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Shining Light on "Dark Winter"

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On 22–23 June 2001, the Johns Hopkins Center for Civilian Biodefense Strategies, in collaboration with the Center for Strategic and International Studies, the Analytic Services Institute for Homeland Security, and the Oklahoma National Memorial Institute for the Prevention of Terrorism, held a senior-level exercise entitled "Dark Winter" that simulated a covert smallpox attack on the United States. The first such exercise of its kind, Dark Winter was constructed to examine the challenges that senior-level policy makers would face if confronted with a bioterrorist attack that initiated outbreaks of highly contagious disease. The exercise was intended to increase awareness of the scope and character of the threat posed by biological weapons among senior national security experts and to bring about actions that would improve prevention and response strategies.

On 22–23 June 2001, the Johns Hopkins Center for Civilian Biodefense Strategies [1], in collaboration with the Center for Strategic and International Studies (CSIS) [2], the Analytic Services (ANSER) Institute for Homeland Security [3], and the Oklahoma National Memorial Institute for the Prevention of Terrorism [4], held a senior-level exercise entitled "Dark Winter," which simulated a covert smallpox attack on the United States. Tara O'Toole and Thomas Inglesby of the Johns Hopkins Center for Civilian Biodefense Strategies and Randy Larsen and Mark DeMier of ANSER were the principal designers, authors, and controllers of the Dark Winter exercise. John Hamre of CSIS initiated and conceived of an exercise in which senior former officials would respond to a national security crisis caused by use of a biological weapon. Sue Reingold of CSIS managed administrative and logistical arrangements for the exercise. General Dennis Reimer of the Memorial Institute for the Prevention of Terrorism provided substantial funding for exercise.

The first such exercise of its kind, Dark Winter was undertaken to examine the challenges that senior-level policy makers would face if confronted with a bioterrorist attack that initiated outbreaks of highly contagious disease. The exercise was intended to increase awareness of the scope and character of the threat posed by biological weapons among senior national security experts and to catalyze actions that would improve prevention and response strategies.

Of all potential biological weapons, smallpox is historically the most ominous and feared [5–7]. It is a disfiguring, communicable disease with a case-fatality rate of 30% [8, 9]. There is no effective medical treatment [9]. The World Health Assembly officially declared smallpox eradicated worldwide in 1980 [10]. Since its eradication, smallpox vaccination programs and vaccine production have ceased around the world [6]. The United States stopped its mandatory vaccination program in 1972. Thus, residents of the United States—and indeed, the global population—are now highly susceptible to an inadvertent or deliberate release of smallpox.

It has been argued that the smallpox virus is the organism least accessible to potential bioterrorists. Since its eradication, the only officially existing stocks of the smallpox virus have been stored in 2 World Health Organization reference laboratories located in the United States and Russia [11]. Many experts believe, however, that the smallpox virus is not confined to these 2 official repositories and may be in the possession of states or subnational groups pursuing active biological weapons programs [12]. Of particular importance and concern is the legacy of the former Soviet Union's biological weapons program. It is widely known that the former Soviet Union maintained a stockpile of 20 tons of smallpox virus in its biological weapons arsenal throughout the 1970s, and that, by 1990, they had a plant capable of producing 80–100 tons of smallpox per year [13].

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EXERCISE PARTICIPANTS

The 12 participants in Dark Winter portrayed members of the National Security Council (NSC). Each is an accomplished individual who serves or has served in high-level government or military positions. Among these, the Honorable Sam Nunn, former US Senator from Georgia, played the President of the United States, and the Honorable Frank Keating, the governor of Oklahoma, portrayed himself. Five senior journalists who currently work for major networks or news organizations observed the deliberations of the simulated NSC and participated in a mock press conference during the exercise (table 1). In addition, ~50 people with current or former policy or operational responsibilities related to biological weapons preparedness observed the exercise.

EXERCISE DESIGN

Dark Winter was a "tabletop" exercise. Decision makers were presented with a fictional scenario and asked to react to the facts and context of the scenario, establish strategies, and make policy decisions. To the extent possible, the decisions made were incorporated into the evolving exercise, so that key decisions affected the evolution and outcomes of the scenario.

Dark Winter was divided into 3 segments and simulated a time span of ~2 weeks. Each segment portrayed an NSC meeting, which were set several days apart in the story: on 9, 15, and 22 December 2002. The participants began segments 2 and 3 with a review of all events that had taken place in the intervening period since the last meeting. In an effort to mirror the process of NSC meetings, exercise participants received information through a variety of sources. Exercise controllers played the roles of deputies or special assistants, providing briefings of facts and policy options to participants throughout the meetings as needed. Participants were also presented with newspaper summaries and video clips of television news coverage of the epidemic. In addition, specific individuals were given memoranda during the exercise on issues or events that would normally fall within the purview of that individual's position or agency. Thus, for example, the Director of Central Intelligence was given memos that provided updated intelligence data during the course of the meetings.

EXERCISE PLANNING ASSUMPTIONS

In designing Dark Winter, the authors of the exercise analyzed plausible delivery methods for bioterrorist attacks as well as available scientific and historical data from smallpox outbreaks in the past [14–18]. Numerous factors influence whether a pathogen will successfully invade a host community and how that pathogen will spread once established in that community [19, 20]. Two key assumptions were made that had a direct effect on the scope of the epidemic portrayed in the exercise: the number of people infected in the initial attack and the transmission rate (i.e., the number of people subsequently infected by each person with a case of smallpox). These assumptions were not intended to be definitive mathematical predictors or models and should not be interpreted as such. However, these assumptions were derived from available data

Table 1. Roles of key participants in the Dark Winter exercise.

