

Forum Interview

with Donald A. Henderson

Smallpox eradication: a WHO success story

The eradication of smallpox marked the end of the pain and suffering of its victims who, as recently as 1967, were estimated to have numbered 10–15 million each year and among whom possibly 1.5–2 million died. It marked the end of the blindness, severe disfigurement and other disabling conditions among those who survived. It meant that all countries could utilize resources previously devoted to smallpox control for other health purposes, that they could stop vaccination programmes and that travellers would no longer need to present certificates attesting that they had been successfully vaccinated. On 26 October 1987 it will be 10 years since the last natural outbreak of smallpox on spaceship earth (1). **World Health Forum** presents an interview with Dr D. A. Henderson, who was head of WHO's smallpox eradication programme from 1966 to 1977.

The Twelfth World Health Assembly in 1959 took the important policy decision to undertake the global eradication of smallpox. Why was smallpox selected when there were other candidates for eradication such as tuberculosis, poliomyelitis and others?

Smallpox was of the greatest concern to all countries because it could spread from person to person in all climates and at all times of the year. There was no natural protection against infection and no effective treatment. Of those who contracted variola major, the prevalent form of smallpox throughout Asia and most of Africa, 20 %

died. Because of this, all countries devoted substantial resources to vaccination of their own populations to prevent possible spread of the disease and required travellers to carry smallpox vaccination certificates. There is no question but that smallpox was the most universally feared of all the infectious diseases.

When the smallpox eradication programme began, the prospects for its success were more favourable than for any other disease eradication programme that might be envisaged even today. Smallpox had a number of features that greatly facilitated

eradication. It had no known animal reservoir; there were no long-term carriers of the virus; and the patient, after recovery from the disease, had essentially life-long immunity. The detection of cases was comparatively simple because the rash was so characteristic and occurred on visible parts of the body. Persons with subclinical infections did not transmit the disease. Finally, a highly effective, easily administered and surprisingly heat-stable vaccine, conferring long-term protection, was available at the start of the intensified programme. Taken together, these characteristics were unique in relation to human infections. Last but not least, the practicability of interrupting the smallpox transmission had already been demonstrated both in the industrialized countries and in many developing ones.

So it was a foregone conclusion that the eradication programme would be successful?

Not at all. Many doubted the technical feasibility of eradicating this or any other disease. Most who believed that it was at least theoretically possible doubted that successful programmes could be conducted

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everywhere given the problems of war, famine, poor transportation and deficient health services in so many infected countries. Certainly, the problems were there and success was by no means a certainty even during the concluding years

Donald A. Henderson

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or even the final months of the programme. Indeed, the gap between success and failure in a number of national programmes was a narrow one, and the issue was often favourably decided by fortuitous political and social developments and with only marginally adequate resources.

The smallpox vaccine discovered by Edward Jenner some 175 years ago was already widely used throughout the world. Following the Second World War, well before the Twelfth World Health Assembly, national governments and colonial administrations conducted smallpox control programmes, some of which were very effective. Why was an international programme necessary?

It is true that smallpox had been controlled in many countries, but disease eradication requires a greater, more concerted and coordinated international effort than does

disease control. National authorities took a great interest in smallpox control when epidemics occurred but as the number of cases diminished, so did their interest. Those who made the additional effort to eliminate the disease continued to experience outbreaks resulting from importations from their neighbours. A concerted and sustained initiative by all countries was required. For this, an international commitment and organization was essential. One or more bilateral assistance agencies might have conducted a programme which succeeded in eliminating smallpox from many countries but it is unlikely that worldwide eradication could have been achieved. Moreover, a scheme to certify that eradication had been accomplished would have carried little conviction without the credit and authority of an international agency that drew on public health authorities and respected scientists from all over the world.

Are you implying that without the World Health Organization smallpox could not have been eradicated?

For a worldwide programme to be successfully undertaken, all countries must agree to it and there must be a mechanism for coordinating field activities and monitoring the work. The World Health Assembly provides the necessary—indeed, the only—forum in which global health policies can be agreed upon; and the World Health Organization alone has the requisite channels of communication with the national authorities through which their several programmes can be coordinated. The World Health Organization, with its access to international scientific expertise, was essential to the success of smallpox eradication. Of crucial importance also was the network of WHO staff, although small in number compared with the tens of thousands of national staff, which facilitated

the rapid communication of new information throughout the world and assisted in adapting and applying it to national programmes.

