitute perhaps the most systematically reasoned criticisms and justifications of the research to date. The first, written by Michael Osterholm and Donald Hernandez, provides one of the first detailed arguments for why the negative aspects of the flu research outweigh any goods that might come from it. The piece constitutes one of the first efforts made by a major figure in flu research community (Osterholm) taking a public stand against the research. The piece is equally significant for the fact that Osterholm is a member of the NSABB and the NSABB's sub-committee assigned to study the flu researchers' work. He his thus one of the first individuals with intimate knowledge of the two papers to articulate a strong public position against the work. Osterholm and Hernandez note that support for non-redacted dissemination of the H5N1 papers turns on the double claim that the full papers (a) will help in pandemic surveillance efforts, and (b) will help in the production of feed-stocks for new vaccines. With these view, Osterholm and Hernandez assert that the key fact in this situation is the WHO-estimated case fatality rate, which they note again is estimated to be in the range of 30-80%. This fatality rate makes H5N1 one of the most deadly viruses known. This high fatality rate might be used to support the argument in favor of the research. However, they note two further facts. First is that current surveillance capabilities are moribund, and hence the notion that knowledge of these new mutations will help with detection of an emerging pandemic is unrealistic. There is simply insufficient infrastructure worldwide to take and sequence samples of new outbreaks. Second is that the production and distribution capacities for new vaccines is grossly inadequate as a means of responding to the emergence of new flu pandemics, as was witnessed with the 2009 H1N1 pandemic. Given these three facts—high fatality, limited surveillance, and inefficient vaccine production—they conclude that widespread dissemination of the specific mutations discovered by the two research groups will not materially help in responding to emerging pandemics. It may well, they argue, equip a malicious actor or occasion a catastrophic accident. Although Osterholm's and Hernandez's piece is framed, in part, as a justification of the NSABB's recommendations, it the beginning of what might be seen as the relative dominance of the "dual-use" framework for setting the political terms according to which further debate about the work will take place. This relative dominance shows itself in the fact that from this point forward Fouchier and other supporters of the work will increasingly be asked to not only justify the research, but to justify themselves and defend the arguments put forward in support of that research. By contrast, Osterholm and others, with the exception a further publication by the NSABB explaining its recommendations, will not be put in a position where they feel obliged to defend themselves against the claim that they are standing in the way of public health.

19 January 2012	In the same edition of *Sciencexpress Policy Forum* Ron Fouchier, along with a lead post-doc on the H5N1 work Sander Herfst, and the director of Erasmus' Institute for Virology Albert Osterhaus, publishes the first systematic justification of the research his group has undertaken. The justification is clearly shaped by the criticisms leveled against their work and the recommendations made by the NSABB. Although the authors assert the positive case for their research, they clearly find themselves in a position where their case must be made according to the terms established by the "dual-use" framing of the events. The piece begins by once again calling to mind the case fatality rates of "naturally occurring" H5N1, and assert that given this fatality rate a possible H5N1 pandemic would like be much more deadly than previous flu pandemics. The authors then offer their most crucial assertion, on which the overall justification of their work ultimately turns: that influenza researchers and public health officials have come to believe that H5N1 does not pose an existential threat to human populations because it cannot be made to be transmissible among mammals. It is in the context of these two facts—high case fatality rates and the belief that H5N1 won't become transmissible in mammals—that Fouchier et al. assert the worth and importance of their undertaking and their findings. The question is not only whether or not H5N1 can become transmissible by respiratory routes; the question is if it can become transmissible without losing its lethality. The answer, they assert, is yes, and that this is precisely what their work has established. The authors conclude the opening portion of their commentary by offering two further justifications for their work: that knowledge of the mutations needed for transmissibility will allow for detection of emerging pandemics through disease surveillance, and that knowledge of the specific mutations will allow for the creation of feed-stocks for new vaccines. The authors do not address the counter-positions on these claims, made by Osterholm and others: neither the criticism that any airborne H5N1 strain emerging in the field is likely to have different mutations nor the claim, nor the criticism that the surveillance and vaccine-response infrastructure is so dysfunctional as to mitigate against bringing new deadly viruses into the world, whatever the public health aspirations. In answering the "dual-use" criticism of their work, the authors introduce a dissonant pair of assertions, which they never fully resolve. The first is that they have done everything necessary to keep their work out of the hands of malicious actors, and to guard against any accidental release: their proposal was reviewed and approved by NIAID; the Dutch Ministry for Infrastructure and the Environment gave them explicit permission to work with airborne H5N1; the Dutch Commission on Genetic Modification reviewed their work and found their facilitates to be adequate for the safe undertaking of work with airborne deadly viruses; they used specialized and redundant lab-safety equipment and procedures commensurate with the requirements of a BSL 3 facility, and were regularly inspected and certified by the CDC, the last inspection having taken place in February 2011. Second, having stressed their assiduous compliance with safety protocols, the authors then go on to argue that their work should be published in full and freely circulated. They explain that their original decision to fully disseminate results was reached in consultation with NIAID, with their colleagues at other NIAID Centers of Excellence in Influenza Research (CEIRS), and with the organizers of the EWSI conference. Nodding to the NSABB's recommendations, they strongly assert the need for as widespread dissemination as possible, include a wide range of public health officials in affected countries, industrial and governmental organizations working on the creation of new vaccines, and the broader influenza research community. They further assert that there

