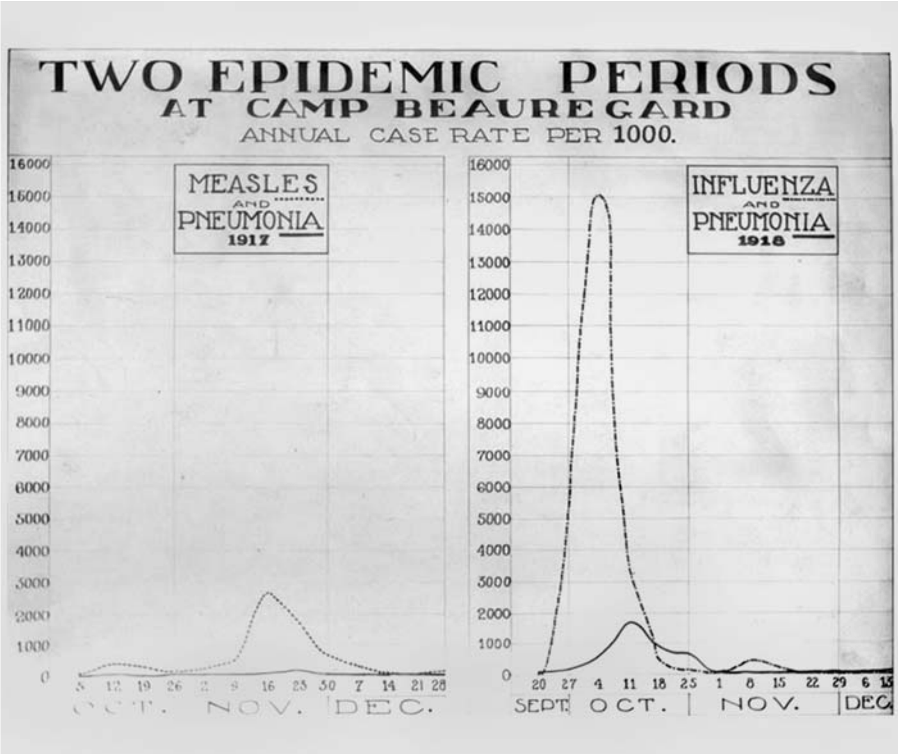

Courtesy of the National Museum of Health and Medicine, Armed Forces Institute of Pathology, Washington, D.C. (Reeve 2707).

Preparing for Pandemics

Barry R. Bloom and Howard Koh
Introduction by Joseph Boyd Martin

This presentation was given at the 1899th Stated Meeting, held at the House of the Academy on March 8, 2006.

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Howard Koh is Harvey V. Fineberg Professor of the Practice of Public Health and Director of the Harvard School of Public Health Center for Public Health Preparedness.

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Joseph Boyd Martin

It's difficult to get through the day without reading about influenza, bird or avian flu, pandemics, flu shots, or impending disasters in general. Today, I received the March 3, 2006, issue of *Science*. The two lead articles in the news section are on H5N1 avian flu. The first comes from an investigator in Italy, Ilaria Capua, who is concerned that data collected on migratory patterns of birds affected by the flu are not published quickly enough to develop the science of migration. Instead, she argues, the need to gain recognition for one's work and elevate one's status in academia is delaying the publication of the databases that would give us a sense of how this potential pandemic might emerge. The second article focuses on the clear evidence we now have implicating migratory birds in the H5N1 spread; we now know that sick birds can fly to distant sites, where they may then transmit the problem to other birds.

Tonight, we have two experts, Barry Bloom and Howard Koh, who will approach the topic of pandemics from different perspectives.

Barry Bloom is Dean of the Harvard School of Public Health and the Joan L. and Julius H. Jacobson Professor of Public Health. He received his B.A. from Amherst College, his M.A. degree from Harvard University, and his Ph.D. from Rockefeller University. Widely recognized in the field of infectious diseases, vaccines, and international health, he was elected President of the American Association of Immunologists in 1984, and President of the Federation of American Societies for Experimental Biology in 1985. Formerly a Howard Hughes Investigator at the Albert Einstein School of Medicine, Bloom came to Harvard seven years ago to become Dean of the School of Public Health.

Howard Koh is Harvey V. Fineberg Professor of the Practice of Public Health and Director of the Harvard School of Public Health Center for Public Health Preparedness. He graduated from Yale College and Yale Medical School; trained in residencies at Massachusetts General Hospital and at Boston City Hospital; received a Master of Public Health from Boston University; joined the faculty there; and, in 1997, was appointed by Governor Weld as the Commissioner of Public Health for the Commonwealth of Massachusetts – a position he held for six years. As Commissioner, Dr. Koh led the Department of Public Health, which encompasses a wide range of services, four hospitals, and a staff of over 3,000 public-health professionals.

