1. ANTIGENIC DRIFT
   genetic composition of the viruses change
   as they mutate in their replications

2. ANTIGENIC SHIFT
   the reassortment (swapping) of genetic material
   from two different species as virus subtypes merge

H5N1: A Special Report
What is the threat and why should the environmental health profession be concerned?

by NEHA Executive Director Nelson Fabian, M.S.

2 pathways of mutation: antigenic drift and antigenic shift
Premise

"By the time this thing burns out, every American will know at least one person who has died from it."

Talk about exciting dinner conversation! My dinner friend—a widely recognized infectious-disease doctor who is also involved in the writing of the pandemic-flu plan for the state of Minnesota—could not be budged. I hit him with everything I had to get him to back off on his apocalyptic editorializing. We talked about the SARS scare, medical treatments, vaccines, media hype, Y2K, flu shots, and the proverbial kitchen sink. Not only did he hold strong, but he effectively shot down every argument that I fired at him. “Nelson,” he said after a moment, “it’s not a matter of if, it is a matter of when, and you had better be prepared.”

It was probably then that I crossed over the line from being a skeptic to a believer.

My learning curve on avian flu actually began several years ago, when I had the opportunity to discuss the 1997 nationwide killing of poultry with officials of the Hong Kong government. Over the past couple of years, I have been fascinated by the arguments of those in the public health community who would give up money for terrorism response planning in order to get funding to plan for “the more serious threat of a pandemic flu.”

Last spring, I was impressed by how vigorously officials from the Centers for Disease Control and Prevention (CDC) were making avian flu their top research agenda item. Last September, I, like you, got a visual of what a widespread disaster (such as a pandemic flu) might look like through the media coverage of the aftermath of Katrina. And as Marty Evans, chairwoman for the Red Cross said, “The effects of a bird flu pandemic would dwarf even the devastation caused by Hurricane Katrina.”

In October we heard our President (who has long championed states’ rights) talk of usurping the power of state governors by taking control of national guard troops to enforce quarantines in a flu pandemic situation. That raised a few eyebrows—mine included.

Also last fall, we heard many prominent people and organizations sound the alarm. The Trust for America’s Health (TFAH) suggested that a pandemic flu was tantamount to a Category 5 viral storm hitting every state.

The combined weight of these incidents had my attention. It was, however, the urgency with which my dinner guest spoke that pushed me from being attentive to being alarmed. He was describing a catastrophe unlike anything I could conceive. My mind kept turning over what he was saying, and it kept coming back with the assessment that this could be the public health crisis of my lifetime.

Since that dinner, I have been digging into this issue and making presentations on it around the country. We at NEHA are now de-voting this major section of the Journal to the story of avian flu for the following reasons:

• Avian flu has the potential to become a major, if not catastrophic, public and environmental health issue.

• Our sense from numerous interactions with both public and environmental health people is that there is very little understanding of the issue within our ranks despite the significant role that our profession will almost surely play in any pandemic-flu response.

• Many people know some of the “dots,” but few know how the dots connect into the big picture.

The special report that follows is an amalgamation of my notes and speeches. It is a combination research article, speech, and editorial.

So What’s Going On … What’s the Big Deal … What Is This Thing Called H5N1?

Our answer takes us first to events in China and Southeast Asia.

In this part of the world, migratory waterfowl have somehow picked up the H5N1 flu virus from lake waters they have visited on their migration journeys. Because of economic development in the region, many of the natural wetlands that these birds visit have disappeared. As a result, the waterfowl have turned to landing in farm areas for water and food. There they have come into contact with local poultry. In the close interactions that follow between waterfowl and poultry, the virus has spread from the migratory birds into poultry flocks. The result has been numerous outbreaks of bird flu in poultry populations.

In addition, over 135 humans are known to have contracted the disease, almost always from chicken blood or droppings.

Many have asked, “What’s the big deal?” So we have a few dead birds (150 million to be exact) and an insignificant number of people (69) who have died from this virus.

The big deal is simply this. If this virus mutates and becomes transmissible among humans, we’re looking at the possibility of a pandemic that could cause an unimaginable worldwide calamity.

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Pandemics happen. In the last century, we’ve had three of them:

• 1918–1919—the Spanish flu,
• 1957–1958—the Asian flu, and
• 1968–1969—the Hong Kong flu.

The World Health Organization (WHO) defines a pandemic as the confluence of three events:
• There must develop a novel virus that the world has never seen before (and to which humanity has absolutely no immunity).
• That virus must demonstrate an ability to sicken or kill people.
• The virus must become transmissible among humans.

The first two of these conditions have now been met. It is therefore little wonder that the public health community is alarmed.

Michael Osterholm, the director of the Center for Disease Research and Policy at the University of Minnesota and a keynote speaker at a NEHA Annual Educational Conference, describes the potential for a bird flu pandemic “as the single greatest risk to our world today.” Richard Falkenrath, President Bush’s former deputy homeland security advisor, has said, “This is a bigger threat than terrorism. It is bigger than anything I dealt with in government.”

And the list of testimonials about the peril of this threat seems endless.

Many reputable people are saying that the third step necessary for a pandemic is inevitable. What is so worrisome is that this is no ordinary virus. It resembles the deadly 1918 Spanish flu virus, and it is absolutely lethal. The World Health Organization (WHO) notes that the mortality rate in birds approaches 100 percent and that birds die from the virus within 24 to 48 hours. So far in humans, mortality from the H5N1 virus is over 50 percent (135 known cases, 69 dead), making it the most lethal form of flu ever experienced by humans. By comparison, the mortality rate from the deadly 1918 flu was around 5 percent.

**H5N1 Is on the March**

Until recently, the virus had been limited to Eastern Asia. It has now made its way into Russia, the Ukraine, Turkey, and parts of Europe. Altogether, H5N1 has been found in 16 different nations. Many experts are afraid that it will soon show up in Africa because it is now in the middle of two great migratory flyways that connect Europe and Africa.

If H5N1 gets a foothold in Africa, it could be a disaster. Most African nations lack the infrastructure to monitor the spread of the virus. They have a limited ability to identify infected bird populations and will likely be unable to quarantine and kill the infected birds to stop and control the spread of the virus.

In addition, tens of millions of people in Africa have weak immune systems because of HIV/AIDS. If the virus acquires the ability to spread from person to person or to spread more easily from birds to people, millions of Africans could die.

**Understanding Viruses and the Nature of the Threat**

In and of itself, the appearance of bird flu isn’t necessarily a cause for alarm. It is the possibility that this virus could mutate and become transmissible between humans that is causing so much concern. To understand the nature of the fear, it is helpful to know a little bit more about viruses.

Viruses and flu viruses in particular are always changing. That’s why we need a new flu shot each year. A new or different flu strain requires a new and different vaccine to protect us from it.

Viruses are actually just strands of DNA or RNA. On their own, they can’t reproduce. To propagate, they penetrate into a cell and hijack the cell’s reproductive mechanism. Once this feat is accomplished, new copies of the virus can be produced.

Antivirals like Tamiflu work by blocking the ability of a virus to move out of a cell once it is produced. If viruses can’t escape cells to spread throughout the host, the threat they pose to health disappears.

Viruses change, or mutate, in one of two ways. They can just randomly mutate over time in a natural-selection process (referred to as antigenic drift). Or they can combine with other viruses to produce new viral strains (referred to as antigenic shift, or reassortment). The great fear among scientists today is that the H5N1 virus will mutate into a form that will become transmissible among people. This mutation could happen either through antigenic drift or through antigenic shift.

With respect to shift, the concern is that the H5N1 bird flu virus will penetrate (infect) a cell that is also infected with a human flu virus. Once together in that cell, the two viruses could swap genetic material to create a new virus that is both lethal and transmissible among people.

The fear of such a mutation explains why countries are killing so many birds. We want to limit the contact between people and sick birds, thereby minimizing the odds that two viral strains will show up in the same person (or bird or pig) at the same time. (We also want to minimize the possibility of more direct bird-to-human transmissions of the disease.)

**Back to China, … the Likely Point of Origin for a Pandemic**

China is estimated to have 1.3 billion people and 14 billion chickens, geese, and ducks. It also has some 70 percent of the world’s pigs. (Like humans and birds, pigs can host both human flu and bird flu viruses, thereby constituting another great “mixing vessel” for antigenic shift.)

Some 50 million Chinese households, located in between a half million and a million villages, raise poultry. Chickens come and go freely in these homes and mix constantly with humans.
With the economic growth that China is experiencing, more and more Chinese are now buying, killing, and eating chickens. The possibility of getting infected by a sick chicken is thus increasing, especially during slaughter.

The increased exposure also means a higher probability that a person could contract bird and human flu at the same time. With all the chickens, pigs, and people living in China and with increasing numbers of bird flu outbreaks occurring there, concern is growing that the feared virus reassortment could happen in that country at any time.

