

SUCCESS OF SMALLPOX ERADICATION PROGRAMME AND LESSONS LEARNED

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The 1967 WHO budget approved by the World Health Assembly in 1966 represented a substantial increase over the previous year. This was because of the inclusion of the necessary funds for implementing an intensified smallpox eradication programme — even though many experts and health administrators were at the time sceptical about the feasibility of the programme. In 1967 the intensified programme was started priority to making as its first improvement of the vaccine quality being used in the programme. At that time almost 90% of the vaccine in use was not up to WHO standards. In three years, 80% of the vaccine came to meet WHO standards.

In many countries where smallpox was endemic, the strategy was a mass campaign to immunize the whole population. Since animals do not harbor smallpox, transmission can be interrupted if an entire population is immunized in a relatively short period of time. It soon became apparent, however, that 100% vaccination was an impossible task in view of the topography, poor communications and scarce health service resources. Therefore, a concept of surveillance-containment measures was introduced, which was designed to discover cases by strengthening the surveillance and vaccinating only those people in the immediate vicinity of the case. This strategy was fully developed during the first half of 1970's, resulting in the rapid interruption of smallpox transmission in many countries in South America, the Asian subcontinent and Africa, south of Sahara. In October 1977, the last endemic case was discovered in the horn of Africa.

There were a few difficulties such as the reoccurrence of smallpox epidemics in war affected areas, the discovery of monkeypox in humans and the occurrence of laboratory associated cases. These problems were all solved, however. WHO's "Global Commission for the Certification of Smallpox Eradication" examined 79 countries (countries where the disease was once endemic or those adjacent to

them) and certified that smallpox had been eradicated throughout the world and would not return as an endemic disease. Based on this, in 1980 the World Health Assembly declared the success of the global smallpox eradication programme.

There are two important lessons to be learned from the programme. Firstly, that the international cooperation is useful and secondly, that the preventive medicine is less costly than the curative medicine. Such lessons are now being applied in the execution of WHO priority programmes such as expanded the programme on immunization, the poliomyelitis eradication programme and the special programme on AIDS. Many who had once worked for the smallpox eradication programme are now engaged in the above programmes.

The success of the smallpox eradication programme appears to be a unique achievement in the history of civilization in the sense that nations collaborated to eliminate a disastrous disease ignoring differences in race, religion and politics. It is a brilliant victory for preventive medicine in the 20th century. Recently WHO published a 1500-page monograph entitled "Smallpox and Its Eradication" which comprehensively documents on the eradication of the disease.

THE ERADICATION OF SMALLPOX

Donald A. Henderson

In 1966, the World Health Assembly voted to commit US \$2.4 million to intensify the Program of smallpox eradication. This program began in January 1967. Although hope was expressed that the goal could be achieved in 10 years, most delegates were, in fact, skeptical of the prospects for its success. Their doubts were understandable. Smallpox at that time was then endemic in more than 30 countries with a population of more than 1,000 million persons. Many of these countries were among the world's poorest and most densely populated. In all, there were between 10 and 15 million cases occurring each year. The obstacles were formidable and the resources available were few indeed.

We began the program with a two-fold strategy. First was to vaccinate 80% of the population in all endemic countries with smallpox vaccine of assured potency. The second was to establish a comprehensive reporting system which would detect cases of smallpox when they occurred and to investigate and to contain outbreaks by isolation of the patient and vaccination of his contacts.

The strategy was different from that which had been employed before 1967. Until 1967, progress in smallpox control had been measured in terms of millions of persons vaccinated. Little had been done to assure that the vaccine in use was potent or that the numbers of vaccinations being reported were accurate. Nothing had been done to improve the reporting of cases and, indeed, as studies later revealed, only one case in 100 was actually being reported at that time.

We estimated a need for more than 250 million doses of vaccine each year. If purchased, this would have exceeded the entire budget available to us. And so, we sought donations while, at the same time, we worked with laboratories in the developing countries to help them produce their own vaccine.

In 1968, we field tested a remarkable new invention developed by Wyeth Laboratories in

the U.S.A.—the bifurcated needle. The needle was dipped into the vaccine. By capillarity, vaccine was held between the tines and 15 rapid strokes implanted sufficient vaccine virus to assure successful vaccination. Only one-fourth as much vaccine was required as had been required with older techniques. Vaccinators could be trained in 10 to 15 minutes. The needles were inexpensive and could be sterilized and reused many times.

During vaccination campaigns, we organized teams which visited a sample of the areas which had been vaccinated to verify that at least 80% had been vaccinated and that the vaccinations were successful.