Role	Participant
President of the United States	The Honorable Sam Nunn
National Security Advisor	The Honorable David Gergen
Director of the Central Intelligence Agency	The Honorable R. James Woolsey
Secretary of Defense	The Honorable John White
Chairman, Joint Chiefs of Staff	General John Tilelli (U.S.A., Ret.)
Secretary of Health and Human Services	The Honorable Margaret Hamburg
Secretary of State	The Honorable Frank Wisner
Attorney General	The Honorable George Terwilliger
Director, Federal Emergency Management Agency	Mr. Jerome Hauer
Director, Federal Bureau of Investigation	The Honorable William Sessions
White House Communications Director	Mr. Paul Hanley
Governor of Oklahoma	The Honorable Frank Keating
Press Secretary to Governor Frank Keating (Oklahoma)	Mr. Dan Mahoney
Correspondent, NBC News	Mr. Jim Miklaszewski
Pentagon Producer, CBS News	Ms. Mary Walsh
Reporter, British Broadcasting Corporation	Ms. Sian Edwards
Reporter, *The New York Times*	Ms. Judith Miller
Reporter, freelance	Mr. Lester Reingold

and the current understanding of the smallpox virus and, therefore, serve as a foundation for the Dark Winter scenario. These assumptions are further articulated below.

The quantity of available smallpox vaccine also significantly affected the options and outcome of the exercise. The authors posited that the quantity of undiluted vaccine available during the exercise equaled the amount in the US Centers for Disease Control and Prevention (CDC) stockpile at that time: ~15.4 million doses of vaccine.

Number of persons infected by the initial attack. In the Dark Winter scenario, 3000 people were infected with the smallpox virus during 3 simultaneous attacks in 3 separate shopping malls in Oklahoma City, Philadelphia, and Atlanta. It has been estimated that only a few virions are required to cause human smallpox infection, and thus the total quantity of virus necessary to cause 3000 infections in humans is small [9]. For example, William Patrick, a senior scientist in the US offensive biological weapons program before its termination in 1969, has stated that 1 g of weaponized smallpox would be sufficient to infect 100 people via an aerosol attack [21]. Accordingly, as little as 30 g of smallpox could cause 3000 infections, the number of infections resulting from the initial attack in this exercise. Given the small infectious dose required to cause disease, and considering that the former Soviet Union was able to produce smallpox by the ton, an attack resulting in 3000 infections is scientifically plausible.

Smallpox transmission rate. The transmission rate for smallpox is not a static characteristic of the smallpox virus that can be readily determined, but a complex, dynamic, fluctuating phenomenon contingent on multiple biological (both host and microbial), social, demographic, political, and economic factors [17, 19]. As such, the smallpox transmission rate within any given population is highly context dependent. Therefore, any effort to estimate how smallpox might spread through contemporary societies must account for contextual differences, to the extent possible.

Dark Winter was designed to investigate the challenges following a covert attack with the smallpox virus. As described in the scenario above, the first recognition of a covert attack with smallpox virus will likely occur when people infected in the initial attack begin showing signs of infection and start appearing in emergency departments and doctors' offices [16]. At this point, those people will have become capable of transmitting smallpox to others. Thus, by the time a covert attack is discovered, the disease will already be spreading to the next generation of cases, known as "second-generation" cases. Given that very few doctors currently practicing medicine have ever seen a case of smallpox, and given that there is currently no widely available, rapid diagnostic test for smallpox, it is likely that the diagnosis of initial smallpox cases will be delayed, further promoting spread of disease. These factors are crucial in estimating the transmission rate in this exercise.

Another important factor in such estimations is the level of national and global susceptibility to smallpox virus infection. Human beings are considered universally susceptible to smallpox virus, unless they have been vaccinated or have been infected previously with an orthopox virus [17]. Given the absence of endemic smallpox in the world and the absence of vaccination programs since the 1970s, the global susceptibility to smallpox virus is higher than it has ever been in modern history [6]. Data from the 2000 US Census indicate that ~42% of the US population is aged <30 years and, therefore, has never been vaccinated against smallpox [22]. For those who have been vaccinated, the susceptibility to smallpox infection is uncertain, because acquired immunity is known to wane over time. Exactly how long and to what extent smallpox immunity endures is unknown. Epidemiologic data offer some information and insights into the expected duration of immunity and the benefits of past revaccination: "an increased level of protection against smallpox persists for $\leq$5 years after primary vaccination and substantial but waning immunity can persist for $\geq$10 years.…antibody levels after revaccination can remain high longer, conferring a greater period of immunity than occurs after primary vaccination alone" ([23], pp. 3–4).

These findings suggest that those who were vaccinated in the United States before vaccination programs ceased 30 years ago would have waning immunity, although those who were vaccinated $\geq$2 times may have maintained higher levels of immunity. A rough estimate of the level of total population herd immunity to smallpox in the United States is 20% (D. A. Henderson, personal communication), a number that will continue to decrease over time. A recent analogous estimate for the United Kingdom is 18% [24]. Thus, an estimated 228 million US citizens would be expected to be highly susceptible to smallpox infection. Some experts have recently argued that immunologic memory in response to vaccination against smallpox may last considerably longer than hypothesized [25] and, consequently, that the level of herd immunity may be higher. However, for now, that remains a matter of conjecture.

The authors of the exercise used a 1:10 ratio for the transmission rate of smallpox in Dark Winter, which was based on an analysis of 34 instances of smallpox importation into Europe between 1958 and 1973 [14, 17]. These smallpox importations were instances in which a person contracted smallpox in a country where the disease still occurred naturally and then unknowingly brought the virus back to a country that no longer had endemic smallpox. Ten of those importations occurred in the months June–November, when the smallpox transmission rate is at its seasonal low. These importations were not included in further analysis, because the smallpox attack simulated in Dark

Winter took place in December, when the smallpox transmission rate is at its seasonal high. Of the remaining 24 imported cases that occurred during the seasonal high for smallpox transmission (December–May), most were quickly diagnosed and contained [14, 17].

The authors of this exercise determined that 6 of these 24 importations most closely paralleled the conditions and context of the Dark Winter exercise, as well as what should be anticipated and planned for in the event of a smallpox attack on the modern United States. In those 6 importations, health care practitioners were slow to diagnose initial smallpox cases, and infected people had considerable interaction with other people before appropriate infection-control measures were initiated [14]. The number of second-generation cases in those 6 outbreaks ranged from 10 to 19 cases, with an average of 13.3 secondary cases per initial case (95% CI, 9.3–17.3). Gani and Leach [24] have recently analyzed these smallpox importations and have estimated that the transmissibility of smallpox in those outbreaks was 10–12 new infections per infectious person. This estimate may be toward the low error bound, because it does not account for seasonal differences in transmission rates (D. A. Henderson, personal communication).