The world community was at first slow in following up its declared intention to eradicate smallpox in terms of financial support both to WHO and to national programmes. How do you explain that discrepancy between declared intent and provision of cash and action?

Countries had been unaccustomed to making voluntary contributions to WHO in support of special programmes except in the instance of malaria eradication campaigns. By 1967, it was clear that the programme was experiencing insurmountable problems and donor support for it was diminishing. There was little enthusiasm at the time for contributing to yet another eradication effort. Fortunately, however, both the USA and the USSR shared a commitment to the programme and their contributions proved to be critical, especially during the early years. At national levels, it is also true that support for global smallpox eradication did not quickly take the form of effective action, often owing to inertia though sometimes for lack of resources. WHO could not compel a Member State to meet the responsibilities to which it had pledged itself, but by the exercise of moral suasion it was eventually able to overcome the reluctance of some national authorities. This required WHO staff to play an active role in advocating that eradication programmes should be started and sometimes meant a direct approach to heads of state or other senior national figures when officials at lower levels failed to respond. This encouragement of national programmes and the subsequent support of their work would not have been possible without a sufficient number of WHO staff who were technically competent and highly motivated.

What might have been the underlying reasons for the lack of support in the first few years?

Well, as we all know, governments tend to be more immediately and generously responsible in providing for the immediate needs of those who are ill. As a practical reality, patients express gratitude for the services they receive and political support for those who provide them; preventive services are less appealing politically, as the results are reflected in fewer or perhaps no patients. Quite simply, those who do not become ill because effective preventive measures have been carried out seldom express the same appreciation as do those whose illness has been cured. Moreover, measures for disease prevention usually require a long period of sustained support and attention before benefits become apparent.

The smallpox eradication programme has been criticized for being a "vertical" programme, going its own way without links to existing health care systems and with a line of command from WHO headquarters all the way down to the villages. Do you agree with this criticism?

Smallpox eradication was indeed conducted as a time-limited special programme with specific targets and with funds allotted specifically for it both in the WHO budget and in most national budgets, and with full-time technical staff assigned responsibility for its supervision. In this respect it may be regarded as the type of categorical programme about which some countries, particularly developing ones, have doubts. Yet it made important contributions to the overall development of health services because, far from being separately or autonomously administered, it worked with and through the existing national health service structures and had to coordinate its activities with those of other programmes.

The basic health services network, for instance, constituted the foundation of the disease-reporting structure, and in all countries this had to be greatly improved by training and supervision in order to become effective and to provide the quick and accurate information on which the containment of smallpox outbreaks depended. The programme had targets and it provided supervision. Some may criticize it for being a so-called vertical programme but I believe it is a characteristic of successful programmes to have goals and necessary specialized management to attain those goals. Until other health programmes perform in a similar manner, I am afraid little progress will be made. Happily, however, some are beginning to do so.

In your opinion, then, the smallpox eradication campaign resulted in improved national health care systems?

Yes, indeed. Traditional health care systems have been limited to serving only a small proportion of the population, usually the better-educated and those in urban areas who take the initiative to seek services. Comparatively few people have benefited from what preventive services offer. Few in the health care system have had the training that would enable them to design or implement programmes for the delivery of services to the whole of the population. National authorities have long recognized the deficiencies of their traditional curative care systems in providing special teams for smallpox vaccination as well as special teams and programmes to deal with malaria, tuberculosis and yaws, vector control, family planning and so on.

Immunization programmes were strengthened in many countries as smallpox vaccination teams undertook to provide other vaccines, such as BCG, measles,

yellow fever and DPT, and assisted with the transport of personnel and supplies for other programmes. Participation of the existing health staff in vaccination and in case-detection and containment activities was required everywhere because of the small numbers engaged full-time in smallpox eradication. In consequence, many thousands of health staff received training in the execution of vaccination programmes and in field epidemiology. In many cases, the only field supervision they received was provided in the course of their smallpox eradication work. A substantial number who now occupy senior positions in national and international organizations are successfully applying methods used for smallpox eradication in programmes to control other communicable diseases.

Could you elaborate on the reasons why a special programme was necessary if smallpox was to be eradicated?