Barry R. Bloom

We live in a world where about 1.2 billion people live on less than a dollar a day, and almost half of the global population lives on less than two dollars a day. The disparities – in health as well as income – are probably greater now than they were in 1970. More people are living in poverty, and half a billion kids in this world are hungry. At the same time, 200,000 people are born every day. Another important demographic factor to consider when examining infectious diseases is the formation of megacities – cities with more than 5 million people. By 2015, the world will have 37 of those.

Some other social, environmental, and political realities to consider: In a very large number of countries, over 40 percent of the population is under the age of 15; if not healthy and educated, they will not contribute to the economic and cultural development of those countries. Global warming is going to have profound effects on the patterns of infectious and vector-borne diseases; and, as the oceans rise because of the melting of the polar cap, many countries, like China and those in the Middle East, are going to have real problems with shortages of water. And don't forget, we are trying to deal with health problems in a world that has had about 30 civil and foreign wars, 35 million displaced people, and 127 failed states in the last 40 years. It's tough to do public-health work in those circumstances.

So what does an epidemic look like? Let's begin with a hypothetical situation: Imagine that, on September 12, we detect a case of a flu-like illness. A week later, there are 6,500 cases. A week after that, 12,000 cases and 627 deaths. In a few months, this agent infects a quarter of the civilian population. And in six months, 20 to 40 million people die. It turns out this case is not hypothetical. Those are real data from Camp Devens, Massachusetts, in 1918. During that time, in this country, a half percent of the people infected with the great flu died from it. Globally, the number of deaths was probably on the order of 4 percent, somewhere upwards of 50 million people – more than all the deaths of World War I.

One of the reasons we are here tonight is because of the resurrection of those strains from the Alaskan tundra in a museum jar in the Armed Forces Institute of Pathology. Molecular genetics reconstructed the 1918 virus and revealed it was a strain of bird flu.

Pandemics occur. We would love to be able to know when they will occur, but we don't. As you can see in figure 1, pandemics occur on an irregular basis. Most scientists believe that, sooner or later, a strain that we haven't seen before and that we aren't immune to will be transmitted between people and be carried around the world. Different strains have arisen since the 1918 H1N1 Spanish flu: the Asian flu in 1957, a quite different strain; and the Hong Kong flu in 1968, again a different, or partially different, strain. These represented major shifts in the composition of the virus; and since we hadn't seen them before, we didn't have prior immunity to them. In none of those cases was there, at the time, a vaccine. It has been 28 years since we last faced a pandemic. That's why a lot of people think we can count on a pandemic occurring, and why we ought to be prepared: time is running out.

Figure 1: Influenza Pandemics 1700 – Present

Years	Interval	Virus Subtype
1729–30	?	
1732–33	2	
1781–82	48	
1788–89?	6	
1830–31	41–48	
1833	2	
1836–7?	3	
1889–90	52–56	?H2
1899–1900	9	?H3
1918	18	H1N1 Spanish Flu
1957	39	H2N2 Asian Flu
1968	11	H3N2 Hong Kong Flu
(1977)	9	(H1N1 Russian Flu)
Next	>28	???

Average frequency: 3 – 4/100 years

Adapted from KD Patterson, *Pandemic Influenza, 1700 – 1900* (Rowman & Littlefield, 1986)

Until recently, people have largely discounted infectious diseases, with attention going to cancer and to chronic diseases – cardiovascular, diabetes, and neuropsychiatric diseases. The Surgeon General of the United States in 1968 wonderfully exemplified how wrong government officials can be in predicting the future: "We can now close the book on infectious diseases." Yogi Berra had it right when he said, "It's tough to make predictions, especially about the future."

It has been 28 years since we last faced a pandemic. That's why a lot of people think we can count on a pandemic occurring, and why we ought to be prepared: time is running out.

