

Public Health Then and Now

Smallpox: Ten Years Gone

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Introduction

Imagine what it would be like if you could get AIDS (acquired immunodeficiency syndrome) by simply standing near an infected person at work, in school, in a hospital or anywhere else; if you had a chance of dying of one in four when you did get it, and if virtually everyone would be infected sooner or later. Imagine that when you did contract the disease it would transform you into a hideous monster, rack your body with constant pain, and cause your family and friends to fear and shun you—some perceiving your illness as evidence of divine wrath. Picture the consternation that would ensue if the same disease had killed Queen Elizabeth II in the sixth year of her reign and confined the president of the United States to the White House for a month, all the while erupting unpredictably in cities and villages around the world, killing millions each year before receding just as mysteriously and temporarily.

That was smallpox!

Although there has been some ill-informed speculation about the current AIDS epidemic becoming "worse than the Black Death," we are indeed lucky that AIDS is not spread by casual contact or airborne transmission. If it were, then we humans of the late twentieth century would experience the kind of terror smallpox engendered in earlier generations. We would understand why Lord Thomas Babington Macaulay called smallpox "the most terrible of all the ministers of death," and why, at its last appearance in New York City only 40 years ago, 1.5 million New Yorkers were vaccinated for each two cases that actually occurred (there were eight cases in all), and nearly tore down some of the health department's clinics in their clamor to be immunized.

Now that we have enjoyed 10 years without smallpox, it is worthwhile to recall what that disease meant to mankind, review how it came to be eradicated, and consider some lessons that may be learned from those experiences.

Historical Influence

Smallpox exacted an enormous toll through the ages. Most of the following historical summary is taken from my book, *Princes and Peasants: Smallpox in History*.¹ The disease was unique in its savagery, fatality, and universality. In epidemic years alone between 1868 and 1885, smallpox

killed an estimated 10 per cent of the population of British India. In 1905, it was estimated that each year 1 per cent of Togoland's population died of smallpox. In late eighteenth century Europe, smallpox was blamed for the deaths of 10 per cent of all Swedish infants, one-seventh of all Russian infants, and over 400,000 Europeans (excluding Russia) each year.

In North and South America, smallpox completely annihilated some tribes of Native Americans and decimated the entire indigenous population of both continents and the West Indies. Here as in eastern and southern Africa, the coincident devastation of native tribes by smallpox materially aided European settlement.

Many who survived an attack were blinded or left with ugly scars on their faces. Among one African tribe, the word for smallpox means "face is spoilt." I remember vividly the scarred face of one of my uncles who was infected during an outbreak in the US in the 1920s. At least one mistress of a nineteenth century Nepalese King committed suicide after her beauty was destroyed by smallpox, and many thusly disfigured European girls and women, including two sisters of Austrian princess Marie Antoinette, spent the remainder of their lives in convents because they had no more prospect of marriage. No less painful was the anguish felt by the family and friends of one Miss Anna Rhodes, whose memorial monument is preserved in London's Victoria and Albert Museum. The stone plaque recalls how she lived for 15 years after ". . . At the age of 17, the Small-pox stripped off all the Bloom of youthful Beauty, and . . . withered those fair Prospects of earthly Happiness which were expected from her uncommon Affection, Sensibility and Tenderness. . . ." It was for these reasons that Voltaire actively promoted smallpox inoculation among his countrymen "for the sake of staying alive and keeping their women beautiful."

Perhaps the most consequential such scarring, however, was that of a man, Peter III of Russia, whose shocked fiancée later recalled how repulsive she found his "quite hideous" appearance following his attack of smallpox. After they were married, she apparently had him killed, and took a string of lovers while she ruled as Catherine the Great.

Europeans and North Americans put on wax make-up to disguise the pocks in their faces, and special fire screens were used in front of fireplaces to protect their vulnerable faces from the intense heat.

In Japan, many persons blinded by smallpox supported themselves as masseuses or masseurs. Elsewhere, during the eighteenth century, smallpox was the reason given why "no country in Europe so swarms with blind people as Poland." A Frenchman later asserted that since smallpox was to blame for one-third of all the blindness in Europe, even if the

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prevention of blindness were the only result of vaccination, "this alone would suffice to render [Edward] Jenner's name immortal."

