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ROTARY CLUB - CLEVELAND, OHIO

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by

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On October 22, 1977, in a southern Somalian town, a 23-year-old cook, Ali Maalin,² developed high fever and headache. Four days later a rash developed. He had smallpox. Ali had exposed 161 people. All were identified, vaccinated and kept under surveillance. None developed smallpox.

Since that date, thousands of field staff in previously infected countries have searched village by village and house by house to discover other cases. They show a recognition card⁶ and ask, "Have you seen anyone with a rash like this?"⁷ "A rash on the face or on the body?" To encourage reporting, the World Health Organization offered a reward of \$1,000 to anyone reporting a case of smallpox.⁸ Tens of thousands of persons with rash and fever have been investigated and thousands of specimens examined. A recent visitor to Somalia with even a case of acne could reasonably expect to have been taken into custody as a suspect case. Two further cases of smallpox occurred during 1978 following a tragic laboratory accident in Birmingham, England. But except for these two cases - none have been smallpox. International Commissions visited each country and confirmed the results. Just 13 days ago, the Director-General of the World Health Organization announced from Nairobi, Kenya,⁹

"I am confident in stating that as of today, smallpox has been eradicated throughout the world - that for the first time in history, a disease has been eradicated from the earth. October 26 shall henceforth be known as Smallpox Zero Day."

Variola virus, once the cause of the most feared and devastating disease known to man, is now confined to glass vials in seven laboratories under conditions of high security.

The origin of smallpox antedates written history. The great Ramses V who died 3,000 years ago, in 1160 B.C.¹¹ is believed to have died of smallpox and the disease was described as long ago in China and India. Even today, throughout India, there are temples¹² to Sitla Mata who is believed to possess the power to ward off smallpox and to prevent death among victims. Recovered patients offered gifts in gratitude. For our surveillance teams, searching for unreported cases, these temples were primary targets. In other cultures there were also deities consecrated to smallpox - Saponna in Western Africa,¹⁴ Omulu in Brazil and others lost to history.

Deities consecrated to other diseases are all but unknown. But no disease century after century was so devastating as smallpox. It killed 20% to 40% of its victims, leaving the others permanently scarred or blinded.¹⁵ It could spread in any climate, in any area. Like measles, essentially everyone eventually contracted the disease. There was and is no treatment.

Smallpox became established in Europe early in the Middle Ages and in the 17th century Lord Macauley wrote: ¹⁶"That disease was then the most terrible of the ministers of death... smallpox was always present filling the churchyard with corpses... and making the eyes and cheeks of the betrothed maiden objects of horror to the lover." Again and again, it altered the course of history.

In 1796, Edward Jenner, an English physician discovered that inoculation of cowpox material into the arm of a susceptible person prevented smallpox. Folklore of the time attributed the celebrated unblemished complexion of dairymaids to their acquisition of cowpox,¹⁸ a localized infection on the hand acquired from cows. Jenner deliberately took material from an infection on the hand of the dairymaid Sarah Nelms and inoculated it into the arm of James Phipps.¹⁹ He later showed that Phipps was protected from smallpox and that the material could be transferred from the pustule on the arm of one person to the arm of another. In less than five years, Jenner's cowpox had been carried around the world, a remarkable feat in the era of sailing ships and stage coaches.

Propagation of cowpox, or what later came to be called vaccinia virus, by transfer from arm to arm permitted only small numbers to be inoculated at one time. But in the late 1800s, it was found that the virus could be grown on the flank of a calf. However, such vaccine, if unrefrigerated, became inactive in a matter of days. Gradually countries in the more temperate areas began to control smallpox. Even so, as recently as 1939, the United States recorded 10,000 cases. In developing countries, the disease was all but unchecked.

During the 1940s, Europe and America finally became free of smallpox. In the developing world, more heat stable vaccines were essential. Finally, in the early 1950s, the technique of freeze-drying of vaccine²² was perfected - much as coffee is preserved today. Vaccine preserved in this manner remains potent for a month or longer at temperatures of 98°F.