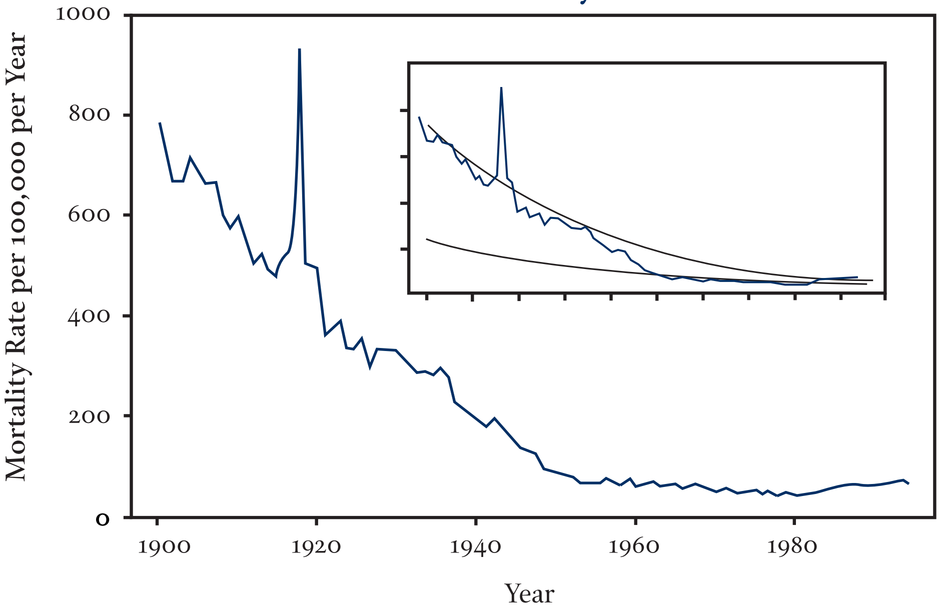
Are emerging infections and epidemics a real threat to the world? Or is it an epidemic of the press? During the last 30 years in the United States, there have been 32 major infectious diseases that had either never existed or reemerged (from rotavirus to Legionnaires' disease to lyme disease) and that we didn't know about before 1982: HIV; helicobactor pylori, which causes ulcers; bird flu in 1998; West Nile in New York; anthrax; and SARS are just some better known examples.

Is this a new problem for our era? In order to answer this question, I looked up some past infectious diseases. I saw that pandemics and epidemics have occurred throughout history. Some looked like flu, or conceivably, an early historical precedent for SARS: smallpox, the Black Death, the White Death, the Great Pox, syphilis, the Red Sickness, scarlet fever, jail fever, malaria. So when one asks what is the likelihood that we will face new emerging infectious diseases, the answer is high. We just don't know what and when.

Now let us consider the impact of pandemics on demography by taking the worst-case scenario – the 1918 flu. If we look at the mortality rates for the United States from 1900 to the 1980s, we see a very striking spike during the 1918 – 1919 period, indicating the devastating impact of the flu on survival in the United States (see figure 2). It's clear that these infectious diseases, if we don't deal with them, have tremendous potential to do enormous damage.

The deaths that occur each year from seasonal flu can help us understand the destruction a pandemic could potentially wreak.

Figure 2: Infectious Disease Mortality, United States – 20th Century



Source: Adapted from GL Armstrong, LA Conn, and RW Pinner, "Trends in infectious disease mortality in the United States during the 20th century," *JAMA* 281 (1) (January 1999): 61 – 66.

We actually know a lot about seasonal flu and have learned quite a bit from it. One important fact to note about seasonal flu is that it occurs every year – usually in the autumn, shortly after summer. Every year, we can pretty much count on a set of new strains to which we are not fully immune emerging (usually in Asia) and coming to the United States. With few exceptions, a group of reference labs that reports to the World Health Organization has done a marvelous job picking up on the most prevalent strains anticipated to spread around the world. Thanks to their surveillance work and the sophisticated vaccine industry, this country has, within nine months, the vaccines to prevent seasonal flu. Yet, even with good vaccines, 34,000 people in the United States die from influenza. If we can't even protect everyone against seasonal flu, how are we going to deal with a pandemic?

In addition, these numbers do not reflect the deaths that were probably indirectly caused by flu but not scored as influenza-related. It is fascinating that there appears to be a temporal correlation between cases of pneumonia and influenza and deaths from cardiovascular disease and stroke. So the deaths attributable to infectious disease extend beyond those directly caused by the infectious disease itself.

The sheer number of possible fatalities is not the only reason people should be frightened of pandemic flu. Ordinary flu, as you well know, is pretty tough on young children and the elderly. But when you look at the pandemics of 1918, 1957, etc. – the spike in deaths occurs in young adults, during their most productive years. This is a significant difference between the seasonal flu and a pandemic strain for which we have no prior immunity. The devastation that a pandemic flu can create is clear. But how do new strains of flu arise every year? And how do we think about preparing for them?

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When we say "H5N1" and "H7N2," the letters indicate the two major outer proteins in the virus, against which we have to develop a good immune response to avoid getting the flu: the "H" refers to the hemagglutinin protein; the "N" refers to neuraminidase. There are at least 15 H's and 9 N's in birds we know about. The flu is also different from many other viruses in that it has not just a single chromosome, but comes in multiple segments, which move around or segregate independently in host cells.

