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Unready for Anthrax

By Lawrence M. Wein and Edward H. Kaplan
 Monday, July 28, 2003; Page A21

In any attempted terrorist attack against this country, smallpox and anthrax would be the only two biological agents capable of causing mass casualties. And while the government has invested considerable effort in planning for a potential smallpox attack, no equivalent plan exists for anthrax.

In a recently completed study, we looked into various emergency responses to an airborne anthrax attack and concluded that the United States is woefully unprepared. Two pounds of weapons-grade anthrax dropped on a large American city could result in more than 100,000 deaths, even if early cases were successfully diagnosed, antibiotics were distributed broadly and drug adherence was high. The reason for the catastrophic death toll: Not enough people would receive antibiotics quickly enough to prevent symptoms from developing, and those who developed symptoms would overwhelm the medical facilities.

Any plan to cope with this scenario must include (1) immediate intervention, (2) rapid distribution of antibiotics to everyone in the affected region, (3) aggressive education to ensure adherence to the full course of treatment and (4) creation of "surge capacity" to treat the sudden influx of patients.

While a response to smallpox can be measured in days, the response to anthrax needs to be measured in hours. As soon as the first case is diagnosed, intervention must be initiated. The risk of a false alarm, which include out-of-pocket costs and perhaps some panic and reduced confidence in the nation's response infrastructure, are dwarfed by the risks of waiting too long to act: an estimated 10,000 deaths per day.

Although the U.S. government promises to get antibiotics to any local airport within 12 hours, cities vary widely in their ability to move these antibiotics from their airports into the mouths of their citizens. There are several options for rapid distribution of antibiotics. We could distribute them within six hours of an attack -- after all, if we can vote in a day, we should be able to hand out pills in a day -- through pre-processing of contraindication data and disclaimer forms, local storage of antibiotics and police-escorted mail workers (or having points of distribution partially manned by nonmedical professionals).

Or we could distribute them prior to an attack. Pre-attack distribution of antibiotics might save 10,000 lives for every day that it would take to hand them out post-attack, and it could also significantly reduce the panic.

These benefits of distributing the antibiotics before any attack need to be balanced against the costs and risks: the possibility of exhausting our antibiotic supply and the chances of generating

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drug resistance in the population through misuse of the antibiotics. Such problems could be mitigated by distributing only a few days' supply in advance, which would also reduce the losses caused by perishability of the drugs.

The third element of an effective response is education about drug adherence. In the 2001 postal attack, only 40 percent of postal workers who were told to take a 60-day course of antibiotics actually adhered to the full regimen. The government needs to educate people now -- before an attack -- about the importance of adherence. And if an attack occurs, public health workers need to go into the neighborhoods and make it clear that adherence is a life-or-death matter.

The most challenging aspect of the response plan is the creation of surge capacity for medical care of anthrax victims. Even if we distribute antibiotics rapidly and make full use of local, federal and military medical personnel, tens of thousands of people could die.

The only way that we can see to avoid such a catastrophe is to tap into the pool of brave and selfless medical workers in this country by starting a national volunteer system of pulmonary specialists, which would behave in much the same way as a volunteer fire department in rural areas. For example, if there were an anthrax attack in New York City, a small fraction of specialist doctors from other major cities would jump on the next airplane with their ventilators, ingest antibiotics and arrive six hours later ready to save lives.

Our analysis also suggests that deployment of biosensors could act as a substitute for rapid antibiotic distribution, but it would be a much more expensive and less reliable measure. If we distribute antibiotics rapidly, the additional savings from biosensors are quite incremental.

Because an anthrax attack seems more likely than a smallpox attack, and its consequences appear to be more difficult to manage in terms of both loss of life and widespread contamination of assets, a stronger case can be made for voluntary pre-attack mass vaccination for anthrax than for smallpox.

Unfortunately, this option is not viable for at least the next few years: The only producer of an anthrax vaccine is having difficulty satisfying the military's requirements, and the vaccine requires a series of six shots over 18 months, along with annual boosters.

We have already dodged one bullet: Had the 10 grams of weapons-grade anthrax from the 2001 attack been airborne rather than mailborne, 10,000 people could have died, even with rapid antibiotic distribution. It is time for a credible national response to anthrax. The government must close this window of vulnerability in our homeland.