Officially, the Chinese acknowledge three confirmed cases of avian flu in humans (two of the victims died). There is considerable speculation, however, that the number of human cases of bird flu could be much higher. It wasn’t until November, for example, that the Chinese acknowledged a bird flu outbreak in Yunnan province. This province borders Vietnam, where more than 90 people have contracted H5N1 infections. Science magazine has also reported that a senior Japanese virologist and advisor to WHO has claimed that upwards of 300 people have died from H5N1 in China and that some 3,000 people have been quarantined. This speculation isn’t easy to dismiss, given the way the Chinese government covered up the initial occurrence of SARS in that country.

One question that people ask is, If a pandemic began in China, could it be stopped?

Researchers have used computer models to explore our ability to stop a pandemic in its tracks. The models suggest that one of two conditions has to be met to break a pandemic before it takes off. We either have to know that a pandemic is starting before the 31st case develops, or we have to intervene within 30 days from the onset of the pandemic.

In the case of a mutated H5N1 flu virus outbreak among people, meeting either of these thresholds doesn’t appear easy. For one thing, the disease doesn’t present for two days. Thus, a person can be infected and contagious without even knowing it. For another, the disease has to be recognized, which usually means that someone who is sick has to show up for care. Chinese people typically don’t show up for care because they can’t afford the “red envelopes,” or doctor bribes, necessary for treatment.

Which leads to another question: If a pandemic does erupt in China (or elsewhere), how dangerous would it be?

Comparisons with the Deadly 1918 Flu

Researchers have recently reconstructed the 1918 flu virus and have found that it is similar to the H5N1 virus. Since H5N1 may ultimately end up looking and acting like the 1918 flu virus, it is appropriate to reconsider what happened in 1918.

More people died of influenza in a single year (1918) than in the four years of the Black Death bubonic plague of 1347–1351. Ill people were herded into emergency shelters and tents to be cared for. Estimates vary, but most seem to agree that upwards of 50 million people died from the 1918 flu worldwide. In the United States, it is estimated that 25 percent of the population was infected and some 650,000 people died. The U.S. population was about 103,000,000 in 1918; a proportional number in today’s population of about 300,000,000 would be some 1,950,000 deaths. (It should be noted that many of the deaths in 1918 were attributed to a secondary bacterial pneumonia in combination with a primary influenza infection. Presumably, with the availability of today’s broad-spectrum antibiotics, we can treat many of these complications, thereby reducing the number of expected deaths.)

The 1918 flu killed people in two or three days. A person would go to work on Monday, have a headache by Monday night, be in bed by Tuesday or Wednesday and be dead by Thursday.
The population was ravaged in other ways as well. For one thing, the illness discriminated against the young and healthy, particularly people 16 to 40 years of age. Normally people in this age group suffer about 10 percent of a season’s influenza deaths. In 1918, this group accounted for over 50 percent of the deaths! Hardest hit was the age bracket between 21 and 30. Health authorities speculate that the H5N1 virus would have a similar impact on younger adults.

Why? As counterintuitive as this may sound, younger, healthier people with healthier immune systems are more likely to fall victim to the virus.

Unlike a normal flu, which lives in the upper respiratory tract, the H5N1 virus penetrates deeply into the lungs. There it suppresses the release of interferon, which primes cells to resist attack. And as with SARS, the virus also prompts an immune system overreaction called a cytokine storm. Such a storm (which younger and healthier people are more capable of generating) results in an intense assault on the lungs by pro-inflammatory proteins called cytokines. (The immune cells that regulate the immune response release the cytokines.) Interestingly, the host’s immune system over-response is what causes death—not the replication of the virus.

The victim’s lungs become so inflamed and so full of dead tissue and blood that pressurized ventilation is needed to get oxygen into the bloodstream. The lungs fill up with fluids and the patient drowns unless ventilation is provided.

In autopsies of birds that have died from H5N1, the lungs have been found to be full of fluid and blood. In short, the stronger the immune system is, the more likely the person is to drown and die by virtue of an immune system over-response.

Another disturbing peculiarity of the 1918 flu was that it killed a disproportionately high number of pregnant women. Thirteen studies note that the mortality rate among pregnant women was between 23 and 71 percent, for a mean of 55 percent. Twenty-five percent of the pregnant women who survived the 1918 flu experienced a spontaneous abortion.

To get a sense of the personal impact of experiencing such a time, listen to Laurie Garrett, acclaimed public health writer, describing what life was like through her uncle’s eyes during this period: “As a boy, my uncle’s family prohibited him from going outside. He would therefore spend his days staring out his family’s front window counting the hearses going up and down the neighborhood. In so doing, he would try to guess which of his schoolmates had died that day.”

Researchers have recently reconstructed the 1918 flu virus. The major difference between the 1918 virus and today’s H5N1 virus is that the H5N1 has yet to develop the ability to be transmitted from one person to another. (It may never do so.) If it does, however—and many experts on the subject seem to think that it will—we could easily have a replay of the 1918 flu pandemic, one that could ultimately prove to be even more catastrophic.

For that nightmare scenario to unfold, the virus must mutate, maintain its virulence, and become transmissible between people. So, is there any evidence that such a mutation is occurring?

It has already been established that this is a fast-mutating virus—which is why many experts in infectious disease insist that it is only a matter of time. Experts in China have reported that the H5N1 strain has changed from the time it killed a person in Vietnam to the time it killed someone in China. Researchers in Vietnam also have found genetic changes taking place. They report two changes of note, one good, the other not. One change is that the virus is adapting to the cooler environment of the human respiratory tract. It is used to the warmer environment of a bird’s gut, where it thrives. (The same kind of mutation occurred with the 1918 virus.)

The National Institute for Hygiene and Epidemiology in Vietnam has also reported that because of slight changes at the genetic level, the virus has become a little less virulent. In other words, the rate of infection among people could be going up at the same time that people infected with the disease have a lower risk of dying from it.

**Worst-Case Projections**

How nightmarish could the scenario be? Many experts (including WHO) suggest that between 25 and 30 percent of the world’s population would be infected and 5 percent killed. Keep in mind that the 5 percent figure represents a hope. Today, mortality from H5N1 is over 50 percent. Many commentators, however, seem to think that if the virus mutates and becomes transmissible among people, it will lose a lot of its ability to kill.

When these percentages are computed into numbers, a scary storyline emerges. With a worldwide population of 6.1 billion, a mortality rate of 1 to 5 percent means between 65 and 325 million deaths. For the United States, with a population of 300 million, these numbers suggest between 3 and 15 million deaths. These figures are what my doctor
friend was getting at when he told me that by the time this thing was over, every American would know someone who had died from it.

Estimates have been made that a pandemic flu would claim more lives in a single year than AIDS has claimed in 25 years.

Many experts suggest that between 25 and 30 percent of the world’s population would be infected and 5 percent killed.

The highly respected TFAH quotes CDC’s FluAid 2.0 computer model to suggest that 67 million Americans could become infected, 2.4 million could be hospitalized, and 541,000 could die.

At the request of Congress, the Congressional Budget Office just released a report defining a severe pandemic as one in which 90 million Americans would become infected and two million would die. It added that 30 percent of the workers in urban areas would become sick and that fully 2.5 percent of them would die.

In a private briefing with members of Congress, Secretary Leavitt warned of 100,000 to 2 million deaths in the United States and 10 times that number of hospitalizations.

No nation, income group, or race would be spared.

This nation's pandemic-flu plan predicts that 200,000 Americans will die within just a few months. If such a pandemic were to occur in waves and last for over a year, those numbers would obviously become much larger.

Reactions to the Projections

In response to these projections, we are seeing reactions that range from no action to some interesting measures.

In the United States, the National Association of Funeral Directors is preparing to work around the clock to build enough caskets for the anticipated deaths. They have also come up with new procedures to extend the hours of crematoriums and cut the length of cremation services by one third.

Some businesses and utilities that are crucial to the maintenance of community infrastructure are making plans for survival during a pandemic. Health departments are engaging in similar exercises and are recalibrating traditional roles to fit emergency scenarios, including quarantine functions, mass distributions of medicines, priority decision making on who gets medicines, emergency health care housing, and the like. States are now preparing pandemic flu plans.

Our President has spoken in terms of calling out the troops to enforce quarantines.

Other nations are also taking steps. On the basis of official fears that 700,000 of their people could die from the flu, British officials are searching their country for suitable sites for mass mortuaries. The British government has conducted emergency simulations and reportedly has readied its secret war room in Whitehall to deal with a pandemic crisis.

Japan now requires that travelers from affected nations have their shoes disinfected at airports to prevent poultry manure from entering the country. Australia has been discussing ways of blocking entrance into their country by those fleeing other nations to escape from the flu.

So What Will Happen If a Flu Pandemic Actually Breaks Out?

We Have a Plan!