Of the smallpox importations analyzed, the importation into Yugoslavia in 1972 is particularly instructive because that outbreak encompassed many of the attributes that would be expected if a smallpox outbreak occurred today (e.g., a large number of susceptible people, delayed diagnosis, both hospital and community transmission, wide geographic dispersion of cases, difficulty in contact tracing) [17]. In that outbreak, a man on a religious pilgrimage to Mecca and Medina became infected with smallpox virus while in Iraq and subsequently brought the disease back to Yugoslavia. His infection with smallpox virus went undiagnosed, and he unknowingly infected 11 others, whose infections also went undiagnosed. The smallpox outbreak was not recognized and control measures were not initiated until the advent of the second generation of cases, which comprised 140 new cases (transmission ratio, 1:13). Ultimately, a single index case caused 175 cases of smallpox and 35 deaths before the outbreak was brought to an end. Gani and Leach [24] estimated the transmissibility of smallpox in the 1972 Yugoslavia outbreak to be 10.8 new infections per infectious person.

Given the low level of herd immunity to smallpox and the high likelihood of delayed diagnosis and public health intervention, the authors of this exercise used a 1:10 transmission rate for Dark Winter and judged that an exercise that used a lower rate of transmission would be unreasonably optimistic, might result in false planning assumptions, and, therefore, would be irresponsible. The authors of this exercise believe that a 1:10 transmission rate for a smallpox outbreak prior to public-health intervention may, in fact, be a conservative estimate, given that factors that continue to precipitate the emergence and reemergence of naturally occurring infectious diseases (e.g., the globalization of travel and trade, urban crowding, and deteriorating public health infrastructure) [26, 27] can be expected to exacerbate the transmission rate for smallpox in a bioterrorism event.

Meltzer et al. [28] have reviewed data from a selected series of past smallpox outbreaks and determined that "the average rate of transmission is <2 persons infected per infectious person" ([29], p. v). However, they also conclude that "data suggest that one person can infect many others," that a "large percentage of the population in the United States is now susceptible" to smallpox, and that "the average transmission rate following a deliberate release of smallpox might be >2 [persons infected per infectious person]" ([29], p. v). The authors of this article believe that the average past transmission rate calculated by Meltzer et al. [28, 29] does not have significant application to planning for a smallpox attack on the contemporary United States. Their analysis does not adequately account for confounding factors, such as poor herd immunity [24], seasonality, and likelihood of delayed or inadequate vaccination or other public health interventions and, therefore, significantly underestimates the transmission rate that should be anticipated if a smallpox attack occurred today. Gani and Leach [24], on the other hand, incorporated a number of these confounding factors in their mathematical analysis and predicted that the rate of transmission of smallpox in contemporary industrialized societies is 4–6 new infections per infected person, and possibly as high as 10–12 new infections per infected person in the absence of appropriate hospital infection-control procedures.

During Dark Winter, participants were told that the rate of transmission beyond the first-generation to second-generation cases (i.e., to third and fourth generations of cases) would be highly dependent on additional variables (e.g., vaccination and isolation). The Dark Winter exercise ended in the middle of the second generation of cases. However, exercise participants repeatedly requested worst-case scenario predictions for the spread of disease beyond the second generation of cases to guide their key policy decisions. Accordingly, participants were given estimates of the projected number of smallpox cases and deaths, on the assumption that no additional vaccine would become available and no systematic, coordinated isolation procedures could be broadly and effectively enacted—in other words, the worst-case scenario. In these worst-case scenario conditions, it was determined that the transmission rate would continue to be 1:10, on average. Therefore, it was estimated that the third generation of cases would comprise 300,000 cases of smallpox and lead to 100,000 deaths, and that the fourth generation of cases could encompass as many as 3,000,000 cases of smallpox and result in as many as 1,000,000 deaths. It was emphasized

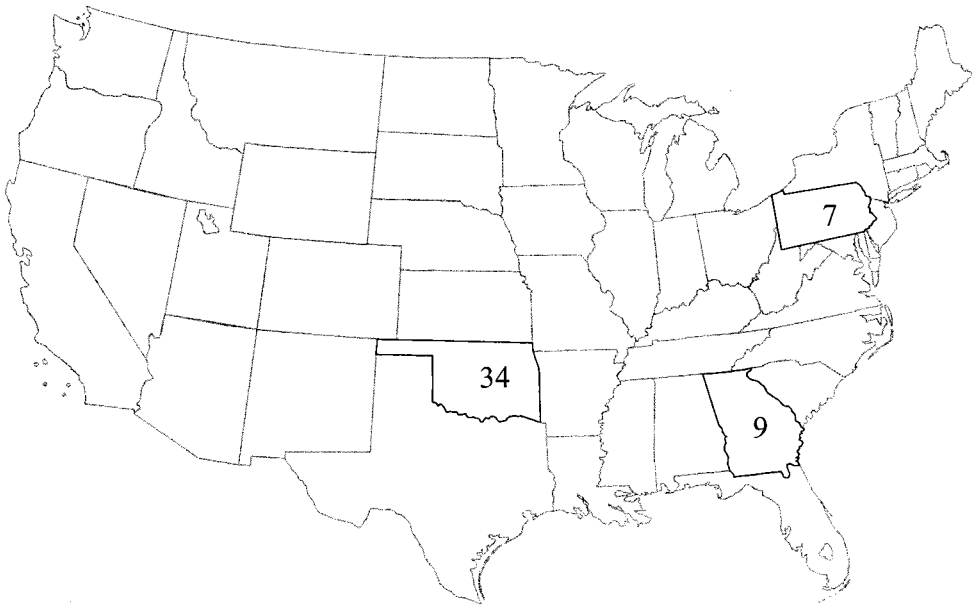

Figure 1. Map showing cumulative reported smallpox cases ($n = 50$) reported to the National Security Council at meeting 1 (9 December 2002) as part of the Dark Winter simulation exercise.

to participants that these numbers were worst-case projections and could be substantially diminished by institution of large-scale and successful vaccination programs and disease-containment procedures.