	is little sense in redacting their papers, that their methods were not particularly novel, and that existing scientific literature is sufficient to allow others to reproduce their work. This suggestion, that it is relatively easy for others to reproduce their work without the full published details, will be repeated by Fouchier and others. It will be coupled with claims that only "high level" researchers could reproduce what they have done and that we should not worry about the actions of rogue scientists or terrorists. Their critics will point out how much easier it is to simply synthesize a new virus once the specific mutations are known than it is to make it from scratch by passing it through ferrets; the publication of the specific mutations thus drops the bar to access by orders of magnitude in terms of resources and person hours. Fouchier, Herfst, and Osterhaus conclude the defense of their work by offering a final "perspective on dual-use." They point out that their paper is being treated as exceptional despite the fact that other researchers regularly publish on deadly viruses. They suggest that unlike infectious disease researchers who conduct their experiments in view of the greater good of public health, "biosecurity experts" cannot tolerate risk. This assertion ignores the fact that the NSABB includes several infectious disease researchers, including Osterholm who directs one of the five CIERS. They state "respect" for the NSABB's decision, but leave open the possibility that they might, in the end, ignore the recommendations. They finish by asserting that they have a moral obligation, in the name of public health, to conduct dual-use research.
20 January 2012	On the day after the publication of the two commentaries, Fouchier and Kawaoka, along with 37 of their colleagues from the influenza research community, announce that they have agreed to a self-imposed 60 moratorium on their research. The published statement does not acknowledge that such a moratorium was recommended to Fouchier and Kawaoka by DHHS, though Fouchier will note this in interviews in the following days. Nor does the published statement acknowledge that the initial reason for the moratorium was to allow for the US Government to sort out a mechanism for sharing the results of the research with relevant members of the broader research community and with public health officials. The statement, rather, begins by strongly underscoring the importance of transmissibility research for equipping disease preparedness, and reasserts that all work with infectious disease is conducted under stringent safety standards. It states that the two papers represent important breakthroughs in understanding flu transmissibility in humans, and that the work needs to be disseminated and continued if knowledge is to prove beneficial to public health. They conclude by stating that despite all the good that comes from their research, they understand that "the public" might be concerned. Hence, they state that they are agreeing to a moratorium in order to "better clarify" the reasons for undertaking their work. The rhetorical strategy of positioning all criticism as arising from a lack of understanding or clarity will continue to be a regularly used trope.
20 January 2012	On the day the moratorium is announced, Fouchier is interviewed by Martin Enserink of *ScienceInsider* in an article entitled "Flu Researcher Ron Fouchier: It's a Pity it has Come to This." The article, as the title suggests, provides Fouchier with an opportunity to restate why his work is crucial to public health, not a danger, and hence how tragic it is that his efforts are being criticized and delayed. It is Fouchier's first systematic, albeit indirect, attack on his critics in a major scientific forum. He expresses particular disappointment in those of his critics, like Osterholm, who he thinks should know better.

25 January 2012	Yoshihiro Kawaoka publishes a short commentary in *Nature* making the case for why he was right to do his work, and why work like his needs to continue. He insists that even as debates about risks and dissemination continue to be debated work on transmission and pathenogensis should continue "with urgency." The piece is significant for two main reasons. The first is the simple fact that to this point Kawaoka has kept himself out of public exchanges about this research. Indeed, in his interview with *ScienceInsider* Fouchier notes that he and Kawaoka have discussed how actively and publically to defend their research, with the two researchers coming to different conclusions about their roles. The second reason is that in this commentary Kawaoka contrasts his research with that of the Fouchier group in two respects. Unlike the Fouchier, his group did not evolve the mutations needed for aerosol transmission by passing it through ferrets; they combined elements of non-transmissible H5N1 with H1N1 strain from the 2009 "swine flu" pandemic. More importantly, Kawaoka states that when his engineered strain of H5N1 became transmissible it lost its lethality. By contrast, he asserts, Fouchier's strain "did kill infected ferrets." The main part of Kawaoka's defense is unremarkable, and basically follows the lines laid down by Fouchier and others: the study of transmissibility is crucial; work can be conducted under safe and secure conditions; and that work should be made public because "there is already enough information publically available" to do what he did. As with Fouchier he does not address the fact that by publishing the specific mutations the barrier to engineering a pandemic strain is dramatically lowered. The one point at which Kawaoka rhetorically diverges from Fouchier is an assertion that the H5N1 virus circulating in nature is actually more deadly threat than the viruses that have been engineered by his and Fouchier's group because it could become transmissible at any time. He states that it would have been irresponsible for him not to have studied the underlying mechanisms of transmissibility. He does not answer either the question of whether he could have studied transmissibility without creating a new pandemic strain, or the fact that although the naturally occurring strain may indeed one day become transmissible it has not yet—the only transmissible strains of H5N1 that exist are in the Fouchier and Kawaoka labs. Kawaoka's commentary introduces a kind of blackmail: if you are for public health, you must be for my research and its wide dissemination. He states that redacted publication will only limit "legitimate researchers," implying that it will be somehow easier for ill-legitimate researchers to get their hands on the results.
27 January 2012	Fouchier conducts an extended interview with Dutch television in which he again offers the double claim that terrorists really could not do what he has done and that his experiments are obvious enough that those who know what they are doing wouldn't need his publications to reproduce his work. In this interview it becomes clear that he has begun to qualify the claims that his work is deadly or scary, attributing these characterizations to his critics. He also has begun to back off of the strong rhetorical link he has previously made between the mutant strains that he has created and the WHO case fatality rates for H5N1, and thus, tacitly, to back off of the strongest public health claims that have been made about the benefits of his work for disease surveillance and vaccine preparedness. He begins walking a rhetorical fine line between the deadliness of the work, which justifies the urgent circulation of findings in support of public health, and suggesting that he has not made something that poses an exceptional threat to biosecurity.

31 January 2012	Given the commentaries published in the wake of their recommendations, the NSABB publishes a further explanation and defense of their position. Their explanation is printed in both *Science* and *Nature*. Unlike most of the commentaries supporting the research, which begin with references to the deadliness of flu pandemics and to the need for public health preparedness, the NSABB begins by stating that increased capacities for understanding and engineering biological systems entails the capacity to do malicious things with those capacities. They further state that in some cases "misuse" of research findings raises possible challenges to national and global security, and that research which greatly increases the harm caused by pathogens falls into this category. The flu experiments conducted by Fouchier and Kawaoka, they state, can be considered one of the first "real-world" cases of such "dual-use research." The NSABB grants that the Fouchier and Kawaoka experiments are important in that they answer the question of whether or not H5N1 can become transmissible in humans. Attributing good faith to the researchers' efforts to contribute to understanding the evolutionary routes by way of which pandemics might arise, they insist that the work nonetheless introduces the grave possibility of a human-initiated deadly pandemic. Given this possibility, the NSABB explains that it took up the task of formulating a strategy whereby results could be "responsibly communicated." And given the scale of the possible harm that could come from malicious use of the engineered H5N1, they recommended that the papers be "greatly limited" in detail. Insisting that the recommendation to redact was an exceptional act arising from exceptional circumstances, the NSABB explains that their decision was guided by three virtues central to their work "as scientists and as members of the general public": (a) acting in a way that does no harm, (b) acting prudently in the face of novel scientific findings with possibly grave consequences, and (c) acting with humility in the face of the immense power of the life sciences. By recommending limited access to the full findings of the two studies, coupled with a mechanism for allowing full access to qualified researchers and public health officials, they conclude that they have done their best to further a commitment to the benefits of research while working against possible catastrophic outcomes. They conclude by recognizing that given the threat it poses worldwide work on H5N1 and is necessary, and they call for "international discussion" on "dual-use" so the "opinions" of various "stakeholders" can be heard. Calling for a moratorium while such discussions take place, they suggest a parallel to the events surrounding the Asilomar conference in the 1970s and the creation of regulations for work with recombinant DNA. Despite stating the need for a more inclusive and nuanced discussion, the NSABB does not address the fact that the "dual-use" framing of new scientific research programs requires some means of projecting and weighing possible future uses of a given technology, an exercise which might, in the end, be untenable no matter how inclusive the discussion.

