

Chapter 27. Smallpox

In 1796, the English physician Edward Jenner first showed that inoculating the arm of a healthy individual with infected material from a mild infection called cowpox (vaccinia), conferred immunity to smallpox. So started a sequence of events that eventually led to a huge international effort coordinated by WHO and ended in the certification of the global eradication of smallpox in Geneva on 9 December 1979. Nowadays, smallpox is a disease of historical interest only, but in the past, with a case fatality rate of up to 20%, it caused the decimation of populations and the collapse of empires.

THEN AND NOW

Smallpox was not a major problem in the Western Pacific Region when WHO was formed in 1948. In contrast to, for example, the countries of the Indian subcontinent, many countries in the Region reported relatively few cases (although cases from this period were greatly underreported and must be treated with caution). Figure 27.1 shows reported cases in 1948 and the year in which smallpox transmission was stopped in selected countries of the Western Pacific Region.

WHO ACTIVITIES

Smallpox eradication is often referred to as one of the greatest public health achievements and as one of the major successes not only of WHO, but of the United Nations system as a whole.¹ Millions of dollars are saved every year because smallpox vaccination is no longer required, and it is difficult to think of a more worthwhile public health achievement. Nevertheless, in its early days, the programme was fraught with obstacles, mostly from within the very system that now acclaims its success.

In 1953, the then Director-General of WHO, Dr Brock Chisholm proposed a global smallpox eradication programme to the World Health Assembly. It was rejected as being too complicated, although the overambitious and far more costly and complex malaria eradication programme was proposed as a matter of high priority.

The first attempt at a global push against smallpox was made in June 1958, when the Eleventh World Health Assembly adopted a resolution to eradicate smallpox.²

No target year was stated, which was probably due to the uncertainty of the outcome at that time. In that year 63 countries reported a total of 77 555 cases to WHO, though this is known to be a gross underestimate. The 1958 resolution called upon all smallpox-endemic countries to vaccinate their populations. Initially the Global Smallpox Eradication Programme gave the responsibility to the countries themselves to conduct national campaigns to vaccinate at least 80% of their total populations, while WHO was given the role of providing technical support and training. The effort seems to have been rather half-hearted and the smallpox programme accounted for only 0.6% of WHO's total expenditure between 1959 and 1966. One reason for this was that at that time smallpox eradication activities had to compete for resources with the malaria eradication programme.

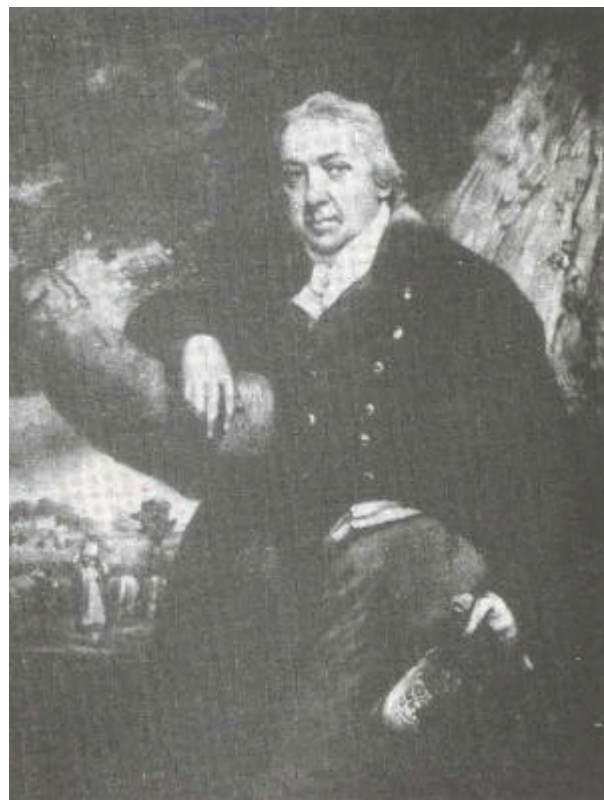
¹ Much of the information in this chapter comes from Fenner F., Henderson D.A., Arita I., Jezek Z., Ladnyi I.D.. *Smallpox and its eradication*. Geneva, WHO, 1988.

² Resolution WHA11.54.