We are very fortunate in the case of H5N1 and the avian viruses because these viruses don't easily enter human beings directly. Otherwise, we would have been "done in" when they first emerged a few years ago. In order for them to get into humans, they have to infect an intermediate host, like a pig. Pig viruses do get into humans. If a pig has a bird virus and a human or swine virus, the genes of the different viruses can shuffle, creating a new virus with the virulence genes of the bird virus and the transmission to humans of the swine or human strain. In countries like China, where people live in close contact with chickens and pigs, a perfect cycle can occur – the viruses get from the bird to the pig and from the pig to humans. Thus, new viruses are being made constantly. And when they have an H and an N we've never seen before, we have a scenario for a pandemic.

How do we plan to prevent the spread of bird flu H5N1? We know, already, that China has something on the order of 13 to 15 billion chickens. So the idea of running around China, vaccinating every chicken, may not be feasible. Yet this idea of stopping it in its place of origin is a major part of the U.S. strategy. The magnitude of chickens in Asia is not the only problem with this plan. Migrating birds can also carry the virus around the world, disseminating it through droppings or when they drop dead. Ducks – or at least certain kinds of ducks – are also quite dangerous. For reasons not clear to me, they can carry and shed the virus, and not get sick at all – and China has lots of ducks.

Bird flu, mercifully, isn't easily transmitted between humans yet. There are a couple of mutations that would enable facile transmission. There have still been only 174 human cases and 94 deaths. These numbers are quite different from those of the 1918 flu, when the mortality rate was 0.5 percent domestically and 4 percent worldwide. We know that many of the genes that were mutated in the 1918 strain are out there in birds, but not in the same virus. Whether a new pandemic strain will incorporate these genes, or others, remains unclear.

We didn't know until recently how this virus could spread around the world so quickly. Now we know part of the answer lies in migratory bird patterns that are well known to people who study veterinary medicine: the East Asian flyway; the East Africa – West Africa one; the Black Sea – Mediterranean one. The East Atlantic flyway is of particular interest. It's very likely that if the virus gets past Europe into our hemisphere, it will take this path and this travel is going to be very hard to stop. We

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may be able to vaccinate chickens in chicken farms, but it's not easy to get your hands on migratory birds.

Where has the virus gone since 2003? It has been found in birds in over 30 countries, and in many of those countries, small numbers of cases have involved direct animal contact. It's all over Asia and Russia and is now moving into Europe. It's also in Africa, which is quite worrisome because the health infrastructures in those countries are not in a position to deal with this crisis. Here, it's important to note that migratory routes are circular. Whatever has moved into Africa or Europe would be predicted to move back into Asia, picking up stuff along the way. These reintroductions, which occur multiple times in multiple places, make the flu difficult to control. We talk about the H5N1 strain because it is spreading in birds, but there are other flu viruses that are also in birds, like H5N2 and H7N2, and have killed or infected people in Canada, New York, the Netherlands, and China.

So if there is a pandemic, we don't know whether it's going to be H5N1 or not. There are flu experts who say that the ubiquity of the H5N1 is such that if it were really going to jump into humans, it would have done so already. They're worried about other strains. Obviously, the fact that we haven't a clue about what the next pandemic is going to consist of has major implications for preparedness. Unfortunately, the United States and most of the world seems to want to combat H5N1 in Asia by getting our hands on all the birds in an infected flock and killing them off. But this strategy will be ineffective, unless we pay a decent compensation to the farmers whose birds are being culled.

Before we can counter an epidemic, we need to characterize how severe it will be. Here, there are two parameters that really count. One is "R_0," the basic reproductive number. This number tells you how many secondary infectious cases derive from a single infectious case. For example, an R_0 of 4 tells you that a single infectious case will infect 4 people. Each of them, in turn, will affect 4 more. Any R_0 greater than 1 means that 1 person is infecting more than 1 other individual and, inevitably, the epidemic will spread. So the challenge of public health is to reduce the R_0 to less than 1.

The second parameter is v, the serial interval, or the time between the development of the first case and a secondary case. The public-health system has to work within this time frame.

What are the R_0 and v for flu? Until Harvard epidemiologist Marc Lipsitch's work, nobody really knew. After all, if you were a really good academic, why would you waste your time trying to model last year's flu, when next year's flu would be different? Because the strains of flu changed every year, no one ever believed that we could generalize a model. In this context, Marc's idea of taking the worst-case scenario was brilliant. Why not model the transmission of the 1918 flu? No epidemiologist had ever done it – so he did it. There were weekly and monthly data showing the number of flu cases in 1918 in fortysome U.S. cities – an extraordinary database from which one can estimate the number of people who died in each of those cities and then model what would happen if a similar pandemic strain got loose.