31 January 2012	Robert Webster publishes a commentary supporting the NSABB position in *mBIO*, a journal of the American Society of Molecular Biology. Webster's commentary is not the first to run in *mBIO* (the journal's editor in chief is Arturo Casadevall, a member of the NSABB). It is unremarkable in terms of its arguments, though Webster is decidedly more evenhanded in his assessment of the arguments being made both for and against the research than has become typical in the unfolding exchange of justification and counter-justification. The important fact of Webster's commentary is that he is the second Principle Investigator of one of the NIAID's Centers of Excellence in Influenza Research (CEIRS) to offer a strong public statement concerning the dangers of disseminating the H5N1 research. Indeed, with the exception of Peter Palese, principle investigators at the other Centers have kept a low profile in the debates. This relative silence is conspicuous on the part of Adolfo Garcia-Sastre, the director of the CEIR at the Mount Sinai School of Medicine, the CEIR which serves as the contracting institution for the research conducted by Fouchier.
13 February 2012	Declan Butler of *Nature* reports on a growing debate among some flu researchers as to whether or not the case fatality rates associated with H5N1 as calculated by the WHO can be trusted. At the broadest level the question is whether or not the WHO's reliance on clinical data alone might be undercounting the number of individuals who are actually infected, but whose symptoms are not sever enough to warrant clinical treatment. Against the premise of the debate, Butler asserts that even if the numbers have been overestimated H5N1 is still extremely dangerous. Despite Butler's interjection, the question of how to estimate case fatality rates in H5N1 continues to be debated, and will come to a modest head two weeks later when Peter Palese and Michael Osterholm publish contrasting meta-analyses of existing data. The publication of the Butler piece further signals the fact that the dual-use framing of the research is becoming politically dominant, and that the public health claims can only be advanced if the case is made that the H5N1 research is not as dangerous as it is usually considered to be.

16-17 February 2012	The WHO convenes a meeting of a small group of global public health and influenza experts in Geneva to discuss the engineered H5N1 influenza viruses. The published reason for the meeting is to discuss extending the temporary moratorium and to publicize the importance of continuing study of "naturally-occurring" H5N1 influenza as an urgent matter of public health. A written report following the meeting will cast the core agenda as consisting in finding "practical, feasible, *ad hoc* solutions to the questions of access to research findings and management of the laboratory-modified viruses." Anthony Fauci will later insist that the Geneva meeting happened at the behest of his office, and says that the reason for this is his commitment to democratic exchange and his acknowledgement that the US alone cannot make a decision on the work and its dissemination (although this is in effect what the NIH asked the NSABB to do). The meetings work to undo the recommendations made by the NSABB, and directly undercut the NSABB's deliberations by insisting on the predominance of the public health framing of work and portraying "dual-use" concerns as "theoretical" in the face of the "real" threat of naturally occurring bird flu. Twenty-two people attend the meeting. Influenza researchers, including Fouchier and Kawaoka, make up the majority of those involved. U.S. representatives include Fauci and NSABB chair Paul Keim. It is later reported that Fouchier and Kawaoka are given the opportunity to address the criticisms of their work, to provide clarifications of their studies and the data included in the original manuscripts. It is also reported that the researchers, Fouchier in particular, present findings that might mitigate the NSABB's and others' concerns about the research. And, indeed, later in the month Fouchier will upset the course of the unfolding events by claiming for the first time that the virus he has created is not lethal and may not be as transmissible as he and others have suggested. The most crucial outcome of the meeting is the non-consensus decision among those in attendance that the research should be published in full. The WHO's initial public statement following the meeting consists of a reassertion of the high case fatality numbers among humans infected with H5N1 and, in that light, the strong assertion that research on the virus needs to continue, albeit in a mode that helps people understand why it is important. The statement casts the meeting as a preliminary technical consultation in a series of meetings. It makes the case that the core matter now in play now is the scale-up flu surveillance efforts. The statement concludes that there is consensus among the participants that delayed publication of the entire manuscripts is better than near-term publication of redacted papers, with full details only available to researchers considered to be "legitimate." It is immediately reported in the NYTimes, and elsewhere, however, that there was not consensus. And it is further reported that Paul Keim and the one bioethicist invited, Jerome Singh, disagree with the proposal to publish in full. Anthony Fauci later states that he and others at the meeting have asked the two authors to rewrite their papers in light of the re-interpretations of the data from the original manuscripts, the introduction of new data, and in order to provide a narrative and rhetoric which will do more to assuage the concerns of those who think this research either ought not to have been done or ought not be circulated. There is again a suggestion that those who disagree with the work or its dissemination do not fully understand what is going on, and that therefore what is needed is greater clarification and better communication. The two short days spent in deliberation by the small group of participants stands in contrast to the hundreds of hours reportedly spent by the sub-committee of the NSABB.