Experience in national smallpox eradication programmes confirmed that the existing health care structures were inadequate to deal with community-wide programmes of disease control. Health centres, for example, were customarily directed by physicians or others whose training and preoccupation were with curative medicine, whose management skills were limited, who rarely left the health centres and whose work was seldom supervised. Few centres gave vaccinations of any type and, when they did, often used vaccine that had not been properly stored or handled. The smallpox patients who were seen were only occasionally reported and then usually with great delay; outbreaks were rarely contained. The hospitals performed even more poorly, the inadequacy or lack of isolation procedures actually serving in many instances to augment the transmission of smallpox; even the hospital personnel

themselves were often unimmunized. Only when the personnel of health centres and hospitals were trained and regularly supervised by senior smallpox eradication

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programme advisers did their performance improve significantly.

It became apparent that in all endemic countries there was a need for a specially dedicated and trained professional staff at all levels to decide and coordinate the strategy and tactics of the smallpox eradication programme and to modify its methodology according to local needs, to develop reporting and surveillance systems, to undertake case-detection and containment measures, and to train local health staff in vaccination procedures and the proper preservation of vaccine. There was a need to seek the support of village leaders and, through them, to obtain the acceptance and participation of the population. Such activities were alien to most traditional health care units.

Once the programme was under way it received increasing support both nationally and internationally. What were the attractions of such a programme to the decision-makers?

Special-purpose programmes such as smallpox eradication are particularly

important in public health because it is always more difficult to obtain a political commitment to and financial support for public health programmes than for those involving curative medical services. There are several reasons for this.

- Political leaders are more readily persuaded to provide funds for curative services which, with their hospitals and health centres, are more tangible than a community-based programme.
- The physicians who are most likely to be consulted regarding needs and priorities in health care are clinicians who are more numerous and usually more influential than public health physicians. Lacking a public health perspective, they tend to favour the development of clinical facilities which they will use.
- People who have the greatest need for community-based health services are usually the most disadvantaged and are therefore the least influential politically.

Thus, special-purpose public health programmes that attract attention can

The smallpox eradication programme made important contributions to the development of health services in general because it worked with and through the existing national health service structures.

redress the traditional biases in allocation of health resources. Special programmes that involve the large-scale delivery of services also permit economies to be realized and can facilitate better management of supplies and

equipment than is possible when services are provided only in established health centres or practitioners' offices.

So with the existence of adequate supplies of potent freeze-dried vaccine, the introduction of the bifurcated needle, and an army of smallpox workers, all that was needed was appropriate management of the whole system?

It is true that, at first, many senior WHO and national staff believed that management skills only were required. The needs, as they perceived them, were simple and straightforward: to procure sufficient vaccine and to organize vaccination programmes. They believed that generalist managers, rather than epidemiologists or other specialists, were sufficient for this task. It was apparent to us, however, that the challenge was far greater than the straightforward application of vaccine. It was necessary to adapt vaccination programmes to different administrative, sociocultural and geographical situations and to devise mechanisms to monitor and assess the work, in terms not only of the numbers of vaccinations performed but also of their effect on the incidence of smallpox. A better understanding of smallpox epidemiology was required in order to refine the strategies and tactics. Better methods for vaccine production were needed, as were improved instruments for vaccination. It was also important to determine with certainty that there was no natural reservoir of smallpox and to demonstrate that the clinically similar and virologically related disease, human monkeypox, was not a serious threat to the programme. Ongoing problem-oriented research was as important as management.

Management itself was a challenge, since multinational health programmes are inevitably difficult to manage because of their complexity. The smallpox eradication

programme could not operate as a monolithic structure, as each independent national programme had its own administrative traditions and sociocultural patterns and utilized resources from many different sources. It was a programme in which WHO, the coordinating organization, provided only a small proportion of the resources and had no weight other than that of persuasion.

Could you tell us about some other problems that the programme faced?

One major difficulty lay in obtaining appropriate and timely information. The national notification of smallpox cases was often the responsibility of a statistical unit, which mechanically consigned such data to statistical reports, showed little concern with the completeness of notifications, and was not responsible for initiating action based on the information. Such systems seldom improved until the smallpox eradication office assumed responsibility for the notifications of smallpox cases. Then the data were used for immediate action in the field, monitoring the programme and allocating resources according to needs.