Available doses of smallpox vaccine. The United States, through the CDC, maintains a stockpile of 15.4 million doses of smallpox vaccine [30]. Exercise participants were asked to assume that only 12 million doses of vaccine would be available. This estimation was based on practical experience obtained during the smallpox eradication program in the 1960s and 1970s. During the World Health Organization's smallpox eradication campaign, it was common to lose ~20% of the available doses of vaccine from any given vial because of unavoidable inefficiencies and waste (D. A. Henderson, personal communication).

EXERCISE SCENARIO

The year is 2002 [31]. The Unites States economy is strong. Tensions between Taiwan and the People's Republic of China are high. A suspected lieutenant of Osama bin Laden has recently been arrested in Russia in a sting operation while attempting to purchase 50 kg of plutonium and biological pathogens that had been weaponized by the former Soviet Union. The United Nation's sanctions against Iraq are no longer in effect, and Iraq is suspected of reconstituting its biological weapons program. In the past 48 h, Iraqi forces have moved into offensive positions along the Kuwaiti border. In response, the United States is moving an additional aircraft carrier battle group to the Persian Gulf.

NSC Meeting 1

Information presented to NSC members, 9 December 2002. The 12 members of the NSC gather for what initially was to be a meeting to address the developing situation in southwest Asia but are given the news that a smallpox outbreak is occurring in the United States. In Oklahoma, 20 cases have been confirmed by the CDC, with 14 more suspected. There are also reports of suspect cases in Georgia and Pennsylvania. These cases are not yet confirmed. The initial exposure is presumed to have occurred on or about 1 December, given the 9–17-day incubation period for smallpox (figure 1).

The governor of Oklahoma, who is in Washington, D.C., to deliver a speech, agrees to participate in the NSC meeting to clearly articulate the priorities and needs of his state before rushing home to manage the growing crisis. NSC members are briefed on the status of the outbreak and on smallpox. It is explained that smallpox produces no symptoms at the time of exposure and that fever, malaise, and rash will develop 9–17 days after exposure; that, although vaccination before exposure or up to ~4–5 days after exposure may prevent or ameliorate disease manifestations, there is no effective treatment once the disease has developed; that the case-fatality rate for smallpox is ~30%; that smallpox virus is communicable from person to person and is spread at close range by respiratory droplets or, in some instances, at longer range by aerosols (i.e., droplet nuclei) [18]; that although the transmission rate for smallpox virus is a complex dynamic that is dependent on multiple factors, epidemiologic evidence indicates that a single infected person in a highly susceptible population can be expected to

infect 10–19 others; and that the US stockpile of smallpox vaccine is 15.4 million doses, but it is estimated that this amount translates to ~12 million usable doses [8, 9].

The Deputies Committee advises the NSC members on possible disease-containment strategies, including isolation of patients, identification and vaccination of patient contacts, and minimization of public gatherings (e.g., closing schools in affected states). In addition, the Deputies Committee provides the NSC members with 3 vaccine distribution policy options. Policy option 1 is a ring vaccination policy, in which enough vaccine would be distributed to each of the 3 affected states to vaccinate patient contacts and essential personnel, and 2.5 million doses would be set aside for the Department of Defense (DoD). Policy option 2 is a combination ring/mass vaccination policy, in which enough vaccine would be distributed to each of the 3 affected states so that all residents of affected cities could be vaccinated, as well as patient contacts and essential personnel, and 2.5 million doses would be set aside for the DoD. Policy option 3 is a combination ring/mass distribution policy, in which enough vaccine would be distributed to each of the 3 affected states so that all residents of affected cities could be vaccinated, and 2.5 million doses would be set aside for the DoD, and the remaining 47 unaffected states would immediately receive 125,000 doses of vaccine each, to use as they see fit.

Critical debate issues and decisions. The NSC confronts an array of important questions and decisions. With only 12 million doses of vaccine available, what is the best strategy to contain the outbreak? Should there be a national or a state vaccination policy? Is ring vaccination or mass immunization the best policy? How much vaccine, if any, should be held for the DoD? Should health care workers, public safety officials, and elected officials be given priority for vaccination? What about their families? Should vaccine be distributed to all of the states now, or as new cases emerge? What should the size be of the aliquots of vaccine given to each state? Should there be a mandatory or voluntary immunization policy? What is the federal role in emergency response? What are the state roles in emergency response? How are the 2 responses coordinated? Should the National Guard be activated? How best can the Guard be used (under state or under federal control)? What should be done about the developing situation in southwest Asia? What should the public be told? What should our allies be told? Was this a deliberate attack on the United States? If so, who is responsible? Is the nation at war?

The NSC members agree that the public should be fully informed as quickly as possible to maximize public confidence and adherence to disease-containment measures and to minimize the possibility that disease-containment measures would need to be forcibly imposed. NSC members decide to use vaccine distribution policy option 1, which is the ring vaccination policy intended to focus and limit vaccination efforts to those at highest risk of contracting smallpox (e.g., patient contacts and health care and public safety personnel in Oklahoma, Georgia, and Pennsylvania) while preserving as much vaccine as possible for use as the epidemic unfolds. NSC members decide that the same directed vaccination strategy will be followed if additional new cases emerge in other cities or states. In addition, NSC members decide to set aside sufficient doses of vaccine for the DoD to meet its immediate needs, with the expectation that this will be ~1 million doses and with direction to the DoD to determine those needs. NSC members decide to proceed with the deployment of the additional aircraft carrier battle group to the Persian Gulf but defer other decisions regarding deployments, pending further developments. NSC officials hope that the people of the United States will view these policy decisions as rational and equitable. The meeting closes as the NSC prepares a presidential statement for the press, detailing their decisions and actions.