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May 30, 2005

Got Toxic Milk?

By LAWRENCE M. WEIN

Stanford, Calif.

WHILE the anthrax scare at Washington post offices this year proved to be a false alarm, it was a reminder of how vulnerable Americans are to biological terrorism. In general, two threats are viewed as the most dangerous: anthrax, which is as durable as it is deadly, and smallpox, which is transmitted very easily and kills 30 percent of its victims.

But there is a third possibility that, while it seems far more mundane, could be just as deadly: terrorists spreading a toxin that causes botulism throughout the nation's milk supply.

Why milk? In addition to its symbolic value as a target - a glass of milk is an icon of purity and healthfulness - Americans drink more than 6 billion gallons of it a year. And because it is stored in large quantities at centralized processing plants and then shipped across country for rapid consumption, it is a uniquely valuable medium for a bioterrorist.

For the last year, a graduate student, Yifan Liu, and I have been studying how such an attack might play out, and here is the situation we consider most likely: a terrorist, using a 28-page manual called "Preparation of Botulism Toxin" that has been published on several jihadist Web sites and buying toxin from an overseas black-market laboratory, fills a one-gallon jug with a sludgy substance containing a few grams of botulin. He then sneaks onto a dairy farm and pours its contents into an unlocked milk tank, or he dumps it into the tank on a milk truck while the driver is eating breakfast at a truck stop.

This tainted milk is eventually piped into a raw-milk silo at a dairy-processing factory, where it is thoroughly mixed with other milk. Because milk continually flows in and out of silos, approximately 100,000 gallons of contaminated milk go through the silo before it is emptied and cleaned (the factories are required to do this only every 72 hours). While the majority of the toxin is rendered harmless by heat pasteurization, some will survive. These 100,000 gallons of milk are put in cartons and trucked to distributors and retailers, and they eventually wind up in refrigerators across the country, where they are consumed by hundreds of thousands of unsuspecting people.

It might seem hard to believe that just a few grams of toxin, much of it inactivated by pasteurization, could harm so many people. But that, in the eye of the terrorists, is the beauty of botulism: just one one-millionth of a gram may be enough to poison and eventually kill an adult. It is likely that more than half the people who drink the contaminated milk would succumb.

The other worrisome factor is that it takes a while for botulism to take effect: usually there are no symptoms for 48 hours. So, based on studies of consumption, even if such an attack were promptly detected and the government warned us to stop drinking milk within 24 hours of the first reports of poisonings, it is likely that a third of the tainted milk would have been consumed. Worse, children would be hit hardest: they drink significantly more milk on average than adults, less of the toxin would be needed to poison them and they drink milk sooner after its release from dairy processors because it is shipped directly to schools.

And what will happen to the victims? First they will experience gastrointestinal pain, which is followed by neurological symptoms. They will have difficulty seeing, speaking and walking as paralysis sets in. Most of those who reach a hospital and get antitoxins and ventilators to aid breathing would recover, albeit after months of intensive and expensive treatment. But our hospitals simply don't have enough antitoxins and ventilators to deal with such a widespread attack, and it seems likely that up to half of those poisoned would die.

As scary as this possibility is, we have actually been conservative in some of our assumptions. The concentration of toxin in the terrorists' initial gallon is based on 1980's technology and it's possible they could mix up a more potent brew; there are silos up to four times as large as the one we based our model on, and some feed into several different processing lines that would contaminate more milk; and the assumption that the nationwide alarm could go out within 24 hours of the first reported symptoms is very optimistic (two major salmonella outbreaks in the dairy industry, in 1985 and 1994, went undetected for weeks and sickened 200,000 people).

What can we do to avoid such a horror? First, we must invest in prevention. The Food and Drug Administration has some guidelines - tanks and trucks holding milk are supposed to have locks, two people are supposed to be present when milk is transferred - but they are voluntary. Let's face it: in the hands of a terrorist, a dairy is just as dangerous as a chemical factory or nuclear plant, and voluntary guidelines are not commensurate with the severity of the threat. We need strict laws - or at least more stringent rules similar to those set by the International Organization for Standardization in Geneva and used in many countries - to ensure that our milk supply is vigilantly guarded, from cow to consumer.