Experts seem to agree that if an avian-flu pandemic breaks out, it will spread fast—even if the index patient lives far from our shores. Consider, for example, that international flights carry 1.6 billion passengers per year and that 120 million people annually come through our airports, seaports, and border crossings. Consider also that victims of H5N1 flu don't tend to exhibit symptoms until two days after they have been infected. Even if we're being vigilant, the disease could easily slip into our country in an asymptomatic person and start spreading.

In response, work has been going on for the last couple of years on the development of a national flu-pandemic response plan. In fact, we now have both a federal plan and a patchwork quilt of 50 state plans.

“The Plan,” rolled out on November 1, 2005, focuses on the use of state and local resources to manage, contain, and deal with a pandemic. State and local public health authorities would also be deeply involved in rationing supplies, defining priority populations, setting up information systems, and maintaining the vitality and viability of a community during a flu crisis. Undoubtedly, many environmental health professionals are going to be in the middle of these decisions and activities, as it will take every resource of local health departments to deal with the burdens that a pandemic could cause.

The major pillars of the President’s plan involve increasing the nation’s stockpile of vaccines and antiviral medications, proceeding with the development of a vaccine specifically for H5N1, re-engineering the process by which we make vaccines, enhancing the planning for emergency response within local health departments, and implementing better surveillance, especially in other areas of the world.

More specifically, the plan calls for a total expenditure of $7.1 billion. Some of the major cost components break down as follows:

- $1.2 billion would be used to purchase 20 million doses of a vaccine being developed for the current H5N1 bird flu.
- $2.8 billion would be spent to develop faster and more reliable ways to produce vaccines.
- $1 billion would purchase 75 million courses of antivirals to go with the five million already in the stockpile by 2007.
- $100 million would be provided to state and local health departments for flu planning.

The Plan’s Shortfalls

As impressive as this preventive strike may sound, the plan and its distribution of expenditures aren’t without flaws.
Recall, also, that we had a plan for a Category 4 storm hitting New Orleans and breaking its levees. That plan had been drilled just last year.

Accordingly, if having a plan is supposed to make us sleep well at night—as some state health directors seem to think—I would suggest that perhaps there really are a few people in this country who missed the news about Katrina.

Whatever their personal perspectives, professionals in environmental health don’t have the luxury of watching all of this from the sidelines. Local public health professionals are the plan—or at least a major part of it.

With respect to the part of the plan that most affects NEHA members (i.e., the part about funding local and state flu preparedness), state and local officials responded within days of the plan’s announcement that the amount of money proposed isn’t nearly enough for the tasks expected of them. The National Association of City and County Health Officials (NACCHO), for example, has represented that antivirals and vaccines mean nothing if health authorities don’t have the necessary staff resources (which aren’t funded by the plan) to distribute the meds, perform the surveillance, and implement the measures needed to contain a spreading disease. The plan doesn’t address such needs.

It is also discouraging that while the plan calls for spending $100 million to enhance local preparedness, in separate actions, the administration is proposing to take away $130 million in existing funding that state and local health departments use to prepare for problems. Thus, federal funding for local emergency preparedness is actually being cut by some $30 million.

Another controversial element of the plan lies in its provision that the states pay 75 percent of the cost of purchasing 31 million of the 75 million doses of additional antivirals that the plan calls for. This means that the stockpile goal for antivirals (such as Tamiflu and Relenza) depends on the states being able to come up with $510 million of their own money. Aside from the added burden that this requirement puts on states such as Louisiana and Mississippi—whose budgets have been devastated by Katrina—there is an ethical question about a public policy that makes people’s health and protection dependent on the ability of their particular state to pay such a bill.

The plan and some of its more enthusiastic advocates correctly point out that the United States is moving into action on many of the appropriate fronts. There hasn’t, however, been a lot of discussion about the implications of the plan’s timeframes. For example, the target date for stockpiling enough vaccine for 20 million people is 2009. The target date for converting the drug industry to more modern manufacturing techniques for vaccine production is 2010. The target date for having 300 million doses of vaccine on hand is 2013. And of course, each target date presumes that progress will be made without any unexpected glitches.

Even assuming that these efforts proceed smoothly, these lag times are acceptable only if the most important event of all and the one event we have absolutely no control over—the mutation of H5N1—doesn’t happen in the meantime.

If, as poignant New York Times editorials have argued, a highly lethal flu virus starts rampaging through the population in the next few years, the plan will fail us all. The health care system will be overwhelmed. We will have neither the personnel nor the medical treatments and resources to adequately handle the problem. The consequences could easily become as far reaching as some have predicted.

As the New York Times has also pointed out, there is no clear chain of command. Nor is there any specific direction on how resource allocation and priority determinations might best be made. After all the confusion that we witnessed following the Katrina tragedy, it is numbing to think of how our combined local-state-federal response would work without a chain of command for a disaster “that would dwarf Katrina.”

There is no indication in the plan of how the United States would respond to requests for vaccines and medicines from other countries. Nor is there any clear policy spelled out for the liability of health care workers and those injured by vaccines.

In addition, the plan is based on a strategy that some are questioning. The heart of this multi-billion-dollar plan is to build a moat around Fortress America. From there, we basically sit back and wait. If the virus erupts, we then start administering antivirals and, if we have them, vaccines. We put into play all of the capabilities of our medical technologies, institutions, and resources.

Critics of the plan argue that instead of spending so much money to treat the problem once it appears in our country, we would be better off spending a large portion of the money strengthening the public health systems of the countries within which a pandemic is most likely to emerge. If we can set up better surveillance systems and position antiviral and vaccine stockpiles in those nations, we might just be able to contain the spread of this disease before it takes off and starts to move around the world.

Perhaps most telling of all is simply the fact that despite the studies and projections warning that a pandemic flu could be unimaginably catastrophic, at the time of this writing—almost two months after the President’s presentation of the plan—Congress continues to refuse to fund it. The House actually voted no to spending the money until offsets could be found in other funded programs. Any progress that we might make toward the goals of the plan can’t even begin until the plan becomes operational, and at this point, it is hard to say when that might be. In the meantime, H5N1 continues to spread around the world, and the odds that it will mutate continue to increase.

So Let’s Look at Our Preparedness

Starting with the Killing of Infected Chickens

Throughout the world, poultry flocks are being tested for the H5N1 virus. If the virus is detected, that flock is killed and farmers are generally compensated for their loss. Diseased birds are disposed of in appropriate ways. Contaminated poultry products (meat and eggs) are blocked from reaching the consumer.

In fact, nations around the world quickly take measures to ban imports of poultry from countries where bird flu outbreaks have occurred.

Still, questions are being asked about what happens when governments in poor nations are no longer able to compensate farmers for destroying their flocks. So, while banning poultry imports from countries that have had bird flu outbreaks can help, such a ban does not prevent migratory birds from spreading the disease to other countries.

China, in view of the number of bird flu outbreaks occurring there, has begun a mammoth project to vaccinate its entire poultry population against the H5N1 flu virus. As impressive as this initiative might sound, it is prompting some concern. Success depends on the use of authentic vaccine (in a nation famous for counterfeit products), capable
workers (many of the workers are uneducated and don't know how to take precautions to protect themselves and to prevent the spread of the disease from their belongings), and ample supplies (many shortages have already been reported).

The Four Public Health Steps to Control
Emergencies like a flu pandemic will trigger the four traditional public health lines of defense or barricades. These four lines of defense, which the United States and other nations are now constructing for the flu, are as follows:
• surveillance,
• vaccines,
• containment measures, and
• medical treatments.

Below are some observations about these lines of defense—including notes on their respective weaknesses.

Surveillance
Surveillance increases the ability to see a threat coming. The earlier we can spot the emergence of a dangerous health threat, the sooner we can intervene.

Surveillance can enable countries to take protective steps. For example, discussions are taking place in the United States and elsewhere about implementing travel restrictions to prevent the entrance of people who are coming from nations where an outbreak of the feared virus has been detected.

Three international agencies work together to conduct surveillance and to track H5N1 and other strains of the flu. WHO has 110 influenza centers in 83 nations, through which it tracks human cases of the flu. In addition, the World Organization for Animal Health and the Food and Agricultural Organization collect and study reports of flu outbreaks in birds and other animals.

This system sounds reassuring, but even its managers describe their information networks as slow and porous—the circumstances in China, as described above, are illustrative.

Another element of surveillance involves tracking the genetic changes that are occurring in the virus so that we can know how close it is to becoming the dangerous virus that we fear so much. When a human case of H5N1 is detected, samples of the virus are usually taken so that changes can be monitored.

Recently, researchers have been able to recreate the genetic sequencing of the deadly 1918 flu virus—and flu viruses preceding it. This development is significant because scientists can now follow changes in the H5N1 virus and compare them with changes that occurred in the 1918 virus before it became so lethal.

As a part of the U.S. surveillance system, information on flulike illness and death is transmitted from hospitals to CDC. CDC Director Julie Gerberding has noted, however, that “the system is not fast enough to enable us] to take the isolation and quarantine action needed to manage avian flu.”

