House on Fire

THE FIGHT
TO ERADICATE SMALLPOX

WILLIAM H. FOEGE

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To my wife, Paula, for making this work even possible;
to Patty Stonesifer, for the support that made it possible to
write the account; and to the legions, from WHO/Geneva
to households around the world, who made smallpox
eradication a reality

If a house is on fire, no one wastes time putting water on nearby houses just in case the fire spreads. They rush to pour water where it will do the most good—on the burning house. The same strategy turned out to be effective in eradicating smallpox.

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Foreword

CARMEN HOOKER ODOM, *President*, *Milbank Memorial Fund*
SAMUEL L. MILBANK, *Chairman*, *Milbank Memorial Fund*

The Milbank Memorial Fund is an endowed operating foundation that works to improve health by helping decision makers in the public and private sectors acquire and use the best available evidence to inform policy for health care and population health. The Fund has engaged in nonpartisan analysis, study, research, and communication since its inception in 1905.

House on Fire: The Fight to Eradicate Smallpox, by William H. Foege, is the twenty-first book in the series California/Milbank Books on Health and the Public. The publishing partnership between the Fund and the University of California Press encourages the synthesis and communication of findings from research and experience that could contribute to more effective health policy.

With an insider's knowledge of the worldwide smallpox eradication program in the 1960s and 1970s, Foege, a physician, relates the strategies used to eradicate smallpox in Africa and India and the challenges

encountered along the way. He reveals the reasons behind the success of this program: a shared global objective; conception, implementation, and management of a clear plan tailored to a specific disease in terms of its context, range, and vulnerabilities; evaluation of the tools and techniques used and their subsequent modification; a willingness at all levels, from the local citizenry and government to country officials and global institutions, to communicate and work together to achieve the end goal; tenacity; and optimism.

As Foege notes, the smallpox eradication program shows that "humanity does not have to live in a world of plagues, disastrous governments, conflict, and uncontrolled health risks. The coordinated action of a group of dedicated people can plan for and bring about a better future. The fact of smallpox eradication remains a constant reminder that we should settle for nothing less."

This book should be useful to policymakers, foundations, and nongovernmental service organizations as well as to professionals in global health as they work together to confront the shared global risk of emerging and reemerging infectious diseases.

Foreword

DAVID J. SENCER

The eradication of smallpox from the entire world has been justly described as one of the most remarkable achievements in the history of medicine and public health. In India—a country one-third the size of the United States but with three times the population, with 638,365 villages and thirty-five cities with a million-plus population—the campaign to eradicate smallpox involved the most acute and challenging difficulties encountered anywhere in the entire smallpox eradication effort. The story of India's successful eradication program can be told fully only by those who were on the team that brought about this achievement, and this book is written by one of the team's two pivotal participants. It is so much richer because this participant happens to have one of the most impressive memories in the world, and he has used his own extensive notes and references from others involved in the campaign.

The other pivotal participant, Dr. M. I. D. Sharma, was the director of the smallpox eradication program for the Government of India during

the years when this final effort was mounted and brought to a successful conclusion in 1975. He also served concurrently as the director of India's National Institute of Communicable Diseases. His unflagging commitment to eradication, the excellence of his leadership, and his skillful use of the human, fiscal, and material resources—committed from all over the world—in the Indian eradication effort constituted a central and indispensable element in the success of this program.

Dr. William Foege, as a Centers for Disease Control and Prevention (CDC) epidemiologist assigned to the Southeast Asia Regional Office of the World Health Organization (WHO), worked on the eradication effort throughout the Indian subcontinent. The methodology of surveillance and containment, an alternative to mass vaccination refined in the 1960s in Africa, enabled the Indian and multinational team to successfully eradicate smallpox in India. Dr. Foege's tenacious advocacy of the containment approach, together with his meticulous monitoring of the continually changing status of the Indian eradication effort and his adjustment of strategy and resources in response to altered circumstances, was an essential ingredient of this success.

Much has been said about the humanitarian benefits derived from the eradication of smallpox, and the importance of these benefits to all the nations of the world cannot be disputed. But another benefit of almost equal weight in the minds of many public health professionals was the demonstration that the Indian government and its people could apply principles of sound management and deliver a program that stretched from the remotest village to the most populous urban centers of their country. Supervision, delegation, evaluation, performance appraisal, and accountability—all commonplace terms in the business schools of the world—acquired operational reality in this vast undertaking. The concepts and practices of sound management became a reality in the work of more than 250,000 workers throughout the nation.

The health and well-being of people throughout the world have been enhanced by the dedication of these Indian smallpox eradication workers, by the responsiveness of the hundreds of millions of Indian people who accepted vaccination and actively collaborated in the reporting of disease and suspected cases, and by the hundreds of health workers

from other nations who, with their Indian counterparts, devoted the best of their skills and capacities to this effort. All of us, and those who will follow us, are indebted to these workers and to their leaders, particularly to the late Dr. Sharma and those who collaborated so closely and effectively with him in this last major battle of the war against smallpox.

The author of this volume was in a delicate position in India. Dr. Foege was recognized by the Indian leadership as a representative of WHO and the CDC, but his precise role and scope of responsibilities in the eradication effort were not crisply defined. He had to persuade the authorities to make necessary changes and to recognize that eradication was achievable only if the CDC continued to provide the resources needed. Dr. Foege demonstrated to all levels of the Indian bureaucracy qualities of leadership that often go unrecognized. For one thing, he was willing to do whatever it took for the effort to continue. It was not unusual for him to place himself in physical jeopardy for the sake of the program. For example, he would carry millions of rupees in his briefcase to make sure that payrolls were met. Some people believe that leadership means being out in front, being visible; Dr. Foege demonstrated that great leaders can lead from behind the scenes, giving others the credit and recognition.

The publisher and a number of colleagues urged Dr. Foege to place himself more visibly in the narrative. But the publisher does not know Dr. Foege. As director of the CDC, I was one of his supervisors while he was working on smallpox eradication in India, and I have known him for more than forty years. He tells stories not about what he has done, but about what others have done. Dr. Foege called me from India about six months before the last case of smallpox was contained. I urged him to remain there and asked whether he realized that in a few months, the last case of smallpox in India would be eradicated and that there would be a huge celebration for one of the most extraordinary events in the history of global health. He responded, "I realize that this is going to happen, but if I remain in India, too much attention would be directed toward the external support that India received, and it is very important that recognition be given to the accomplishments of the hundreds of thousands of Indians who really did the work." He said to me, "This is

why I am coming home." And against my suggestion, he packed up, and he and his family came home.