Meanwhile, outbreaks of smallpox continued to occur in Europe as travelers brought the disease back from endemic countries. Smallpox was as severe and as fatal as in the developing countries. There was and is no treatment. So frequent were importations that England and Germany maintained special smallpox hospitals to be opened and staffed when importations occurred. Vaccination certificates were required of all international travelers and national smallpox vaccination programs were routine in all countries, including our own.

Mass vaccination programs were conducted in a number of developing countries. Only a few were successful. Countries which stopped transmission experienced reinfection from their neighbors. Most discouraging was that the mass vaccination strategy itself did not seem to be working. In many areas of India, a larger number of vaccinations were performed than there were people - but still smallpox persisted.

The 1966 World Health Assembly decided to allocate \$2.5 million from its regular budget for an eradication program. New hope often springs from new buildings and it was in 1966 that WHO occupied its new quarters

overlooking Geneva.²⁶ The sum of \$2.5 million seems more impressive than it was. For programs in fifty countries, it amounted to only \$50,000 per country. But it was almost 5% of WHO's total budget. Publicly, the delegates were enthusiastic and proposed a 10-year goal for achievement. Privately, it was difficult to identify any who believed eradication to be possible. The skeptics were realistic considering that the program would have to be undertaken in some of the most inhospitable parts of the world and in some of the least developed countries. No disease had ever before been eradicated and WHO's only other disease eradication program - that for malaria - was failing.

The program commenced on January 1, 1967. The target date for the occurrence of the last case was December 31, 1976.

²⁷In 1967 when the program began, smallpox was endemic in 34 countries - nine other countries experienced importations that year. The belief that eradication of smallpox could be achieved was based on a number of unique characteristics of the disease. Of principal importance is the fact that man is the only host for the virus. There is no animal reservoir.

²⁸He can transmit infection only from the time when the rash first begins until the last scabs fall off. After recovery he is immune.

There are no carriers. Thus, it was possible to know whether or not smallpox was present in an area by searching for patients with a visible rash. ²⁹The disease spreads in a continuing chain of infection as a result of face-to-face contact between a patient and a susceptible person. Usually, the patient does not infect more than two to five

additional persons. ³⁰Smallpox, when introduced into a remote village, for example, will die out after only a few generations of disease, even if nothing is done. This may also occur in extensive, sparsely populated areas. In Brazil, the smallpox program concentrated on the heavily populated areas near the coast. When teams then systematically moved up the Amazon, no cases were found. The same happened in Nepal making it unnecessary to conduct extensive, continuing campaigns in remote Himalayan mountain regions. ³¹Finally, there is a heat-stable vaccine which confers long-lasting protection.

We needed 250 million doses of vaccine each year. Much vaccine was already being used to control smallpox but was it effective? Laboratories in Canada and the Netherlands volunteered to test the vaccine. Less than 10% met accepted standards. Some contained no detectable vaccinia virus at all. A plea was made for donations. The Soviet Union volunteered 140 million doses during the early years; the United States 40 million but donations eventually came from more than 20 countries. ³² A meeting of vaccine producers was convened and from this came a simplified step-by-step manual describing the production process. Consultants assisted laboratories in the developing countries. By 1970 all vaccine met accepted standards. By 1972, 80% of the vaccine was being produced in the developing countries themselves. Some such as India, Iran, Kenya, and Guinea contributed vaccine to others. Uniquely the program grew to become a truly collaborative global effort rather than an assistance program of the rich giving to the poor.

A unique invention, the bifurcated needle,³³ emerged from Wyeth Laboratories in 1968 and immediately we tested a new vaccination technique - multiple puncture vaccination. The needle was dipped into the vaccine - sufficient vaccine was held between the tines. Fifteen rapid strokes implanted enough vaccine in the skin to obtain a take. Only one-fourth as much vaccine was required as had been needed with older techniques. Vaccinators could be quickly trained. The needles were inexpensive and could be sterilized and reused many times.