In several dozen cases, when travelers have returned from Asian nations with severe flulike symptoms, samples have been rushed to CDC. There, a determination can be made within 40 hours as to whether H5N1 is involved.

CDC is active in other aspects of surveillance. The agency is now working with airlines and ships, for instance, to set up ways of obtaining and maintaining (for 60 days) electronic passenger lists so that individuals exposed to an ill person can be identified and tracked.

It should be noted that these proposals could cost the airline industry, which has had losses in excess of $30 billion in recent years, hundreds of millions of dollars to implement. How effective this measure might be is therefore subject to question.

Because two days typically elapse before symptoms begin to show and because it takes time to identify the presence of the H5N1 viral strain, the possibility is real that the virus could be spreading within the population before we realized that it was present, even with well-conducted surveillance.

Vaccines—The Second Line of Defense
A comment heard often from the public at large—familiar with yearly flu shots—is “just make a vaccine!” Public health professionals know that it isn’t quite so easy.

For one thing, before a vaccine can be produced, we need to know exactly what virus we’re attempting to make the vaccine for. In the case of H5N1, we don’t know exactly how it might mutate and what that transmissible virus that we fear so much is going to look like. A vaccine for that virus can’t be made until the virus itself actually comes into existence.

A typical dose of vaccine takes some six to seven months to produce. The first supplies of the vaccine will be of small quantity, and they will of necessity go only to the priority people, thus leaving the majority of the population vulnerable for some time to come.

So as promising as this line of defense sounds, there are some real holes in it.

Let’s look at the vaccine story a little more closely.

Today, vaccines are made in a fairly inefficient way. The virus of concern is identified, isolated, and modified into an inactive form. Enough of the virus’s genetic makeup is preserved that the modified form still stimulates an immune system response even though...
the virus is no longer dangerous. This new seed virus is injected by robots into fertilized eggs laid by hens under hygienic conditions. The pathogen then replicates wildly inside the egg.

To make the vaccine, we then extract the proteins (or antigens) that trigger the human immune system into making the antibodies specific that particular virus.

Even under normal conditions, serious concern has developed over how much vaccine the system can produce. (Just last year, our country was unable to acquire the volume of flu vaccine that it desired.) With H5N1, that concern has grown.

Because this virus is so lethal, and because our human biology has no previous experience with it, it has already been noted that protection will probably require two doses, not one. An initial shot and a booster a month later have been suggested.

It has also been reported that H5 viral strains grow poorly in eggs, a circumstance that would limit the quantity of the vaccine that could be produced.

Of even more concern are reports from early work on a vaccine for H5N1 that a much more powerful vaccine will be needed to confer protection from this virus. The typical annual flu shot has 15 micrograms of protein antigen per virus (the typical flu shot is really a combination vaccine for three different flu viruses and thus totals to 45 micrograms of protein). Preliminary trials have indicated that 180 micrograms of H5N1 antigen protein are required to induce an immune response. This means that the average person would require 12 doses of vaccine to obtain protection. Other reports suggest 6 doses. Whether we need 6 or 12 times the normal dose, the inescapable worry is that when the first vaccines roll out, we may have but a fraction of the quantity that we thought we had.

Putting aside concerns about how much vaccine each person might need to gain protection from this flu virus and how much the production of that vaccine might cost, there are other concerns about producing enough vaccine to meet worldwide demand. As HHS Secretary Michael Leavitt explained on November 20, 2005, in a nationally televised Meet the Press segment, “We have a problem in capacity.” He clarified that it will take three to five years (on top of the six to seven months required for actual production) to ramp up to produce enough vaccines for all Americans. And it should be noted that Secretary Leavitt was referring to one dose per person, not 6 to 12.

Acknowledging that one dose per person might not be enough, CDC Director Julie Gerberding referred on that same Meet the Press segment to work under way to produce an adjuvant or, as she put it, “hamburger helper,” to stimulate the immune system into a response with the smaller quantity of vaccine. It remains to be determined, however, how much that adjuvant might cost and what its implementation would do to the affordability of the supply we are seeking to obtain.

Today, worldwide production of normal flu vaccines is about 300 million doses per year. The major American supplier, Sanofi Pasteur, is building a new plant in Pennsylvania and expects to double its output by ... 2009—four long years from now.

It’s important to note that plants can make only one vaccine at a time. If all of the vaccine production capacity is turned over to making pandemic-flu vaccine, no vaccines for the normal flu cycle will be produced. Even with flu vaccines, some 35,000 Americans lose their lives to the flu every year. If the entire production capacity of today’s flu vaccine manufacturing effort were turned over to the production of an H5N1-type vaccine, we could expect the death rate from “normal” flu to rise.

In the discussion thus far, we have been talking only about American needs and demands. If the 300 million doses per year of manufacturing capacity reported in the press are an accurate number and we are looking to obtain 300 million vaccine doses (one for every American), how is the demand from other countries going to be accommodated? There is very little discussion in the literature about this question.

And there are other problems with respect to vaccines.

Still unresolved are the liability concerns that have plagued vaccine manufacturers for years. Also unresolved is the need for vaccine manufacturers to have some guarantee of profit, especially if they are investing in their infrastructure to increase capacity. No company would invest such money if there weren’t reasonable assurances that they would be able to sell their product and make a return on their investment.

Although the President’s plan acknowledges such concerns, remember that the plan has yet to be funded, which means that the governmental actions the plan contemplates on these fronts can’t even begin. Until these issues are resolved, it is highly unlikely that the mammoth production effort we are counting on will begin.

In addition, questions remain about how long it would take to determine the effectiveness and the dosing and delivery schedules of the vaccine candidates in development. Still more questions exist about how long it would take for a new vaccine to be licensed and approved for human use. These considerations could easily delay even further the time when ample vaccine supplies would be available for most Americans.

A vaccine for the H5N1 virus is now in testing. It is also showing promise as an effective flu vaccine.

Despite these discouraging aspects of the vaccine story, there is actually some good news to report. A vaccine for the H5N1 virus is now in testing. It is also showing promise as an effective flu vaccine. Although this vaccine won’t match some new and mutated strain of the virus, it is thought that it will still confer some measure of protection against any pandemic-flu strain that is likely to evolve.

The President’s plan calls for the country to have enough vaccine for the H5N1 virus to treat 20 million Americans. If, however, each person will in fact need 12 doses to acquire immunity from H5N1 and if an effective adjuvant can’t be developed, then instead of protecting 20 million Americans, 20 million doses would constitute enough vaccine only for 3.3 million people. (And these numbers assume that the H5 virus will grow as expected in eggs.)

Another consideration that comes into play is that vaccines have a shelf life of a couple of years. Therefore, unless manufacturing capacity materially improves, it will be difficult to have enough vaccine on hand to confer immunity on the American public. That’s one reason the President’s plan also calls for a re-engineering of the way vaccines are produced.
If enough time passes before a pandemic occurs that we can develop new and faster technologies for the manufacture of vaccines and if liability protections and profit guarantees can be worked out and if vaccines can be made to be more effective at lower doses so that fewer doses will be needed to protect public health, we just may be able to defend ourselves against this threat if it materializes.

The Third Public Health Line of Defense—Containment Strategies Such as Quarantines, Isolations, and Interventions

The President’s plan orders communities to update their quarantine procedures, laws, and regulations. The environmental health profession can and should be involved in this activity. We have an ability by virtue of our training and experience to assess how great the threat is and who might be affected by it.

On a national level, CDC is actively updating and refining quarantine activities. The agency is working to set up a clearer appeals process for people subjected to quarantines. It is also establishing procedures for offering vaccinations and medical treatment to quarantined people. The number of quarantine stations at airports, ship ports, and border crossings has been increased from 8 to 18. Medical officers are now stationed at 17 airports and at the El Paso border crossing.

CDC has also been successful in changing policies such that the agency—not the local health authority, as before—must now be notified if an ill passenger arrives at a port.

These activities represent the first substantial overhaul of quarantine regulations in over 25 years.

To appreciate the significance of quarantine in connection with any response to this virus, it is important to realize that H5N1 must be stopped fast. Flu spreads quickly because it has such a short incubation period. A person can become infectious with the flu one to two days after becoming infected. By contrast, it took people 10 days after infection with SARS before they became infectious. That made it possible to trace contacts and get to any person who might have been exposed, thereby stopping the spread of that disease.

One computer model warns that for a population of 83 million (using Thailand as an example) health workers would have only 30 days to provide vaccines if they were to have a chance of stopping the spread of the disease.

In practice, it generally takes some 20-plus days to confirm a case of H5N1. Assuming that the virus is identified, enormous quantities of antivirals would then somehow have to be transported to, and distributed within, the affected area within the next 10 days.

Moreover, these measures would likely have to be achieved somewhere in Asia, which has poor transportation systems, weak public health infrastructure, and little local understanding of the threat and the actions that need to be taken to control it. (It was recently reported that in one Cambodian village, a woman was killed shortly after local chickens and children became sick because her neighbors thought that she was a sorceress who had invoked a curse on the community.)