This principle of "ego suppression" continued to guide Dr. Foege as he returned to the United States and pursued his lifelong career goal of working as the director of the CDC, as the founder of the Task Force for Child Survival, as the executive director of the Carter Center, and as a senior advisor to the Bill and Melinda Gates Foundation, all in the pursuit of global health equity. The world's debt to William Foege is enormous.

Preface

We lose our histories far too fast. In the dozens of public health efforts in which I have been involved throughout my career, the histories have rarely been written soon enough. Within years, sometimes within months, people's accounts begin to differ. Often the participants simply do not keep journals or record their notes. In an effort to capture the history of the smallpox eradication effort forty years after the fact, the participants at the 2006 reunion of the first smallpox workers sent by the Centers for Disease Control and Prevention (CDC) in Atlanta to West and Central Africa in the mid-1960s were invited to record oral histories. Many commented that they had forgotten details, and their accounts were incomplete. Based on this experience, the CDC decided to collect oral histories from the people involved in the 2010 H1N1 influenza phenomenon right away, in 2010. This is a wise practice, for much that might benefit future generations can be learned from eyewitness accounts of important events.

Thousands of people participated in the global smallpox eradication effort in the 1960s and 1970s, and each one has a story to tell. Their stories might vary, yet the people involved shared common attributes. They were optimists; they actually thought they could change the future—and they did. They were risk takers; there was no shortage of people telling them that the effort was futile and they were hurting their career chances—this proved untrue. They were problem solvers; they had little idea of what they were facing, and they took on the problems in order and in stride. They also knew how to mix hard work and fun. Working under sometimes grueling conditions in hot and humid village regions worldwide, with few amenities, these field-workers gathered periodically for meetings where humor and the shared sense of being part of something important carried the day.

This book tells the story of one of those workers, and, like the accounts of any single team member, it is subject to memory defects, biases, and faulty interpretations. One advantage is that I was involved in the eradication effort from the beginning. I did keep rudimentary notes, but errors in my account are probable and I am responsible for them.

My gratitude goes first to the countless workers around the world who achieved smallpox eradication. I am especially grateful for my colleagues in India, including Drs. P. Diesh, M.I.D. Sharma, Mahendra Dutta, and C.K. Rao. There is no way to adequately thank the World Health Organization (WHO) and CDC people I worked with: in New Delhi, especially Drs. Nicole Grasset, Zdeno Jezek, Larry Brilliant, Don Francis, Don Hopkins, Prem Gambhiri, and Harcharn Singh; in Geneva, the WHO staff, led by D.A. Henderson; and in Atlanta and around the world, the CDC workers, especially Dave Sencer, Bill Watson, Stu Kingma, Don Millar, Bill Griggs, Stan Foster, Joan Davenport, Jeff Koplan, Don Eddins, Frances Porcher, Ann Mather, Maudine Ford, and Carol Walters—and at least one hundred others.

Countless colleagues in Nigeria helped make the early days productive. These include Wolfgang Bulle, David Thompson, Paul Lichfield, and the missionaries who helped during the first smallpox outbreak in Ogoja, among them Annie Voigt, Hector Ottemüller, Harold Meissner, and Wally Rasch. The support staff in Lagos included George Lythcott, Rafe Henderson, Jim Hicks, and Stan Foster.

Institutions help provide the structure, the resources, and the ability to develop objectives, coalitions, and programs. I am especially thankful for the support and assistance of the Centers for Disease Control and Prevention, the Carter Center, Emory University, and the Bill and Melinda Gates Foundation. It is an honor to have been involved with any one of the four. To be involved with all of them is beyond any expectations.

Many assisted with the collection of materials and with organizing and writing this book, especially Stu Kingma, M.I.D. Sharma, Frances Porcher, and Ann Mather. I am grateful to Mark Rosenberg for his help and his persistence in urging me to complete the manuscript, and to Sam Verhovek, Don Hopkins, and Dan Fox for their reviews and suggestions. Polly Hogan gave invaluable assistance in turning numbers into graphs, concepts into maps, and ideas into written text.

Ordering the material into a logical sequence with understandable sentences was the special contribution of Carolyn Bond, whose own experience living in India enriched her grasp of the material at hand. At the University of California Press, Lynne Withey, Hannah Love, Jacqueline Volin, and Sue Carter provided valuable ideas and guidance throughout the manuscript preparation process.

I also want to acknowledge countless mentors and friends, some mentioned in the book, and some mentioned, as it were, only in my mind. Truly, the book's coauthor is my wife, Paula. For over fifty years she has played a key part in my engagement in global health interests, and as I wrote these chapters, she not only compensated for my failing eyesight but also shared her acute sense for where the real story lay. When you are writing, it's often difficult to discern the wheat from the chaff; I thank Paula for her unerring instinct about what to leave in, and what to take out—as well as for her excellent suggestion for the book's title. To David, Michael, and Robert, I give heartfelt thanks for your sacrifices over the years.

PART ONE Africa

IDENTIFYING THE KEY STRATEGY

ONE A Loathsome Disease

You can smell smallpox before you enter the patient's room, but it's hard to describe. Even medical textbooks fall short when it comes to smells. The odor, probably the result of decaying flesh from pustules, is reminiscent of the smell of a dead animal. On at least two occasions, smell alone alerted me to the presence of smallpox. As I walked down a hospital hallway in India, the dead-animal odor stopped me in my tracks; following the smell, I located a smallpox patient. Another time, as I walked down an alley in an urban slum in Pakistan, the same smell hit me. There are competing smells in such places, but again one smell stood out. Knocking on doors, I found two siblings with smallpox.

Today, thirty years after the last recorded case of smallpox on the planet, I still find myself contemplating alternative tactics for its eradication, including one using smell. What if back then we'd been able to use trained dogs to identify smallpox patients? This would have sped up the

searches in urban alleyways and railway stations, where people often lay on the ground, obscured under blankets.

Those of us working in the worldwide smallpox eradication program in the 1960s and 1970s made countless visits to smallpox patients. Most of these visits were to small, crowded, airless, single-room dwellings with the windows covered. In the dark, we were taken to the patient's bed, and it was possible, with a penlight, to examine the lesions and estimate the stage of the disease. Early on, the pocks would be surprisingly hard and deep. As the disease developed, they would fill with pus and soften, becoming pustules. Once the pustules began to break down, the mixture of pus and blood would stain the patient's bed and clothing. The person in the bed might have been happy and productive the previous week, but now had limited prospects of even seeing another day.