NSC Meeting 2

Information presented to NSC members, 15 December 2002 (6 days into the epidemic). A total of 2000 smallpox cases have been reported in 15 states, with 300 deaths (figures 2 and 3). The epidemic is now international, with isolated cases in Canada, Mexico, and the United Kingdom. Both Canada and Mexico request that the United States provide them with vaccine. All of the cases appear to be related to the 3 initial outbreaks in Oklahoma, Georgia, and Pennsylvania. The public health investigation points to 3 shopping malls as the initial sites of exposure. Only 1.25 million doses of vaccine remain, and public unrest grows as the vaccine supply dwindles. Vaccine distribution efforts vary from state to state, are often chaotic, and lead to violence in some areas. In affected states, the epidemic has overwhelmed the health care systems, and care suffers. The DoD expresses concern about diverting its critical supplies and personnel to the civilian health care system, given the evolving crisis in the Persian Gulf.

Several international borders are closed to US trade and travelers. Food shortages emerge in affected states as a result of travel problems and store closings. Sporadic violence has been reported against minorities who appear to be of Arab descent. There are no solid leads regarding who may have perpetrated this attack. The government response to the epidemic has been criticized. The media continues its 24-h news coverage of the crisis. Misinformation regarding the smallpox outbreak begins to appear on the Internet and in the media, including false reports of cures for smallpox. Schools are closed nationwide. Public gatherings are limited in affected states. Some states limit travel and nonessential gatherings. The Department of Health and Human Services establishes a National Information Center. Three US drug companies agree to produce new vaccine at the

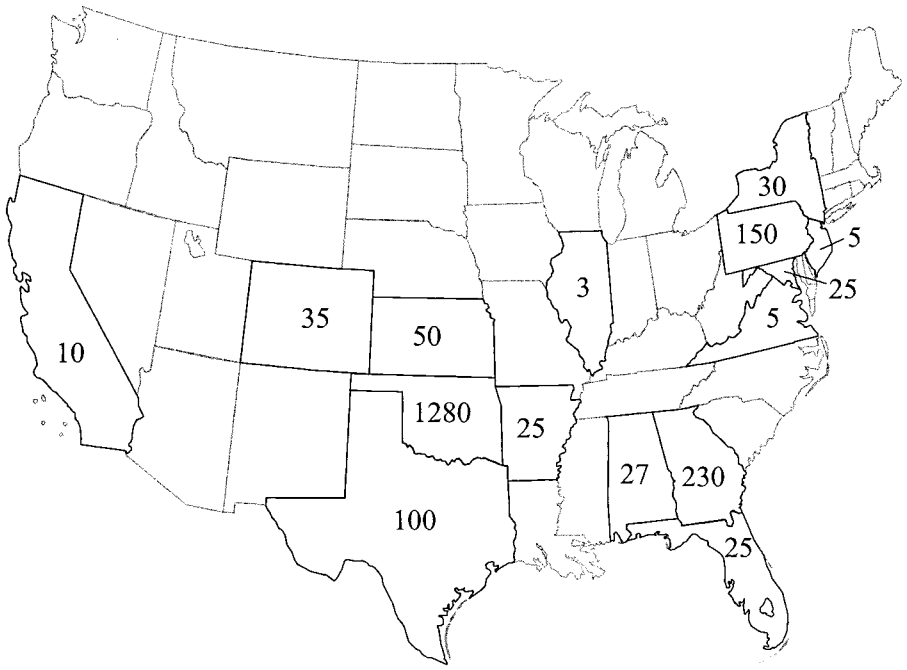

Figure 2. Map showing cumulative reported smallpox cases ($n = 2000$) reported to the National Security Council at meeting 2 (15 December 2002) as part of the Dark Winter simulation exercise.

rate of 6 million doses per month, with first deliveries in 5 weeks. Russia offers to provide 4 million doses of vaccine.

Critical debate issues and decisions. NSC officials confront a growing set of challenges and decisions. Given the shortage of vaccine, how can the spread of smallpox be halted? Should patients with smallpox be confined to facilities dedicated to care for them? Should contacts of patients be forced to remain at home or in dedicated facilities until they are proven to be free of smallpox? Should national travel restrictions be imposed? How can disease containment best be balanced against economic disruption and the protection of civil liberties? To what extent can and should the government infringe upon civil liberties? Under what conditions can those powers be exercised? What federal actions can and should be taken to care for the sick? Should the National Guard be federalized (i.e., put under federal control)? What additional assistance can the federal government provide to the states? Should troops continue to deploy overseas to southwest Asia? What should

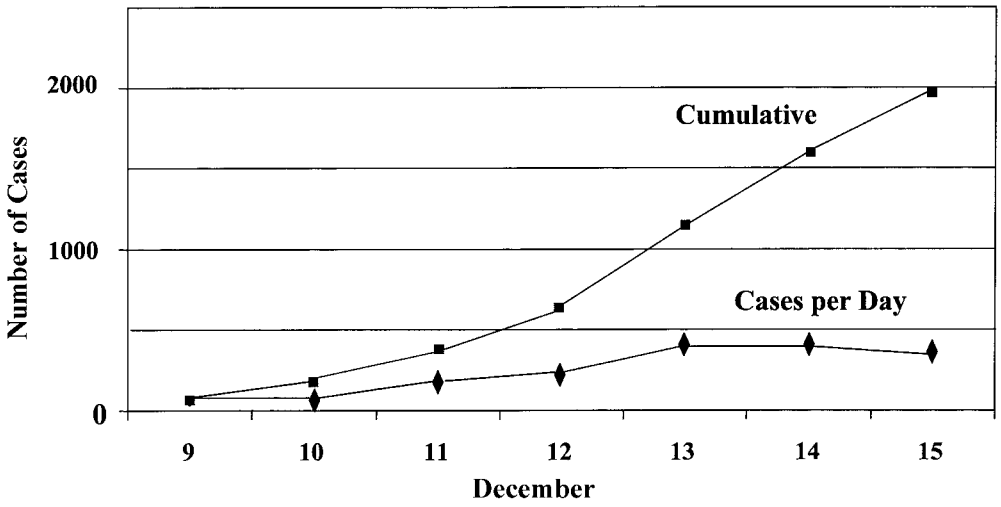

Figure 3. Smallpox cases reported to the National Security Council at meeting 2 (15 December 2002) as part of the Dark Winter simulation exercise.

the President tell the people of the United States? Who orchestrated this attack and why? Is the nation at war?