Many villages lack even a phone, meaning that if an outbreak were to occur, it could take days to report it, let alone confirm it.

Some work has suggested that by vaccinating populations in that part of the world with the H5N1 vaccine, we could enhance our chances of stopping any expression of the disease from exploding into a pandemic.

Pursuing such a strategy would mean that countries such as the United States would have to give up their stockpiles of the vaccine in the hope that by deploying the vaccine elsewhere, we would protect ourselves. It is hard to imagine people in policy-making positions taking such a stand even if it seems sensible; if the strategy failed, we would be left defenseless.

Other computer models have indicated that for a quarantine to work, it would have to be implemented by the 31st case, an unlikely event given that 1) you can’t quarantine people who don’t present with symptoms, 2) the virus travels with great speed, and 3) the public health system in Asia (the likely place of origin for a pandemic) is in such poor shape that it probably can’t respond quickly enough.

Under the stop-it-by-the-31st-case scenario, it is crucial that an adequate surveillance system be in place. Surveillance in Indonesia—where cases of H5N1 are occurring—was recently upgraded; the upgrade consists of 1,000 college-age students walking around that huge nation to monitor for cases. In principle, the only entity big and strong enough to actually conduct surveillance in that country—the army—refused any such role, noting that “the military doesn’t do health.”

In Cambodia, whole villages have no phones, to say nothing of doctors or medical professionals who could catch and quarantine an outbreak.
After surveying these conditions during a recent tour of Southeast Asia, HHS Secretary Leavitt returned saying, simply, “We can’t quarantine this.”

Many experts believe that even in an advanced country such as ours, a quarantine would be ineffective. Health officials are quick to point out that quarantines won’t work when you have asymptomatic people and large, urban, mobile populations.

“Once a virus arrives, we can only try to slow it; we can’t halt it.”

Coming from the New York City Department of Health and Mental Hygiene is the comment: “Once a virus arrives, we can only try to slow it; we can’t halt it.”

Which Brings Us to Our Fourth and Last Line of Defense—Medical Treatments

As is typically the case in our culture, while attention and resources for prevention get limited support, we brim with confidence in the ability of our medical system to fix us if we become sick. In the case of flu, the medications we would turn to are the potent antivirals—Tamiflu and Relenza.

Many believe that these two new-generation antiviral medications may provide some protection against the bird flu. This is why some 40 nations around the world are stockpiling them. Assuming an infection rate of 25 percent, many countries are putting in orders for enough of these antivirals to cover 25 percent of their populations. Roche, the manufacturer of Tamiflu, maintains that if the flu is treated with Tamiflu within two days of infection, it should at least minimize flu symptoms of any H5N1-type flu infection.

Interestingly, there are those who disagree and who claim that these antivirals are worthless. Of greatest concern is a report that quotes Dr. Nguyen Tuong Van, a Vietnamese doctor who has treated 41 victims of the H5N1 flu, saying that the drug is “worthless” against H5N1. She runs the intensive-care unit at the Center for Tropical Diseases in Hanoi and has also said, “We place no importance on using this drug in our patients.”

WHO has also acknowledged that Tamiflu has not been widely successful in humans, although the organization adds that the drug may simply have been administered too late to have an impact.

Antivirals work in an interesting way. For a virus to spread throughout the body, it has to escape the cell in which it was produced so that it can go on to infect other cells. Tamiflu adheres to certain geometries on the surface of the virus that are necessary for the virus to poke through the cell wall. In particular, it blocks the function of the enzyme neuraminidase, which otherwise allows the virus to escape the cell.

Additional concern has been expressed over the possibility that the H5N1 virus could develop a resistance to the drug if the drug is given widely. Some fear that if the drug is provided to health care workers in low doses, the virus will acquire resistance even more quickly.

Whatever the reservations about Tamiflu (which comes in pill form) and Relenza (which is inhaled), these two drugs represent the only medical line of defense we have. After that line gets breached, all we have left are support devices such as ventilators, which could be used to help patients get through the worst of their crisis until their bodies begin to recover. I’ll talk more about these measures shortly.

Estimates vary as to how many Americans could become ill in a pandemic scenario. TFAH suggests that some 67 million people could become infected. Secretary Leavitt recently described a planning exercise that was conducted “to exercise the most severe case.” That exercise was based on the assumption that 92 million people would become ill within four months.

If a pandemic were to break out anytime soon, no treatment would be available for 61.5 million Americans.

The United States has thus far stockpiled 2.3 million courses of the antiviral drugs. Three million more doses are in the pipeline. That means—even with the lower number of estimated illnesses—that if a pandemic were to break out anytime soon, we would have some 5.3 million doses available to treat an ill population numbering some 67 million people. Conversely, no treatment would be available for 61.5 million Americans for this highly lethal form of the flu.
To supplement the national stockpile, the President's plan calls for adding enough Tamiflu to treat 81 million people. There is, however, a catch. Thirty-one million doses of the supply are to come from the states. The plan calls for the states to pay 75 percent of the cost for this additional Tamiflu, which amounts to a bill of $510 million.

Many are questioning whether states can afford this cost. Questions are being asked about whether it is appropriate public policy to make the safety of Americans subject to the ability of their particular states to pay for this bill. In addition, states like Louisiana and Mississippi are already deep in debt trying to recover from the economic impact of Hurricane Katrina. And if these states were excused from paying, given the tragedy that they have just gone through, does that mean that the bill for the other states would increase?

Other considerations need to be noted with respect to any plan that relies on the use of Tamiflu.

Obviously, in view of the severe shortages of medicine that we are facing, many voices are calling for major increases in production. Even if drug-manufacturing capacity could be increased, it takes about a year to produce a course of treatment.

But that's not all. We are at the back in the worldwide queue. Ordering the drug and even paying for it doesn't mean that we will get it anytime soon. Other countries, such as Canada, Britain, and France, are ahead of us. As more supplies are produced, they will go first to orders at the head of the line. It is not possible to say when we could get ours. And remember, Congress still hasn't approved the funding to pay for these additional supplies.

Even if production capacity could be quickly increased (and many efforts are being directed in that direction, including even illegal moves by governments to produce their own versions of Tamiflu, as has happened in Taiwan), other questions remain. For example, what about the rest of the world? How would the inevitable clash play out between those countries that could afford large supplies and those that couldn't? (Ironically, some of those that couldn't are the most likely to be the sources for a pandemic.)

This is more than just an academic or social-justice question.

For example, it is interesting to note that as the avian-flu literature has evolved, less discussion seems to be taking place about the biological and health implications of this issue and more about the economic disruption that a pandemic could cause. The world is a vastly interconnected living organism. Supply lines, labor, backrooms, and even decision making processes now extend all over the globe.

If a pandemic were to strike in a developing nation that had no stockpile of antivirals, the economic shock from a loss of supplies would hit our country over night.

Almost all computers are made outside of the United States; many are built on the Asian continent. If that part of the world were to shut down, we would be without new computers until major manufacturers could retool here. And then the cost of the product would likely skyrocket.

If India were to go down, many multinational companies with backrooms in that country would be in conditions of dysfunction.

The “what-could-happen” list could go on and on, and many companies are now beginning to think out how they would respond in such a scenario.

To return to the United States: We often find comfort in the modern world of health care facilities. As noted earlier, the more typical disease progression with avian flu is that it causes a cytokine storm to develop and the lungs to flood with fluids, blood, and eventually dead tissue. To help a patient get through such an ordeal, a doctor will utilize a ventilator to artificially push oxygen into and through the lungs.

Experts are projecting that as many as 2.5 to 4 million people may require hospitalization and possibly this form of care. In the United States, we have 105,000 ventilators. On any given day, 75,000 to 80,000 are in use. During a typical flu season, that number goes up to 100,000. So at most we have a capacity of 10,000 ventilators for what is likely to be hundreds of thousands of people in need.

Furthermore, the American Hospital Association estimates that the United States has 965,256 staffed hospital beds. During normal flu season, there is an excess of 100,000 hospitalizations. Given the economics of the hospital business, most of these beds are in use.

If there is a demand for 2.5 to 4 million hospital beds, there is simply no way to even come close to meeting the demand. And these numbers don't begin to address the waiting lines in emergency rooms or the staffing levels that could be required during such a period of demand on our health system.

Some say we had a social-justice problem during and after Katrina. My dinner friend advised me that “we haven’t seen anything yet … should we be faced with this kind of a pandemic.” If the well-to-do get all or most of the available beds, it isn’t out of the question that those in need and living in areas surrounding hospitals could understandably be moved to social protests and even civil disorder. What good are the hospital beds if the hospital itself is the middle of some type of civil disorder?

I will address such concerns in more detail momentarily, but first, it is important to put the numbers into further perspective.