The disease took each of its hosts by surprise. They were not aware that a virus had entered their body and was silently establishing a beachhead by multiplying in the mindless way that viruses do. The virus carried no ill will; it was simply responding to the drive to perpetuate itself. It cannot reproduce on its own; it has to borrow cells from a human being. The borrowed cells put out ever more viruses, which in turn take over other cells.

Having borrowed and destroyed the cells in order to reproduce, the virus shows its gratitude, as it were, by wreaking havoc on its host. After two weeks of multiplication, just when the immune system is organizing a defense, the virus's host for the first time realizes something is wrong—a fever, a headache, perhaps a backache and vomiting. We all experience such symptoms occasionally, so the host doesn't worry. But after another two days, there is no denying the truth. The throat is sore because of lesions on the mucous membranes, and red bumps have appeared on the skin, especially on the face, arms, and legs. Over the next few days, the bumps turn to pustules. A robust immune system and a strong constitution might, at this point, turn the tide against the virus, and the host will recover. Even so, for most survivors, the price is high: pockmarks or even permanent blindness. Many, however, are unable to develop sufficient defenses; they die.

We saw some patients who didn't live long enough to develop pustules. The skin became swollen, the fever was high, and the patient became toxic. The virus completely overwhelmed the immune system.

The patient began to bleed with a hemorrhagic version of the disease that led, mercifully, to an early death.

Once the virus had left the host's body in absolute chaos, it sought out a new host to repeat the process. To me, the process made no sense—what was the purpose? What was the meaning? But the reality of nature seems to be that some species provide no evident benefit to the community of living organisms.

While working in the smallpox eradication program, I visited many villages. In one house I might find a baby, face swollen, eyes closed, breathing hard, with exposed surfaces thick with raised, pus-filled blisters. In such cases I would have to admit that there was nothing to be done. The devastated parents were about to lose the child. The next house might reveal two children lying in the same bed. At first glance they might appear well nourished, though sick with smallpox. However, lifting the blanket would reveal that they were very thin and poorly nourished. Their swollen faces, for just a moment, concealed their starvation.

In another house a young man might be wearing only a loincloth, because he didn't want anything touching his face or limbs, which were covered with lesions. His legs were bloody. He was trying not to move, grimacing in pain when he did. Any touch caused the lesions to bleed. His face was contorted with pain; he wanted only to die.

Each patient was part of a family and a community, yet others could do little to help. There was—and is—no cure for smallpox, and in this sense each patient faced the disease largely unaided. Shift your perspective to a larger scale of place and time, and these individuals become statistics—markers of suffering, but not the real thing. Shift your perspective again and the numbers become changes inflicted on whole cultures, dynasties, and nations, their place in history forever altered by this microscopic organism.

SMALLPOX IN HISTORY

Until its eradication, smallpox accompanied humans and human cultures throughout recorded history. Lesions are apparent on Egyptian mummies dating from the second millennium B.C.E. In 1979, Dr. Donald

Hopkins—instrumental in smallpox eradication in Sierra Leone and later in India—was allowed to examine the upper half of the mummified remains of Ramses V, who died in 1157 B.C.E. of a disease characterized by a rash.[1] Hopkins concluded that the rash he observed was compatible with a diagnosis of smallpox, although attempts to identify a virus in detached pieces of skin were unsuccessful.[2]

Hopkins details how the virus propagated itself in human populations through the centuries following Ramses' time, especially in Asia, Africa, and Europe. It came to the Americas with the European explorers, missionaries, and traders, who reported death rates exceeding 50 percent and as high as 90 percent among some indigenous peoples. In one of the saddest chapters in human history, proud, competent, and powerful groups were destroyed as settlers, carrying the smallpox virus and other diseases, moved into their ancestral homelands. From the Eastern seaboard, settlers carried smallpox with them as they moved westward in the 1830s and 1840s. Smallpox also traveled northward from what is now Mexico. The Blackfoot, once the most feared among Native American tribes, were decimated by smallpox. And the disease had, by 1837, reduced the population of the Mandan Indians to 150.[3]

Smallpox played a significant role at key moments in U.S. history as well. In the early battles of the Revolutionary War, American troops were placed at a disadvantage because they, unlike the British, had not been immunized by means of variolation, a prevaccination method then widely practiced in England that uses the smallpox virus itself to immunize. A risky procedure at best, variolation carried much greater risk in low-density populations, where smallpox was a sporadic disease and thus immunity levels in the population were low. The low immunity levels meant that variolation itself could cause widespread outbreaks. During the Battle of Quebec, on December 31, 1775, the Americans outnumbered the British, yet they were unable to sustain their attack because so many were weakened by smallpox. The English prevailed, and Canada remained with England rather than becoming part of the future United States. On February 5, 1777, after more than a year of deliberation, General George Washington gave the order to variolate all American troops. It was a tough decision with high military and medi-

cal risks: if the British learned of the program, they could have attacked while the American troops were sick, and the variolation itself, though much safer than smallpox, still destined some troops to die. By the time the British became aware of the operation, however, the two armies' susceptibility to smallpox was close to equivalent. Variolating the troops may have been Washington's most important tactical decision in the pursuit of independence.[4]

Nearly a century later, smallpox would come close to impacting what some historians have described as a watershed moment in U.S. history, when "the United States" shifted from a plural noun to a singular noun: Abraham Lincoln's delivery of the Gettysburg Address on November 19, 1863.[5] Reporters at the time described President Lincoln as appearing "sad, mournful, almost haggard." When he left that night for Washington, he had a severe headache and was forced to lie down, and for the next two weeks he was confined. His doctor originally diagnosed the illness as "bilious fever," and when a rash appeared, he called it scarlatina. A consultant, Dr. van Bibber, was called in to examine Lincoln, and he diagnosed the president's condition as smallpox. How Lincoln contracted the disease is unclear, but it might have happened while he was visiting hospitalized Union Army troops in Washington two weeks earlier. Had his incubation period been only one day shorter, the Gettysburg Address might not have happened.[6]

The clinical picture has varied through history and across geography in part because of differences in the strains of smallpox: the highest consistent death rates occurred in Asia (30 to 40 percent), intermediate death rates in West and Central Africa (20 to 30 percent), and the lowest in South America and certain parts of East Africa, where deaths were rare. High death rates among populations where the virus had only recently been introduced, as cited earlier for the Americas, usually resulted from the population's not having had a chance to develop resistance over the centuries. Yet that may be only part of the reason, since even in Southeast Asia, despite many centuries of exposure, smallpox still killed about one-third of those who became sick. So virus type also had a strong influence on mortality. Personal characteristics, including nutrition and variations in immune systems, may also have contributed to how dif-

ferent individuals reacted to the same virus. Population density had an indirect influence on mortality by affecting the age groups attacked. In low-density populations, occurrences tended to be sporadic and to affect all age groups when the virus was introduced, whereas in high-density populations, the disease was more a disease of childhood and young adulthood. In general, death rates are higher in the very young and the very old; therefore, changes in the ages of cases can change the mortality results.