In Europe especially, the rise in smallpox which began in the sixteenth century was associated with increasing urbanization (and wars). The danger of contracting smallpox in eighteenth century London made it almost impossible for persons who had not yet had smallpox to get a job there working for a family or in a hospital. Even in the seventeenth century, the well-known risk to students of contracting smallpox in densely populated English cities was a distinct stimulus to establishment of colleges in the North American colonies. Among persons raised in large cities, most contracted smallpox in childhood. Of 6,705 deaths from smallpox in Berlin between 1758 and 1774, for example, only 45 were in persons over the age of 15 years. This concentration of people and smallpox in cities also extended to the royal houses of Europe, China, and Japan.

The Royal Houses

The impact of individual deaths due to smallpox was often manifest most spectacularly when the egalitarian disease attacked royalty. It claimed the lives of five Japanese emperors, five maharajahs of Tripura, two kings of Dahomey, two Chinese emperors, and shifted the Austrian Habsburg line of succession four times in four generations. In the 80 years between 1694 and 1774, smallpox killed a queen of England, an Austrian emperor, a king of Spain, a tsar of Russia, a queen of Sweden, and a king of France. An example of the direct consequence of one such intervention was Emperor K'ang Hsi. He became one of the three greatest and longest reigning emperors of China, after having been raised to the Dragon Throne expressly because he alone among his father's three oldest sons had already had smallpox when his father, the first Manchu emperor, died of the disease in 1661.

Military Operations

Further evidence of smallpox's awesome power and unique historical influence abounds. Three final examples, of its effects on military operations, will illustrate this aspect of its role as an historical force:

- By devastating a nearly victorious Colonial American army besieging Quebec City in 1776, smallpox preserved Canada for the British Empire and left a string of mass graves along the army's line of retreat from Fort Chambly, near Montreal, to Crown Point, New York.

- One year earlier, fear of what this "King of Terrors" would do to his vulnerable army caused General George Washington to prolong his siege of smallpox-ridden Boston.

- In 1779, an outbreak of smallpox among sailors of a powerful French and Spanish armada in the English Channel saved England from perhaps the most serious danger of invasion it has ever faced, at a time when most of the British Navy was engaged on the opposite side of the Atlantic, in North America.

Three cross-cutting responses to smallpox were nearly as amazingly widespread and ancient as the disease itself.

Worship of the Gods

The oldest of these was the attribution of smallpox to the wrath of a specific god or goddess, with associated worship of that deity to prevent or ameliorate illness and death from the disease.

Shitala Mata ("the cool one"), the Indian goddess of smallpox (Figure 1), is apparently the oldest of the deities associated specifically with smallpox, possibly dating to as



FIGURE 1—Shitala Mata, India's goddess of smallpox (Drawing by Chris L. Smith)

long as 2,000 or 3,000 years ago. She is usually depicted as riding side saddle on an ass, with a broom in one hand and a jug of water in the other. My favorite legend of this goddess' origin describes how she flew into such a rage on seeing how ugly she was when she contracted smallpox, that she went up into the sky and devoured half the body of the moon (thus explaining its periodic crescent shape). When the chief god, her father, saw this, he said, "I will give you all humanity to eat, but leave the moon alone." After that, she attacked men instead, and gave them smallpox.

Worship of this goddess, and refusal of vaccination for that reason, were still quite strong in parts of northern India, especially Bihar State, during the eradication campaign there in the early 1970s.

In China, T'ou-Shen Niang-Niang, the Chinese goddess of smallpox, is traditionally traced to an eleventh century Buddhist nun who is said to have introduced her and the practice of inoculation from India.

Europeans of Roman Catholic faith prayed for relief to St. Nicaise, their patron saint of smallpox who was the bishop of Rheims, France when he was beheaded by the invading Huns in 451 or 452 AD. A striking larger-than-life statue of this saint, holding his head with its bishop's miter still in place, graces the north entrance to Rheims cathedral (Figure 2).

Among the Yoruba of West Africa, worship of Shapona, god of smallpox, was well-established by the time Europeans arrived in that part of Africa in the seventeenth century. Here, too, strong persisting belief in this god and fear of offending him by accepting smallpox vaccination was a feature of the smallpox eradication campaign in some parts of Nigeria, Dahomey (Benin) and Togo in the late 1960s. The cult of Shapona survived transposition to the New World with African slaves from Yorubaland to Haiti, Cuba, and



FIGURE 2—St. Nicaise, Catholic patron saint of smallpox
(Photo from author's book)

especially Bahia, Brazil. In Latin America, he was known by one of his other names from West Africa, Obaluaye ("King of the Earth") or Omolu. This same god was the subject of a popular recording by Cuban-American entertainer Desi Arnaz in the 1950s: "Baba Luaye".