The resource numbers that I’ve cited all rest on a critical assumption—that the health care system will continue to function in an orderly manner. The significance of this assumption cannot be overstated.

This nation watched with disbelief as the infrastructure of New Orleans crumbled in what seemed like minutes following the break in the levees. Imagine then the impact of a Category 5 viral storm that lasts not for a week but for a year. It is virtually inconceivable that the system would function in an orderly manner.

In fact, emergency response exercises that are being conducted assume that only 33 percent of health care workers will even report to work in the midst of a pandemic.
the limited resources we thought we had will be in play. It is much easier to imagine that the system simply will not function—or not function to anywhere near the levels of performance we need and expect.

In addition to staffing concerns, the modern health care system depends on electricity, water, transportation systems, supply lines, and in general a functioning community infrastructure. The discussion thus far has addressed only internal operational issues. When external considerations are taken into account, an even scarier picture emerges.

It would almost be a miracle for the system to work at all in the face of these challenges.

**The Prospect for Civil Disorder and Unrest**

In considering how the health care system might function should a flu pandemic worst-case scenario unfold, we begin to truly come to terms with the potential magnitude of such a crisis. The projected number of illnesses and deaths is enough to scare anyone. It is not out of the question, however, that the human suffering might be mild compared with the impact of a mass breakdown in civil infrastructure and order. In fact, the number of articles and commentaries expressing concern about social disorder and anarchy seems to be growing in the literature on pandemic flu.

To get some perspective, it is instructive to refer back to some of the lessons learned from exercises involving widespread social panic, anxiety, and unrest. Together with what was witnessed in New Orleans, these considerations can be helpful in imagining just how widespread the impact of a flu pandemic could really be.

I had an opportunity to observe such an exercise several years ago as a participant in a $10 million Topoff exercise. Part of this exercise involved a biological attack on terrorists on metropolitan Denver.

My most enlightening experience took place at a mass-vaccination center, or POD (point of distribution), as it was called. There I got a firsthand look at how the system might deal with large numbers of sick people and “worried wells” (well people who thought they might be sick) during high-stress circumstances.

The POD was staffed primarily with local health department employees of every background and job description. It is fair to say that these people were thrown into their functions with little training or advance warning. A similar scenario with mass-vaccination clinics could be expected from a flu pandemic, and local health departments across the country are conducting exercises for such a situation right now.

In the Topoff exercise, it was striking how quickly the system reached its “tipping point.” Hoards of people descended on the POD, and it wasn’t long before chaos ensued.

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**The tipping point will come early. After that it is pretty much every man and woman for him- or herself.**

Not long after that, complete control was lost, and no option was left us but to order National Guard troops to shoot and kill people to regain control. Although some semblance of control was regained, the shock and horror experienced by the fatigued staff as they watched dead people falling around them was enough to spin the system further out of control. The system essentially shut down.

I came away from this experience convinced that in a pandemious situation, the tipping point will come early. After that it is pretty much every man and woman for him-or herself.

This storyline is fiction and comes from my piecing together of the different threads of the planning exercise I went through. The concerns I’ve raised, however, are echoed even in our national flu pandemic plan.

The plan warns that if a pandemic occurred, the United States is woefully unprepared. Hospitals would be overwhelmed. Riots would engulf vaccination clinics. Power and food would be in short supply.

Interestingly, the plan does not spell out how troops would be used. Nor does it specify who would be in charge of the national response. Nor does it stipulate how supplies would be distributed. Nor does it give guidance on how local, state, and federal resources might be coordinated and mobilized. As Katrina showed, local authorities simply do not have the expertise to plan and execute broad-based emergency response efforts without significant assistance from the federal level. Without guidance, help, or both on such fundamental points, it is hard to imagine how local agencies (and especially local health departments) in charge of a response could proceed in orderly ways to protect as many people in their communities as possible.

Further contributing to what could easily become a panic situation is the way the plan anticipates dealing with the earliest outbreaks of the flu in our country.

Many expect that the first cases of pandemic flu would show up on the West Coast. Los Angeles receives 22 percent of air travelers coming from Asia. The plan is to rush the antivirals to those areas that are first infected in the hope of containing an outbreak.

What if the infection isn’t contained? Quarantining large metropolitan areas in this day of mobility is regarded as almost impossible. If the disease can’t be stopped, we will have used up the few supplies that we currently have, leaving the remainder of the country exposed and without medications to fight the disease. It is hard to imagine that our population would be content with such a situation.

Other aspects of life in a pandemic would seem disruptive to social order as well.

Priorities for the antivirals and vaccines that we have are being established. While this approach means that vaccine workers, health care workers, the immunosuppressed, governmental officials, and so forth will be at the front of the line for medications, it also means that many more, including children, will be denied. Yet the illness is expected to spread the fastest among school-aged children, with some 40 percent of them expected to become infected. It has yet to be shown how people will react to such a prioritization scheme.

The same questions are appropriate when we consider who gets the beds, the ventilators, the masks and gloves, and so forth.

The basic rhythm of life also can be expected to change. Group functions could be cancelled, mass transit could be stopped, workplaces could close (thereby putting many Americans in financial crisis), travel could be curtailed or even cancelled, major events could be called off, essential services such as water and power could be disrupted, and forced quarantines and isolations could be implemented.

Because of the global interconnectedness of today’s world, supply chains could be cut,
decision-making processes could be disrupted, and labor shortages could occur.

A couple of real-world stories and observations about today add some additional drama to these points:

Broward County in Florida sits right next to the county that was hit by Hurricane Andrew in 1992. It might therefore be presumed that these people know something about hurricanes. Also, Florida was hit hard by four different hurricanes last year. And few people anywhere could have missed the extensive media coverage of Katrina and its aftermath.

Last October, Broward County’s time had come. It watched and listened to reports about Hurricane Wilma. Weather forecasters correctly predicted a full week out that this hurricane was going to come straight at this county. There was ample time to prepare and tremendous understanding of how devastating a hurricane could be.

Yet, with all this time, information, and warning, 12.3 percent of households, or 45,000 (and many more people), reported not having even a three-day food supply. Among households with a child under two years of age, 43 percent did not have access to a three-day supply of diapers, formula, or both.

This story involved people who were warned and thoroughly educated about hurricanes. What would the results be if in a matter of days a horrible flu pandemic started spreading toward such a community?

Upon a recent trip to Albuquerque, I had the opportunity to visit with a food consultant. He advised me that the city of Albuquerque essentially had a two-day food supply. He explained that each day, trucks pour into the city to deliver the food to the citizens of that community require. Imagine how a major American city would fare in a pandemic situation when supply lines are compromised and food shortages surface.

In describing what a pandemic would be like, the European Commission writes that economies could be affected and medical and civil services could collapse.

TFAH notes that store closures would result in complications in the delivery of food and basic supplies. Daily life and economic problems would likely emerge in the United States even before the pandemic flu hit the country, because of the global interdependence of world economy.

A major Canadian brokerage firm warns of another great depression being triggered.

One local health official recently advised me that his state health department had issued a warning to its local health departments to “prepare for anarchy.”

The Beginnings of a Backlash?

To be sure, plenty of critics regard such assessments as tantamount to crying that the sky is falling. Such critics have even coined a new term to denigrate the character of those who worry about the potential consequences of a pandemic flu. Instead of addressing the arguments, they label those who make them “shock epidemiologists,” as if to discredit the person is to discredit the argument.

Of greater concern to me are those officials who call public jitters by reassuring the media that we’ve got everything under control or that “we have a plan.”

As noted earlier, we had a plan in New Orleans. That plan was amazingly accurate in its prediction of a Category 4 hurricane breaking levee walls. Even as the storm neared New Orleans, state and local officials advised federal authorities that federal assistance would not be needed. The city was prepared. It had a plan.

Who would have thought that in the modern era we would see law officials walk off their jobs, authority vanish, or hospitals allegedy practicing euthanasia? A particularly enlightening article published in Scientific American noted that the plan wasn’t executed. Many wonder if in the face of such a disaster, the plan was ever executable.

Why would anyone think that things would be different in the face of a pandemic flu that lasts not a week but possibly more than a year?

Early Signs of Panic Now

In fact, all isn’t even quiet now. There are already signs of anxiety:

Consumer demand for Tamiflu became so great that Roche terminated the sale of the drug to all but governments under contract.

Ebay decided to stop the sale of Tamiflu in its auctions. By the time it took this action, the price of Tamiflu had been bid up from its normal cost of $44 to $175!

Prescriptions for Tamiflu are already up four times over last year. Counterfeit supplies have also been discovered entering the country. Commentators suggest that shortages of masks, gloves, and even over-the-counter flu medications could come next.

Google has made its fortune largely because of the advertising that it sells on the right-hand margin search-result pages. If one searches under bird flu, one can see an array of supplies advertised and even cures for bird flu. A close look at some of these ads shows things like 90 percent filter masks selling in sets of five for $150. At outlets like Home Depot, similar masks can be found for half the price.