THE DREAM OF ERADICATING SMALLPOX

The dream of eradicating smallpox had its beginning on May 14, 1796, when Edward Jenner, a physician practicing in Berkeley, England, inoculated cowpox taken from the hand of Sara Nelmes, a milkmaid, into the arm of a young boy named James Phipps. Jenner's experiment was grounded in his keen observational abilities and unusual patience. He was aware that poets described the complexions of milkmaids as lovely, and at the urging of his mentor, John Hunter, he applied himself to the question of why that would be true. Milkmaids, he observed, rarely had smallpox scars. Indeed, he had heard a milkmaid claim that she was protected from smallpox because she had previously had cowpox. He became convinced that the milkmaids' smallpox protection resulted directly from the cowpox sores on their hands, acquired from sores on cows' udders. Cowpox, unlike smallpox, was a self-limiting event and of little consequence.

Jenner, like other scientists of that time, lacked any understanding of viruses, immunology, vaccines, or vaccinology. He thought of the use of cowpox to protect people from smallpox in terms of mimicking nature. After twelve years of careful observation and note-taking, Jenner performed his experiment on the young James Phipps. A few days later, Phipps developed a sore at the site where cowpox had been inserted. After a few weeks, Jenner exposed the boy to smallpox by inoculating him with material collected from the lesions of a smallpox patient, using the method of variolation. The boy remained healthy, confirming

Figure 1. Statue of Edward Jenner vaccinating a child

what Jenner suspected: cowpox somehow provided protection against subsequent exposure to smallpox. In 1798, Jenner published an account of his experiment, a publication that has become a classic in the public health literature.[7] By attempting to copy nature, Jenner discovered the basic principle of vaccination. It is possible, using something similar to a deadly virus but itself innocuous, to fool a person's immune system into developing antibodies that destroy both viruses on contact. Over the years, scientists have made many vaccines by altering a virus that usually causes a disease. Vaccinologists have also learned how to modify the toxins caused by some organisms, such as the tetanus toxin, so that antibodies destroy the toxin itself. More recently, scientists have been working on vaccines against bacteria and, even more astounding,

against parasites such as malaria. And viruses (with the exception of influenza) do not become immune to vaccines, as they do to antibiotics, so vaccines often provide lifelong protection. Jenner's discovery of this tool for preventing disease is one of the great breakthroughs in science. Indeed, the modern era of public health can be traced to Jenner's 1796 experiment.

Jenner saw the possibilities of his discovery and began to supply vaccine and instructions to interested persons. Thomas Jefferson, ever the scientist, also saw the potential and by 1801 had acquired vaccine from a medical friend in Boston. Jefferson personally administered the vaccine to his own household and to neighboring households around Monticello. Aware that Native Americans suffered from high smallpox death rates, he provided Meriwether Lewis and William Clark with vaccine to protect the tribes they met on their expedition across the continent between 1804 and 1806. This idea was better in theory than in practice, since they lacked a way of keeping the vaccine viable for long periods. In a letter to Jenner in 1806, Jefferson envisioned the eradication of smallpox: "Future nations will know by history only that the loathsome smallpox has existed."[8]

Sadly, despite the fear of smallpox and the availability of a preventive vaccine, effective vaccination programs were slow in coming and smallpox continued to be a scourge to the world. It was not until the middle of the twentieth century that the world began to fulfill the promise of Jenner's discovery and Thomas Jefferson's prediction. In 1958, the World Health Assembly (WHA), the governing body of the World Health Organization (WHO), passed a resolution to eradicate smallpox globally, and finally, in 1966, the WHA ratified a plan and a budget to support a global smallpox eradication program.

There are several reasons why the world had to wait 170 years after Jenner's work for smallpox to be eradicated. First, it was not until the 1960s that a vaccine was developed that could be produced in the countries where smallpox was endemic. Second, better vaccination techniques were developed, specifically, the jet injector, which was used in Africa and elsewhere around the world, and the bifurcated needle, which was tested in field trials and used widely, especially in India and Bangladesh.

Third, the new world order that emerged after World War II, including the development of the United Nations and WHO, made a global initiative possible. Fourth, enough people believed that eradication was possible. It took a new passion to proclaim that a disease that had plagued humanity for so long was not a fixed entity in the human landscape.

Finally, there was a crucial shift in vaccination strategy, from mass vaccination as the primary strategy to a highly focused form of surveillance and containment that turned out to be ideal for interrupting the progress of the smallpox virus. Surveillance and containment was envisioned from the beginning as the logical next step after mass vaccination had reduced the level of smallpox transmission; but it was found that surveillance and containment could be used as the primary strategy, speeding up the eradication effort. It was applied first in Nigeria in 1966 and 1967, then in other parts of West and Central Africa, and eventually elsewhere. It was refined six years later in the most intense smallpox area of the world: Bangladesh and the northern Indian states of Uttar Pradesh and Bihar. The chapters that follow track the story of this development.

TWO A Succession of Mentors

My participation in the smallpox eradication program was the result of my engagement with a host of mentors, some of whom I encountered only in books. Family, friends, and teachers also had a tremendous influence on me, the earliest, of course, being family.

My father was a Lutheran minister who was raised on a farm in Iowa. Growing up with four sisters and a brother in a series of parsonages provided me with an unvarnished, down-to-earth beginning in life. The houses always seemed too small. Each paycheck was cashed, and the money was distributed into Band-Aid cans marked for groceries, clothes, gas, and so on. My mother made many of the family's shirts and dresses, and clothes were handed down from one sibling to the next. A large garden, chickens, and one or two milk cows provided a major portion of the family diet. We canned food for the winter. The town's grocer—in Eldorado, Iowa (population one hundred)—always treated the family to a pint of ice cream when the grocery bill was paid at the end of each month.

When my family moved away from Eldorado, the town's population diminished by 8 percent. My father had received a call to a new church in Chewelah, Washington, a town of fifteen hundred people sixty miles north of Spokane. At the time, I thought Chewelah was a really big city. It was only when we moved twenty miles farther north, to Colville, that I realized what a big city was: Colville's population topped four thousand. There, my father started a new church.