	The report which is published after the meeting makes introduces very little by way of new content. However, its style of reasoning is crucial, providing a sustained statement of the importance of H5N1 for global health, and only noting briefly that the work has to be considered in a "social context," i.e. that "concerns have been raised" about possible nefarious uses. It frames "dual-use" as a matter of opinion, while stating unequivocally that if disseminated the work will "offer significant benefits to global health." The concluding next steps are to (1) convene more experts, (2) develop a better communication plan, and (3) to hold further discussions on "societal issues."
23 February 2012	Peter Palese, writing with Taia Wang and Michael Parides in *Sciencexpress*, reinserts himself into the debate for a third time. Having argued that ferrets are not a good model and that this is no different than his publication of the 1918 flu, he now argues that the case fatality rates associated with H5N1 and calculated by the WHO are likely significantly overestimated. Continuing the rhetorical posture of the earlier interventions, which assumes that much of this debate turns on the critic's lack of scientific support for their position, Palese et al. insist that "Fear needs to be put to rest with solid science and not speculation." Palese et al. hypothesize that because most outbreaks of H5N1 occur in areas of the world with minimal health care infrastructure, the WHO's clinic-based assessment of the total number of people who have contracted H5N1 is likely to be low. They further hypothesize that those individuals with acute symptoms would be likely to seek clinical help, and therefore that the total number of fatal cases presented is likely disproportionally high in relation to the total cases confirmed. Surveying serological data on H5N1 infections, including multiple studies which did not use the WHO's criteria of assessment, Palese et al. conclude that the overall infection rate in affected regions is probably in the range of ~1-2%. They conclude that this likely means that the case fatality rate is probably lower by an order of magnitude than the ~60% of all cases, as the WHO concludes. The implication of the argument is clear: they think that Fouchier's and Kawaoka's engineered viruses are not as lethal as even the researchers themselves have suggested, and hence they think that the NSABB is wrong to limit the circulation of findings.
24 February 2012	Michael Osterholm and Nicholas Kelly publish a perspective in *mBIO* which takes on the accusation that the NSABB has formulated its recommendations without appeal to "solid science" and "sound scientific principles." The accusations were made by Peter Palese in his *Sciencexpress* commentary on case fatality rates, and by Vincent Racaniello in an *mBIO* commentary, which also questions the accuracy of the WHO case fatality rates. In response, Osterholm and Nelson provide a detailed explanation as to why the WHO numbers can and should be trusted, and that even if the WHO numbers are overestimated by an order of magnitude, H5N1 would still be the most virulent and dangerous form of influenza. Moreover, they argue (again) that one of the core justification for Fouchier's and Kawaoka's work, namely that it will contribute to the production of pandemic countermeasures such as vaccines and antivirals, is unsupportable given the ineffectiveness of the current influenza-response infrastructure. They conclude their perspective by strongly stating that they think debates about case fatality rates and about the usefulness of the engineered H5N1 viruses for the generation of countermeasures are without merit and that continued focus on these issues detracts from the core problem of how to best manage research with deadly viruses. Osterholm and Nelson do not acknowledge the fact that the dual-use framing of the research itself is largely responsible for setting the terms within which influenza research has to be justified, and that this framing thereby contributes to creating a political environment within which arguments about case fatality rates and countermeasures can be taken seriously.

29 February 2012	The "Biodefense and Emerging Diseases Meeting" of the American Society of Microbiology organizes an *ad hoc* one-hour session in the early hours of the final day the meeting to address developments in the unfolding controversy centered on the H5N1 research, its justification, and what needs to be done. The one-hour panel is chaired by the NSABB's Acting Chair Paul Keim. It is composed of four ten-minute presentations, given by Fouchier, Osterholm, Fauci, and *Science* editor-in-chief Bruce Alberts. It thus serves as an opportunity for the major players involved to restate and clarify the judgments they have made about the research and the actions they have recommended and the first scientific forum within which the recommendations of the NSABB and the supersession of those recommendations by the WHO can be discussed. The most significant moment in the panel comes at the half-way point of Fouchier's presentation. Having spent the first half of his presentation rehearsing much of what was already known about how he did his work and the biosafety conditions under which the research was conducted, he presents several slides on what he characterizes as crucial "misperceptions" of his work. He attributes these misperceptions to the fact that he has not been allowed to publish his paper and to the press having "picked up" his story. He does not remark on the fact that the NSABB had full access to his manuscript and had taken the opportunity to interview him. Fouchier says that there are two main misperceptions: (a) that if released his engineered strain of H5N1 would "spread like wildfire," and (b) that his engineered strain is highly lethal. For the first time since the Malta meeting Fouchier shows data on his work. He displays PowerPoint slides purporting to show that, although his study is not a "quantitative model for transmission," it nonetheless suggests that the engineered strain is less contagious than the seasonal flu. He then displays another slide, entitled "Not lethal upon aerosol transmission," which purports to show data indicating that his engineered strain did not kill any of the ferrets that were infected via respiratory transmission, but only those who received the engineered virus directly through a nasal rinse. In sum, he strongly underscores that the virus was only fatal to those who received "very, very high titers" in their lower respiratory tract, and was not fatal to any of the ferrets who were infected by air. He adds, as a kind of extra defense of his conclusions, that those ferrets which had been exposed to seasonal flu seemed to have cross-protective immunity to H5N1. Fouchier's presentation is later reported as having introduced a "twist" in the story. In fact, his presentation contradicts the spirit and logic, if not the letter, of previous statements he and his colleagues have made. At his presentation in Malta and in the reports that immediately followed, the lethality of H5N1, and by implication his strain of H5N1, was consistently underscored as a means of emphasizing the vital worth of his research to public health. Kawaoka in print had reported that Fouchier's strains were lethal. And the members of the NSABB who had read the manuscript had been led to believe that it was lethal. In the wake of Fouchier's presentation it is suggested that Fouchier's original paper was simply obscure on this point, and that he had not in fact changed his story, only clarified it. The other significant aspect of the ASM panel is that Fauci once again makes it clear, albeit tacitly, that he disagrees with the NSABB framing of the research. He confirms that he had been instrumental in arranging for the WHO meeting, and he praises that meeting for having brought to light important clarifications about the research, including Fouchier's clarifications about transmissibility and lethality. Fauci announces that NIAID is joining the WHO in asking the two research groups to rewrite their papers in light of the controversy that their work has occasioned. The rewritten papers should not so much include new scientific material, but should be