Inoculation

Inoculation, another cross-cutting response, was the first effective specific preventive measure to be deployed against smallpox. This procedure, in which infectious material from pus or crusts of smallpox victims was implanted into the skin of susceptible persons so as to infect them and thereby render them immune after experiencing mild symptoms or none at all, was apparently used in India since before the birth of Christ. It was much less risky than catching smallpox in the usual way, by inhalation, but recipients could still spread normal smallpox to others for one or two weeks until their inoculation site and any accompanying rash healed.

Inoculation is thought to have been introduced into China in the eleventh century. It was introduced into medical practice in England from Turkey in 1721, and into North America from African slaves the same year, although it was a folk practice in parts of England, Scotland, and Germany before then. By the time Cotton Mather and Zabdiel Boylston introduced it into Boston during a bitter public controversy, it was widely known and practiced among slaves there from many different parts of Africa. When Cotton Mather asked how long inoculation had been practiced in their homelands, some of the slaves replied that it had been known since long before they were born.



FIGURE 3—Smallpox god Sopona was worshipped by the Yorubas of Nigeria
(Photo: World Health Organization)

The Red Treatment

The third ancient practice which was adopted in many different cultures to prevent or ameliorate smallpox was the Red Treatment. This curious and persistent belief, in some ways the most remarkable of the three, was based on faith in the therapeutic efficacy of red colored objects to combat smallpox. It is evident as early as tenth century Japan, when a medical treatise describes use of red cloth hangings in the sick room of smallpox victims. In the seventeenth century, a European doctor described the red furnishings in the apartments of the Japanese emperor's convalescing children, and noted that even persons who came near the patients had to dress in red. At least up to the late nineteenth century, red prints depicting a twelfth century Japanese archer were hung in the sickrooms of smallpox patients. Belief in, and practice of, the red treatment extended into China, India, Turkey, and was practiced in Tonkin, Indochina in the 1890s.

In Europe, the red treatment was recommended in medical writings of the medieval Arabic scholars Averroes and Avicenna and came to be widely practiced in England, France, Italy, Rumania, Sweden, Denmark, and elsewhere. King Charles V of France, Elizabeth I of England, and Joseph I of Austria were all subjected to this treatment when they had smallpox. Whereas the latter two monarchs were merely wrapped in red blankets, the French king was dressed in a red shirt, stockings, and veils during his illness. After a Danish dermatologist, Dr. Niels Finsen, began championing the therapeutic virtues of his "red light treatment" in 1893, that version of the ancient treatment was tested in clinical trials in Britain, South Africa, Russia, and in such cities as Boston, Dubuque, Indianapolis, and Philadelphia in the USA during the first decade of the twentieth century. From Philadelphia's municipal hospital in 1902, Dr. Jay Schamberg reported:

Our red room was complete in its appointments. The window panes were of a ruby red color, the gas jet at night was surrounded by a red globe, the walls of the room were painted deep red, and a red curtain covered the inner of two doors so as to completely exclude the light of day.

Evidence of the red treatment was reported in Poland in World War I, and in parts of Russia, France, and Rumania in 1925. A Canadian, K.B. Roberts, said when he was vaccinated as a schoolboy in the 1930s, his father insisted that he wear a red ribbon around his upper arm for the next few days. Vestiges of this belief may also have been the reason why the woolen blankets in many British infectious disease hospitals as recently as a generation ago were traditionally red in color.

When and where smallpox first arose is not known. The evidence suggests it first appeared in Africa or India some time after humans began concentrating in agricultural settlements around 10,000 BC, but before 1,000 BC. The earliest specific apparent victim was the Egyptian pharaoh Ramses V who died in his thirties of an acute illness with a characteristic rash in 1157 BC. It probably is not a chance coincidence that this and other first specific evidence of smallpox in ancient Egypt date to the period, the New Kingdom (18–20th dynasties), when the Egyptian Empire expanded to its greatest



FIGURE 4—Ramses V, Pharaoh of Egypt who died in 1157 BC, may have been the earliest known victim of smallpox (Photo: World Health Organization)

geographical extent by far, with extensive conquests and expeditions in Africa and Asia.