In the Western Pacific Region, the country with the largest number of smallpox cases was China, which carried out an initial nationwide vaccination campaign using specially recruited vaccinators, followed by revaccination every six years by village doctors. In some provinces, such as Yunnan, additional campaigns were needed. Unlike recent poliomyelitis campaigns which have been targeted at children only (usually under five years of age), smallpox campaigns had to reach the whole population. For example, massive campaigns which reached over 90% of the population resulted in a decline in smallpox in Yunnan from 661 cases in 1958 to zero in 1962. Elsewhere in the Region, WHO supported smallpox eradication efforts in countries such as Cambodia and the Philippines. In these two countries, between 1960 and 1965, mobile teams conducting treponematoses surveys and resurveys in smallpox-endemic areas included smallpox vaccination in their activities.³

Of course, many of the countries afflicted with smallpox could not support the programme without external support and, not surprisingly, by 1963 there had been little progress. Out of the 44 endemic countries, 14 were conducting eradication programmes, 22 had programmes on paper only, and 8 had done nothing. Only about 5% of cases were being reported, there was very little external funding support, and there was considerable resistance to establishing a special smallpox budget, as the malaria eradication programme was having financial and technical difficulties. There were doubts too, about the likely success of smallpox eradication using the existing strategy of vaccinating 80% of the population, which was considered to be impossible in many areas. However, the Union of Soviet Socialist Republics continued to urge global eradication and provided smallpox vaccine (approximately 140 million doses a year) to a number of countries, including India.

Eventually, in 1965 global coordination was enhanced when WHO first established a separate smallpox eradication unit in Headquarters, with one



Edward Jenner (1749–1823) who developed the process of producing immunity to smallpox by inoculation with cowpox vaccine

medical officer and a secretary. In the same year, the United States of America began active technical and material support for the smallpox programme.

In 1966 the Nineteenth World Health Assembly decided to establish a special allocation for an intensified programme.⁴ At the end of 1966 there were only seven WHO staff assigned to smallpox eradication worldwide. Despite advocating intensified efforts against smallpox, senior WHO officials did not at first provide adequate funds. On the contrary, funds were cut and regional offices were instructed to use smallpox funds to develop basic health services as the highest priority. It was argued that strengthening basic health services was the highest priority and smallpox eradication would result from this approach. Despite these difficulties,

³ *The second ten years of the World Health Organization*, Geneva, WHO, 1968: 106.

⁴ Resolution WHA19.16.

Figure 27.1 Smallpox in the Western Pacific Region in 1948 and year transmission stopped

Country/area	Cases in 1948	Year smallpox transmission stopped
Cambodia	n.a. ^a	1959
China	50 575 ^b	1961
Japan	29	1951
Lao PDR	n.a. ^a	1953
Malaysia	521	1960
Philippines	282	1949
Republic of Korea	1197	1954
Viet Nam	n.a. ^a	1959

^a Data not available. The total of the three countries was 2569.

^b 1950.

in cooperation with the Centers for Disease Control and Prevention, Atlanta, United States of America, new staff were recruited and national plans were established. Steps were taken to increase surveillance, which had been inadequate. It is now estimated that there were 10 to 15 million cases in 44 countries at that time, although only 131 000 cases were reported in 1967.

In 1967 the Intensified Smallpox Eradication Programme began. Great efforts were required to obtain funding for global vaccine requirements and eventually over 40 countries contributed, with the Union of Soviet Socialist Republics and the United States of America as the principal partners.

At about this time the programme began to accelerate rapidly, helped by two innovations, the introduction of the bifurcated vaccination needle, and the search and containment strategy. The bifurcated needle was simple to use, cost only US\$ 5 (1970 price) per thousand needles and could be used after very little training. It could be sterilized by flaming or boiling and used for over 100 vaccinations. The search and containment strategy worked by sending teams to investigate reports, search for additional cases, and contain the outbreaks by isolating patients and vaccinating entire villages in a specified area

around the case. Initially there were problems with vaccine quality, and WHO support was needed to improve production methods and quality control. The freeze-dried vaccine that was used exclusively in the later stages of the Smallpox Eradication Programme had the enormous advantage of being heat-stable for at least one month in almost any climate. Thus vaccinators could carry both the vaccine and bifurcated needles in their shirt-pockets as they travelled in the field on surveillance and containment duties.

ACHIEVEMENTS

Any doubts about the potential success of the programme were dispelled when in the course of only three and a half years (1967–1970), 20 contiguous countries in West and Central Africa were rendered smallpox-free. Having convinced the doubters, the smallpox campaign was now able to grow into a massive international effort. In the ten-year period from 1967 to 1977, almost 700 advisers from 55 countries, and over 200 000 national health officers and volunteers had given their services to the campaign.

At this stage it should be emphasized that the Western Pacific Region was never a major participant in the programme because smallpox was eradicated from the Western Pacific Region before the intensification of the Smallpox Eradication Programme in 1967 (see above). However, the two last countries to be certified by the Global Commission as being free of endemic smallpox were both from the Region. Cambodia and China were both certified as being free from endemic smallpox on 9 December 1979, although in fact smallpox had not been endemic in either country since the 1950s. In China, as in other countries, some provinces experienced cases even after smallpox had been eradicated in the rest of the country. Yunnan province was the last focus of smallpox in China and the last case of smallpox in China occurred in 1961 in Monglian county, Yunnan province, on the border with Burma (now Myanmar). Cambodia was last endemic in 1959.⁵ In both cases