Second, the dairy industry should improve pasteurization so that it is far more potent at eliminating toxins. Finally, and most important, tanks should be tested for toxins as milk trucks line up to unload into the silo. The trucks have to stop to be tested for antibiotic residue at this point anyway, and there is a test that can detect all four types of toxin associated with human botulism that takes less than 15 minutes. Yes, to perform the test four times, once for each toxin, on each truck would cost several cents per gallon. But in the end it comes down to a simple question: isn't the elimination of this terrifying threat worth a 1 percent increase in the cost of a carton of milk?

One other concern: although milk may be the obvious target, it is by no means the only food product capable of generating tens of thousands of deaths. The government needs to persuade other food-processing industries - soft drinks, fruit juices, vegetable juices, processed-tomato products - to study the potential impact of a deliberate botulin release in their supply chains and take steps to prevent and mitigate such an event.

Americans are blessed with perhaps the most efficient food distribution network in history, but we must ensure that the system that makes it so easy to cook a good dinner doesn't also make it easy for terrorists to kill us in our homes.

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November 29, 2005

Op-Ed Contributors

Think Inside the Box

By [STEPHEN E. FLYNN](#) and LAWRENCE M. WEIN

THIS week President Bush will seek to focus the nation's attention on border security and immigration reform. But the president's proposals won't protect Americans from our gravest cross-border threat: the possibility that a ship, truck or train will one day import a 40-foot cargo container in which terrorists have hidden a dirty bomb or nuclear weapon.

The Bush administration maintains that it has a smart strategy to reduce this risk. A new 24-Hour Rule requires that importers report the contents of their containers to customs inspectors one day before the boxes are loaded on ships bound for the United States. The Department of Homeland Security's National Targeting Center then reviews the data, checking against other intelligence to determine which boxes may pose a threat. Although the containers deemed high risk are inspected at cooperating foreign ports or when they enter the United States, the rest - more than 90 percent - land here without any perusal.

We have two concerns about this strategy. First, it presumes that the United States government has good enough intelligence about Al Qaeda to reliably discern which containers are suspicious and which are not. But our inability to thwart the attacks in Iraq demonstrates that we lack such specific tactical intelligence. And supporting customs inspectors, who must make the first assessment of risk, is not a priority for the intelligence agencies. Inspectors must rely on their experience in spotting anomalies - a company that claims to be exporting pineapples from Iceland, for example.

Second, determined terrorists can easily take advantage of the knowledge that customs inspectors routinely designate certain shipments as low risk. A container frequently makes 10 or more stops between its factory of origin and the vessel carrying it to American shores. Many of the way stations are in poorly policed parts of the world. Because name-brand companies like Wal-Mart and General Motors are widely known to be considered low-risk, terrorists need only to stake out their shipment routes and exploit the weakest points to introduce a weapon of mass destruction. A terrorist cell posing as a legal shipping company for more than two years, or a terrorist truck driver hauling goods from a well-known shipper, can also be confident of being perceived as low risk.

So what needs to be done? A pilot project under way in Hong Kong, the world's largest container port along with Singapore, offers one piece of a potential solution. At an estimated cost of \$7 per container, new technology can photograph the box's exterior, screen for radioactive material, and collect a gamma-ray image of a box's contents while the truck on which it is carried moves at 10 miles per hour.

Terrorists can defeat radiation sensors by shielding a dirty bomb with dense materials like lead. But by combining those sensors with gamma ray images, the Hong Kong system allows inspectors to sound the alarm on suspiciously dense objects. Inspectors would need to analyze enough of the scans - perhaps 20 percent to 30 percent - to convince terrorists that there is a good chance that an indistinct image will lead a container's contents to be sent for more reliable X-ray or manual examinations. Images of container contents would then be reviewed remotely by inspectors inside the United States who are trained to spot possible nuclear weapons.

If terrorists were to succeed in shipping a dirty bomb, for example, the database of these images could serve as a kind of black box - an invaluable forensic tool in the effort to identify how and where security was breached. That information could help prevent politicians from reacting spasmodically and freezing the entire container system after an attack.