In India, ancient religious and medical texts of uncertain antiquity and Hindu mythology indicate the disease almost certainly existed there for some time before the birth of Christ. Most evidence pertaining to China, however, seems to point to the disease having been introduced into that country by the Huns around 243 BC. From China, it spread to Korea and then Japan in 583–5 AD. It may have spread into relatively sparsely populated Europe as early as 430 BC, as the mysterious "Plague of Athens". Americans first experienced this scourge of the Old World early in the sixteenth century, and Australia not until late in the eighteenth century.

Global Eradication

The intensified global Smallpox Eradication Campaign is thoroughly described in the 1500-page official account, "Smallpox and Its Eradication", which was published by the World Health Organization in 1988. The important supporting role played by the US Centers for Disease Control (CDC) in that public health triumph has also been described in Horace Ogden's Book, *CDC and the Smallpox Crusade*, published by the US Government Printing Office in 1987 to commemorate the tenth anniversary of smallpox eradication.

President Thomas Jefferson, who actively promoted smallpox vaccination, including among American Indians, foresaw the ultimate result of vaccination when he wrote Edward Jenner in 1806:



FIGURE 5—Edward Jenner, discoverer of vaccination against smallpox in 1796, announced his findings in 1798 and, by 1801, 100,000 persons had been vaccinated in England. Jenner's pamphlet on the subject was translated into five languages. (Photo: Jenner Trust)

"You have erased from the calendar of human afflictions one of its greatest. Yours is the comfortable reflection that mankind can never forget that you have lived. Future nations will know by history only that the loathsome smallpox has existed."

In 1801, only five years after his epochal discovery of the utility and safety of cowpox vaccination as a preventive against smallpox, Jenner himself predicted that "the annihilation of smallpox—the most dreadful scourge of the human race—will be the final result of this practice." Even so, mankind still had a lot to learn about smallpox and its prevention.

We have seen how several societies had sought, some since time immemorial, to control or prevent smallpox by recourse to special gods or goddesses, the red treatment, or inoculation of the smallpox virus itself. In Western countries the tenth century Arabic scholar Rhazes is credited with first distinguishing smallpox from measles, although Ko Hung clearly described clinical smallpox in China around 340 AD. In Italy, Girolamo Fracastoro published a book first explaining the concept of specific contagion for smallpox and measles in 1546, shortly after the French coined the term "small-pox" (*la petite verole*) to distinguish the then familiar infection from a similar new one, *la grosse verole* (syphilis), which had recently become widespread in Europe. William Heberden definitively established chicken pox as a separate disease from smallpox in England around 1768, although that distinction had been made in China centuries earlier. This differential diagnosis especially helped reduce confusion about second attacks of "smallpox" following natural infection or inoculation.

The English physician Thomas Sydenham (1624–1689) saved many lives by distinguishing patients with confluent smallpox from those with discrete smallpox rashes, and persuading physicians to withhold their harmful "treatments" from the latter patients, while he encouraged cooling regimens rather than "hot" treatment for all other smallpox patients. The concept of contagiousness of smallpox was firmly established by Jean Baptiste van Helmont (1578–1644) of Belgium, and Hermann Boerhaave (1668–1738) of The Netherlands.

Controversies over introduction of what was seen as a radical innovation, inoculation, into Europe and North America from Asia and Africa in the early eighteenth century helped prepare physicians and the public in Europe and the Americas to rapidly adopt Jennerian vaccination when that became available. The practice of inoculation also advanced medical understanding of the concept of an incubation period between the time of actual infection and appearance of physical signs or symptoms.

Following Jenner's discovery, it remained for Negri of Naples to show how the vaccine could be mass produced from inoculated cattle in 1842; for Britain's Monckton Copeman to demonstrate the germicidal effect of adding glycerine to smallpox vaccine in 1891; and for Dutch and French researchers to develop a heat-resistant dried vaccine for use in their colonies in the 1920s. The ultimate improved method of freeze-drying vaccine was developed at the Michigan State laboratories in 1949, field tested in Peru, and adapted to commercial production at England's Lister Institute in 1954. Two final technological advancements which aided eradication were development of the jet injector by the US Army and its later adaptation for use to inject smallpox vaccine intra-

dermally in the early 1960s, and development of the bifurcated needle by Wyeth Laboratories during the eradication campaign in 1968.

