proteins for replication and proteins for constructing the virus particle. By encoding the reverse transcriptase, retroviruses have evolved the ability to integrate themselves into the cell chromosome as a provirus. This is a very sheltered environment in which to live; only mutation interferes with the continual transmission of the virus to the progeny of an animal that is infected in its germ cells. In this context, the ability of some retroviruses to cause cancer is a gratuitous one. But it is today the most challenging and important attribute of these retroviruses and the one that will dominate future research efforts in this area.

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NEWS AND COMMENT

Anatomy of a Decision: How the Nation Declared War on Swine Flu

Late on the afternoon of 24 March, President Gerald R. Ford appeared before White House reporters to discuss "a subject of vast importance to all Americans"—the appearance of a new strain of flu. A month earlier, scientists had discovered that Army recruits at Fort Dix, New Jersey, were infected by "swine flu virus." One of them had died. The last time an outbreak of swine flu appeared in the United States was in 1918–19 when, the President told reporters, "a widespread and very deadly flu epidemic" killed 548,000 Americans of all ages. The 1918 epidemic was really a pandemic; in successive waves, swine flu swept around the world, leaving 20 million persons dead. It is said that the pandemic killed more individuals in a short period of time than any other catastrophe in history.

After consulting with his top health advisers and virologists from throughout the country, Ford was concerned about the "very real possibility" of a dangerous epidemic in the United States next fall and winter. To head off this threat, the President announced that he would ask Congress to appropriate $135 million right away to buy enough vaccine to inoculate "every man, woman, and child in the United States."

This would be the largest immunization campaign ever launched in this country, far more ambitious even than the polio immunization drives of the 1960's. Then, about 100 million Americans received polio vaccine during a period of a year and a half. Ford was launching a campaign to vaccinate twice as many citizens in a matter of months. Officials said that all his health advisers thought

it was the right thing to do. Ford even had Jonas Salk and Albert Sabin, heroes of the successful polio campaign, by his side to lend their prestige and support.

Sabin acknowledged that the decision to vaccinate America was based on anything but absolute certainty. He said that nobody was sure there really would be an epidemic next fall or that the swine flu virus of 1976 is really as lethal as the one that was around in 1918. It was only a matter of days before others began asking questions about the wisdom of the President's decision. What is clear now is that there are as many uncertainties as certainties about the "very real possibility" of an epidemic.

In an effort to dissect the process that led the President to declare war on swine flu, *Science* interviewed most of the major participants. Many of them supported the vaccine campaign on the grounds that there is little to lose, that it is better to be safe than sorry; but even conservative gamblers are betting that the odds there really will be a serious epidemic are less than 50:50. What is evident from an analysis of the decision-making process is that once the "stop-the-flu" bandwagon got rolling, it had too much momentum to be brought to a halt and it was easier for advisers, in and out of the government, to vote yes rather than no on the question of going ahead.

It was only after the President's surprise press conference that grumbling and second-guessing were heard. Then there were complaints that the Administration had overreacted and launched a massive campaign on flimsy evidence of hazard. People accused the Administration of using "scare tactics" to sell the program and predicted that it might be a wasted effort in any case because flu vaccines have been notoriously ineffective in preventing epidemics in the past.

Soon Washington was buzzing with rumors that the campaign was a political ploy to bolster Ford's chances for reelection during the flu season next fall, or that it was engineered by vaccine manufacturers who saw a chance to make enormous profits, or that the Army had somehow orchestrated the drive in the belief that a national campaign would divert attention from health problems at Ft. Dix.

In reality, the forces behind the campaign are probably far less Machiavellian. The decision was primarily triggered by David Sencer, director of the Center for Disease Control in Atlanta, after exhaustive consultation with other government health officials and scores of outside consultants, mostly serving on advisory committees to the Center for Disease Control, the Bureau of Biologics, or the National Institute of Allergy and Infectious Diseases. "We have not found anyone who would recommend any course of action other than the President is taking," David Mathews, Secretary of Health, Education, and Welfare, asserted in what later turned out to be an overstatement.