NSC members make a series of important policy decisions. Members decide to leave control of the National Guard as well as decisions on quarantine and isolation in the hands of state officials. Members decide to pursue a crash production program for new smallpox vaccine, despite unresolved liability issues. They also decide to accept smallpox vaccine offered by Russia, provided it passes safety evaluations. In addition, a statement is produced for the President to deliver in a press conference. In the press conference, the President provides an assessment of the gravity of the situation and discusses the government's response. He appeals to the people of the United States to work together to confront the crisis and to follow the guidance of their elected officials and their public health professionals regarding necessary disease-containment measures.

NSC Meeting 3

Information presented to NSC members, 22 December 2002 (13 days into the epidemic). A total of 16,000 smallpox cases have been reported in 25 states (14,000 within the past 24 h) (figures 4 and 5). One thousand people have died. Ten other countries report cases of smallpox believed to have been caused by international travelers from the United States. It is uncertain whether new smallpox cases have been transmitted by unidentified contacts of initial victims, by contacts who were not vaccinated in time, or by people who received ineffective vaccine, or are due to new smallpox attacks, or some combination of these. Vaccine supplies are depleted, and new vaccine will not be ready for at least 4 weeks. States have restricted nonessential travel. Food shortages are growing in some places, and the national economy is suffering. Residents have fled and are fleeing cities where new cases emerge. Canada and Mexico have closed their borders to the United States. The public demands mandatory isolation of smallpox victims and their contacts, but identifying contacts has become logistically impossible.

Although speculative, the predictions are extremely grim: an additional 17,000 cases of smallpox are expected to emerge during the next 12 days, bringing the total number of second-generation cases to 30,000. Of these infected persons, approximately one-third, or 10,000, are expected to die. NSC members are advised that administration of new vaccine combined with isolation measures are likely to stem the expansion of the epidemic. NSC members ask for worst-case projections. They are advised that in worst-case conditions, the third generation of cases could comprise 300,000 new cases of smallpox and lead to 100,000 deaths, and that the fourth generation of cases could conceivably comprise as many as 3,000,000 cases of smallpox and lead to as many as 1,000,000 deaths. It is again emphasized to participants that these numbers are worst-case projections and can be substantially diminished by large-scale and successful vaccination programs and disease-containment procedures (figure 6).

No solid leads as to who masterminded the attack have emerged. A prominent Iraqi defector claims that Iraq is behind the biological attack. Although the defector cannot offer proof beyond a reasonable doubt, the intelligence community deems his information highly credible. Polls of US citizens show overwhelming support for retribution when the attacker is identified.

The scenario ends when it is announced that the *New York Times*, the *Washington Post*, and *USA Today* have each received an anonymous letter demanding the removal of all US forces from Saudi Arabia and all warships from the Persian Gulf within 1 week. The letters threaten that failure to comply with the demands will result in new smallpox attacks on the US homeland as well as other attacks with anthrax and plague. To prove the veracity of these claims and the seriousness of their threats, each letter contains a genetic fingerprint that matches the fingerprint of the smallpox strain causing the current epidemic, demonstrating that the author of these letters has access to the smallpox strain.

Critical debate issues. With no vaccine remaining and new vaccine not expected for at least 4 weeks, how can the rapidly expanding epidemic be contained? What measures should the federal and state governments take to stop the epidemic, given the scope of the crisis, the lack of remaining vaccine, and rising stakes? Should the United States pull its forces out of the Gulf in response to the anonymous letters? With no conclusive evidence as to who orchestrated the attack, how and should the United States respond? If the United States discovers who is behind the attack, what is the proper response? Would the American people call for response with nuclear weapons?

LESSONS OF DARK WINTER

The authors of this article have drawn a series of lessons from the Dark Winter exercise. These lessons are based on an analysis of comments and decisions made by exercise participants during the exercise, subsequent Congressional testimony by exercise participants, and public interviews given by participants in the months after the exercise [32]. The lessons learned reflect the analysis and conclusions of the authors from the Johns Hopkins Center for Civilian Biodefense Strategies and do not necessarily reflect the views of the exercise participants or collaborating organizations.

In this section, these lessons are listed, each accompanied by a short explanatory note and quotations from participants in the exercise to illustrate it. The Dark Winter event did not permit attribution of comments without permission from individual participants. Where comments are ascribed to a particular person, permission has been obtained.

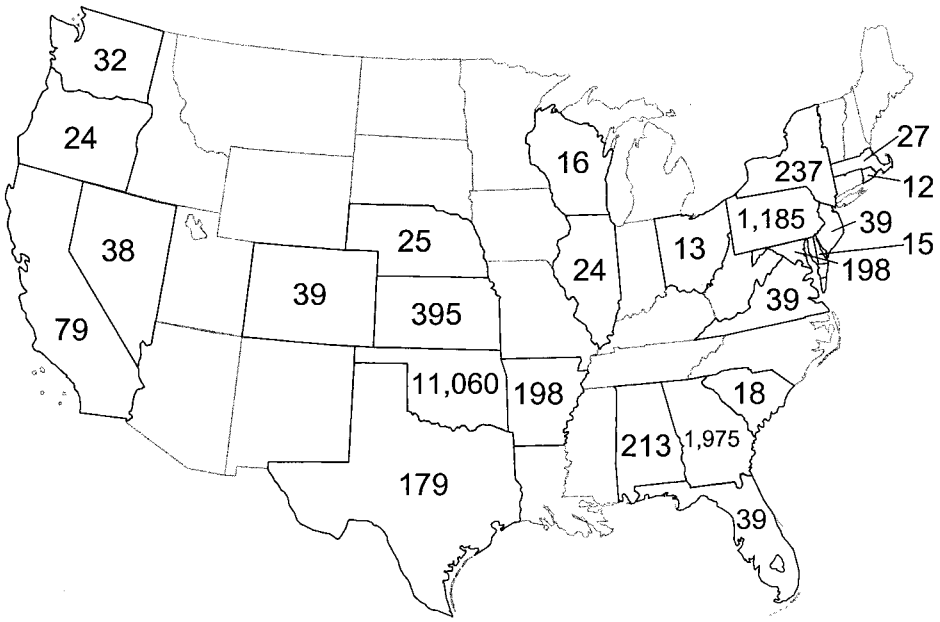

Figure 4. Map showing cumulative reported smallpox cases (n = 16,000) reported to the National Security Council at meeting 3 (22 December 2002) as part of the Dark Winter simulation exercise.