	narrated in a fashion which directly addresses “concerns” that the research raises. The reworked papers should also provide “clarifications” as to why the research was conducted in the first place. They should include better interpretations of the original data, which will help avoid further misunderstandings. In short, Fauci proposes yet again that the principle criticisms of the work have arisen out of ignorance and lack of understanding, and that the appropriate solution is that two authors adopt a different rhetorical strategy in composing their scientific results. Fauci proposes that with these rewrites the members of the NSABB might revisit the papers, and perhaps come to a different conclusion given “an opportunity to see all of the data [presented] in Geneva.”
February 2012	In view of the unfolding events and the uncertainty of any definitive resolution, the Los Angeles Times reports that the National Security Council has begun work drafting regulations that would exert greater Federal control over with deadly viruses and lethal biological toxins, including regulations for the restriction of publications. The paper reports that the government “plans to issue guidelines for research grants that would give agencies the authority to delay or restrict publication of findings they considered susceptible to ‘dual use’ by terrorists or enemy states.”
1 March 2012	In response to the unfolding events, and with specific reference to Anthony Faucet’s presentation at the ASM meeting, representative Jim Sensenbrenner (R-WI), former head of the House committees on science and the judiciary, currently vice chair of the House Committee on Science, Space, and Technology, sends “fact-finding letter” to White House science adviser John Holdren. In the letter he expresses concern about the incoherence in the US position that has been introduced by Fauci’s request that the authors rewrite their papers and that the NSABB reexamine them. Citing the NSABB’s assessment that this research is a cause for grave concern, Sensenbrenner asserts that the real question is not whether or not the work should be published but why it was done in the first place. Citing Hilary Clinton’s address to the United Nations Biological Weapons Convention Review on December 7, he concludes that at a time when terrorists are actively seeking weapons of mass destruction Fouchier and Kawaoka have succeeded in creating one for them. He writes that he finds it astonishing that this work did not “hit the radar” of Fauci and others at the NIH until after the fact, and that the government’s response has been delayed, confused, and ad hoc. He asks the Whitehouse to explain how the system could have failed and what governance structure is going to be put in place to control “dual-use” research at an early stage.

2 March 2012	Jon Cohen and David Malakoff of *ScienceInsider* ask members of the NSABB to respond to Fauci's request that they take another look at the two manuscripts in revised and resubmitted form. Members note that they have been caught by Fauci's request. Though they formulated their responses differently, member are nearly unanimous in saying that Fouchier's recent "clarifications," on the surface, did not change their assessment of the dangers posed by the research and the circulation of its findings, though they remained open to hearing the clarifications in fuller detail. NSABB member David Relman underscores the fact that the two most salient points of the matter—that H5N1 is deadly and that the researchers have made it transmissible the respiratory route—have not changed and so his conclusions are unlikely to change either. Susan Ehrlich stresses that though the NSABB is committed to free scientific inquiry, it is their responsibility to make recommendations based on public security. She notes again that the researchers have taken a deadly virus and made it more dangerous, and that she thinks this is the key point. Stanley Lemon, in a similar fashion, emphasizes that what matters is aerosol transmissibility, a point which is unlikely to change with any new rewrite. Michael Imperiale explains that Fouchier had led the NSABB to believe that his virus was not only transmissible via aerosol, but that it was also lethal, and thus what he is saying now is not what he said in the original paper.
29-30 March 2012	The NSABB convenes the NSABB to review revised versions of the Fouchier and Kawaoka group manuscripts. The published findings from the meetings begin by stating the NSABB's independence. The statement of findings reports that the NSABB has unanimously recommended that the Kawaoka manuscript should be published in full. It reports that the NSABB will recommend that the Fouchier paper be published in full, but that the Board was divided 12-6 on this. The report from the meeting provides what is cast as a restatement of the general principles guiding the NSABB's deliberations. It states that the NSABB is guided by a strong commitment to unrestricted publication unless "that information could be directly misused to pose a significant and immediate risk to public safety." The three qualifying terms – "directly," "significant," and "immediate" are not explained. However, they provide the terms by which the prior decision to redact the papers can now be reversed. The report explains that the revised manuscripts "do not appear" to provide information that would "immediately" enable misuse. It additionally explains that during deliberation over the new version of the manuscripts "new evidence emerged" that suggests that full publication of the specific mutations "may" improve" surveillance and public health. Neither of these statements is explained in the report on the meeting. The report also notes that the NSABB's deliberations were guided by the newly released "United States Government Policy for Oversight of Life Sciences Dual Use Research of Concern."

30 March 2012	In coordination with the meeting of the NSABB, the Executive Branch releases the new "United States Government Policy for Oversight of Life Sciences Dual Use Research of Concern." The purpose of the new policy is to create an initial framework for the regular review and oversight of US government funded or conducted research with "high consequence pathogens and toxins" and to minimize the possibility that such research would rise to the level of what it calls "dual use research of concern (DURC). It policy states that the fundamental aim is to "preserve the benefits of life sciences research" while "minimizing the risk of misuse." The policy enumerates a series of what it refers to as principles for implementation. These consist in broad statements about the need to preserve and promote the contribution of life science research to health, wealth and security, and to articulate risk mitigation strategies consistent with that commitment. The policy notes that these new oversight guidelines are intended to harmonize and not replace existing regulations and agreements. The policy is designed to address the "risk of deliberate misuse" of work that has significant potential to cause (i) mass casualties, (ii) economic devastation, (iii), destruction to critical infrastructure, or (iv) serious damage to public confidence. It further defines which types of research must be reviewed. This includes any work with one of fifteen specified agents or toxins, or research programs guided by seven categories of experimental outcome. The list of toxins includes influenza. The list of research categories includes alteration of host range and studies to increase transmissibility. The policy gives considerable power of self-governance to agencies and departments within the US government which fund or conduct life sciences research. It instructs them to review all of their existing and proposed research and identify those project which would fall into the defined categories. It further instructs them to determine which of these might meet rise to the level of "research of concern." It then instructs the agencies and departments to assess the risks and benefits of these projects, to determine how risk is generated, and if "open access" to the results might prove problematic. It further instructs and empowers them to develop mitigation plans, to be incorporated where the agency deems necessary. Such plans might include biosafety requirements, restriction of publication, making the work classified, and even defunding. The agencies and departments are told that they will need to provide reports on a biannual basis. The policy instructs the agencies and departments to consult an existing OBA framework for conducting its assessments. It does not otherwise explain how the agencies and departments will develop the capacity for worthwhile assessment or mitigation worthy of the name. It does not provide uniform instructions for implementation, but appears to give considerable latitude to the discernment and discretion of the individual agencies and departments.