As late as 1935, the 12th edition of William Osler's *Principles and Practice of Medicine* still had to list smallpox among the diseases of uncertain etiology. The smallpox virus itself was not seen until Canadian and United States scientists used an electron microscope to do so in 1947. And the *Variola minor* virus, whose appearance at the end of the nineteenth century caused great consternation and confusion, especially in North America, was only distinguished from *Variola major* in the laboratory in 1961.

Sweden was apparently the first country to use Jenner's vaccine to totally eliminate smallpox, in 1895. Most nineteenth century efforts tended to focus on protection of individuals, not nationwide eradication. Austria, Cuba, and Madagascar eliminated the disease in the 1920s; England, the Philippines, and the USSR in the 1930s; and Canada and the United States in the 1940s. When a Japanese delegate to the International Sanitary Conference of the League of Nations proposed in the 1920s that smallpox should be declared an internationally reportable disease, however, a Swiss delegate objected that since smallpox existed everywhere, the disease had "no place in an international convention," and the original motion was weakened to apply only when smallpox was epidemic. A similar effort to try to standardize smallpox vaccines 20 years later was rejected.

Two years before the last outbreak of smallpox in the US occurred in Hidalgo County, Texas in 1949, a rather small outbreak of eight cases, the first of which was imported into New York City from Mexico and misdiagnosed, generated a panic reminiscent of the great Montreal epidemic of 1885–86. This stimulated research which led to the freeze-dried vaccine.

The Pan American Sanitary Bureau first approved a regional eradication campaign for the Americas in 1950, when smallpox was still reported from over 90 countries worldwide. This early resolution by the Pan American Sanitary Bureau had only limited success (e.g., Venezuela, Mexico, Peru) before the World Health Organization adopted a resolution proposed by the Soviet Union in 1958 which called for a global eradication campaign. This time there were more vigorous efforts in Latin America so that by the end of 1966, the disease remained only in Brazil and neighboring Argentina. Comparable progress was not recorded in other regions during that period, however.

When the Nineteenth World Health Assembly issued another call for global eradication of smallpox in 1966, it established a deadline of 10 years hence, and allocated funds from the regular World Health Organization budget to establish the intensified Smallpox Eradication Program (SEP). At the time, 44 countries still reported smallpox. Although 131,000 cases of the disease were officially reported in 1967, the estimated true incidence then was 10–15 million cases. The rationale for smallpox's eradicability, as reasoned then, apart from the manifest progress in several countries already, was that smallpox was easily diagnosed and without covert infections, there was no animal reservoir, the duration of infectiousness was short, natural immunity was complete and life-long, and there was an excellent vaccine available. The final push began in January 1967, led by a medical epidemiologist loaned to the World Health Organization from CDC, Dr. Donald A. Henderson.

One of the SEP's earliest needs was to secure large amounts of reliable vaccine, which it did by establishing

international reference laboratories in Canada and The Netherlands and by accepting millions of doses of vaccine donated by the USSR for use in India and elsewhere. Another need was met in 20 countries of West and Central Africa, for which President Lyndon Johnson had announced US support in November 1965 for national programs to eradicate smallpox and control measles. The West and Central African Program was funded by the US Agency for International Development and executed, on the US side, by CDC. In three and a half years, that region of about 100 million persons—including seven of the 12 most highly endemic countries of the world, and which included the most difficult operating conditions expected anywhere—was rendered free of smallpox when the last cases occurred in Nigeria in May 1970. This gave the global program an enormous victory and psychological boost.

The campaign in West Africa also introduced a radical shift in strategy. Rather than relying on mass vaccination, which required trying to reach 80–100 per cent of each country's population, the new "selective-containment" strategy called for concentrating on the less than 5 per cent of the population which had smallpox at any one time. It required rapid case finding and effective control of outbreaks once they were discovered, but was much more efficient than the early strategy. It also took maximal advantage of the natural annual reduction in smallpox incidence during the rainy season. This new approach was first practiced in 1967 by Dr. William H. Foege, who was then an epidemiologist assigned to the eradication program in eastern Nigeria. It was introduced elsewhere in West Africa in 1968—the same year in which the bifurcated needle became available as a result of WHO-inspired research.