Leaders are unfamiliar with the character of bioterrorist attacks, available policy options, and their consequences. The senior decision makers in Dark Winter were largely unfamiliar with the sequence of events that would follow a bioterrorist attack. Important decisions and their implications were dependent on public health strategies and possible mechanisms to care for large numbers of sick people—issues that the national security and defense communities have not typically analyzed in the past.

"We are used to thinking about health problems as naturally occurring problems outside the framework of a malicious actor.…If you're going against someone who is using a tool that you're not used to having him use—disease—and using it toward—quite rationally and craftily—…an entirely unreasonable and god-awful end—we are in a world we haven't ever really been in before" (James Woolsey).

"This was very revealing to me—that there is something out there that can cause havoc in my state that I know nothing

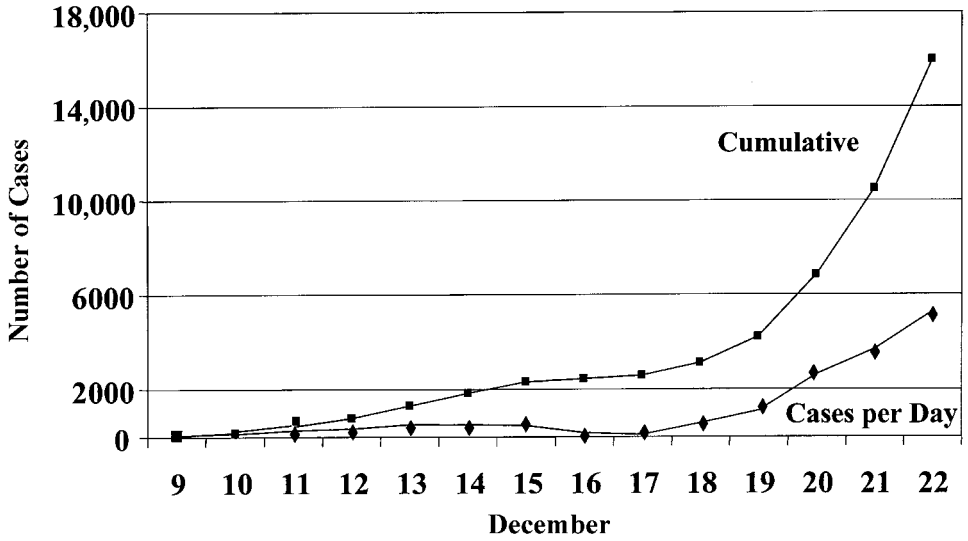

Figure 5. Smallpox cases reported to the National Security Council at meeting 3 (22 December 2002) as part of the Dark Winter simulation exercise.

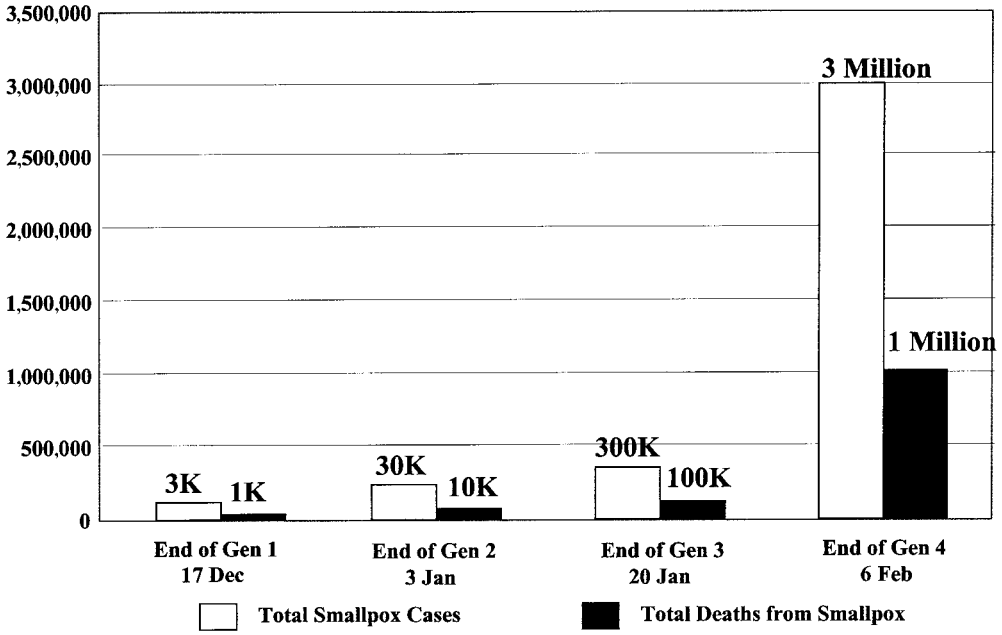

Figure 6. Smallpox epidemic projections, worst-case scenario (in the absence of disease-containment measures or new vaccine delivery), reported to the National Security Council meeting 3 (22 December 2002) as part of the Dark Winter simulation exercise. Gen, generation of cases; K, thousand.

about—and, for that matter, the federal family doesn't know a whole lot [about] either" (Frank Keating).

"My feeling here was the biggest deficiency was, how do I think about this? This is not a standard problem that I'm presented in the national security arena. I know how to think about that, I've been trained to think about that…a certain amount of what I think went [on] around this table was, 'I don't get it. I'm not in gear in terms of how to think about this problem as a decision-maker.' So then I get very tentative in terms of what to do" (John White).

"This was unique…[you know] that you're in for a long term problem, and it's going to get worse and worse and worse and worse and worse" (Sam Nunn).

After a bioterrorist attack, leaders' decisions would depend on data and expertise from the medical and public health sectors. In Dark Winter, even after the smallpox attack was recognized, decision makers were confronted with many uncertainties and wanted information that was not immediately available. (In fact, they were given more information on locations and numbers of infected people than would likely be available in reality.)