During the course of the SARS epidemic, Marc and colleagues and a group in London also modeled an infection in real time for the first time in history. They estimated an R_0 of 3 for SARS. Their model told us that by both isolating patients and quarantining those exposed to others with SARS, and with a little luck, we could get an R_0 of less than 1, and the epidemic would disappear. When China finally got its act together to do both, the epidemic went away.

Since SARS had a serial interval somewhere of between 8 and 10 days, there was time to identify people who were sick. In addition, there was no evidence of transmission by people who were infected but appeared healthy; only when they actually showed signs of sickness were they able to transmit.

Now compare the 1918 flu to SARS. I would have guessed that the transmissibility of the 1918 flu, the R_0, would be far greater than in the case of SARS because the flu killed so many people. In fact, the R_0 was no greater than that of SARS, maybe even a little less. My response: "We didn't really know how serious SARS could have been." But it could also mean, in the case of the bird flu, that if we knew what to do and could do it, we could get an R_0 of less than 1 and eventually squash the epidemic.

But there's a catch. The major difference between the 1918 flu and SARS is not the transmissibility – the R_0. It's the serial interval v. In the case of the 1918 flu, the v was 2 to 4 days – people were transmitting the flu before they even knew they were sick. So the idea of identifying sick people, isolating them, and quarantining their contacts, as we did with SARS, becomes very difficult.

What would a pandemic, not as bad as the 1918 flu but still pretty bad, look like? According to the U.S. government's projections, 200,000,000 people would be infected, with perhaps 75 million sick, 50 million needing outpatient care, 500,000 needing hospital care that we can't provide, and 100,000 dead. As for the economy, a mild epidemic, according to the Congressional Budget Office, would cost us about $60 billion. In the worst case, it would impact GDP by $500 billion.

What can we do? By isolating the infected, quarantining contacts, screening borders, improving hospitals, closing schools and public gatherings, and increasing social distance, we were able to stem SARS. My

Currently, we have good vaccines against regular flu. We need a similar vaccine against bird flu. But how do you make a vaccine against a strain that doesn't yet exist?

sense is that travel restrictions and local quarantine alone are very unlikely to work in the event of a pandemic flu. We will certainly try them, but we know they're likely to fail because of asymptomatic travelers whom we have no way of detecting but who will inevitably spread the disease. There is the added problem of smuggled birds and pets. With half a million people crossing the U.S. borders every day, it's going to be very tough to keep the virus out of here.

To contain the disease, we have to know, in a crisis, who's sick from bird flu and who has any of a slew of flu-like illnesses.

What about drugs? Can Tamiflu or Zanamivir prevent a pandemic in this country? By reducing viruses and the viral load, they will keep people who have a serious case of the flu from dying. But it is almost inconceivable to me, except under the most favorable conditions, that they could stop an epidemic in one place, not to mention multiple sites simultaneously. We couldn't get them out quickly enough. Since only one company makes Tamiflu, we don't have enough, nor will there be enough, at least in the near future. While drugs are important tools for treating people who do get sick, and can prevent people from dying, I don't see drugs as a way of preventing an epidemic in the United States.

Currently, we have good vaccines against regular flu. We need a similar vaccine against bird flu. But how do you make a vaccine against a strain that doesn't yet exist? And when we do know what that strain is, how do we tool up the vaccine industry so that we can actually produce a vaccine in a timely fashion? Everybody who died in 1919 died in 5 or 6 months. Right now, we can't get a vaccine for seasonal flu in fewer than 9 months. We don't have enough seasonal flu vaccine, let alone the potential to create massive amounts of vaccine against a new strain. And we don't have that potential because there aren't enough fertilized eggs in the world, which we currently use to cultivate vaccines. A big thrust in research is to find an alternative method of growing flu vaccine so that we can produce more vaccine than we are capable of at the moment.

And if we had a vaccine, we would still face significant dilemmas: How much could we produce? Would we have enough for everybody in the country? If not, what would the market be like for the vaccine? Would only the rich be able to afford it? How would we distribute it?

Today, we only have enough seasonal-flu vaccine for a quarter of the people in the country, and we know from research trials on bird-flu strains that it takes at least four times as much, under present circumstances, to get a comparable immune response. Production will be a problem. Companies won't make this vaccine if they're not given immunity from liability, and that's hard to do unless you guarantee everybody who takes it that they're going to receive indemnity if they experience any adverse effects. We know what the adverse effects are for childhood vaccines, which enables us to have a compensation program based on what we know are appropriate symptoms of adverse effects. But we have no idea what the adverse effects of a bird-flu vaccine are. Finally, even if we had a vaccine, we would have difficulty getting it out there and getting people to take a new strain.