It is not generally recognized that most of the government's own health experts believe the odds are against an epidemic of swine flu occurring next fall or winter. Incredibly enough, one flu expert who participated in most of the key decision-making meetings and who supports the campaign told *Science* he believes there is only a 2 percent chance of a swine flu epidemic in the 1976–77 season, though he acknowledges that the number was just plucked out of the air and that he doesn't have great confidence in it. Other experts consulted by *Science* pegged the probability at 10 percent, 35 percent, and "less than even." Those probability estimates, though far lower than the official rhetoric of the campaign would lead one to expect, do not necessarily mean that the vaccination campaign is a foolish endeavor. But they do indicate that the decision to vaccinate was a very close and calculated gamble—a judgment with which reasonable men might disagree.

Fort Dix Outbreak Misdiagnosed

One of the ironies of the vaccination campaign is that the event that triggered it—the outbreak of swine flu at Ft. Dix—was almost missed by health officials. The man who inadvertently launched the chain of events that led to its discovery was Colonel Joseph Bartley, chief of preventive medicine at Ft. Dix, who noticed an increase in hospitalizations for acute respiratory disease at the base in January. But Bartley did not realize that he had flu on his hands. He assumed he was dealing with the adenoviruses, another infective agent of the respiratory tract that has typically been a problem at Ft. Dix shortly after soldiers report in after the Christmas holidays. Bartley's assumption was reinforced when an Army laboratory isolated adenovirus 21 in specimens taken from soldiers at the base.

As the hospitalizations mounted, Bartley called the county health officer to alert him that the presumed adenovirus outbreak might also affect civilian populations nearby. The county officer in turn alerted state health officials who became dubious that adenoviruses were the problem. According to Martin Goldfield, director of public health laboratories for New Jersey, the explosive spread of the infection at Ft. Dix (hundreds were hospitalized), the symptoms of the victims, the presence of influenza in other parts of south Jersey, and other factors all led him to suspect that Ft. Dix was actually suffering from an outbreak of flu. He therefore called Bartley and asked him to send over some throat washings from the victims and, sure enough, they contained flu virus. Of 19 specimens sent to the New Jersey laboratory on 29 January, 11 were found to have isolates of the A/Victoria strain of flu—the strain most prevalent in the country—while another 3 had isolates of an A strain of flu that could not be identified with the testing agents available at the state labs. These were sent to the federal Center for Disease Control in Atlanta, where they were characterized on 13 February as a form of swine flu virus.

Had this chain of events been initiated just 1 week later, Bartley speculates, the outbreak of swine flu would most likely have gone undetected. Indeed, when Army doctors took throat washings a week after collecting their first specimens, they found no swine flu. The new strain had disappeared while the A/Victoria strain remained dominant. Sending the washings to Goldfield's state laboratory rather than through Army channels may also have been a critical move. "The Army laboratories are not set up for influenza," Bartley observes. "They probably would have missed it."

The abrupt appearance and disappearance of the swine flu at Ft. Dix has provided ammunition for both sides in the debate over the vaccination campaign. Those who favor the campaign suggest that there may have been similar small outbreaks elsewhere that have gone undetected, that these outbreaks may be "seeding" the population with the swine virus, and that the virus may be on the verge of exploding into a pandemic.

Those who oppose the campaign suggest that such undetected outbreaks may have been occurring for years without leading to a pandemic. The unique thing about the Ft. Dix outbreak is that, for the first time, scientists have detected two radically different flu viruses circulating in the same population. But they are uncertain whether they are witnessing the first steps by which a new strain (the swine flu) begins to replace the prevalent strain (A/Victoria) or whether they are witnessing evidence that the swine flu lacks the ability to compete successfully against other flu strains. If the latter is true, there may be little to worry about.