For example, it was difficult to quickly identify the locations of the original attacks; to immediately predict the likely size of the epidemic on the basis of initial cases; to know how many people were exposed; to find out how many were hospitalized and where; or to keep track of how many had been vaccinated. This lack of information, critical for leaders' situational awareness in Dark Winter, reflects the fact that few systems exist that can provide a rapid flow of the medical and public health information needed in a public health emergency.

"What's the worst case? To make decisions on how much risk to take…whether to use vaccines, whether to isolate people, whether to quarantine people.…I've got to know what the worst case is" (Sam Nunn).

"You can't respond and make decisions unless you have the crispest, most current, and the best information. And that's what strikes me as a civil leader…that is…clearly missing" (Frank Keating).

The lack of sufficient vaccine or drugs to prevent the spread of disease severely limited management options. In Dark Winter, smallpox vaccine shortages significantly affected the response available to contain the epidemic, as well as the ability of political leaders to offer reassurance to the American people. The increasing scarcity of smallpox vaccine led to great public anxiety and flight by people desperate to get vaccinated, and it had a significant effect on the decisions taken by political leaders.

"We can't ration.…Who do you choose and who do you not choose to get vaccinated?…People are going to go where the vaccine is. And if they know that you're going to provide the vaccine to my people, they'll stay to get vaccinated. I think they'll run if they think the vaccine is somewhere else" (Frank Keating).

"If we had had adequate vaccine supplies…we would have had more strategies to help deal with this thing and help control the epidemic" (Margaret Hamburg).

The US health care system lacks the surge capacity to deal with mass casualties. In Dark Winter, hospital systems across the country were flooded with demands for patient care. The demand was highest in the cities and states directly attacked, but by the time many victims became symptomatic, they were geographically dispersed, with some having traveled far from the original site of attack. The numbers of people flooding into hospitals across the country included people with common illnesses who feared they had smallpox and people who were well but worried. The challenges of distinguishing the sick from the well and rationing scarce resources, combined with shortages of health care staff, who were themselves worried about becoming infected or bringing infection home to their families, imposed a huge burden on the health care system.

"We think an enemy of the United States could attack us with smallpox or with anthrax—whatever—and we really don't prepare for it, we have no vaccines for it—that's astonishing. That's like, for me, in Oklahoma, where we do have tornadoes, to be assiduously studying hurricanes, or not studying tornadoes" (Frank Keating).

"It isn't just [a matter of] buying more vaccine. It's a question of how we integrate these [public health and national security communities] in ways that allow us to deal with various facets of the problem" (James Woolsey).

To end a disease outbreak after a bioterrorist attack, decision makers will require ongoing expert advice from senior public health and medical leaders. The leaders in Dark Winter were confronted with rapidly diminishing supply of smallpox vaccine and an expanding smallpox epidemic. Some members advised the imposition of geographic quarantines around affected areas, but the implications of these measures (e.g., interruption of the normal flow of medicines, food and energy supplies, and other critical needs) were not clearly understood at first. In the end, it is not clear whether such draconian measures would have led to a more effective interruption of disease spread.

"A complete quarantine would isolate people so that they would not be able to be fed, and they would not have medical [care].…So we can't have a complete quarantine. We are, in effect, asking the governors to restrict travel from their states that would be nonessential. We can't slam down the entire society" (Sam Nunn).

Federal and state priorities may be unclear, differ, or conflict; authorities may be uncertain; and constitutional issues may arise. In Dark Winter, tensions rapidly developed between state and federal authorities in several contexts. State leaders wanted control of decisions regarding the imposition of disease-containment measures (e.g., mandatory vs. voluntary isolation and vaccination), the closure of state borders to all traffic and transportation, and when or whether to close airports. Federal officials argued that such issues were best decided on a national basis to ensure consistency and to give the President maximum control of military and public-safety assets. Leaders in states most affected by smallpox wanted immediate access to smallpox vaccine for all citizens of their states, but the federal government had to balance these requests against military and other national priorities. State leaders were opposed to federalizing the National Guard, which they were relying on to support logistical and public supply needs. A number of federal leaders argued that the National Guard should be federalized.

"My fellow governors are not going to permit you to make our states leper colonies. We'll determine the nature and extent of the isolation of our citizens.…You're going to say that people can't gather. That's not your [the federal government's] function. That's the function, if it's the function of anybody, of state and local officials" (Frank Keating).

"Mr. President, this question got settled at Appomattox. You need to federalize the National Guard" (George Terwilliger).

"We're going to have absolute chaos if we start having war between the federal government and the state government" (Sam Nunn).

The individual actions of US citizens will be critical to ending the spread of contagious disease; leaders must gain the trust and sustained cooperation of the American people. Dark Winter participants worried that it would not be possible to forcibly impose vaccination or travel restrictions on large groups of the population without their general cooperation. To gain that cooperation, the President and other leaders in Dark Winter recognized the importance of persuading their constituents that there was fairness in the distribution of vaccine and other scarce resources, that the disease-containment measures were for the general good of society, that all possible measures were being taken to prevent the further spread of the disease, and that the government remained firmly in control despite the expanding epidemic.

"The federal government has to have the cooperation from the American people. There is no federal force out there that can require 300,000,000 people to take steps they don't want to take" (Sam Nunn).

CONCLUSION

In conducting the Dark Winter exercise, the intention was to inform the debate on the threat posed by biological weapons and to provoke a deeper understanding of the numerous challenges that a covert act of bioterrorism with a contagious agent would present to senior level policy makers and elected officials. Since the Dark Winter exercise, the country has endured the horrific events of 11 September, as well as anthrax attacks through the US postal system. Bioterrorism is no longer just the subject of war games and the source of "futuristic and

disturbing topics for…[Congressional] committee meetings" ([33], p. 2454). Many of the challenges and difficulties faced by the Dark Winter participants, unfortunately, have been paralleled in the response to the recent anthrax attacks. The Dark Winter exercise offers instructive insights and lessons for those with responsibility for bioterrorism preparedness in the medical, public health, policy, and national security communities and, accordingly, helps shine light on possible paths forward.

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