WHO staff in Pakistan designed a unique needle holder.³⁴ Sterilized needles were dispensed from one holder and used needles placed in a second. At the end of the day the plastic holders could be dropped in boiling water, removed after 20 minutes, shaken once and the vaccinator was prepared for the next day.

Vaccination was further simplified when it was demonstrated that an alcohol saturated cotton swab did little more than rearrange bacteria on the skin surface. Field tests confirmed that infection rates were no different whether the skin was cleansed or not. Vaccinators were thus instructed only to wipe away caked dirt if present.³⁵ Thus, with heat stable vaccine, a vaccinator could carry in his pocket all the equipment he needed for a month's work.

Between 1967 and 1969 programs began in most infected and neighboring countries and by 1971, all were in operation. Our strategy was to conduct a nationwide vaccination programs over two to three years. During this time, reporting systems would be developed to detect

remaining cases and to eliminate them. The program had just begun when an advisor in Eastern Nigeria showed that even in a poorly vaccinated developing country an effective system to detect and eliminate outbreaks could be rapidly developed. ³⁶In early December, 1966 cases were reported from a village called Yache. The patients were isolated and intensive vaccinations conducted in that village, followed by vaccination along the trails leading to the village and in the nearby market. Tracing of cases from the outbreak led to two other villages. There, too, patients were isolated and the villagers vaccinated. In all, 43 cases occurred but the outbreak was stopped in just five weeks. In fact, smallpox spread throughout all of Eastern Nigeria was stopped in months and at a time when less than half the population had vaccination scars. Similar observations followed in Indonesia and in Brazil. The program strategy was changed to give priority to "surveillance - containment", as it was called. Surveillance teams of 2 to 3 persons visited health centers and hospitals. Schools and weekly markets were visited to ask if any had seen smallpox cases. When cases were reported, the surveillance teams, with local health workers, contained the outbreak.

Progress in most of Africa, and in the Americas was rapid. ³⁷By 1970, the number of endemic countries had decreased from 33 to 17. ³⁸By 1973, smallpox was confined to the Indian subcontinent, to Ethiopia whose program did not begin until 1971 and to Botswana which became free of smallpox later that year.

The Indian subcontinent, however, appeared to be an impossible problem. Efforts such as we had made in Africa had little impact. Nearly 700 million people lived in the most densely crowded areas on earth. Trains and buses traveled everywhere, many carrying smallpox patients who had been infected in cities and were returning to their villages to recover or to die. Many cases and outbreaks were not reported. During the long, hot summer of 1973, a special campaign was planned with Indian colleagues. In essence, the plan called for all health workers during one week each month, to visit every village - later every house in India - in search of cases. When cases were discovered, special teams moved in to contain the outbreaks. The logistics were formidable. The plan called for 120,000 workers to visit over 100 million households. Assessment teams visited a 10% sample of households to verify the work. And special supervisory teams checked the assessment teams. More than 8 tons of forms were needed for each search and thousands of vehicles, tens of thousands of bicycles, boats and rickshaws.

The first search took place in October. The results were worse than we had expected. In the Indian State of Uttar Pradesh,³⁹ we had already been spent two years to improve the reporting system. Several hundred cases were reported each week. During the search, nearly 7,000 cases were found in one week - later assessment revealed that the workers had visited only half the villages. However, the outbreaks were now being found. Once found, they could be contained. The quality of the searches steadily improved. Much more rigid containment methods began to be used.⁴⁰ House guards were posted round the clock at each house to

prevent patients from leaving and to vaccinate all visitors. Vaccination teams, posted to each infected village, searched and vaccinated in a five mile radius around the infected village. As cases diminished in number,⁴¹ a reward was offered to the villager who reported a case and to the health worker who first investigated it. The same technique was quickly adapted for us in Pakistan, Nepal and Bangladesh.