How might a pandemic affect us? Right off the bat, we know that it will make a lot of people sick, disrupt the health-care system, and, if it's really serious, cause a huge number of deaths. It's going to wipe out the travel and hospitality industries. It's going to interfere with business supply and demand, particularly if an industry relies on a just-in-time approach that depends on a steady, balanced flow of materials throughout the production process. If everybody is home sick, you're in trouble. A pandemic will also affect essential services and human resources. It's going to disrupt government; legislatures will not function. Kids will not go to school. There will be public protests. When we obtain vaccines and drugs, they're always going to be scarce, at least the way we're going about it now, and this scarcity will cause nightmarish disputes.

So, what's our strategy? We have a couple of options we can think about now. Clearly, one of them is to reduce the risks through surveillance – get an early warning of what's coming. Right now, surveillance in poor countries is particularly ineffective because we have not provided them with adequate laboratories, training, and research opportunities.

Second, we can try to prevent the spread of disease between animals and humans. Europeans now keep all chickens in houses that have roofs to keep droppings from contaminating them. Otherwise, we don't have many options, except good hygiene – hand washing or even masks.

In the event of an emergency, we also need mechanisms to inform the public truthfully about what we know and don't, and to keep their social distance. Medically, we must stockpile antivirals to keep people from dying, and we must contain the disease to the extent that we can. We can give people some vaccines even now. For many older people, the major consequence of flu is death from pneumonia. We already have very good pneumococcal vaccines, so we can be more effective in preventing this type of death. We could also administer more flu-vaccine strains. If we had a vaccine for a new flu, I would add this fourth strain – an avian strain – to the three seasonal strains we give out every year and start building up immunity to bird strains. Even if it's the wrong strain, it could be helpful.

To contain the disease, we have to know, in a crisis, who's sick from bird flu and who has any of a slew of flu-like illnesses. Currently, Harvard University and most of the hospitals don't have diagnostics. We must develop them if we want to be able to distinguish between seasonal flu and a pandemic strain.

Our highest priority should be to work really hard to get a vaccine against all kinds of strains because one of them may be the right one and it could be too late to develop it once the epidemic is underway.

We must raise "surge" capacity by increasing the number of hospital beds as well as available antivirals and ventilators for people in respiratory distress. Massachusetts has spectacular respiratory surge capacity, but it still doesn't have enough ventilators. Finally, we need people who consider the risks and challenges of a pandemic, including what to prioritize when resources and knowledge are limited.

Most scientists believe there will be mutations in some bird-flu strain that will enable it to jump between humans. It has happened before. It's just not clear to me whether it's going to be H5N1, but we do have time. Developing a strain that picks up all the bad genes from 1918, or its equivalent, in a single virus could take time. However, no one knows where the 1918 flu came from. It did not come from any known source that accumulated bad genes over time. It appeared out of nowhere.

On the systems side, we should recognize that all epidemics, like politics, are local. They may spread globally, but we fight them locally.

The tactics that worked with SARS – like isolation, quarantine, and closing borders – are not going to be particularly serious options for a disease that has a serial interval of two days and a transmission rate even as low as three, nor are drugs likely to prevent the spread of the pandemic. This means our highest priority should be to work really hard to get a vaccine against all kinds of strains because one of them may be the right one and it could be too late to develop it once the epidemic is underway. On the systems side, we should recognize that all epidemics, like politics, are local. They may spread globally, but we fight them locally. Unfortunately, we have degraded our local public-health systems and infrastructure over a long period of time.

Can we prepare? I'm always optimistic. One of the leaders of the Manhattan Project, Leo Szilard, later became a key figure among scientists opposing the use of the A-bomb, and he gave what is my favorite definition of an optimist: "An optimist is someone who believes the future is uncertain."

Howard Koh

In the twenty-first century, some extraordinary public-health challenges have already confronted us. In 2001, the United States experienced bioterrorism and anthrax, which culminated in 22 cases and 5 tragic deaths. Then, the global community suffered through SARS in 2003 – over 8,500 cases; the Indian Ocean tsunami in 2004 – 300,000 dead or missing; and Hurricane Katrina in 2005 – over 1,300 dead. Now, the ongoing threat of pandemic flu is upon us. With all these challenges and many more to come, the question is: how do we build the best public-health system possible, one that will protect all people, all the time?

The World Health Organization (WHO) describes six potential phases for pandemic flu. According to this framework, we are currently in phase three: human infections documented, but no, or rare, instances of human-to-human spread. To date, WHO has confirmed about 175 cases and about 95 deaths worldwide. Everyone fears that we will, at some point, move through phases four and five, and then, ultimately, into phase six – a pandemic period – marked by increased, sustained human transmission.