Such a program could significantly reduce the likelihood that terrorists will smuggle plutonium or a dirty bomb through American ports. But it still would not stop a terrorist from importing highly enriched uranium, which can be used to construct a nuclear weapon. Lengthening the time that a container is screened for radiation would help, and this could be done without increasing waiting times if additional monitors were added to the Hong Kong system near the gate where the trucks must already stop for driver identification checks. Better still would be for the Department of Homeland Security to make the development of new technology that can recognize the unique signature of highly enriched uranium an urgent priority.

Finally, we must find ways to ensure that terrorists do not breach containers before shipments arrive at loading ports. Sensors should be installed inside containers in order to track their movements, detect any infiltration and discern the presence of radioactive material. Where boxes are loaded, certified independent inspectors should verify that companies have followed adequate protocols to ensure that legitimate and authorized goods are being shipped.

Taken together, these recommendations will require new investments and an extraordinary degree of international cooperation. But increased container security will not only help the United States prevent terrorism, it will also help all countries reduce theft, stop the smuggling of drugs and humans, crack down on tariff evasion and improve export controls. What's more, such a program would require an investment of just one one-hundredth of the capital that could be lost if we shut down the global container shipping system after an attack.

Container security is a complex problem with enormous stakes. American officials insist that existing programs have matters well in hand. But we cannot afford to take these perky reassurances at face value while the same officials fail to embrace promising initiatives like the Hong Kong pilot project.

Stephen E. Flynn, a fellow at the Council on Foreign Relations, is the author of "America the Vulnerable." Lawrence M. Wein is a professor at Stanford's graduate school of business.

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Face Facts

By LAWRENCE M. WEIN
Published: October 25, 2006

Stanford, Calif.



Jennifer Daniel

DESPITE all the attention given to anthrax and smallpox and potential weapons of mass destruction, pandemic influenza is probably the world's most serious near-term public health threat. If a strain similar in effect to the 1918 Spanish flu (which killed tens of millions of people worldwide) emerges in the next several years, it is highly likely that an effective vaccine will not be available during the pandemic's first wave, that we won't have enough antiviral drugs for large-scale prophylactic use, and that hospitals will be too overwhelmed to treat most cases.

Consequently, as in 1918, we will need to combine medical efforts with voluntary and forced social changes — closing schools and churches, canceling public gatherings, keeping workers at home — to hinder the flu's spread. Our government must draw up a plan for educating the public about effective nonpharmaceutical interventions like hand washing and face protection like masks.

A prerequisite for doing so is determining the biggest culprit in spreading influenza: droplet transmission, in which an infected person sneezes or coughs directly into the mouth, nose or eyes of someone who is susceptible); contact transmission, in which virus is transferred via hands either directly, say, through a handshake, or indirectly through an object like a doorknob; and aerosol transmission, in which evaporated virus-containing particles are inhaled.

Remarkably, this issue has not been resolved: the Department of Health and Human Services' Pandemic Influenza Plan states that "the relative clinical importance of each of these modes of transmission is not known." As a result, the government enthusiastically endorses frequent hand washing — which would reduce contact transmission, and costs nothing — but remains noncommittal about face protection. While the government says that it might be beneficial, it doesn't make respirators or masks available. Yet face protection would guard against aerosol and droplet transmission, and even reduce contact transmission by making it difficult to place fingers into one's mouth or nose.

A Stanford graduate student, Michael Atkinson, and I recently performed a detailed study of the routes of transmission, using data on influenza and on rhinovirus, which causes the common cold. Our findings suggest that the dominant mode of transmission for influenza is aerosol — implying that hand washing will make little difference. This is consistent with the views of leading researchers several decades ago, views that have somehow been forgotten by the public health community.

We found that ventilation, like placing a fan in an open window, and humidifiers (most influenza strains survive in the air for much less time when the humidity is raised to about 65 percent) can reduce transmission slightly. Sleeping in separate bedrooms (and working in separate offices) can help even more.

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But the single most effective intervention is face protection. And because roughly one-third of influenza transmissions occur before an infected person exhibits symptoms, these precautions should be taken whenever people are in the same room throughout the pandemic period.

There are two kinds of face protection: N95 respirators, as worn by construction workers, for instance, and surgical masks of the sort worn by dental hygienists. (The respirators cost roughly a dollar apiece, the surgical masks 10 cents.) Their efficacy in preventing aerosol transmission depends on three factors: the extent to which the face filter prevents virus particles from passing through, how tightly the device fits and — most important — how long people can be coerced into wearing them.