Wherever we lived, my brother, four sisters, and I always had chores to do, and older siblings were responsible for supervising younger siblings. We were all expected to work hard but also to have fun, and we enjoyed much laughter and warmth. Games were a constant, even though some of the more conservative church members frowned upon such worldly frivolities. When the doorbell rang, playing cards would disappear in a flash, magically reappearing as soon as the visitor left. Our house was always intensely busy but well organized, and at the end of the day we children fell asleep to the comforting sounds of our mother playing hymns or classical music on the piano or violin, after which she often worked on correspondence courses.

My mother was not only well organized and interested in everything; she was also quite resourceful. Soon after my parents married in 1928, their Model T broke down a mile from home. Having grown up on a farm, my father was comfortable with mechanical repairs, and he set to work, asking my mother if she would walk home to fetch the pliers he needed to finish the job. His bride readily agreed but, having been raised in a city, she had no idea what pliers were and was too embarrassed to say so. By the time she arrived home she had a plan: she looked up "pliers" in the Sears catalog.

On another occasion, an ice storm brought below-freezing temperatures and took down the power lines. My father was away at a conference, and the hundreds of baby chicks in the chicken house, where lightbulbs warmed the interior to springlike temperatures, were at risk. My mother spread newspaper on the kitchen floor, closed the kitchen doors, let the chicks loose in the kitchen, and used the gas cooking stove to heat the room until the electricity was restored. The chicks survived. For a person who believed that cleanliness was next to godliness and

who knew the smells of a chicken coop, this was an impressive approach to problem solving.

My father never let go of the work ethic he had learned growing up. He was always busy, calling on church members, visiting the sick in hospitals, or working in his study on his sermons and Sunday school lessons. He also tended the garden and the cows, helped with canning and house maintenance, and drove us children to music lessons or to work. He seemed content with his life choices, though when he was in his nineties he told me that he regretted that as a boy, he had never learned how to play, and that as a father, he had not played with us more when we were young.

My parents placed a high value on education. As children, all six of us were expected to take piano lessons and learn to play one other musical instrument, and it was assumed that we would go to college. Both at home and at our one-room school, there was little emphasis on science. Two of the first people to stir my interest in science were Shirley and Jim Kohlstedt. The Kohlstedts were just out of college, starting their own drugstore in Colville, living above the store. They later told me they hadn't really needed another employee, especially a thirteen-year-old who had just moved to town, but they were moved to sympathy by my apparent handicap. Having broken my leg during a basketball game, I had on a long leg cast, which was hidden by my trousers. When the cast was removed some weeks later and I walked into the store without a limp, they realized their mistake, but retained me as an employee anyway.

The Kohlstedts gave me a hands-on introduction to the world of science. Drugs altered the outcomes of disease, the metric system was an alternate way of measuring the world, and precision rather than opinion dictated how prescriptions were filled. Under their supervision, I filled prescriptions, demonstrating by oral test that I knew what each drug was intended to do. Soon I was also babysitting for their children and sharing in their family activities. I would come to realize that the best mentors not only have qualities one wants to emulate but also take a personal interest that often leads to involvement with their families and a relationship that continues through the years.

Tony Steiger, a frequent visitor at the drugstore soda counter, would become for me the epitome of a scientist. He was not a physically imposing man, but he was possessed of a keen intelligence and wide-ranging curiosity. He worked as an assayer, analyzing ore samples brought in by miners, but his interests went far beyond his work. He encouraged my budding interest in science, introducing me to the mysteries of logarithms. He taught me at night, in his home, and after each lesson I would experience the heady feeling that I knew a little more of a new and rarefied language.

When I was fifteen, I spent three months imprisoned in a body cast to treat a separation of the head of my femur. This was before the days of television in our town, which meant that I spent long hours reading, both for school and for pleasure. Albert Schweitzer's *Out of My Life and Thought* provided a glimpse into as foreign a world as I could imagine and left a lasting curiosity about other lands and peoples, the conditions of their lives and their health. I was hooked. I had earlier developed an interest in psychiatry as the result of reading a single novel about a colorful psychiatrist, but tropical medicine now became a competing interest. While in high school, I began subscribing to publications in both fields.

For two summers I worked for the U.S. Forest Service in Washington State and Oregon, and was regularly diverted to fight fires. The principles were simple and drilled into us repeatedly: separate the fuel from the flames, and the fire stops. Usually this meant building a fire line that went right down to soil so the flames could not cross it. At least two people would be sent to a fire, even a small one. We planned our approach with aerial maps and then carried in food and drinking water, basic firefighting tools, and lightweight sleeping bags made of paper. Water was almost never available to douse the fire. Our basic tool was a Pulaski, a combination ax and mattock that made it possible to cut down trees, chop logs in two, and dig a fire trench all with the same tool. Working in shifts, we would contain the fire as quickly as possible, hike back to the vehicle, report in, and be directed to the next fire. We might keep going for several days and nights in a row. During my second summer of firefighting, I graduated to chainsaw operator, with the task of determining the fire line's placement and cutting and removing logs

that crossed the line. A series of Pulaski-wielding line builders would follow in leapfrog fashion, building the fire line as fast as the chainsaw operator could walk. Teamwork was essential—another valuable lesson I learned early in life.

TOWARD A CAREER IN EPIDEMIOLOGY

In 1953, I entered Pacific Lutheran University in Tacoma, Washington, as a biology major, which brought me into the sphere of influence of Bill Strunk, a charismatic biologist. He was tall with a full head of white, wavy hair that made me think of Einstein. He engendered great loyalty from young, impressionable, and eager students. A formidable instructor, he would walk from his office and down the corridor, his lecture already under way, to the classroom, where he would walk up to the blackboard and, without a pause, begin writing out phyla, families, classes, and genera with both hands simultaneously—an ability I have never again encountered. Strunk was my advisor when I applied to medical school at the University of Washington. A true scientist, if he was to recommend a student, he required the student to take a series of tests, including IQ tests, psychological tests, and tests of reasoning ability. If the student passed, Strunk became an active part of the process, mentoring the student right through admission and then maintaining contact over the years.