So, as we live and work in the midst of a pandemic-alert period – phase three – what should be our priorities? I would like to propose five teaching points:

- First, pandemics, and disasters in general, expose global disparities.
- Second, we must create better surge capacity.
- Third, we need ongoing risk communication to rebuild trust in our public-health system.
- Fourth, all preparedness starts locally, so building social capital is essential.
- Fifth, and most important, preparedness means reinvesting in a rejuvenated public-health system.

First, Hurricane Katrina exemplified tragically the fact that pandemics and disasters expose global disparities. Instead of affecting all people equally, Hurricane Katrina exposed disparities in terms of race/ethnicity, socioeconomic status, age, mobility and disability level, and many other dimensions. We witnessed what happens when preparedness does not work: the most vulnerable are disproportionately affected. In this case, this vulnerable population was overwhelmingly African American, poor and without insurance, and/or without the ability to mobilize and move. We should consider these issues with respect to preparedness for any disaster, particularly pandemic flu.

Why should we be concerned about this disparity? Because in this shrinking world, what happens to some of us concerns and affects all of us. Consider, for instance, the known practice of Asian farmers sleeping with their poultry. Infections in such farmers, a tragedy in and of itself, could potentially ignite disease in broader populations around the world. As the columnist James Carroll has written, "Avian flu makes the point. A disease that incubates among the world's most impoverished people can threaten the most privileged. We humans are all down river from the same coming flood. No one is safe unless everyone is."

Second, we need better surge capacity. The Health Resources Services Administration (HRSA) defines surge capacity as "a health-care system's ability to rapidly expand beyond normal services to meet the increased demand in the event of large-scale public-health emergencies or disasters." In the event of a disaster, are we truly capable of further ramping up our health-care system, which is currently operating at full capacity? We have no choice but to build that capacity to prevent suffering and death from pandemics.

How do we build the best public-health system possible, one that will protect all people, all the time?

We need more space, staff, and supplies. According to the HRSA, communities should aim for an additional 500 hospital beds per million people (urban settings); more decontamination facilities, portable and fixed; more isolation facilities per health-care system; more doctors, nurses, and other allied health-care workers; and more supplies and equipment, such as ventilators and personal protective equipment (PPE).

How does our society build surge capacity for a possible pandemic tomorrow when there are so many pressing medical needs today? That is a challenge when the health-care system is already at full throttle. In Massachusetts, statewide hospitals have

Pandemics and disasters expose global disparities.

16,500 licensed acute-care beds, but only 13,000 of them are staffed, reflecting ongoing nursing shortages. The state also has about 5,000 ICU beds. In addition, hospital and public-health officials are working diligently to identify level-two and level-three surge-capacity beds. About 4,400 level-two beds could be freed up if hospitals canceled elective surgery and other procedures. Creating level-three beds would require clearing out hospital cafeterias, chapels, and other spaces to allow for patient care. In addition, state and city officials need to identify appropriate community spaces for care, if needed. This occurred in New Orleans during Hurricane Katrina when the Superdome and the Astrodome were employed.

Mobilizing staff poses yet another challenge. Our state has 29,000 physicians and about 75,000 registered nurses. But an emergency such as pandemic influenza would require many more doctors, nurses, and allied health professionals. Our country is just beginning to address how health volunteers can be readily recruited, mobilized, trained, and deployed in a time of pressing need. The Harvard School of Public Health (HSPH) Center for Public Health Preparedness, like many organizations around the country, is helping to enlist health volunteers in the Medical Reserve Corps, a national effort sponsored by the U.S. Surgeon General. In collaboration with the Boston Public Health Commission, we are actively encouraging available health professionals to volunteer and receive online training in preparation for a disaster. In addition, all countries are mobilizing supplies such as antiviral agents. All these efforts are integral to increasing surge capacity to protect people in a time of need.

Third, we must improve risk communication to rebuild public trust. As the Massachusetts Commissioner of Public Health during the anthrax crisis of 2001, I was charged with delivering risk communication through daily press conferences with the Governor, the Secretary of Health and Human Services, the Secretary of Public Safety, FBI officials, and U.S. Postal Service leaders. Our common mission was to keep the public informed through a very uncertain time and coordinate protection for all 6.5 million people in this Commonwealth.

Now, recent public-health events have again underscored the critical importance of high-level risk communication. One prominent example centers on the challenges our country has faced in distributing seasonal flu vaccine. Last year, during the 2004 – 2005 season, an England-based Chiron facility shut down and ceased flu-vaccine production. As a result, Sanofi Pasteur was left as the sole producer of the national flu vaccine – about 61 million doses that year. This overall shortage forced the Centers for Disease Control and Prevention (CDC) to promulgate priority groups of those who should be vaccinated ahead of the general population. Those prioritized included people over 65 years of age, young children aged 6 – 23 months, and people with chronic health conditions.

