# A victory for all mankind

## Brought about by hundreds of thousands of health workers from all over the world, eradication is a triumph of international cooperation and of preventive medicine

### by D. A. Henderson

For centuries, variola virus stalked the world with impunity causing unmeasured suffering, death and blindness. Today it is confined to glass vials kept under high security in six laboratories. To those who vividly recall the suffering of its victims, to health staff who so diligently conducted vaccination programmes, to quarantine inspectors who carefully examined vaccination certificates, it is difficult to believe that "sporadic" cases are not still occurring somewhere. However, convincing data, diligently assembled by tens of thousands of health staff, now demonstrate that smallpox is a disease which can be consigned to history—the first disease ever eradicated by man.

It was little more than two decades ago, in 1958, that the Soviet Union proposed to the Eleventh World Health Assembly that the countries of the world cooperate in a globally coordinated effort to eradicate smallpox. In that year, 63 countries reported 280,000 cases. This is itself a substantial number of cases but, because of incomplete reporting, it would need to be multiplied by 100 or more to describe the true magnitude of the problem. Data regarding deaths are likewise incomplete, but it is reasonable to assume that at least 20 per cent of those infected died and tens of thousands were permanently blinded. There was, and is, no treatment for smallpox; prevention through vaccination was the only way to cope with this disease.

After further study of the Soviet proposal, the Assembly in 1959 agreed that a global smallpox eradication programme should be undertaken as a matter of urgency. It was thought that, by "vaccinating or revaccinating 80 per cent of the population within a period of four to five years", smallpox could be eradicated from endemic areas.

During the following eight years, WHO encouraged governments to undertake programmes, solicited contributions of vaccine, encouraged and coordinated studies of vaccine strains, and assisted laboratories in starting vaccine production. Many countries started programmes and some succeeded in interrupting transmission. But not all did or could embark on eradication with their own limited resources. Contributions were far less than the funds required and many countries which interrupted transmission were reinfected by their neighbours. Of greater concern was the discovery that, even when vaccinations were administered to 80 per cent of a population, smallpox often persisted. Health authorities became discouraged and pessimistic. It was one thing to eliminate the disease from countries with a developed health infrastructure, but could this be done in the numerous countries, so recently independent, whose limited health services scarcely extended beyond their urban centres? And could these many countries coordinate their efforts sufficiently for smallpox to be eliminated from large geographical areas?

It was a concerned and less confident World Health Assembly which in 1966 decided that WHO should undertake an intensified eradication programme. Approximately US $2.5 million was included in the Organization's regular budget to provide for overall programme coordination and for assistance to those countries requiring it. This was a small sum indeed to provide support in some 50 countries with a population of more than one thousand million persons. But it represented almost five per cent of WHO's total budget that year. Hopes were expressed that more substantial vol-

*This was smallpox. The world will never again witness the suffering that was caused by the*

Smallpox is dead
Cover design
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*The end of smallpox in Asia meant that more resources could be made available in Ethiopia. The net was closing on the last places on earth where the disease lurked. (WHO) E. Shafa*

that all countries would give the programme a high priority. Some delegates optimistically proposed setting a 10 years goal for eradication, but most believed realistically that better control of smallpox was the best that could be expected.

The intensified programme began in January 1967. That year, 46 countries recorded 131,697 cases, a number representing perhaps one per cent of the true number of cases. Four endemic areas were present. A major reservoir was Africa where virtually all countries south of the Sahara were infected. A second important reservoir of smallpox was in Asia, extending from Bangladesh through India, Nepal, Pakistan and Afghanistan. The third was the Indonesian archipelago and the fourth was Brazil, itself comprising half a continent.

Of primary concern as the programme began was the need for sufficient vaccination devices and vaccine—the guns and bullets of the campaign. Large contributions were made initially by the Soviet Union and the USA; eventually 26 countries became contributors. A detailed manual on vaccine production was produced and vaccine batches were routinely tested to ensure that they met international standards. By 1971, all vaccine in use in the programme met accepted standards and by 1973, fully 80 per cent was being produced in the endemic countries, some of which supplied vaccine to others. In 1967, the jet injector was introduced in programmes throughout the countries of western and central Africa and Brazil. In 1968, field studies conducted by WHO showed that the newly developed bifurcated needle could be used to administer vaccine by a new technique—multiple puncture vaccination. The bifurcated needle soon became the standard method for vaccination.