The fact that the concept of surveillance, although simple in principle, proved so difficult to apply, reflected the lack of experience with measurement throughout the health field and, indeed, the lack of programme goals that would encourage such measurement.

Did you have problems with the quality control of the smallpox vaccine?

Yes, in many countries. Few countries with production laboratories had separate national control laboratories. Thus, the production laboratories themselves were the ultimate arbiters of quality. Those who were least

competent in production were likewise least able to monitor vaccine quality. Although it was WHO policy to have a WHO collaborating centre regularly test vaccine

Measures for disease prevention usually require a long period of sustained support and attention before benefits become apparent.

batches, the laboratory directors in the endemic countries often opposed this and sometimes refused to submit samples. The national smallpox eradication programme officers had no authority to enforce the policy and so it was frequently necessary for senior WHO staff to intervene with higher-level government officials.

The evident disinterest in quality control of vaccines that characterized smallpox programmes before 1967 is difficult to understand but, in fact, it typifies large segments of even current health practice. In many countries biological and pharmaceutical products are accepted and used with little assurance of their potency or purity and with little confidence that they had been properly refrigerated.

The programme seems to have been able to find solutions to most of the problems it faced!

One problem that was never fully solved, however, was that of transport. Most health ministries were short of roadworthy transport and usually unable to provide emergency requirements. For vehicles of foreign manufacture there was usually a delay of 12–18 months between the

submission of a purchase order and their delivery but it was often impossible to gauge needs more than 3–6 months in advance. The difficulty was resolved in some countries by purchasing locally manufactured or assembled vehicles and in others by the

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local purchase of already imported vehicles, although this was usually more costly; in some instances, special workshops were established to repair and maintain the often large fleet of unroadworthy vehicles. Better results would have been obtained if it had been possible to procure a reserve fleet of new vehicles which could be dispatched quickly when needed, and if more efforts and resources had been directed to the development or improvement of national vehicle maintenance and repair facilities.

Was there any participation by the community in the programme's activities?

It became evident early in the programme that the villagers and their leaders, if properly approached, were usually willing—indeed, keen—to cooperate in organizing vaccinations, in detecting cases and in containing outbreaks. Smallpox was a disease with which the ordinary villager was familiar and that he could easily recognize. From 1973, when programmes in the remaining endemic countries were intensified, many local people were recruited and trained for part-time work in these activities. The quality of their performance,

as that of other field staff, was directly proportional to the clarity of the direction provided and the quality of the supervision they received.

In brief, it was clear that comparatively few, strongly motivated and knowledgeable professionals could organize and effectively mobilize large numbers of persons and that in most countries they could count on the eager support of the health staff and the general population alike. The limiting factor was the inadequate number of motivated and knowledgeable leaders, largely because too few were recruited, trained and assigned to responsible positions.

So the activities were not as centrally directed as one might think?

Certainly not. Programmes were expected to be designed locally by the national staff and their WHO counterparts working in collaboration and to evolve in the light of experience. Consequently, programmes differed greatly from country to country and from time to time.

What role did WHO country staff play in the programme?

This varied from country to country. The most effective staff were those who served as working counterparts and took an active role in field operations. Those who assumed the more traditional role of passive technical advisers, rarely travelling outside the capital city, were encouraged to leave the programme. As working counterparts, WHO staff with experience in other smallpox eradication programmes transmitted confidence in the feasibility of eradication and were better able to introduce new methods; they frequently served to provide continuity and sustain momentum in programmes when the national leadership

changed; and it was sometimes easier for them than for their national colleagues to approach the more senior health officials in the country to seek additional support or changes in policy.

What role did research play in the programme?

It was essential! The fact that most research was undertaken in the context of field work in order to answer practical questions or to resolve apparent paradoxes provided an unusual impetus to the research effort. The close interlacing of research with programme execution permitted the prompt practical application of many of the findings.

The lesson for other disease control programmes seems evident. However, even today, despite countless discussions about the important part that research played in the eradication of smallpox, other problems of importance to the developing countries receive little research support. Research in applied technology and the social sciences is notably neglected and the potential offered by modern molecular biology has barely begun to be realized. For health programmes in the developing countries, research is neither an academic luxury nor merely an interesting intellectual exercise, as has sometimes been suggested. It is a necessity for the successful prosecution of disease control and was inherent in the achievement of the goal of smallpox eradication.