Scientists also are uncertain about how virulent the swine strain really is. The virus has been stigmatized as a "kill-

er'' in part because of the analogy to the virus that helped slaughter so many millions in 1918–19, and in part because a recruit who died at Ft. Dix was found to have swine virus. But the health significance of that single death can be disputed. Bartley states that the recruit, who was seen in the dispensary and then assigned to his quarters for 48 hours, left his bed before then to join a forced march at night with the other recruits. He began to lag behind, took frequent rests, and eventually collapsed, whereupon he was rushed to the hospital and died shortly thereafter. Bartley speculates that if the recruit had stayed in bed, he'd be alive today. He also suggests that if the recruit had suffered from the Victoria strain rather than swine flu, he might also have died on the forced march. State health official Goldfield also scoffs at the notion that swine flu is a proven killer. He notes that the Victoria strain killed a dozen people of varied ages in New Jersey without attracting the notoriety of the swine flu, which was implicated in only one death.

As for the analogy with the 1918–19 catastrophe, many experts believe that has been vastly overdrawn. They note that the 1918–19 pandemic was exacerbated by conditions peculiar to the time. Overcrowding in military camps and widespread troop movements provided ideal conditions for propagating the disease around the world, and there were no antibiotics available in those days to combat secondary infections, such as pneumonia. Moreover, while the swine virus at Ft. Dix is considered antigenically similar to the virus believed prevalent in 1918–19, it is not identical and may not be as virulent. Indeed, the swine flu patients at Ft. Dix had symptoms no worse than those of the Victoria strain victims—perhaps even somewhat milder. That does not mean the swine virus might not mutate and become more virulent, but there is nothing in its record so far to justify calling it a particularly severe "killer."

Although the specter of 1918 has been raised to rally political support for the program, most experts involved agree that the vaccination campaign is not premised on the fear of another 1918 catastrophe. Rather, it is based on the notion that the swine flu might be the next pandemic strain—following on the heels of the Asian flu of 1957 and the Hong Kong flu of 1968. These strains were damaging enough. The Hong Kong pandemic of 1968–69 afflicted more than 50 million Americans, was blamed for some 27,000 excess deaths, and cost an estimated $3.9 billion in medical care, industrial absenteeism, and the future earnings of those who died.

Even before the swine virus had been isolated from the Ft. Dix specimens, the Center for Disease Control, which monitors virus outbreaks nationwide, realized that it had a new strain of flu on its hands, so it hurriedly called a meeting in Atlanta on 14 February. The situation was deemed urgent. Scientists had been predicting another flu pandemic for the late 1970's because previous pandemics had occurred at 10- to 12-year intervals. Some had even predicted that the next pandemic strain would be a swine virus, based on a theory that previous pandemic strains reappear in a cyclic fashion when the population they originally infected dies out and the bulk of the remaining population lacks antibodies to the flu virus in question. Few Americans under 50 have been exposed to swine flu virus.

Those who attended this first meeting included officials from the Army, New Jersey, and the three federal agencies most concerned, namely the Center for Disease Control, Bureau of Biologics, and National Institute of Allergy and Infectious Diseases. By the time of the meeting, the virus at Ft. Dix had been identified as a swine virus. All present agreed there should be a major effort to determine the extent of the outbreak at Ft. Dix and whether there had been similar outbreaks elsewhere.

The Hunt for More Cases

The investigation at Ft. Dix, conducted largely by the Army itself, convinced most specialists that the outbreak had been fairly extensive, if short-lived. In the final tabulation, five cases were unequivocally identified as swine flu by virus isolation. Another eight cases were almost certainly identified as swine flu because the patients showed an increase in swine antibody levels in two successive blood tests. And a screening of single blood readings from a large sample of recruits found hundreds with high concentrations of antibody to swine flu (much higher than their civilian counterparts of similar age); most of these were concentrated in companies in which other cases of swine flu had been positively identified. Some purists contend that a single blood sample proves nothing because it cannot show that there has been an increase in antibody in response to the virus. But most experts believe the totality of the evidence demonstrates that more than 500 individuals were infected at Ft. Dix and that the virus spread from human to human (because most of the recruits had no contact with swine and many had not been off the base in some time). Although there have been isolated civilian cases that might conceivably have involved human-to-human transfer, the Ft. Dix episode is the first well-documented evidence that the swine virus may possess the capability to spread through man.