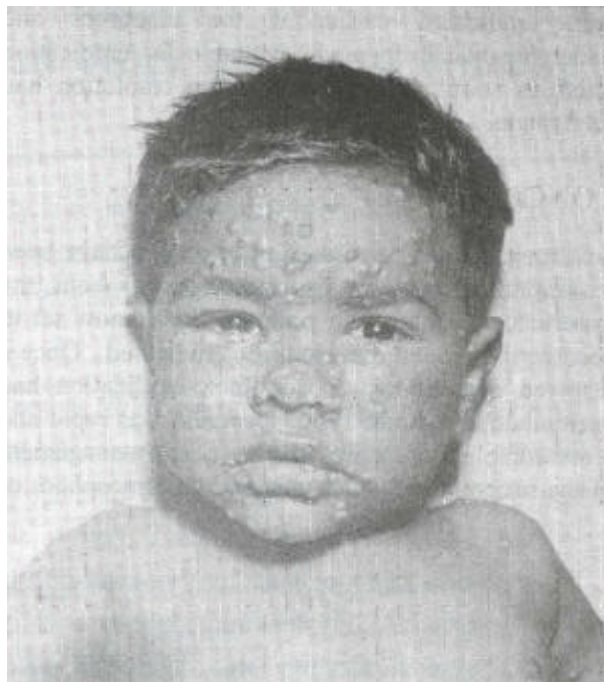
⁵ For more information on eradication in Cambodia and China, see Fenner *et al.* *Op cit*, Ref 1: 1197 and 1250.

late certification was for political reasons; in China's case because the People's Republic of China did not resume its membership of WHO until 1972 and in Cambodia's because of the history of conflict in that country.

Worldwide progress continued. While in 1967, 31 countries had been endemic, this had been reduced to 17 countries by 1970 and to 6 by 1973. In the 1970s, intensive efforts were made to eradicate smallpox in the Indian subcontinent. Thousands of cases were found, especially when the international teams stepped up their efforts in late 1973. However, by using the search and containment strategy and vaccinating everybody in affected villages and for a five-mile radius around them, the campaign achieved rapid results. The last case occurred in Pakistan in 1974, and in India, Nepal and Bangladesh in 1975.

By 1976 only Ethiopia remained infected, but civil war and logistical problems hampered efforts and cases were imported into Somalia which had previously been smallpox-free. The last endemic case of smallpox in the world was Ali Maow Maalin, a Somali cook, who developed the disease on 26 October 1977. No other cases have been detected despite intensive searches. However, an unfortunate accident resulted in two people becoming infected from laboratory specimens in Birmingham, United Kingdom, in 1978.

The certification of eradication began in 1973 with the establishment of international commissions. Recently-endemic countries became eligible for certification after two years without cases despite intensive searches for all rash with fever cases. The process of certification was carried out first by the preparation of country reports by the countries concerned, in collaboration with WHO staff. Once the documentation was judged to be sufficient, groups of independent international experts known as international commissions visited the countries to validate the information provided in the reports. Countries of the Western Pacific had not needed the support of the WHO smallpox eradication programme because they had eradicated the disease before the establishment of the global effort. Nevertheless it was necessary to obtain information from them that would lead to their certification. This information was received both from country visits by independent



From 1971, this photograph was used as a case recognition card by smallpox surveillance teams

experts and from country reports supported by data from the WHO Regional Office.

Stocks of the variola virus have been held at the Centers for Disease Control and Prevention, Atlanta, United States of America and the Russian State Centre for Research on Virology and Biotechnology, Koltsovo, Russian Federation. After noting that sequence information on the genome of variola virus strains and the cloned DNA fragments allowed scientific questions about the virus to be resolved and that the escape of the virus represented a serious risk, in 1996 the World Health Assembly recommended that all stocks should be destroyed by 30 June 1999.⁶

UNDERACHIEVEMENTS

It may seem inappropriate to discuss underachievements of a programme that has successfully eradicated a disease and has resulted in huge savings in both human and financial terms.

⁶ Resolution WHA49.10.

However, there is no doubt that smallpox could have been eradicated earlier if the resources and leadership had been made available for eradication activities soon after the eradication resolution had been made.

CONCLUSIONS

Smallpox is the first disease in history to have been eradicated and much has been learnt from the experience. As a result, poliomyelitis is now set to become the second disease to be eradicated. Once a renewed commitment to smallpox eradication had been made in the mid-1960s, progress was rapid and a remarkable feature was the excellent management of the programme, which fostered an atmosphere of

innovation and adaptation of strategies to local conditions, and allowed immediate feedback of evaluation findings into programme operations. Smallpox eradication was a targeted, time-limited programme with full-time technical staff (a 'vertical' programme). However, because it worked through national health services it also contributed to their development, particularly for providing other immunizations.

The history of smallpox eradication is both a triumph and a study in missed opportunities. The mistakes should be understood and avoided, while the best features have been put to use against poliomyelitis, and will later be used against other diseases.