The most important component of strategy in the campaign, however, was the addition of surveillance for smallpox cases. "Surveillance" incorporated a number of different activities designed to improve the detection and reporting of smallpox cases. Our target was "0" cases of smallpox. To measure progress, we had to know how many cases were occurring. By continually determining which groups of individuals were developing smallpox, we were able to alter our strategy to assure vaccination of those who were most frequently afflicted and to stop outbreaks by isolating patients and vaccinating their contacts. Roving teams visited health centers and hospitals to ask that they report cases each week. When cases were reported, the teams promptly investigated then and contained the outbreaks.

Between 1967 and 1969, programs began in most infected countries and by 1971, all were in operation. Progress in most of Africa and the Americas was rapid. By 1970, the number of endemic countries had decreased from 33 to 17. By 1973, smallpox was confined to the Indian subcontinent, to Ethiopia whose program had just begun and to Botswana which became free of smallpox later that year.

The Indian subcontinent, however, proved to be a formidable challenge. Efforts such as we

had made in Africa had little impact. In the endemic Asian areas, nearly 700 million people lived in the most densely populated regions on earth. They traveled frequently and for long distances by trains and buses. Many smallpox patients, infected in cities, returned to their villages to recover or to die. The disease spread rapidly and widely.

During the summer of 1973, a special campaign was planned. All health workers, during one week each month, would visit every village in India—later every house—in search of cases. When cases were discovered, special teams moved in to contain the outbreaks. The logistics were formidable—120,000 workers were assigned to visit over 100 million households.

The first search took place in October. The results were appalling. However, with the search program, more outbreaks were found, and more rapidly. Once found, they could be contained. The quality of the searches steadily improved. More rigid control measures were used. As cases decreased, a reward was offered to the villager who reported each new case. Techniques employed in India were soon adapted for use in Pakistan, Nepal and Bangladesh.

By the summer of 1974, we knew that eradication in Asia could be achieved. And, on 16 October, the last Asian case occurred.

Only Ethiopia remained to be conquered. Ethiopia, however, was a challenge unto itself. It was a country of 25 million people scattered across desert and highland plateau in an area three times larger than Japan. It is a country where half the population lives more than a day's walk from any accessible road. Health staff were few. Gradually an intrepid team, including volunteers from Japan, the U.S.A. and Austria, eliminated the disease and in August 1976, the last outbreak was contained.

There was, however, one last chapter. Somali guerrillas, then fighting Ethiopian forces, brought the disease back to Somalia.

The first cases were reported in September 1976. For yet another year a smallpox campaign was waged throughout Somalia. But, at last, the final chains of transmission were severed. Ali Maalin, a cook from Merka, Somalia, proved to be the last case in a continuing chain of infection extending back at least 3,000 years. The 10-years time target had been missed, but only by 9 months and 26 days.

Two questions remained: (1) How could we be certain that eradication had been achieved; and (2) even if we were confident, how could national authorities also be sufficiently confident to permit them to stop vaccination?

Smallpox, to persist, had to continue to spread from person to person. Thus, evidence of persistent transmission would be increasingly apparent with time, either through detection of one of an increasing number of cases or through detection of facial scars. After the last cases occurred in a country, we publicized a reward to be given to anyone who reported a case which could be confirmed as smallpox. In addition, special teams conducted repeated house to house searches over vast areas. No cases were found.

To provide assurance to others that eradication had been achieved, international commissions were appointed to visit each previously infected country after at least two years had elapsed since the last case. The commissions reviewed detailed reports of the programs and verified these through visits in the field.

Finally, in 1978, the Director-General of WHO appointed a Global Commission to satisfy themselves personally that global eradication had been achieved. After two years' work, the Chairman was able to report to the World Health Assembly that there was adequate evidence. Vaccination has now been stopped and international vaccination certificates are no longer needed.

Variola virus is now confined to glass vials in just two laboratories.

The savings to be realized because of the cessation of vaccination and quarantine measures are estimated to be U.S. \$2,000 million dollars each year. In comparison, international assistance to the program amounted to an average of only U.S. \$8 million per year.

The program illustrates how inexpensive and effective prevention can be and how applicable it is for developing countries. Prevention based on immunization is especially applicable. Indeed, WHO has built on the smallpox program to begin a global program of Immunization to protect the 100 million newborns each year against six major infectious diseases.

A small but important step has been taken in a long and difficult journey toward better health but it taking that step, we have renewed confidence that other successes in prevention and public health are possible.