The hunt for similar outbreaks elsewhere in the country turned up nothing definitive, however. There had been isolated cases of swine flu infection in Minnesota in 1974 and Wisconsin in 1975, and the new hunt found cases in Virginia, Mississippi, and Pennsylvania. But in most cases, people probably caught the virus from pigs, and there was nothing on the scale of the Ft. Dix outbreak.

That left public health officials in a quandary. Was the episode at Ft. Dix a freak occurrence? Or was it a forerunner of disaster? And complicating the picture was the fact that decisions had to be made quickly if there was to be enough time to manufacture, distribute, and administer a vaccine.

The nationwide hunt for cases was not even complete when the Bureau of Biologics hosted a workshop on 20 February to get government, industry, and university investigators preparing for a massive campaign *if* such a crash effort should be deemed necessary. A feeling of urgency gripped the session; 1 April was mentioned as the date by which a go or no-go decision would have to be made if industry was to have time to prepare the vaccine. Excitement—and visions of heroism—filled some minds. As Harry Meyer, director of the Bureau of Biologics, put it: "In the world I deal with every day, there are so many things you do that are not terribly interesting but which are called 'real chores.' To have a challenge of something that is a real public health interest is really stimulating."

By early March, with the flu season waning, it seemed clear that there would be little new data that could help in making a decision. Consequently the Center for Disease Control called a special meeting of its Advisory Committee on Immunization Practices on 10 March to consider the evidence and make recommendations. That group, which traditionally recommends the steps to be taken to immunize against flu, stopped short of recommending a mass vaccination campaign. It agreed that vaccine should be produced and that a *plan* for administering it should be developed, just in case, but it shied away from any statement as to whether the vaccine should actually be given to people.

The decision to go ahead was largely

made by Sencer, the head of the Center for Disease Control. Immediately after the advisory committee meeting, his staff drew up an option paper from which Sencer and an aide, on 13 March, prepared an "action memo" that recommended an all-out immunization campaign. That memo said there was a "strong possibility" of a swine flu pandemic in 1976–77. It warned that the routine annual vaccination of the elderly and other high-risk groups would not halt such a pandemic, and that "a decision must be made now" if extraordinary measures were to be undertaken. After analyzing the pros and cons of various options, it recommended that the federal government buy some 200 million doses of vaccine and make them available at no cost through state health agencies. It recommended that the citizens be immunized "in three months time." The vaccine would be administered by public health doctors, private physicians, or any other appropriate source. Total federal costs were estimated at $134 million.

It was only after this memo had been delivered to higher-ups in the Department of Health, Education, and Welfare that Sencer conducted a telephone poll of members of his advisory committee to see if they agreed with the recommendation. Sencer told *Science* that the majority seemed firmly in favor of going ahead and that none objected. But the presentation of a fait accompli may have muted some criticism. One member of the group—E. Russell Alexander, chairman of epidemiology at the University of Washington's School of Public Health—told *Science* he favors producing and distributing the vaccine but would hold off administering it until there is evidence of an outbreak of swine flu.

Sencer's recommendation was approved virtually intact as it shot upward through the bureaucracy—passing through the Assistant Secretary of Health, the Secretary of Health, Education, and Welfare, the White House Office of Management and Budget, the Domestic Council, and the President himself. The decision was elevated to the presidential level, according to a Domestic Council staffer, because it required a supplemental budget request and because the massive effort would clearly require strong federal leadership. The campaign would also have political implications. Sencer's action memo had noted that "the Administration can tolerate unnecessary health expenditures better than unnecessary death and illness, particularly if a flu pandemic should occur." And it suggested that Congress would act on its own initiative if the Administration failed to take action.

Before endorsing the campaign, the White House staged a quick meeting (less than 48 hours notice) between the President and a "blue ribbon panel" of scientists, drug industry leaders, the medical profession, public health officials, and state and local political leaders. This meeting seemed partly designed to assure the President that people outside his own Administration favored the campaign, and partly to serve as window dressing for a decision essentially made. The scientific opinions expressed at the meeting were hardly an "independent" view. The scientists who participated were picked by the federal health officials who were recommending the campaign. Moreover, the four scientists who are said to have dominated the discussion—namely Sabin, Salk, Edwin D. Kilbourne, of Mt. Sinai Medical School, and Fred M. Davenport, of the University of Michigan—are all strong proponents of vaccination. At the end of the meeting, the President waited only a few minutes before making his announcement to the press, suggesting that he had not taken much time to evaluate what he had been told.