In the aftermath of that flu season, Cait DesRoches and Robert Blendon from the Harvard School of Public Health polled over 1,200 adults in the United States and asked, "Were you confident in the fair distribution of the 2004 flu vaccine?" About 60 percent of respondents replied, "Yes, we are somewhat (or very) confident." But about 40 percent said, "No, we're not very confident (or not confident at all) in this triage process." In a similar survey, recently published in *Health Affairs* by Professor Blendon and his colleagues, people in four countries were asked, "Do you trust government public-health authorities as a source of useful and accurate information about an outbreak?" In Taiwan, Hong Kong, and Singapore, over 50 percent of the people responded affirmatively ("Yes, we trust government public-health authorities a lot") while in the United States only 40 percent responded similarly.

So in the event of a pandemic, when government public-health authorities propose priority groups for vaccine prophylaxis or social-distancing measures, will the American public comply? During SARS, officials in Toronto quarantined 23,000 people, all but 27 voluntarily. To assure such levels of public cooperation in the event of a crisis, officials need to be afforded the highest levels of trust. This theme is particularly important at the local community level. In his fascinating book, *Bowling Alone*, Harvard professor and world-renowned author, Robert Putnam, argues that the cohesion of the American community has declined dramatically to the point that we don't know our neighbors and don't invest in building social capital as we did in the past. The threat of a pandemic offers an opportunity to reinvest in our communities, rebuild trust, and create better social networks so that no one is "bowling alone."

On the local level, hospitals and medical professionals are wrestling with the issue of how to define appropriate standards of care in a crisis. In our society, we expect unlimited medical resources to be made available for our loved ones in a time of need. In a time of mass casualties, however, society may need to employ the public-health ethic of the greatest good for the greatest number. What's an acceptable standard of care in such an instance?

Meanwhile, hospitals are not the only institutions that need to plan ahead. Businesses should have continuity-of-operations plans, beginning with the assumption that up to 40 percent of their workers may be out sick. Schools and religious organizations also need to plan as well.

How does our society build surge capacity for a possible pandemic tomorrow when there are so many pressing medical needs today?

Planning can be enhanced by working at the regional level. This can be challenging in states such as Massachusetts, where there are 351 cities and towns but no county or regional form of public-health structure. With the recent infusion of federal preparedness-related funds, many states have emphasized the public-health opportunity offered by regional planning. For example, fire departments have long benefited from mutual-aid agreements. In the event of a major fire in one town, colleagues from neighboring cities and towns in the region can join in to help. For public-health officials in cities and towns, such agreements are still in a state of evolution. Regional planning can offer an efficient way for adjoining hospitals, emergency-medical services, and public-safety organizations to build a common web of protection. Each community and region must know how to report cases to state and federal authorities; administer prophylaxis or vaccines on a community-wide basis; obtain more personal protective equipment for community members; and effectively communicate information in a timely and transparent manner that builds trust.

We must improve risk communication to rebuild public trust.

Preparedness is not simply a theoretical issue but rather an area of concrete implementation and practice. As part of our educational mission, therefore, the HSPH Center for Public Health Preparedness has emphasized drills and exercises as a highly effective means of role-based training. In such simulations, gathered leaders from local government, the community, schools, and indeed all sectors of society are asked to respond to an unfolding set of pandemic scenarios. Many concrete issues immediately arise. If an outbreak occurred at a university, for example, what would be the appropriate trigger to administer prophylaxis, institute social-distancing measures (if possible), cancel classes, or send students home? And what would be the most effective and appropriate risk communication messages to students, faculty, and families? This hands-on method of teaching people highlights the importance of unified command and understanding roles and responsibilities – all in a safe environment.

In these exercises, we pose some very basic questions to assess readiness, such as: Does your business have an emergency plan of operation? Who would be in charge? Do you know your role within an emergency plan? Whom will you contact or who should be contacting you? Does your family have an emergency plan? Do you have backup food and medical supplies for your family? Such burning questions haunted us during Hurricane Katrina and will undoubtedly arise again in any emergency.

Finally, preparedness represents an opportunity to reinvest in a rejuvenated public-health system. The media has focused much attention on the need for better vaccines and an antiviral supply. In addition to more shots and pills, however, we also need a comprehensive system that works efficiently and effectively to protect all people. Public health protects every life and, indeed, every day of every life. Public health adds years to all of our lives and quality of life to all of our years. If we maximize this crucial opportunity to promote public health – what it is, why it's important – then we will all enjoy the promise of a healthier future. ■

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