12 April 2012	Michael Osterholm writes an extensive open letter to Amy Patterson, the Associate Director for Science Policy at the NIH. The purpose of the letter is to reflect on what Osterholm takes to be the considerable failings of the way in which the March 29-30 meeting of the NSABB was organized and conducted, and to detail those failings in such a way that key lessons might be learned moving forward. Writing for the record, Osterholm states that he voted to approve full publication of the Kawaoka manuscript, but redaction of the Fouchier manuscript. Osterholm's core critique of the meeting was that it "was designed to produce the outcome that occurred. It represented a very "one sided" picture of the risk-benefit of the dissemination of the information in these manuscripts." He states that he does not think this was the result of bad motives on the part of the organizers. The over-determination of the outcome of the meeting, in Osterholm's account turned on several factors. Among these three stand out. A first, is that no scientific experts presented to the NSABB who were not in some direct fashion connected to the research at hand. Osterholm underscores that it is unlikely that a fair and critical discussion of the worth and danger of the research would be likely to follow from such a restricted and interested selection of scientific experts. Osterholm reports that he asked that influenza researchers unconnected to the research (or even to the type of research) under consideration be included. They were not. A second factor reported by Osterholm is that Fouchier's work, even in the revised manuscript, in his estimation does indeed pose an immediate and direct threat. The current state of the art in the engineering of viruses is such, Osterholm argues, that Fouchier's work provides a blueprint for the production of a transmissible form of H5N1. Whatever revisions Fouchier provided, this fact does not change. Moreover, Osterholm reports that Fouchier has continued his work and has developed a strain with a sixth mutation, a mutation which allows for researchers to produce a transmissible strain without having to passage the virus through ferrets. Osterholm stresses that no one was asked to testify at the meetings who could speak to the fact that Fouchier's work makes it much easier for researchers to reproduce the transmissible strain. A third factor reported by Osterholm is that no one spoke at the meetings who has first-hand knowledge of how influenza surveillance actually happens in countries where H5N1 is endemic. Osterholm explains that he has talked with several such individuals during the course of the six-month reflections on the significance and dangers of the H5N1 research. What he concludes from these conversations is that the infrastructure for conducting disease surveillance is nowhere near functional and rapid enough to make positive use of the specific mutations that the Fouchier and Kawaoka groups have identified. Osterholm reports that he stressed this point at the meeting. Without the participation of experts who understand the reality of the lack of surveillance capacities on-the-ground the claims made by Fouchier and his supporters that full publication of the mutations would empower surveillance and prediction of a coming pandemic were allowed to stand. A fourth factor reported by Osterholm was that the classified security briefing given at the NSABB meeting was, in his estimation, one of the most useless he had been a part of in his 20+ years of work for the US government on biosecurity. The briefing, as he reports it, basically concluded with: "we don't really know if

	there are rogue actors who would make use of this data, so there's nothing to be worried about." As a result, the question of how much the H5N1 work would or would not empower a rogue scientist was not seriously discussed and certainly could not be considered on any empirically sound grounds. He concludes this point by stating "I am particularly concerned about this aspect of the two days of deliberations, because I heard several members remark how the security briefing had a substantial impact on their decision of how to vote." A fifth – countermeasures and the difference between flu and other diseases. Osterholm concludes with in a tone of resignation suggesting that all the NSABB has done is "kick the can down the road" with regard to the difficult question of the point at which research with deadly pathogens rises to the level needed to restrict publication or even restrict pursuit of the work in the first place.

Table of Primary Actors

Name	Affiliation(s)	Biography
Alberts, Bruce	*Science*	Bruce Alberts is the Editor-in-chief of Science and a prominent biochemist who serves as one of President Obama's first three Science Envoys. Alberts is also Professor Emeritus in the Department of Biochemistry and Biophysicsat the University of California, San Francisco, to which he returned after serving two six-year terms as the president of the National Academy of Sciences (NAS). (http://biochemistry.ucsf.edu/labs/alberts/)
Butler, Declan	*Nature*	Declan Butler is a writer for *Nature*. Declan's interests include science in France, global health, science and development, computing, electronic publishing and space science. Before joiningNature in 1993, Declan wrote freelance, and worked for the French biotechnology magazine Biofutur. He graduated in biology from Queen's University, Belfast, and has a PhD in marine biology from the University of Leeds. He was made a Chevalier of France's National Order of Merit in 2003 for service to science and society. (http://www.nature.com/news/author/Declan+Butler/index.html)

Campbell, Philip	*Nature*	Philip Campbell is the Editor-in-Chief of Nature and the Editor-in-Chief of Nature-branded publications. Philip joined Nature in 1979, becoming physical sciences editor in 1982. He left Nature in 1988 to be the founding editor of Physics World. He took up his present position as Editor-in-chief in December 1995. He is a Fellow of the Institute of Physics and a Fellow of the Royal Astronomical Society. Philip's first degree was in aeronautical engineering, following which he took an MSc in astrophysics (Queen Mary College London), and a PhD in upper atmospheric physics (Leicester University). (http://www.nature.com/npg_/company_info/npg_board.html)
Casadevall, Arturo	NSABB, mBio	Aruro Casadevall is Professor and Chair, Department of Microbiology & Immunology, Division of Infectious Diseases, at Albert Einstein College of Medicine. He is Editor-in-Chief of mBio and severs as member of several editorial boards. (http://oba.od.nih.gov/biosecurity/PDF/Casadevall_Short_bio2010.pdf)
Cicero, Anita	Center for Biosecurity of UPMC	Anita Cicero serves as the Chief Operating Officer and Deputy Director of the Center for Biosecurity of UPMC. Ms. Cicero has managed a consortium of companies that focused on advancing public policy to foster research and development of medical countermeasures. Among its accomplishments, the consortium provided invited analysis to the U.S. government on strategy and organizational capacity and developed recommendations for advancing the science of efficacy studies for countermeasures in the absence of human subject data. (http://www.upmc-biosecurity.org/website/our_staff/cicero.html)
Cohen, Jon	*Science*	Jon Cohen is a correspondent with Science, and also has written for the New Yorker, Atlantic Monthly, the New York Times Magazine, Smithsonian, Outside, Slate, Technology Review, Discover, the Washington Post, New Republic, Glamour, Surfer, and other publications. (http://www.kff.org/upload/cohen%20bio%202010.pdf)
Collins, Francis	NIH	Francis S. Collins, M.D., Ph.D. is the Director of the National Institutes of Health (NIH). In that role he oversees the work of the largest supporter of biomedical research in the world, spanning the spectrum from basic to clinical research. Dr. Collins is a physician-geneticist noted for his landmark discoveries of disease genes and his leadership of the international Human Genome Project, which culminated in April 2003 with the completion of a finished sequence of the human DNA instruction book. He served as director of the National Human Genome Research Institute at the NIH from 1993-2008. (http://www.nih.gov/about/director/directorbio.htm)
Ehrlich, Susan		Susan Ehrlich, MD is a faculty at the University of Wisconsin School of Medicine and Public Health . She earned her medical degree from the University of California-San Francisco and completed her residency at the Children's Hospital Medical Center of Northern California. Her special interests include behavioral and developmental pediatrics and adolescent medicine. (http://www.uwhealth.org/findadoctor/profile/susan-d-ehrlich-md/5934)