Ford's Decision Inevitable

A Domestic Council staffer later described the flu campaign as "a no decision decision—once the issue is discussed it takes care of itself." Faced with the possibility of an epidemic that could cost many billions of dollars, and offered a chance to present it through a vaccination program that would cost only $135 million in federal funds, there was little doubt what choice Mr. Ford would make, the staffer said.

Congress, too, promptly jumped on the bandwagon. There were grumbles that the White House should have consulted with congressional leaders before launching such a massive effort, and there were jurisdictional squabbles between congressional committees. But there was no significant questioning of the program. Appropriations were approved rapidly lest Congress be accused of impeding the time-urgent program.

The federal program would provide most people with a vaccine to protect only against swine flu, but a bivalent vaccine to protect people against both prevalent strains of influenza A—namely, swine and Victoria—would be made available for high-risk groups, such as the elderly and chronically ill. Those at risk could also obtain through private sources a vaccine to protect themselves against influenza B. Meanwhile, the military is expected to immunize its personnel with a vaccine designed to protect against all three strains.

It was only after the campaign had been announced that serious reservations began to surface. At least one expert believes the campaign is such a risky waste of effort that he opposes even manufacturing the vaccine. He is J. Anthony Morris, director of the slow, latent, and temperate virus section at the Bureau of Biologics and longtime critic of influenza vaccines. Morris said he sees "nothing to get alarmed about" in the circumscribed outbreak at Ft. Dix—certainly nothing to justify vaccinating 200 million people. He contends that vaccines have been largely ineffective in past epidemics, and that they cause enough adverse reactions to warrant caution before administering them. "If it were up to me, I wouldn't even start making the vaccine," he says. "There is no clear-cut evidence that inactivated influenza vaccines offer appreciable protection to the recipients."

Most critics take an intermediate position—endorsing the need for manufacturing and distributing the vaccine but preferring to wait until there is another confirmed outbreak of swine flu before administering the vaccine. That is the position of Sidney M. Wolfe, the head of Ralph Nader's Health Research Group, and of several state health officials, including New Jersey's Goldfield, among others. Federal health officials considered the possibility of just stockpiling the vaccine, according to Sencer, but concluded that flu typically spreads so fast it would be impossible to vaccinate people in time to do any good once an outbreak was confirmed. (It takes about 2 weeks for the vaccine to attain its maximum effect.) Thus the decision was made to vaccinate the population even if there is no evidence of an epidemic. Other federal officials say it was also deemed difficult to sell a program that involved buying vaccine but not administering it, and that it would be hard to get people geared up to carry out the campaign on a "might not happen" basis. But the skeptics are so dubious that a pandemic will occur that they are willing to take a chance that there would be time to vaccinate after another outbreak. They stress that a needless campaign of this magnitude imposes costs of its own—it diverts health manpower and money from other important tasks; the vaccine will cause a certain number of adverse reactions; and the public may become cynical about future immunization drives if this one later turns out to have been unnecessary.

The wisdom of the decision is difficult

to assess. In a sense, the participants took what was probably the easiest decision under the ambiguous circumstances. The consequences of a failure to vaccinate followed by a pandemic of swine flu seemed far worse to most decision-makers than the consequences of a vaccination campaign that later turned out to be needless. "We're betting dollars against lives" became a byword of the participants. Moreover, many of those who joined the bandwagon would find a vaccination campaign congenial for professional or institutional reasons. The health bureaucrats in charge of the war would enjoy an infusion of funds into their agencies and the spotlight of public attention; the scientists would have a chance to test immunization theories and new vaccines; the drug industry would reap profits and perhaps develop a broader market for future vaccines; and the politicians could champion the public health. That does not mean that the decision-makers were primarily acting from base motives, merely that a vaccination campaign would be easy for them to adopt. By contrast, those who criticized the campaign thought they had something to lose. The Nader group, for example, acting as representative for the vaccinees, worried about side effects needlessly imposed. And the state health officials were concerned that they would have to divert resources from other important programs to administer the vaccine. Most of the critics had been left out of the decision-making.