A second concern from the start was the question of an appropriate strategy. Mass vaccination designed to reach 80 or even 100 per cent of a population had succeeded only in some smaller countries and those with more developed health services. For most of the still endemic countries, a different strategy was required. The decision to emphasize surveillance as an important component of the strategy proved to be the much-needed critical breakthrough. The new strategy called for a systematic two- to three-year vaccination campaign designed to reach 80 per cent of the population in each country. During this time, it was planned for a nationwide reporting system to be developed which would be sensitive enough to detect such smallpox foci as remained and to eliminate them.

Soon after the programme began, it was discovered first in Nigeria, then in Indonesia and Brazil, that effective reporting systems could be developed in months rather than years. By isolating the patients and vaccinating their contacts, outbreaks could be rapidly contained. Even in areas where vaccination coverage was poor, smallpox transmission could often be stopped quickly. So now increasing emphasis was placed on the surveillance-containment component of the strategy. Special surveillance teams were recruited and trained. They visited each health unit in an area to ensure that each week it submitted a report indicating the number of cases seen. When cases were reported, the teams worked with local health staff to contain the outbreaks, and they visited schools and public places to inquire about rumours of smallpox. A special "WHO Recognition Card" showing a picture of a smallpox patient was printed and distributed to help them in their search.

The first campaigns started in 1967 and, by 1969, all countries except Ethiopia had started eradication programmes. Ethiopia's programme began in 1971. In 20 countries of western and central Africa, a USA-assisted programme of smallpox eradication and measles control succeeded in eliminating smallpox in just three and a half years. Brazil's last case was detected in 1971 and Indonesia's in 1972. By the summer of 1973, smallpox transmission had been interrupted throughout the whole of Africa, except in Ethiopia. That country plus five countries in Asia remained as the only smallpox infected countries.

However, India, Pakistan and Bangladesh, with a population of more than 700 million persons, presented a special problem. Surveillance-containment measures such as had been successful in Africa and South America proved far less effective in these densely populated areas where people travel frequently and far. A different approach was required. During the summer of 1973, Indian health authorities with WHO staff planned a different surveillance strategy. All health personnel were asked to undertake an intensive search of each village, and later each house, to detect smallpox cases. This would need to be done rapidly to be successful and so the search was planned to be completed during a seven- to ten-

lay period. In heavily infected areas this vas done each month and, in less infect-d areas, every second or third month. During the first search in October 1973, housands of unreported cases were letected. But once discovered, the out-breaks could be contained.

Through careful planning, training nd assessment, the searches became in-reasingly thorough. Between searches, surveillance teams visited schools and markets seeking to learn about cases of mallpox. Containment measures were trengthened. As the numbers began to decrease, a reward for the detection of a ase was offered to the first person eporting it and to the health worker in-vestigating it. Similar approaches were oon employed in Bangladesh, Pakistan nd Nepal. On 16 October 1975, only wo years after the start of this new trategy, the last case of smallpox oc-curred in Asia—on Bhola Island in Ban-gladesh. This marked the end of variola major, the severe form of the disease. As 1975 drew to a close, only Ethiopia emained with smallpox. There, variola minor was prevalent, a form of smallpox which killed only one per cent of its vic-ims in contrast to variola major which killed 20 per cent or more.

Ethiopia's programme, besides being he last to begin, faced incredibly diffi-ult problems. Although the country is arger than France and Spain together, he available staff numbered little more han 100 persons. There was almost no ealth infrastructure. Roads were few nd it was estimated that half the popu-ation lived more than a day's walk from ny accessible road. Civil war and amine compounded the problems. owever, with the interruption of small-ox transmission in Asia, more resources ould be made available to Ethiopia. Vil-ge residents were recruited and trained serve as surveillance workers and vac-nators; more transport was provided; elicopters were laid on to facilitate pervision. Less than one year later, on August 1976, the last case occurred ere.