To our surprise, we found that the filters in surgical masks, although not as good as the filters in N95 respirators, are still quite effective. And although a surgical mask fits much more loosely and allows more leakage, it's also more comfortable — and therefore likely to be effective because it's used more. Wearing nylon hosiery over a surgical mask essentially eliminates the face leakage, making this combination a practical, albeit macabre, alternative. The less comfortable N95 respirators would probably result in lower compliance.

The government doesn't stockpile masks and respirators, and the manufacturers aren't able to produce a huge number of them quickly. But the way forward seems clear: the government needs to build up a supply of respirators and masks just as it does with vaccines and antivirals. It should first hire a whiz-bang design company to create, within one month, a surgical mask that comfortably adheres to the face, and then decide on the appropriate mix of respirators and masks. Next, it needs to sign contracts with manufacturers to stockpile masks and respirators, relieving the manufacturers of liability issues.

Although there is very little technological risk involved (masks and respirators are easier to make and safer to use than vaccines), several issues need to be ironed out. First, the effectiveness of N95 respirators and masks varies widely. The government needs to educate the public (the brands are anonymous in the published studies) and should stockpile only the most effective brands.

Also, if respirators and masks are discarded daily, as they are in many hospitals, the national demand during a three-month pandemic could be 10 to 20 billion, and the cost for respirators for a family of four several hundred dollars. Such waste isn't necessary. The virus does not survive longer than a few hours on the material used for masks and respirators, so they should be re-used until they disintegrate.

The government and the public health community must switch mindsets, from the current perspective of protecting workers paid to do a dangerous job everyday, to that of providing citizens with the tools to best protect themselves during a pandemic.

It may take 18 months to build a stockpile of respirators and masks, so there is no time to lose. The American people's faith in their government will be seriously undermined if, along with larger measures like school closings, it cannot provide effective face protection for its citizens during a deadly pandemic. Masks and respirators may be our main lines of defense during a pandemic.

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Biological and Chemical Safety Nets

By Lawrence M. **Wein**

1333 words

27 February 2007

[The Wall Street Journal](#)

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As Congress revisits homeland security, now is a good time to assess the government's progress in preventing or mitigating another, more catastrophic attack -- 100,000 or more deaths -- from biological, chemical or nuclear threats. Setting aside genetically engineered agents which may take years for terrorists to master, most experts agree on the three most dangerous bioterror agents: smallpox, anthrax and botulinum toxin.

Smallpox is the only agent of the three that results in a contagious disease; thankfully a smallpox attack appears to be the least likely due to the difficulty of obtaining the virus. Here we can point to one of the biggest homeland security achievements: the stockpiling of enough smallpox vaccine for every American, and the plans that are in place for widespread mass vaccination in the event of an attack.

It is true that the response is likely to be delayed, because there are only 40,000 first responders vaccinated nationwide (in contrast to the original government goal of 500,000). And an uncontrolled smallpox epidemic would be disastrous. Nevertheless, widespread mass vaccination (e.g., one million people vaccinated per day per afflicted city), coupled with the difficulty of initially infecting large numbers of people (the virus does not survive long in the air) and the slow speed of disease spread (each generation of the disease is approximately two weeks), precludes a situation in which tens of thousands of U.S. citizens will die.

What about anthrax? Late last year the government cancelled a \$877 million contract with VaxGen Inc. for developing and stockpiling a new generation of anthrax vaccine suitable for civilian use. Consequently, the number of deaths in a large-scale aerosol anthrax attack would depend largely on the response, or lack thereof, during the first several days. For anthrax, the single most important post-attack capability is rapid antibiotic distribution.

Unfortunately, this has been left to individual cities and states, whose capabilities vary widely. Based on a suggestion I made along with Edward Kaplan of Yale, Washington, D.C. will, in the event of a large attack, use postal workers to deliver antibiotics door-to-door to minimize the mayhem and the time required for distribution. The federal government should roll out this program nationwide.

The third bioterror agent of grave concern is botulinum toxin, the deadliest substance known to humans. The obvious mode of attack is via the water or food supply; but fortunately, reservoirs are too large and their treatment systems too harsh to make it workable.