Health officials won't know until next fall or winter whether a large outbreak of swine flu actually occurs. If it does, they will look prescient. If not, the grumblings may be expected to rise, especially if those who have been vaccinated against swine flu come down with some other flu strain against which the vaccine provides no protection.

—PHILIP M. BOFFEY

Wetlands: Denial of Marco Permits Fails to Resolve the Dilemma

To the satisfaction of environmentalists and to the dismay of many developers, the U.S. Army Corps of Engineers on 16 April truly "bit the bullet" on the question of coastal wetlands preservation by denying two dredge-and-fill permits requested by the Deltona Corporation for the next phase of its huge Marco Island project in southwest Florida. The proposed dredge-and-fill project, which was to have involved the excavation of 18.2 million cubic yards of material, is the largest "finger-fill" waterfront housing project ever to come before the Corps of Engineers for permits. In reaching its decision, the corps faced a dilemma because some of the policies under which the permits were to be denied are relatively new and thus are catching the Marco project—begun nearly 12 years ago—in mid-course.

The corps knew that denial of the so-called Barfield Bay and Big Key permits (see map) could have bad consequences for Deltona, which already had sold more than 4000 lots in these two permit areas. Unless the company could overturn the corps decision in federal court, it would probably have to make refunds to purchasers totaling tens of millions of dollars as the result of its inability to deliver on its sales contracts. Also, the retirement plans of many purchasers—mostly well-to-do Northerners—would be upset.

On the other hand, if the permits were granted, the massive alteration of Marco Island would continue with a vengeance. Viewed from the air, the island—or at least a good part of it—already looks as though it has been stamped out by a giant cookie cutter. The mangrove swamps that once lined the northeast side of the island along the Marco River have been replaced by an intricate system of canals and fingers of land, with each finger divided into expensive waterfront lots.

Destruction of the mangroves means the loss of much food and habitat for marine fauna. It also eliminates a buffer against violent storms—indeed, Florida old-timers say there is no better place for a small boat to ride out a hurricane than in a sheltered moorage up a mangrove creek. And it wipes out dense mazes of prop roots that trap much of the sediment suspended in tidal waters and thus make the waters cleaner. Now, if the Barfield Bay and Big Key permits were granted, another 2100 acres of mangroves eventually would be gone, not to mention the disturbance of several hundred acres of grass-covered bay bottom which would be used as a source of land fill.

What clearly was lacking in the decision-making scenario was some way to bring about a redesign of part of the Marco project to accommodate the same number of people as originally planned, yet without destroying wetlands on anything like the scale previously contemplated. Redesign proposals were in fact advanced by the Environmental Defense Fund (EDF) and some other groups that opposed issuance of the permits.

These proposals focused largely on a third and less environmentally sensitive permit area, known as Collier Bay. The hope was that Collier Bay could be redesigned to have duplexes, townhouses, and low- to medium-rise condominiums replace single-family detached homes and thus accommodate in that one area the 14,000 people who were to have originally been spread out over all three permit areas. But the permit for the Collier Bay area was granted without any change from the original plans having been made or demanded.

Situated almost due west of Miami on the opposite side of the Florida peninsula, Marco Island has long been recognized as one of the most promising resort properties any real estate developer has ever come by. The wide Marco beach, made up of fine white sand and stretching for some 5 miles along the Gulf of Mexico, is one of Florida's best. Little imagination has been needed to see this magnificent strand lined by posh high-rise condominiums and resort hotels. Nor has it been hard to envision golf courses built on the island's higher ground as centerpieces for a handsome development of single-family homes for upper-income retirees.

Equally evident has been the rich opportunity for the developer presented by Marco's extensive mangrove swamps, which once covered nearly half of the island's 10 square miles, occurring especially along the Marco River and Caxambas Pass. By use of the dredging and filling techniques well known in Florida ever since the creation of Miami Beach