Brazil became smallpox-free, and with it the American region, in April 1971. Indonesia, the third epidemic zone, eliminated the infection in January 1972. By the Fall of 1973, only four endemic countries remained: Bangladesh, Ethiopia, India, and Pakistan. Meanwhile, however, imported cases of smallpox caused two deadly outbreaks in Meschede, West Germany in 1970, and in Yugoslavia in 1972.

India saw its last case of smallpox in May 1975, only a year after suffering a massive outbreak centered in the northeastern state of Bihar, where over 10,000 persons died of smallpox in May 1974 alone. This last tragic explosion of smallpox in India received wide publicity since it coincided with the large influx of international reporters who had been drawn to the country by the detonation of India's first nuclear bomb that same month. The massive epidemiological problem was successfully matched by an equally massive eradication program. India intensified its monthly search and containment efforts to a point that by April 1975, some 115,000 health workers conducted a house to house search for smallpox in each of India's 615,000 villages, towns and cities!

Bangladesh had apparently eliminated smallpox as East Pakistan in 1971, only to have the disease widely reestablished during repatriation of hundreds of thousands of its citizens from India in 1972. It then saw population movements caused by rural floods, famine, and an ill-timed urban slum clearance campaign in Dacca in October 1974 erase the gains achieved during the previous 21 months before it finally eliminated the disease in October 1975.

The final showdown took place on the Horn of Africa, where Ethiopia's dogged struggle to eliminate *Variola minor* stopped transmission of the virus in 1976. Shortly before then, the virus had quietly invaded neighboring Somalia,

where the last case of naturally occurring smallpox became ill on October 26, 1977. Only two cases of smallpox occurred after that date, as a result of a laboratory accident in Birmingham, England in August 1978.

In May 1980, the Thirty-third World Health Assembly accepted the report of the Global Commission for the Certification of Smallpox Eradication, and declared that smallpox was eradicated. The certification process included intensive active surveillance for smallpox for at least two years after the presumed last case in each endemic country and on-site inspection of the results (and a sample of villages) by teams that included members of the Global Commission.

DECLARATION OF GLOBAL ERADICATION OF SMALLPOX

The Thirty-third World Health Assembly, on this the eighth day of May 1980;

Having considered the development and results of the global programme on smallpox eradication initiated by WHO in 1956 and intensified since 1967;

1. Declares solemnly that the world and all its peoples have won freedom from smallpox, which was a most devastating disease sweeping in epidemic form through many countries since earliest times, leaving death, blindness and disfigurement in its wake and which only a decade ago was rampant in Africa, Asia and South America;

2. Expresses its deep gratitude to all nations and individuals who contributed to the success of this noble and historic endeavour;

3. Calls this unprecedented achievement in the history of public health to the attention of all nations, which by their collective action have freed mankind of this ancient scourge and, in so doing, have demonstrated how nations working together in a common cause may further human progress.

Lessons and Legacies

As we commemorate the tenth anniversary of the eradication of smallpox, it may be too much to expect that all of the consequences of that momentous achievement are necessarily yet understood. Many have already been enumerated. I believe four lessons of the eradication campaign are especially noteworthy and deserve mentioning here:

- The Smallpox Eradication Program was a stunning demonstration of the power of applied epidemiology and active surveillance. It was these principles, long championed by Dr. Alexander D. Langmuir, that led to the successful surveillance-containment strategy when they were applied to smallpox during the earliest days of the intensified campaign. One must know exactly where a disease is in order to contain it, and thoroughly understand its epidemiology in order to discover its most vulnerable characteristics. As diseases and their epidemiology differ, one important consequence of the latter principle, for example, is that the current mania for a vaccine as the only or best solution to all manner of infectious diseases is not always appropriate.

- Another important lesson can be found in the way the smallpox program so effectively stimulated, harnessed, and managed the energies of numerous workers and focused them effectively on a single goal: elimination of smallpox (not smallpox vaccination). Particularly during the latter part of

the global campaign, this system was awesome to behold. Dr. Larry Brilliant has summarized these principles, as they were applied so effectively in India, in his 1985 book, "The Management of Smallpox Eradication in India." These principles could and should now be adapted to several other high priority diseases simultaneously so as to achieve specific, measurable improvements in the health of populations. Most of all, this lesson teaches us to beware of focusing entirely on processes, or on any other means to an end (e.g., either primary or tertiary health care), rather than on the end itself, which is reduction in morbidity and mortality.