Unfortunately, coincident with the last tbreak in Ethiopia, smallpox was in-oduced into neighbouring Somalia. fore fully effective surveillance sys-ns could be established, nomads dis-minated the disease throughout the uthern part of the country. In ly 1977, a national emergency was clared, additional staff were recruited l special assistance was provided by

ment and vaccination programme continued throughout the summer months. More than 3,000 cases occurred, the last of them on 26 October 1977.

Nevertheless, surveillance teams and search workers continued for two years and more in their efforts to discover cases. In many countries, a reward was offered and tens of thousands of cases chickenpox, measles and other rash di eases were reported by villagers in hop of collecting a reward. Thousands of sp cimens were taken and sent to WH Diagnostic Centres in Moscow and A lanta, USA. None proved to be smal pox. For the disease to persist in a popu lation, it must be passed from one perso to another in a continuing chain of infec tion. Since there is no animal reservoi and no asymptomatic carrier (perso having the disease but showing no symp toms), each person who is a link in thi chain must experience the characteristi illness. During the programme, it wa found that smallpox never persisted fo more than eight months in a country without being detected by the surveil-lance network. Continuing search during a two-year period, that is, three times this eight-month period, provided addi-tional assurance that the spread of small-pox had stopped.

To confirm that transmission had been interrupted, specially constituted WHO International Commissions visited each country. In 1978, the Director-General of WHO appointed a Global Commission to review the experience in all countries. The Commission completed its work on 9 December 1979, at which time it agreed that there was sufficient documentation to certify worldwide eradication.

The eradication of smallpox means that vaccination everywhere can be stopped and that travellers will no longer need vaccination certificates. The savings throughout the world are estimated to be $1,000 million anually. The cost of this achievement was only $112 million in international assistance, or $9 million spent annually during the 13-year period 1967-1979. This includes all funds spent by WHO plus bilateral and multilateral contributions from 42 countries. It is estimated that globally the endemic countries spent perhaps twice this amount but, in fact, few spent much more than they had hitherto been spending on never-ending smallpox control programmes.

Now the chapter entitled "smallpox" is closed—let us hope for ever. The achievement of eradication is a victory for hundreds of thousands of health workers in many different countries. WHO staff alone were drawn from 73 different countries. It is a triumph of international cooperation and of preventive medicine. With coordination, cooperation, dedication and imagination it is clear that much

## A windfall for development

**Already the international community is starting to collect part of the health legacy—and it is likely to be huge—that smallpox eradication will bequeath. Calculations indicate that in the post-smallpox era a sum of nearly US $1,000 million annually will be released, or some $10,000 million over a decade.**

The cost to the world of a disease like smallpox included production or purchase of vaccine, maintenance of vaccination programmes, the treatment of vaccination complications, spending to maintain national surveillance and frontier controls, and the cost involved in handling the emergencies caused by sudden outbreaks. Thus in the United Kingdom, an outbreak sparked by an imported case in 1961 involved a bill for an estimated $3.6 million. United States experts calculate that smallpox protection was costing the American taxpayer about $150 million a year—or about half the total cost of the global eradication programme which was just over $300 million.

The release of money that has hitherto been tied up for smallpox could have massive impact—provided it is diverted to development programmes. In one recent year, 1975, total funds available for the health sector (including water supplies) as bilaterial aid from the Organization for Economic Cooperation and Development (OECD) and from the European Economic Community (EEC), or as multilateral aid via the UN specialized agencies, amounted to $1,500 million. The new resources could therefore make a massive addition to the funds available.

In the view of WHO, these funds would have their greatest strategic impact in the area of primary health care. They could be applied to a combination of health development activities, including clean water and sanitation, immunization programmes, action to promote correct and adequate nutrition, particularly for infants and young children, maternal and child care, and programmes for the supply of oral rehydration kits to combat diarrhoeal diseases and to ensure the availability of essential drugs to all who need them.