Enserink, Martin	*Science*	Martin Enserink is a science writer and contributing editor for *Science* magazine. Specializing in infectious diseases, global health, science policy. Living in Paris and Amsterdam. (http://twitter.com/#!/martinenserink)
Fauci, Anthony	NIAID	Dr. Fauci is the Director of NIAID. He oversees an extensive research portfolio of basic and applied research to prevent, diagnose, and treat infectious diseases such as HIV/AIDS and other sexually transmitted infections, influenza, tuberculosis, malaria and illness from potential agents of bioterrorism. Dr. Fauci also serves as one of the key advisors to the White House and Department of Health and Human Services on global AIDS issues, and on initiatives to bolster medical and public health preparedness against emerging infectious disease threats such as pandemic influenza. (http://www.niaid.nih.gov/about/directors/biography/Pages/biography.aspx)
Fouchier, Ron	Erasmus Medical Center	Ron Fouchier is a faculty at the Erasmus Medical Center. He received a PhD in Medicine from the University of Amsterdam in 1995, for his studies on molecular determinants of HIV-1 phenotype variability at the Department of Clinical Viro-immunology, Sanquin Research. He was also a post-doctoral fellow at the Howard Hughes Medical Institute, University of Pennsylvania School of Medicine in Philadelphia, from 1995-1998. (http://www.erasmusmc.nl/MScMM/faculty/CVs/fouchier_cv?lang=en)
Garcia-Sastre, Adolfo	Mount Sinai School of Medicine- CEIR	Dr. García-Sastre is Professor in the Department of Microbiology and Co-Director of the Emerging Pathogens Institute at Mount Sinai School of Medicine in New York. He is also Principal Investigator for the Center for Research on Influenza Pathogenesis (CRIP), one of six NIAID Centers of Excellence for Influenza Research and Surveillance (CEIRS). Together with Charlie Rice, he is the leader of the basic research component on Viral Therapeutics and Pathogenesis of the North East Biodefense Center proposal, which was funded by NIAID and involves the collaboration of more than 20 academic institutions in New York, Connecticut and New Jersey. (http://research.mssm.edu/garcia-sastre/adolfo-garcia-sastre.html)
Garrett, Laurie	*Foreign Policy, CFR*	Laurie Garret is an author, lecturer and policy analyst. She is a member of the Council on Foreign Relations, where she runs the Council's Global Health Program, and serves as the Senior Fellow for Global Health. (http://www.lauriegarrett.com/index.php/en/home/2581/)
Harmon, Katherine	*Scientific American*	Katherine Harmon covers the health, medicine and neuroscience beats for ScientificAmerican.com. She joined the online group in January 2009 after completing an M.A. in journalism at the University of Missouri–Columbia. Her previous work has won regional and national awards and appeared in books, magazines, newspapers and web sites. (http://www.scientificamerican.com/mediakit/assets/pdf/editorial_bios.pdf)

Henderson, D.A.	Center for Biosecurity of UPMC	Dr. Henderson is a Distinguished Scholar at the Center for Biosecurity of UPMC and a Professor of Public Health and Medicine at the University of Pittsburgh. He is Dean Emeritus and Professor of the Johns Hopkins School of Public Health and a Founding Director (1998) of the Johns Hopkins Center for Civilian Biodefense Strategies. From November 2001 through April 2003, he served as the Director of the Office of Public Health Emergency Preparedness and, later, as a Principal Science Advisor in the Office of the Secretary of the Department of Health and Human Services. (http://www.upmc-biosecurity.org/website/our_staff/henderson.html)
Herfst, Sander	Erasmus Medical Center	Sander Herfst is a lead post-doctoral researcher on the H5N1 transmissibility study in the Fouchier Lab at the Erasmus Medical Center.
Hernandez, Donald *	Center for Biosecurity of UPMC	
Holdren, John *		
Imperiale, Michael	NSABB	Michael Imperiale is a board member of the NSABB. In 1984, Dr. Imperiale joined the Department of Microbiology and Immunology at the University of Michigan Medical School as the Arthur F. Thurnau Assistant Professor of Microbiology and Immunology. He was promoted to Associate Professor in 1990 and to Professor in 1996. From 2003-2004 he served as Interim Chair of the Department of Microbiology and Immunology, and he is currently Associate Chair. Dr. Imperiale served as Chair of the Institutional Biosafety Committee at the University of Michigan from 2000-2008. He is currently the Arthur F. Thurnau Professor of Microbiology and Immunology (http://oba.od.nih.gov/biosecurity/PDF/Imperiale_Michael_2010.pdf)
Inglsby, Thomas	Center for Biosecurity of UPMC	Dr. Inglesby is Director of the Center for Biosecurity of UPMC. Since becoming Director in 2009, he has expanded and deepened the Center's expertise related to public health threats, while also establishing new Center initiatives to build U.S. preparedness for and resilience to emerging infectious diseases, natural disasters, nuclear terrorism, and nuclear accidents. (http://www.upmc-biosecurity.org/website/our_staff/inglesby.html)
Kawaoka, Yoshihiro		Yoshiro Kawaoka is a faculty of the University of Tokyo and the University of Wisconsin in Madison. Dr. Yoshihiro Kawaoka received his DVM and Ph.D. in 1983 from Hokkaido University. During his postdoctoral fellowship at St. Jude Children's Research Hospital under Dr. Robert Webster, Dr. Kawaoka's studies focused on bird flu. At the University of Wisconsin-Madison, Dr. Kawaoka continued to study fundamental concepts in influenza virology including developing H5N1 influenza virus vaccines. Information uncovered by Dr. Kawaoka is used globally by public health agencies as they undertake the enormous task of influenza pandemic planning. (http://www.cell-symposia-influenza.com/bio_kawaoka.asp)