The number of cases which were reported continued to rise dramatically. In 1974, the total of reported cases was the highest in 15 years. The newspapers proclaimed "disaster" but by the summer of that year it was apparent to us that eradication could be achieved even in the ancient home of smallpox. ⁴²In October 1974, the last case occurred in Pakistan, in May, 1975, in Nepal; in June 1975, in India; and, finally, on October 16, 1975, in Bangladesh, Rahima Banu⁴³ became the last victim of smallpox in Asia.

⁴⁵Only Ethiopia remained to be conquered. Ethiopia, however, was a challenge unto itself. A country of 25 million people scattered across ⁴⁵desert and highland plateau in an area larger in size than France, Germany and Denmark - a country where half the population lives more than a day's walk from any accessible road⁴⁶ - the definition of "road" was loosely defined⁴⁷ - a country where then, as today, insurrection and fighting was widespread. WHO and national staff were periodically kidnapped and fired upon; one of our 3 helicopters was destroyed by a hand grenade and others damaged by bullets. It was a country where vaccination was all but unknown and widely distrusted - a country with

only 100 health staff for the smallpox program and those that did, worked with difficulty as these paintings by an Ethiopian artist illustrate.^{48 49} In 1971, when the program began, 26,000 cases were found but the actual number was probably 10 times this. Gradually an intrepid group comprised of national and WHO staff and volunteers from the United States, Japan and Austria succeeded in eliminating the disease from the northern highland areas, leaving localized foci among nomads of the southern Ogaden desert⁵⁰ - a scrub desert where it was difficult even to find the nomads - where encampments⁵¹ could be rapidly assembled and as rapidly dismantled and carried 20 or 30 miles in a night. Nomads themselves were hired and trained to search for cases and to vaccinate. Amazingly, they walked 40 miles or more a day and, seemingly by instinct alone, located nomad bands. Whether or not there was smallpox, they were vaccinated. Finally, smallpox was stopped - the last cases occurring in August, 1976 in this encampment⁵³ known as Dimo.

There was still to be one last chapter, however, Somali guerrillas then fighting against Ethiopian forces in the desert brought the disease back to Somalia, previously smallpox free. The first cases were discovered in September 1976. For yet another year campaigns were waged throughout Somalia. More than 3,000 cases were discovered but, at last, the disease had been cornered.⁵⁴ Ali Maalin proved to be the last case in a continuing chain of infection extending back at least 3,000 years. Eradication had been achieved - the 10 year time target missed but only by 9 months and 26 days.

International assistance to the program amounted to an average of only \$8 million per year. For many developing countries, where health budgets are little more than \$1 to \$2 per person, the conquest of smallpox represented the first substantial and tangible achievement of a developing health service. Many issued commemorative stamps to celebrate the victory.^{55 56}

With confidence, new initiatives were sought. To build hospitals and to provide curative medicine was too expensive. Prevention of disease, however, was possible and so the World Health Assembly decided to begin a global program to immunize the 100 million newborns in developing countries against six destructive diseases⁵⁷ for which good vaccines are available - the cost - about \$3 per child. Already, more than \$25 million per year is being contributed.

More than 700 international staff from more than 50 countries served in the field during the smallpox program. More than 150,000 national staff were also engaged. It is they who are now providing a new impetus and a new sense of mission to an international commitment to better health for peoples throughout the world. It is they whom the Lasker Foundation honored when in 1976 a Special Award was given with these words:

"We salute this historic milestone as one of the most brilliant accomplishments in medical history. We hope that it will provide an example of how, with coordinated international effort many of the other health problems that afflict mankind can be successfully attacked."

The task has begun. Prevention is the key. To now serve as Dean of the world's largest school devoted specifically to this future - Johns Hopkins - is a privilege, an honor and a welcome responsibility.

In the 1920's Cleveland welcomed my Canadian family to this city where I was born. To acknowledge that my own roots rest in Lakewood, the City of Cleveland and Oberlin College, I do with pride. My greatest regret is that my father who died just 6 years ago could not be with us today to share with me in acknowledging our gratitude to all of you and to this great city.