- It is important also that, despite the earlier skepticism of many otherwise knowledgeable critics, *smallpox was eradicated*. Eradication of carefully chosen diseases is a uniquely useful tool for advancing the public's health, and should be so used appropriately. In my opinion, four important diseases are appropriate targets for eradication at this time, namely dracunculiasis (guinea worm), polio, yaws, and measles. That children are still being mutilated and crippled by yaws, which is curable by a single injection of penicillin, but which, far from being eradicated, is resurging in several countries, is a global disgrace.

- The fourth lesson is the indispensable value of *international cooperation* in combatting global diseases, especially infectious diseases. Both developed and developing countries benefited from smallpox eradication—a feat which could not have been accomplished in such a short time by either group acting without the other. We need only note the unseemly squabbles between US and French scientists over discovery of the AIDS (acquired immune deficiency syndrome) virus, the dissemination of disinformation by Soviets alleging that the AIDS epidemic resulted from US experiments in biological weaponry, and some of the absurd speculation by various outsiders about certain African practices, as well as the resultant African hypersensitivity about whether the virus first emerged in Africa, to demonstrate how far the world is from acting on this lesson.

Apart from the various lessons, learned and unlearned, certain legacies of the smallpox eradication program are already complete and accruing interest daily. Among these are the people who participated in the campaign and were thereby transformed. I for one count it as one of the greatest accidents of luck in my life that I began my professional career in such an enthusiastic, important, and successful public health effort. The camaraderie amongst veterans of the campaign transcends nationalities and other boundaries and pervades a host of public health workers in formerly endemic countries. Some of this spirit and taste for positive action may be experienced in current campaigns of WHO's Expanded

Program on Immunization (EPI), in PAHO's campaign to eliminate polio from the Americas by 1990, and in the effort to eradicate dracunculiasis.

Eradicating smallpox saved all countries large amounts of resources (money and people) which otherwise would have had to be used in continuing control programs. The endemic countries also saved people who would otherwise have died of smallpox. The United States, which invested over \$30 million in the global eradication of smallpox, was also one of the largest beneficiaries, recouping its investment more than four times over each year, in 1968 dollars, since 1971.

One important issue still outstanding is whether the remaining stocks of variola virus in Atlanta and Moscow should be destroyed. I believe their destruction would be a mistake. DNA (deoxyribonucleic acid) mapping has eliminated the former need to preserve intact smallpox virus as a standard against which to compare any new similar viruses such as monkeypox. I do not believe we can be certain, however, that no one will ever conceive of some potentially beneficial use for the smallpox virus, even if we cannot imagine such a use now. If the last smallpox viruses are destroyed, they would be gone forever. I think the wisest course would be to agree to preserve the virus indefinitely under strict, secure conditions, without conducting any more experiments using the smallpox virus, unless there is an international consensus to do so.

Future historians will surely remark on the irony that even as the world was celebrating the eradication of smallpox, perhaps a little too smugly, a new, even more deadly virus—HIV (human immunodeficiency virus) was beginning to affect mankind, and soon escalated into another global challenge: AIDS. They likely will be amazed and saddened to see how closely the responses of some of our contemporaries to the new virus match the fear, ignorance, xenophobia, and political opportunism formerly engendered by smallpox.

ACKNOWLEDGMENTS

The photographs in Figures 1, 2, and 5 are reproduced from Dr. Hopkins' book, *Princes and Peasants: Smallpox in History*, cited in the bibliography below. Figures 3 and 4 are from WHO, Geneva.

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World Conference on Lung Health Scheduled for May 20–24, 1990

A "World Conference on Lung Health" will be held May 20–24, 1990 in Boston, Massachusetts under the co-sponsorship of the American Lung Association, the American Thoracic Society, and the International Union Against Tuberculosis and Lung Disease.

Between 9,000 and 10,000 scientists, clinicians, and health educators from around the world are expected to attend the enclave. In addition to important and timely plenary sessions and symposia, over 2,500 scientific and public health research papers will be presented.

For additional information about the conference, contact: Richard Grimes, Director, World Conference on Lung Health, American Lung Association, 1740 Broadway, New York, NY 10019-4374. Tel: (202) 315-8700.