Before beginning my senior year at Pacific Lutheran, a classmate and I decided to arrive a week early to attend freshman orientation, so we could meet the new freshman girls before the other upperclassmen had a chance to. The plan worked better than I could have imagined. On Thursday evening of that week, as we sat outside the cafeteria after dinner, my friend offered me a challenge: "I will bet you a quarter you can't get a date with the next girl out of the door." A minute later, the door opened and out into the refreshing September evening walked Paula Ristad, a freshman from Palo Alto, California. She did not make it easy for me to win the bet. Having met me briefly at a freshman party earlier that week, she pegged me as a freshman. My attempt to impress

her by saying I was a senior backfired. She concluded that I was both a freshman and a liar. My tenacity, however, eventually paid off. I started medical school at the University of Washington in 1957; Paula and I were married in December 1958. After our marriage, Paula transferred to the University of Washington to complete her degree in education.

In medical school, it was my good fortune to meet Rei Ravenholt, an epidemiologist who continued the chain of larger-than-life, charismatic people who influenced me. He had a booming voice and take-charge attitude that attracted students but also got him into disputes with peers. I was present the day he won a bet with some cancer researchers who had organized a study specifically to disprove Ravenholt's assertion that cancer is simply an extension of Darwin's law of evolution.[1] The study failed to disprove the assertion, and Ravenholt won the bet.

Besides teaching at the medical school, Ravenholt was also the Seattle–King County epidemiologist. Along with other medical students, I worked for him at the county health department after school, on Saturdays, and for several summers. Under Ravenholt's influence, public health became my primary interest, alongside my existing interest in tropical medicine, while my old interest in psychiatry faded. Public health and tropical medicine together pointed me in the direction of the relatively new field of global health, which is public health on a worldwide scale. At the time, global health was poorly defined, but I found it compelling .

Public health looks at illness and other risk factors in aggregate populations and comes up with wholesale solutions, such as changing the environment through water improvement or changing the resistance of the population to a certain disease through a mass immunization campaign. Its philosophical base is social justice, and its scientific base is epidemiology.

The first department of epidemiology in this country was established at Johns Hopkins School of Hygiene and Public Health in 1919. Wade Hampton Frost, who had received high praise for his studies on the 1918 influenza epidemic, was detailed by the U.S. Public Health Service to Johns Hopkins as the first resident lecturer. He later became a professor of epidemiology. Frost was a pioneer in epidemiology, originating the concept of the "index case," or first known case in an outbreak. Once the

first case in an outbreak is identified, epidemiologists can work backward to determine the source of infection for that case and therefore for the entire outbreak.

Dr. Alex Langmuir, a graduate of Johns Hopkins, once summed up epidemiology as the selection of a numerator and a denominator to get a rate, and the gathering of enough information to interpret that rate. Clinical medicine concentrates on numerators, on the portion of society suffering from illness and seeking cure. Epidemiology addresses both numerators and denominators as it studies the distribution of illness or other conditions in the population as a whole.

In 1949, Langmuir began working at what was then called the Communicable Disease Center (CDC) in Atlanta, Georgia.[2] There, he developed the Epidemic Intelligence Service (EIS).[3] The original purpose of the EIS was to defend against possible biological warfare. The immediate source of the fear of biological attack was the unfounded belief that Korean hemorrhagic fever, which plagued both sides during the Korean War, had been intentionally introduced by the Chinese. (True to the Cold War spirit, the director of a viral research program in China told me in 1978 that his program had been started in response to the belief that the United States had intentionally brought Korean hemorrhagic fever into Korea.)

The practical training of the EIS epidemiologists for biological warfare can't wait for the real thing, so they focus on the everyday problems of public health in the United States and worldwide. The program helped to strengthen epidemiology as an integral part of public health practice. Langmuir had great confidence both in his own abilities and in the power of epidemiology to provide insight into how to prevent public health problems.

In 1962, after completing medical school and then an internship in New York, I joined the EIS training program at the CDC. Originally, I had intended to do an internal medicine residency in order to broaden my clinical background. Again, a mentor would influence the course of my life. Rei Ravenholt, visiting us in New York, was passionate about promoting epidemiology as a career specialty. He had been one of the first EIS officers, and he recommended that I apply to the EIS. I did, and was accepted. Instead of doing the residency, I headed for Atlanta.

THE THREAT OF SMALLPOX IN NEW MEXICO

In 1962, I became an EIS officer—a medical detective—and was stationed in Colorado. Paula and I made the drive from Atlanta to Denver during the final weeks of her pregnancy with our first son, David. She began having what threatened to be labor pains during the three-day trip. Our first stop in Denver was to make an appointment with an obstetrician at the Fitzsimmons Army Hospital, and the second stop was to get a motel room. We were still living in the motel when the real labor pains started and David was born. He spent his first week sleeping in a dresser drawer in the motel.

The assignment was exciting from the beginning. Within a month I had worked on a case of imported malaria, an outbreak of typhoid traced to a typhoid carrier in the southern part of the state, the introduction of the new Sabin oral polio vaccine, and several outbreaks of hepatitis. Seven months into my new position, I got a call from Drs. Don Millar and D. A. Henderson at the CDC. There was a suspected case of smallpox in Farmington, and they wanted me to check it out.

They told me that on Tuesday afternoon, March 19, 1963, a Dr. Frank Nordstrom, a pediatrician from Farmington, had called the CDC to report that a ten-month-old Navajo girl from a reservation, now hospitalized in Farmington, had a puzzling, vesicular rash. Nordstrom knew a great deal about rashes in children, but this one was different. He was concerned that it might be smallpox.

Millar and Henderson suggested that in the hours before my flight to Farmington I acquire *Smallpox,* a textbook written by C. W. Dixon.[4] The University of Colorado Medical School library had the book, but it was checked out to a student. First, I had to find the student. Second, I had to convince him that my need was greater than his—no mean feat, as he was writing a paper. I succeeded in talking him out of the book and then read key sections of it at the airport and during the flight. As the plane came to a stop on the Farmington airport tarmac that evening, I felt relatively comfortable with my knowledge about the clinical differences between smallpox and other diseases, especially chickenpox. I was unnerved when I saw the car waiting at the foot of the airplane stairs.

The local health department staff whisked me to the hospital, where a group was waiting for the diagnosis by the out-of-town expert—a twenty-seven-year-old EIS officer who had never seen a case of smallpox.

Scrubbed and gowned, I entered the patient's room. It was only a few steps from the door to the bed, hardly enough time to consider every diagnostic possibility, but my comfort in understanding the differential diagnosis crumbled in those few steps. I saw a very sick, lethargic, feverish baby. Her young mother hovered nervously as I examined the girl. The lesions, primarily on her extremities, were round, single-chambered, and well circumscribed, yet they were not typical of either smallpox or chickenpox. After sending specimens off to the CDC, I phoned Henderson and Millar in Atlanta to review the findings. Since we did not yet know what was going on, we had to treat the situation as "possible smallpox" until the laboratory results were returned.