Keim, Paul	NSABB	Dr. Paul Keim is the Cowden Endowed Chair of Microbiology at Northern Arizona University (NAU), the Director of Pathogen Genomics at the Translational Genomics Research Institute (TGen) and research affiliate at Los Alamos National Laboratory (LANL). Dr. Keim is a fellow of the American Academy of Microbiology and a member or the National Science Advisory Board on Biodefense (NSABB). (http://oba.od.nih.gov/biosecurity/PDF/Keim_Paul_2010.pdf)
Lemon, Stanley	NSABB	Dr. Stanley M. Lemon serves as an NSABB board member. He is the John Sealy Distinguished University Chair and Director of the Institute for Human Infections and Immunity at the University of Texas Medical Branch at Galveston. (http://www.utmb.edu/ihii/lemon.shtml)
MacKenzie, Debora *	New Scientist	
Malakoff, David	*Science*	David Malakoff is a staff writer of Science. His writing informs the scientific community on the decisions of politicians that affect the world of science. (http://www.shepherd.edu/englweb/tcprofiles/dmalakoff.htm)
Nabel, Gary	NIAID	Dr. Gary Nabel serves as Director of the Vaccine Research Center (VRC) of the National Institute of Allergy and Infectious Diseases of the National Institutes of Health. The VRC was established in 1999 under Dr. Nabel's leadership by President Clinton to assist in the development of a vaccine against AIDS. (http://www.niaid.nih.gov/about/organization/vrc/about/pages/officedirector.aspx)
Osterhaus, Albert	Erasmus Medical Center	Albert Osterhaus is the Head of the Department of Virology at the Erasmus Medical Center at the University of Rotterdam. He is one of the world's leading virologists and his group was the first to identify human infection with the avian influenza strain H5N1. (http://ec.europa.eu/research/profiles/index_en.cfm?p=1_osterhaus)
Osterholm, Michael	NSABB	Michael Osterholm is director of the Center for Infectious Disease Research and Policy (CIDRAP), director of the NIH-supported Minnesota Center of Excellence for Influenza Research and Surveillance (MCEIRS) within CIDRAP, a professor in the Division of Environmental Health Sciences, and an adjunct professor in the Medical School, University of Minnesota. He is also a member of the Institute of Medicine (IOM) of the National Academy of Sciences and a member of the Council on Foreign Relations. In June 2005 Dr. Osterholm was appointed by Michael Leavitt, Secretary of the Department of Health and Human Services (HHS), to the newly established National Science Advisory Board on Biosecurity. In October 2008 he was appointed to the World Economic Forum's Global Agenda Council on Pandemics; he serves as chair of that council. (http://oba.od.nih.gov/biosecurity/PDF/Osterholm_Michael_short_bio7_14_09.pdf)

Palese, Peter	Mount Sinai School of Medicine	Peter Palese is a Professor and the Chair of the Department of Microbiology at Mt. Sinai School of Medicine, a position he has held since 1987. Dr. Palese is an international leader in the study of viruses that cause respiratory diseases in humans. (http://www.vivaldibiosciences.com/biopalese.html)
Parides, Michael	Mount Sinai School of Medicine	Michael Parides is a faculty of the Mount Sinai School of Medicine and is Director of the Mount Sinai Center for Biostatistics as well as the Director of Biostatistics of the International Center for Health Outcomes and Innovation Research (InCHOIR) (http://www.mssm.edu/profiles/michael-k-parides)
Relman, David	NSABB	David Relman is a board member of the NSABB. He is the Thomas C. and Joan M. Merigan Professor in the Departments of Medicine, and of Microbiology and Immunology at Stanford University, and Chief of Infectious Diseases at the VA Palo Alto Health Care System in Palo Alto, California. (http://oba.od.nih.gov/biosecurity/PDF/Relman.pdf)
Sensenbrenner, Jim	United States Congress	F. James Sensenbrenner, Jr., (Jim), represents the Fifth Congressional District of Wisconsin. The Fifth District includes parts of Jefferson, Milwaukee, and Waukesha counties, and all of Ozaukee and Washington counties. His current committee assignments include serving as the Vice Chairman of the Committee on Science and Technology and he also serves on the Committee on the Judiciary. Congressman Sensenbrenner is Chairman of the Crime, Terrorism and Homeland Security Subcommittee. He also serves on the Intellectual Property, Competition, and the Internet Subcommittee (Judiciary), as well as the Space and Aeronautics Subcommittee (Science and Technology) and the Investigations and Oversight Subcommittee (Science and Technology). (http://sensenbrenner.house.gov/Biography/)
Singh, Jerome		Jerome Amir Singh, BA, LLB, LLM, PhD, MHSc, is Head of Ethics and Health Law at the Center for the AIDS Programme of Research in South Africa (CAPRISA) and an Adjunct Professor in the Dalla Lana School of Public Health Sciences and Joint Center for Bioethics at the University of Toronto, Canada; (http://mrcglobal.net/jerome_singh)
Wang, Taia *	Mount Sinai School of Medicine	
Webster, Robert		Robert G. Webster is Professor in the Division of Virology, Department of Infectious Diseases at St. Jude Children's Research Hospital, and Director of the World Health Organization Collaborating Center for Studies on the Ecology of Influenza in Animals and Birds. His interests include the emergence and control of influenza viruses, viral immunology, the structure and function of influenza virus proteins, and the development of new vaccines and antivirals. (http://www.upmc-biosecurity.org/website/events/2005_bullsbearsbirds/speakers/webster/bio.html)