The issue of shortages is real. Developments forced Roche to take the action that it did. Even President Bush has stated that in a pandemic, everything from syringes to hospital beds, respirators, and protective equipment would be in short supply. To that list one could possibly add such items as caskets, food—and jobs and income.

There is a field of professional practice called “continuity planning.” The aim of this profession is to help businesses respond to and recover from “incidents.” Continuity-planning professionals approach scenarios with the goal of graceful degradation and agile restoration.

As they think out scenarios and help businesses plan to deal with them, they preach three basic steps:

• Establish effective surveillance programs (metrics are defined and then followed that serve to determine when to act and with what measures).

• Make the appropriate assumptions about an incident (in avian-flu planning, these include the assumption that 30 percent of the population will fall ill and that businesses will be unable to depend on local authorities).

• Train, drill, and exercise.

Continuity planners offer some provocative—and possibly instructive—comments on the following categories:

• Re: the continuity of local government—expect that
  — Governmental control could collapse worldwide.
  — Use of the military by governments to maintain order could have negative effects.
  — Loss of workforce could create inabilities to implement plans.
  — An inability to protect population and infrastructure could result.

• Re: transportation systems—expect that
  — Quarantine, flight restrictions, lack of workforce, inability to ship goods to markets may occur.
  — Lack of security of systems could create havoc for businesses and customers.
  — Shortages would occur immediately.

Other categories of warnings address utilities, banking and finance, water supply systems, emergency systems, and the communications industry.
Is Anyone Doing Anything to Prepare for Such Possibilities?

For a while, it was difficult to find much discussion having to do with how businesses and organizations were planning to deal with pandemic flu. That, however, is changing. While most people still seem to prefer to dismiss the possibility of a pandemic flu and most businesses seem too busy to be bothered, more and more are taking the threat seriously.

Deutsche Bank proclaims: “The moment that there is human-to-human infection, we would execute a set of measures.” It has a plan for pandemic flu. Pitney Bowes has been hard at work developing plans that ensure that large numbers of their employees can work at home.

Every firm on Wall Street now has committees studying bird flu issues. These committees are looking at issues ranging from the quarantine of employees to the availability of antiviral meds. Lehman Brothers is focusing on enabling employees to work from home and connecting companies to each other to prevent a financial panic.

IT leaders are now being advised to plan from the boardroom down to operations for a possible pandemic. Stories on how local businesses are beginning to plan for such an event are showing up in local newspapers.

Even here at NEHA, we are into processes aimed at determining how we might maintain both our vitality and viability in the event of a flu pandemic.

Preparation can mean other things as well. For example, it is reasonable to explore how one might best manage one’s investments through a crisis period of this nature. Investment firms are already giving professional advice on precisely such concerns.

Citigroup has been advising investors that even a mild pandemic would cause a sell-off in airlines, luxury goods, hotels, insurers, and shopping-mall companies. On the flip side, Citigroup is advising positively for drug companies, hospital chains, cleaning-product makers, and home entertainment providers.

If the outbreak was severe and of the nature suggested in this article, Citigroup predicts protracted weaknesses in the financial markets. Citigroup is also predicting a swift end to all unnecessary travel—which would spark falls in airline and tourism stocks. Business declines are expected for restaurants, casinos, pubs, and malls as people stay home. On the other hand, gains can be expected in the telecommunications industry and freight delivery firms.

The World Bank has been extensively involved in looking at and taking action on the bird flu issue. In one of its studies, for instance, it suggests that a pandemic could cost the global economy $800 billion. By contrast, the economic cost of the SARS episode was estimated to be $60 billion, noninclusive of medical costs and research. Moreover, SARS took fewer than a thousand lives. If a pandemic claims the lives of 65 to 325 million people worldwide, the economic costs could be incalculable.

The World Bank is also active in efforts to combat the possibility of a disease outbreak, pumping some $300 to $500 million into programs to fight the disease. It is setting up mechanisms by which donors can make grants to help strengthen health systems and control efforts. One particularly positive initiative aims to compensate farmers for killing their chickens, thereby building buy-in to efforts to stop the disease.

While these short clips give us some confidence that efforts are afoot to prepare for difficult times, other studies show that many entities are not preparing. One study of multinational companies indicated that 72 percent had no plan. Results from another study indicate that less than 5 percent of businesses surveyed had plans.

While the temptation might be to dismiss business preparedness and think more in terms of health care system preparedness, the fact is that businesses hold us together. This consideration is so important that CDC has actually dedicated a special part of its pandemic-flu Web site to helping businesses across America plan and prepare.

So What Can We Do to Prepare?

Actually, there is much we can do.

A first measure for any employer might be to insist that all employees get their annual flu shots. The standard flu shot won’t protect against H5N1. One circumstance that no one would want, however, is to have both H5N1 flu and a normal flu at the same time. Also, if vaccination production turns over to producing an H5N1 vaccine, it’s best to get a flu shot while one can.

Another step that employers could take is to get the word out. An employer has a certain responsibility to keep employees aware of issues and concerns facing the company or organization. The more that awareness can be increased, the more employees may be expected to buy into the plans that management might be considering. In addition, employees themselves can become a useful pool for ideas and measures that could ultimately prove useful in an effective response plan and protocol.

When employees realize that such plans represent not only a way for a business to survive, but also a way to maintain their employment, buy-in becomes much easier to achieve.

Clearly, IT becomes the giant consideration in business continuity. Increasing numbers of companies are examining ways of becoming more home based. To do so, a company has to be properly wired, and procedures and processes for information exchange must be developed. Adequate inventories of IT resources must be taken, and measures must be taken to ensure that enough of these resources are deployed into home environments to allow the business to work.

Businesses and organizations need to think through how their normal business functions can be transformed into acceptable processes in a home-office work setup. Fundamental processes such as sending and receiving, accounting, customer service, database management, sales and marketing, order fulfillment, patrol, benefits administration, Web site maintenance, and so forth need to be examined.

Once procedures are developed, they need to be tested, fine-tuned, and tested again.
The time to work out the kinks in a plan is not when the plan is first implemented under live conditions.

Personnel policies should be re-examined in a number of ways. The heroic sick employee who somehow gets himself or herself to the office needs to be told not to come to work. Some consideration of what sick days might mean in such a scenario should be clarified. Wage issues for those who are unable either to come to work or to work from their homes will need to be considered.

Guidance or education on minimal staffing levels in the office should be thought out. Processes can be re-examined to minimize the number of people who must work in close proximity to one another. Even office arrangements might be re-considered in the efforts to keep people away from each other. (CDC recommends that patients in doctors’ offices be no closer to each other than 3 feet.) Employers might encourage employees to consider some type of family plan, thereby prompting employees to consider how they might run their households in the event of a flu threat or if a family member becomes ill with the flu.

Employers might also consider some degree of cross-training, especially for work tasks that are regarded as crucial and are known by only a few.

Backups for supplies should be identified. Backup procedures for essential work functions might also be considered.

It would seem prudent for employers to think out what their essential functions are and then to think about how they would keep them going if severe limitations were placed on the company or organization.

A key element in any response plan is to have a method by which accurate and reliable information can be provided to employees—especially if many are forced into working from their homes.

Even today, employers should probably be encouraging employees to bank some of their vacation days, sick days, or both.

In the budgeting process, businesses and organizations might think out how they would function if travel and meetings were diminished. In any long-term contracts that businesses or organizations have with hotel suppliers, wording should be added to make contract obligations null and void in the event of travel restrictions or a flu pandemic.

As near term as this might sound, there is a certain wisdom in pushing profits now—and until antiviral production and vaccine-manufacturing capacity are increased. In that way, should a pandemic emerge before we have the resources to deal with it, businesses and organizations should have enough of a financial cushion to get themselves through the difficult times.

Some thought might be given to how markets are likely to change in a pandemic situation. Traditional business continuity plans assume that markets will be viable despite “events.” That is a tenuous assumption to make should a global pandemic strike and affect all businesses, not just certain markets, geographical areas, or demographics. It may be helpful to try to envision how markets are likely to change in the event of something as widespread as a global flu pandemic.

Similarly, it is important to appreciate how the economy itself will change and how that change will affect one’s organization or business. The avian flu has already caused $10 billion in economic damage to the Asian nations most affected. In the HHS worst-case scenario, which envisions 1.9 million Americans dead and 8.5 million people hospitalized, an economic impact of over $450 billion is estimated.

Employers certainly should be educating employees on basic personal hygiene and preventive measures. Flu spreads via respiratory droplets from others and can be picked up from environmental surfaces. Since our hands can pick up the germ so easily, it is important to limit hand-to-face patterns. It is extremely important to wash one’s hands frequently. It is also prudent to be mindful of the dangers of being in crowds.

Assuming that at least some social stress could develop in the wake of a flu outbreak, it is practical for people to store some supplies of food, water, and essentials—including cash.