If this was smallpox, it was a very big public health event. The last case of smallpox in the United States, in 1949, was the result of an importation of the disease to New York. Many still remembered the hundreds of people in lines snaking around city blocks waiting to get vaccinated. The working definition of an "outbreak" is "an unusual occurrence" of a disease. The definition is thus situational, different for different diseases, and even different for the same disease depending on geography. For many infectious diseases, dozens or even hundreds of cases might be required for it to be called an outbreak. For smallpox in the United States, a single case would qualify as an outbreak.

The state and local health departments in New Mexico made staff and vehicles available, and we launched an immediate effort to do several things simultaneously. First, we needed to track the child's contact with other people for the previous three weeks, even secondary contacts, and determine their histories of recent illness. Second, we had to learn about outsiders who might have come to the area and about trips by local persons to other parts of the world, even in the absence of evidence of direct contact with the child. An undetected case of smallpox, or even two generations of the disease, could have occurred between the introduced case and the current case. Third, we had to identify every person who had been in contact with the child who could be at risk if this proved to

be smallpox. Finally, we needed to begin a vaccination program immediately for everyone with potential contact with the child to prevent secondary cases. Vaccination even days after exposure can still prevent the disease or modify its severity.

After initiating these efforts, I spent the remainder of the first full day on the Navajo reservation, reconstructing time lines, questioning people, and vaccinating contacts. That night I learned that the initial laboratory report results were compatible with smallpox. The seriousness of the situation was increasing. Late that night I read a local newspaper interview with a former medical missionary who had worked in Asia and was familiar with smallpox. He had seen the hospitalized child and thought her symptoms were typical of smallpox.

Dr. Nordstrom, the child's pediatrician, had me stay at his house, so concerned was he that I have nothing else to worry about. The next morning, on the drive to the hospital, he took a long, scenic route, saying that he did so every morning to get "centered" before meeting the problems of the day. It struck me as an important mental health prescription for anyone, and especially for people in his line of work.

Over the next several days we established that tourists from Asia had recently come to Farmington, but they had no connection, even indirectly, with the child. Men from the reservation had been to Mexico, but none reported exposure to anyone with a rash disease.

Control procedures were superb. Every possible contact was found and vaccinated, and the child remained in isolation. She was improving clinically, and her mother began to relax. On the third day, two pieces of information ended the control efforts. We had mapped the lesions daily; now, new lesions had developed that were not typical of smallpox. Smallpox starts with red bumps, progresses to vesicles (blisters), then to pustules, and finally to scabs. The progression is consistent in any one area of the body, though it may be at different stages in different areas. Now we were seeing new bumps in areas that had already progressed through blisters and scabbing. Then came the definitive CDC laboratory report: the first report had been erroneous. It wasn't smallpox; it was herpes virus.

What made the case so confusing? The child, in addition to having

pneumonia, severe thrush, and enteritis, was recovering from measles, which had left a base rash on top of which were superimposed lesions of disseminated herpes. The child recovered well, the physician and the investigators breathed a sigh of relief, and life returned to normal. But it was a peripheral brush with what could have been a deadly disease.[5]

One month later, in April, I returned to Atlanta for the annual EIS conference, during which current officers had the opportunity to present cases to their peers and the CDC staff. The report of the smallpox scare naturally generated high interest. Many former officers found the week-long gatherings so stimulating that they would attend the conference on their own time and money just to hear about the latest investigations. The camaraderie among EIS officers tends to be lifelong. An annual publication updated information on the location of current and former EIS officers, and officers would often seek each other out in institutions or overseas locations.

At this meeting it was announced that the physician who served the Peace Corps volunteers in India had to leave his post unexpectedly because of illness, and the Peace Corps was looking for a short-term replacement while they recruited his successor. The duties would include traveling throughout India to provide medical care for Peace Corps volunteers and arranging for ongoing care by local practitioners. Because of my interest in global health, I decided to volunteer. After interviews in Washington, D.C., I was accepted for the position, and after many briefings, I departed in May 1963 for a three-month tour of duty in India.

SEEING SMALLPOX IN INDIA

As is true for so many travelers to India, my first few hours in the country were overwhelming. My flight landed at 3 A.M. in New Delhi. May is a very hot month in North India, and my initial reaction as I walked down the steps from the plane was disorientation: it could not possibly be this hot in the middle of the night. But it was. As I left the baggage area I stepped out into a virtual sea of people, many pressing in to be the

one to take my suitcase and briefcase, escort me to a vehicle, and deliver me to my next destination. With experience one becomes accustomed to this scene, but the first time is entirely confusing. Just in time, I saw a sign with my name on it held by the Peace Corps driver assigned to meet me. We drove to the hotel through predawn streets already crowded with people. By the time I checked in at my hotel, I had experienced two of the constants in India: heat and crowding.

Yet this was only a hint of what was to come. Summer temperatures that year reached 50 degrees Centigrade (122 degrees Fahrenheit). I saw asphalt roadways so soft that they retained the footprints of people crossing the street. A walk through Old Delhi's markets was an immersion in real crowding. Yet what I expected to be a totally overwhelming experience turned out to be surprising as I saw how people could be cheerful, resourceful, and productive in situations that would have left most Westerners demoralized and unable to function.

During this assignment I worked under the supervision of Dr. Charlie Houston and found in him yet another important mentor. He was a cardiologist by training and a mountain climber and social activist by avocation. He worked over the years trying to develop an artificial heart, and he became a world authority on high-altitude physiology. Houston was an example of undaunted courage and had long been famous in mountain-climbing circles for his role in an attempt, in 1953, to rescue a sick climber from K-2, the second-highest mountain on earth, during a storm.[6] He faced each day with the cheerful confidence that he could make a difference, and the challenges of doing health work in a developing country never seemed to dampen his enthusiasm.

Houston made sure that in addition to taking care of Peace Corps volunteers, I made rounds at hospitals so I could begin to understand the health problems facing India. This was my first opportunity to see smallpox patients. The experience was life changing. Textbook descriptions miss the often catatonic appearance of patients attempting to avoid movement, the smell of rotting pustules that permeates the room, and the social and psychological isolation imposed by the disease. I had seen polio patients in iron lungs who could see their families only through a window and with the help of a mirror. Smallpox separated patients from

their loved ones, too, but in a different way. Pustules mixed with pus and blood might cover the face. The smell was overpowering. Visitors recoiled, and even hospital staff tried to avoid touching the patient.