Does the experience gained in eradicating smallpox set the stage for the eradication of other diseases through immunization?

Unfortunately not. The smallpox eradication programme cannot serve as a model for other disease control or eradication campaigns. Every disease has its own epidemiological characteristics and requires

specific strategies for its control. Also, the approaches taken to the eradication of smallpox differed considerably from country to country and were continually modified to capitalize on an evolving understanding of smallpox epidemiology and to deal with different local conditions. During recent years, four diseases have been seriously advanced as candidates for global eradication within the foreseeable future: poliomyelitis, measles, dracunculiasis, and yaws. In 1985, the Pan American Health Organization approved a regional poliomyelitis eradication programme, the objective of which is the interruption of poliovirus transmission in the western hemisphere by 1990; in 1986, a programme for the global elimination of dracunculiasis was approved by the World Health Assembly although no time limit was established for its accomplishment.

In my opinion, however, the present prospects for the global eradication of most human diseases are not good. Epidemiological characteristics preclude many from consideration, while the nature and cost of the available technologies rule out others. However, with a growing international interest in prevention programmes and the emergence of new and better vaccines and other technological developments, there is hope that other global eradication programmes may eventually be successfully mounted.

Of the four diseases you mention, which would be the first one that might be eradicated from a continent—or globally?

The feasibility of eradicating poliomyelitis appears greater than that of the others, as poliomyelitis is more universally accepted as being of sufficient importance to warrant an eradication programme. Man is the only host of the virus and good protection is usually provided by both the inactivated

vaccine and the attenuated live vaccine. Many industrialized countries and some developing ones have, in fact, already been successful in interrupting poliovirus transmission, mostly through use of the oral, attenuated vaccine; some industrialized countries have also been successful using the inactivated vaccine.

The decision by the Pan American Health Organization to begin a regional poliomyelitis eradication campaign was preceded by national vaccination campaigns in the Americas in which the inexpensive and easily administered oral vaccine was used. In the early 1970s continuing circulation of poliovirus ceased in North America, and by 1985, the number of reported cases in the western hemisphere had diminished to fewer than 500 a year. A surveillance system for paralytic poliomyelitis is being developed in the Americas which involves laboratory confirmation of suspected cases and community-wide containment vaccination. The efficacy of this approach and its sensitivity in detecting circulating virus remain to be determined. The experience acquired in the Western hemisphere will determine the feasibility of eradication in other areas.

It has been estimated that the world is saving some US\$ 1000 million annually since routine smallpox vaccination and surveillance is no longer necessary. Do we have data to show the real cost-benefit of smallpox eradication?

Unfortunately, the data are not so complete as we would like. Even so, they show that the cost of smallpox to the developing countries alone in 1967 was substantial indeed, being not less than US\$1000 million. For all countries, the economic benefits of the programme were

enormous as it became possible to stop all preventive measures and to close treatment facilities. The USA, one of the largest donors, is estimated to realize in savings every 26 days the total of all its contributions to the programme.

It is certain that the total annual allocation of US\$ 2.4 million for the global programme was not large in relation to the overall need, and minuscule compared with the amounts that were being expended for the prevention of smallpox in the industrialized countries.

As a past staff member of WHO and presently the Dean of a prestigious school of public health, how do you see the role of WHO in the world of the future?

WHO, whose role in smallpox eradication was so vital, offers a unique—although as yet not fully realized—potential for promoting the new and growing efforts to achieve greatly improved health for all by the year 2000. It is an organization that has demonstrated its ability to catalyse achievements far out of proportion to the financial resources it commands. The extent to which it is successful will depend on the confidence which its Member States place in it, on its effectiveness in enunciating clear and measurable objectives and in mobilizing support for their realization, on the number and competence of its professional staff, and on its ability to set aside extraneous political questions. WHO's ability to respond appropriately to challenges, old and new, will be decisive in its task of helping all the people of the world to the attainment of the highest possible level of health. □

Reference

1. Fenner, F., Henderson, D. A., Arita, I., Jezek, Z., & Ladnyi, I. D. *Smallpox and its eradication*. Geneva, World Health Organization, 1988.