It is also useful to think about how one might live within the context of certain restrictions—restrictions on such things as trips to the store or even to doctors’ and dentists’ offices.

In short, much can be done to prepare for the type of world we could be facing should a pandemic break out.

The Environmental Health Role

Not only will the world change in a pandemic but so too will the role of environmental health. What will this world look like?

To the extent that health departments are also employers, virtually all of the thoughts offered above would apply as much to a local health department as it would to any business. Health departments will be pressed to find ways to maintain their services even when employees are ill, supply chains are broken, and infrastructure is comprised. In addition, the traditional roles of environmental health professionals could be expected to change in significant ways in a period of pandemic flu.
As Secretary Leavitt has noted, states and local jurisdictions will be at the forefront of a battle that has 5,000 fronts. A lot is going to be expected of us. Fortunately, a great deal of the preparation activities laid out below have already become part of our awareness and skill set as a result of some of the terrorism and emergency response planning that our profession has recently been through.

Planning will also be necessary to conceive and implement surge capacity relief, especially for the operation of the health care system.

Health risk assessment calculations will have to be conducted to track which population groups are in most danger from the flu and in most need of support.

Mass-vaccination centers, PODs for the dispensing of medications, or both will need to be planned, set up, operated, staffed, and managed. One environmental health director advised me that he was training his staff to conduct traffic control in such centers.

It is not out of bounds to imagine that environmental health staff could actually be involved in the administering of medications and caring for the sick—keep in mind the projected shortages of health care workers and the potential need for warehouse hospitals. The community also needs to consider ways in which it can help sustain and care for the health care workforce. Employees of local health departments could easily become involved in providing assistance on this front.

Another environmental health director told me that many communities have many households in which children are taken care of by a single parent or even by elderly relatives or friends. Some monitoring of these households would be in order to assure that the children are still being cared for, especially if the care provider becomes ill or dies.

Ways of getting food, water, and supplies to quarantined populations need to be figured out and implemented. We must also work with grocers to ensure that food supplies are maintained and that people have access to them.

Public-education campaigns, which only public health professionals can devise, need to be developed to teach everything from cough etiquette to carrying alcohol hand wipes with you to remembering to limit hand-to-face patterns.

It is likely that environmental health professionals will also become involved—if only to a limited extent—in some of the state pandemic-flu planning now taking place.

There will be a crucial need for health authorities to stay in touch with the public and to communicate accurate, reliable, and helpful information about everything from health resources to the state of the pandemic to basic risk assessment to measures by which people can take care of themselves. Such public communication programs will have an enormous impact on how a crisis will play out. The public will look for information that answers their questions. Providing that information will help maintain community order and confidence in the government. Such programs also provide an opportunity to dispel misperceptions. Success or failure on this one function can tip the scales between peace in the streets and public panic and disorder.

It is easy to envision environmental health professionals working with elements of the community’s infrastructure so that essential and even normal services can be maintained. It is also essential that public utilities—especially power and water utilities—get the help they need to keep their workplaces as safe as possible and to have backups in place so that they can continue to operate. If a pandemic-flu episode erupted suddenly the American workplace was transformed into essentially a home operation, the need for operational utilities would be paramount.

It is not too early to be looking at how outdated quarantine laws and protocols can be revised.

Health departments will likely be involved in determining when to close schools and when public gatherings, social events, or both will need to be cancelled.

We may also be called upon for basic consulting. For example, health departments would be a logical place for businesses to turn to for advice and assistance on measures they could take to limit the impact of the flu.

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Surveillance will have to be conducted to monitor the patterns of illness in a community and the speed with which flu is spreading. Medical supplies will be stockpiled in communities. The logistics of the task—from identifying locations to supervising shipments to managing the inventories to determining who will be eligible for medications—will fall in whole or in part on the shoulders of health department personnel.

Plans and procedures will need to be drawn up for the proper handling, storage, and disposal of large numbers of dead bodies, pets, and wild animals.

Interagency work will need to be envisioned and coordinated to allow for effective community response.
health departments. Decisions about how to allocate masks, gloves, antivirals, vaccines, palliative drugs, and the like will be difficult. More tough decisions will also need to be made about makeshift or warehouse hospitals in hotels, schools, and stadiums. Decisions might even be necessary for food supplies for quarantined populations. All of these decisions have the potential to involve members of our profession simply because environmental health professionals are also public health professionals.

All in all, in a pandemic situation, the life of an environmental health professional is likely to look much different from the way our work lives look today.

**Some Concluding Thoughts and Some Perspective**

This story has many facets. Obviously, much of this special report has outlined the potential consequences of a flu pandemic. If such a disaster happens, people in environmental and public health are going to be called upon to serve their communities in ways few have ever imagined. That is why I’ve spent so much time addressing how our world and how the life of an environmental health professional could change if a pandemic were to occur. We need to be prepared—our communities are depending on us.

It must nonetheless also be noted that the worst-case scenarios being discussed here are just that—worst-case scenarios. The critics (and there really aren’t that many of them) are quick to point out that the shock epidemiologists are grabbing the headlines when in fact the odds of such a crisis erupting are unknown. Even in China, at least two companies are now selling bird flu insurance policies that would pay if any family member contracts the illness. They have obviously calculated that the crisis is not that serious but that the public fear is great enough that they can make some good money on it.

Other officials, while acknowledging that a pandemic flu is possible, nonetheless seek to reassure us that we have the plans and the ability to deal with such a challenge.

The critics may be right. The reassuring officials may be right. **But what if they aren’t?**

Within our own profession, many scoffed at and criticized FEMA in the aftermath of Katrina. This time, we are part of the response and in significant ways. If a flu pandemic occurs and if it is as bad as many believe it could be, we will be the next FEMA if we don’t prepare now for the roles we would play in such a crisis. Hence this report and the emphasis points within it.

After a study of the issue, my own view comes out somewhere in the middle of the spectrum of opinions and predictions.

The mutation may never occur. If the virus does mutate, it may lose its virulence to the point of becoming harmless. And if the mutation occurs far enough down the road, there is a good chance that we will have the medicines by then to effectively deal with it.

On the other hand, this issue is a serious one and worthy of the considerable media attention that it has been getting. Moreover, it is a public health issue and therefore by definition one of enormous concern to each of us in this profession.

I believe it is possible that a pandemic of almost unimaginable consequence could occur (just as I believe that it may never happen). I also believe that in light of the interconnectedness of the global economy and the many very real holes that exist in the public health defense lines, this threat is much more serious than many of our reassuring officials would have us believe.

I would also suggest that concerned professionals—along with the shock epidemiologists, if that’s what you want to call CDC, HHS, WHO, TFAH, Deutsche Bank, Lehman Brothers, and even our fiscally conservative president who believes that 69 deaths is worthy of a $7.1-billion-dollar investment in preparedness—have served an important purpose. Awareness is up, and aggressive steps are now (and finally) being undertaken to resolve the vaccine production and capacity issue that has become more and more of a problem over the past decade.

Because of these actions and the planning now taking place, the challenge being posed by H5N1 would seem to be more a function of time than some sort of inevitable avian Armageddon.

The key question is what happens between now and the time when we will have the vaccine-manufacturing capacity that we need? As Secretary Leavitt has said, we’re looking at a **minimum** of three to five years before we get to where we need to be. The President’s plan calls for the ability to produce 600 million doses of a vaccine by 2013—seven long years from now.

Our public health ethic would seem clear on the answer to this key question. We need to be prepared. Moreover, as we have been learning in terrorism and all-hazards response planning, there is no major downside to being prepared. Plus … if this thing ever breaks loose, I am convinced that we will need every preparation, every resource, and every body that we have to manage it in a way that minimizes its impact. It would be an irresponsible and unforgivable dereliction of our professional duty to delay our preparations until a pandemic is actually under way.

Homeland Security Secretary Michael Chertoff said, “Hurricane Katrina was an ultra-catastrophe that exceeded the foresight of the planners.” NEHA and the **Journal** hope that this article has helped to inform the foresight of this profession.

In the case of a pandemic flu, I suspect many would agree with me that the tipping point of the system won’t take long to reach. Our job is to delay that tipping point for as long as possible through our preparations. If this thing explodes before we are fully prepared to deal with it and if the system breaks down or disorder breaks out, the dimensions of the crisis could far exceed any health impact actually caused by the flu virus. In my opinion, that would be the ultra-catastrophe in this case, because that degree of breakage doesn’t need to happen.

If I were visiting with my dinner friend again, I would tell him that and give him something to think about—as he did me.

As the European Commission has said, “Members of the public will not excuse authorities, who will be held responsible for not having put in place up-to-date preparedness.” We agree and hope that through this article the gravity of the issue has been conveyed persuasively enough that you agree also. It’s time to get to work.

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**Editor’s note:** Readers are cordially invited to contact the **Journal** of Environmental Health if they are interested in the sources from which any of the information in this article was derived.