To their credit, after 9/11 the government and dairy industry intensified the heat pasteurization formula for milk -- the most obvious food target, because the toxin mixes well in liquids, and seven billion gallons of milk are consumed annually in the U.S. The inactivation efficacy of the new pasteurization formula is classified, however, so it is not clear whether this is sufficient to prevent a large number of casualties in the event. But a post-pasteurization attack would be inefficient for terrorists because milk is bottled soon after pasteurization.

That's the good news. The bad news is that the government has made no other perceptible move to prevent deliberate food contamination. Just as the 1990 Clean Air Act led to consequence analyses to estimate the number of casualties from an accident at chemical facilities, legislation is now

required to estimate the number of casualties from a terrorist attack at food and beverage facilities. This undertaking would allow for an effective allocation of counterterrorism resources -- such as security upgrades, process changes (as in the dairy industry), and testing for botulinum toxin during food production -- targeted at the food facilities, and perhaps their upstream supply chains, that could generate a huge death toll if attacked.

Chemical security is not much farther along than food security. We do know which specific facilities -- the ones that store or produce heavier-than-air chemicals that can travel 10 to 20 miles -- could generate the most casualties if attacked. And we know there are 700 plants nationwide that, if attacked, could result in the death or serious injury of over 100,000 people. But the only progress toward prevention thus far are voluntary security investments made by the private sector.

Fences and background checks on workers might deter or thwart an attack by an unsophisticated or under-resourced terrorist group. But a determined group can compromise any chemical facility or shipment that it puts its mind to. Consequently, what is needed is a redesign of the processes or products of the most dangerous facilities, such as replacing hydrofluoric acid with sulfuric acid or modified hydrofluoric acid (neither of which pose nearly as dangerous a risk) in the alkylation process at large oil refineries in urban areas, where immense amounts of this acid are currently stored.

Although both houses of Congress last autumn produced chemical security bills with some teeth, there was no vote. Rather, a watered-down version was attached as a rider to the Department of Homeland Security's budget appropriation, which does not require high-risk facilities such as oil refineries to consider or use safer chemicals or processes.

Both houses of Congress are currently considering a chemical plant security bill. But it is not yet clear whether it will improve real security by mandating process changes, or merely produce a facade in the form of fences and background checks.

The biggest chemical threat may be the transport of the 100,000 90-ton tank cars containing toxic gases such as chlorine or anhydrous ammonia that are shipped each year in the U.S. Attacks on these well-marked cars in a densely populated area could also harm 100,000 people.

Tank cars cannot currently be designed to weather a suicide attack or a bombing. We therefore need to ban these hazardous shipments through populated areas, and not simply require their continuous tracking, as the Department of Homeland Security recently proposed. Incredibly, when Washington attempted to block hazardous rail shipments through its municipality, the federal government sided with the rail industry in court and had the ban overturned.

The worst-case scenario is a nuclear weapon detonated in a major U.S. city. The most effective way to deal with this threat is to secure all the nuclear weapons and materials in the former Soviet Union. This has not been done; hence we must resort to keeping this material from entering the country.

A second-line-of-defense program has put in place detection systems at some critical roads leading out of the former Soviet Union. But the Bush administration's approach to preventing nuclear weapons and materials from coming through our ports has been dismal -- essentially amounting to radiation testing of shipping containers that are flagged by the deeply flawed targeting system of U.S. Customs.

Radiation testing and two-dimensional scanning (which detects heavy-metal shielding) of all U.S.-bound containers, and human analysis of enough of these scans to provide a deterrent effect, is possible without increasing port congestion. It should be undertaken immediately at overseas ports. True, President Bush signed the Safe Port Act last October, which requires radiation testing at 22 domestic ports. But terrorists can detonate a bomb remotely at a U.S. port and shield a weapon's emissions with heavy material. Thus the law provides only the illusion of security.

We are today safer from a smallpox or a botulinum-in-milk attack, but only marginally safer from an anthrax, botulinum-in-food, chemical or nuclear attack. Most of the cost to secure the latter three scenarios can be passed on to consumers, but the federal government needs to lead the way.

Let us hope that during the next five years, these gaping holes are fixed so that terrorists are forced to use much less dangerous methods.

Mr. **Wein** is Paul E. Holden professor of management science at Stanford's Graduate School of Business.

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