And, since smallpox patients were getting no specific treatment, being in the hospital offered no medical advantage to them. It merely ensured quarantine. Even if patients recovered, they would likely have lifetime facial scars, in which case the social separation in the hospital was simply a harbinger of their future life. I left India with the conclusion that although many diseases and conditions are tragic, smallpox was in a class by itself for the misery it inflicted on both individuals and society.

A RESEARCH PROJECT IN TONGA

Nine months after returning to the United States from India, I said yes to another foreign assignment. D. A. Henderson asked me to go to Tonga as part of a CDC research team. The CDC had incorporated a new vaccination technology, the jet injector, into its programs, and the Tonga study was meant to determine if the smallpox vaccine could be effectively diluted for use in the jet injector, and if so, what the optimal dilution would be. Tonga had not had smallpox or a smallpox vaccination program since the early 1900s; therefore, it provided a virgin population in terms of smallpox antibodies. The plan was to use different dilutions of vaccine on different population groups, compare the results, and determine the optimal dilution.

The CDC research team arrived on the island of Tonga on Easter weekend of 1964. Dr. Ron Roberto was the team leader for a group that included Drs. Peter Greenwald and Pierce Gardner, as well as Vachel Blair, a movie photographer who would be making a documentary of the project titled *Miracle in Tonga.* The final leg of the trip was in a small plane from Nandi, Fiji, to Nuku'alofa, Tonga. We landed on a grass airstrip in a classic South Sea island paradise.

However, the sense of being in paradise was almost immediately shattered. We learned on arrival that a major earthquake had occurred in Alaska, and there was concern about a tidal wave spreading throughout

the Pacific and ultimately coming to Tonga. The main island is quite flat, and the guesthouse where our team was supposed to stay was on the north end of the island. Our hosts decided that we should be driven to the south end of the island, for safety's sake.

As we settled into our temporary lodgings, we set up a schedule of two-hour shifts so that one person would remain awake listening to the radio, which was broadcasting emergency reports through the night in Tongan and English. About 2 A.M., the radio announcer reported that a tidal wave this far south had not materialized, so the station was going off the air until morning, as usual. The person listening decided to turn off the radio, let everyone continue sleeping, and explain what had happened in the morning. At 5 A.M., another member of the group woke up, turned on the radio, and found only static. Assuming the tidal wave had hit and knocked out the radio station, he woke the team as well as the people in the surrounding houses to alert them to the arrival of the (thankfully nonexistent) tidal wave. It was an exciting beginning to our stay.

The vaccine dilution testing project went well. We learned how to use and fix jet injectors, and by comparing various dilutions with a standard vaccination group we decided on a 50:1 dilution as optimal. The results of the study were very useful a few years later when the West and Central African smallpox eradication program used the jet injector to deliver measles vaccine to children and smallpox vaccine to the entire population. With this useful tool, tens of millions of injections were given within a few short years.

CAN SMALLPOX BE ERADICATED?

Earlier in 1964, before going to Tonga, I had read an article in the *New England Journal of Medicine* that prompted me to decide, on the spot, that I wanted to study with the author, Dr. Tom Weller.[7] Weller had presented the *Journal* article the previous year as the commencement address to the Harvard Medical School. He expressed a vision of global health that I wanted to explore. He was saying to those young graduates: now that

you have developed these medical skills and the knowledge that goes with them, think about using them in the parts of the world that need them the most.

In the fall of 1964, I left my job as an EIS officer with the CDC to begin an academic year in the Tropical Public Health Department at Harvard, of which Weller was chair. During that year of study I had the opportunity to spend considerable time with Weller, a Nobel Prize–winning scientist.[8] I had gone to Harvard to study global health, not smallpox, but when it came time to choose a topic to present in Weller's spring semester seminar class, I decided to write a paper on the possibility of eradicating smallpox globally. At the time, I had no way of knowing that I would be involved in exactly such a venture by the following year.

The paper was a purely academic exploration of what might be involved. In India I had seen the absolute misery of smallpox patients. In Tonga I had seen that the jet injector offered a standardized vaccination method that could be used widely with reliable take rates (a "take" is a successful vaccination as evidenced by the appearance of a sore, crater, or blister at the vaccination site several days after the vaccination). The smallpox vaccine was good; it lasted ten years or more, and it was inexpensive. Moreover, the smallpox virus's life cycle did not involve a nonhuman host, which would have complicated the strategy (yellow fever eradication had failed when it was found that nonhuman primates also harbored the virus). And because of the disease's obvious symptoms, surveillance (tracking a disease) was relatively easy. Finally, people—including government officials—feared the disease and were therefore likely to cooperate. Citizens would likely participate, and governments would likely fund the program. I used the word *eradicate* in my presentation quite deliberately both because I believed in the possibility of eradication and because many people didn't. Some believed that eradication was impossible because of the failed attempts at eradicating both yellow fever and malaria. Others assumed that emptying a viral niche was impossible—even though species extinction occurs all the time.

My presentation sparked an intense debate. Weller's own questioning unnerved me at first. He probed from various angles, exposing the weakness of my arguments by using the failed attempts at malaria eradication

as his lever. Later, one of his staff members told me that Weller would never deliberately embarrass a student and that his intense questioning was meant to explore ideas he thought had merit.

A classmate, Dr. Yemi Ademola, head of preventive medicine for Nigeria, continued the discussion with me for weeks after the seminar. He became so interested in the possibility of a smallpox eradication program in Nigeria that he eventually traveled to Atlanta to discuss its possibilities with D. A. Henderson and Alex Langmuir. They had already been working with WHO officials to secure a commitment from the World Health Assembly to adopt the global goal of smallpox eradication.[9]

Indeed, other people had been thinking along similar lines for some time. Several years before smallpox eradication was discussed at the CDC and WHO, Charlie Houston had suggested a program to eliminate smallpox from India by using Peace Corps volunteers to head up mobile vaccination teams. His plan was rejected at the time in Washington, D.C. Rei Ravenholt had a similar idea and wrote to Sargent Shriver, head of the Peace Corps, on June 24, 1961, suggesting that the Peace Corps launch a smallpox eradication program using Peace Corps volunteers to train vaccination teams, all supervised by medical officers. Ravenholt notes in his letter that there is "no technological obstacle to its rapid eradication."[10] A movement toward smallpox eradication seemed to be building from many directions.