How smallpox showed the way

by Donald A. Henderson

Ten years have passed since a WHO Commission declared that for the first time in history, a disease – smallpox – had been eradicated from the globe. Smallpox hospitals are no longer needed and its vaccination *everywhere* has stopped. The *annual* savings are at least US $1,000 million, more than three times the cost of the entire programme. Given these extraordinary benefits, it was logical for scientists to ask whether other diseases might be candidates for eradication. After lengthy discussions, they decided that poliomyelitis was the best prospect. Accordingly, the World Health Assembly in 1988 agreed on a global polio eradication campaign to be completed by the year 2000.

The two diseases, poliomyelitis and smallpox, differ in many ways, as do the vaccines for preventing them and strategies for their eradication. Knowing what we do about the problems in eradicating smallpox, what can we say about the prospects for getting rid of polio? In some respects, polio eradication should be easier, but there are far more difficult technical problems, especially in the detection and diagnosis of cases and in the quality of vaccine available. Research is urgently required to address these aspects.

On the positive side, the infrastructure of transport, communications and health services has improved greatly over the past two decades in virtually all countries. There are far larger numbers of trained health staff; radio, telephone and even television are found in areas where none existed 20 years ago; and air and road transport leave few populated areas on the globe which are truly inaccessible. Admittedly, there are larger populations and a greater movement of people who may spread disease, but these are not major problems.

Most encouraging is the already demonstrated political commitment on the part of governments throughout the world, as well as international assistance agencies, to assign a high priority and resources to the effort. I sense a greater commitment than there was to smallpox eradication when it began. This may appear puzzling because smallpox, notably in Asia and Africa, caused many times more cases and deaths than does poliomyelitis. However, smallpox patients who survived returned to normal health. Most poliomyelitis victims, in contrast, are sentenced to lifelong paralysis and dependency. In the poorer countries, most survive as beggars. Poliomyelitis is thus a more constantly visible disease and, not surprisingly, is greatly feared.

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The first national efforts to defeat poliomyelitis began in the United States during the 1930s. They were encouraged by President Franklin D. Roosevelt, who had been crippled by polio as a young man and thereafter was confined to a wheelchair. With his support, the National Foundation for Infantile Paralysis (as polio was then called) raised large sums of money for prevention research and treatment. Meanwhile, the number of cases each year rose steadily until, during the early 1950s, 30,000 to 50,000 cases were being reported annually in the USA alone. During the summer polio season, theatres, swimming pools and other facilities were frequently closed to prevent children from gathering and spreading infection. The discovery and introduction of an inactivated (Salk) vaccine in 1955 and, soon afterwards, of a live oral (Sabin) vaccine were landmark events. In little more than a decade, polio cases in the industrialised countries dropped from more than 75,000 per year to fewer than 1,000.

Until the 1970s, many scientists believed that paralysis due to poliomyelitis was primarily a problem of the industrialised countries. They believed that children in the developing countries were infected early in life and did not experience paralysis. When rehabilitation centres developed, however, it soon was apparent that polio victims accounted for most of their patients. Special surveys to detect lameness in children quickly revealed that it was an important problem in all developing countries. Thus, when the Expanded

WHO/US National Foundation for Infantile Paralysis

Franklin D. Roosevelt, 32nd President of the United States, had polio as a young man and remained paralysed for the rest of his life. He lent powerful support to the fight against polio in his country.

Programme on Immunization began in 1974, polio vaccine was one of the vaccines to be included.

The effects of polio itself have served to foster a political commitment to the programme so that, today, international and national authorities alike know that global polio eradication can be accomplished. They have confidence that national health services can be effectively mobilised, even in the least developed parts of the world. They have also seen that adding resources for the polio campaign strengthens other community-based programmes, such as those for immunization, family planning, diarrhoeal disease and vitamin A deficiency. Today, many agencies which did not contribute to smallpox eradication are providing important support for the polio campaign. These include UNICEF, the Inter American Development Bank and many bilateral agencies. Rotary International Foundation, in addition to providing volunteer support, has pledged to raise US$125 million, an unprecedented type of collaboration by private citizens. In fact, Rotary has already raised more than twice this sum!

The better infrastructure and more favourable response to polio eradication is counterbalanced by two important problems which make the task of eradication more difficult than was the case with smallpox. The first pertains to difficulties in detecting the presence of polio virus in an area and in containing its spread – the important surveillance-containment strategy of the smallpox programme. The second problem is that polio vaccine is less efficacious and less heat-stable than was smallpox vaccine, thus making it more difficult and costly to conduct the large-scale vaccination programmes that are called for.

Information is essential

It is critical in an eradication campaign to know where cases are occurring and how the virus is spreading, in order to allocate resources optimally and to make necessary changes in strategy. The characteristic smallpox rash was seldom confused with any other disease, so that laboratory studies to confirm the diagnoses were unnecessary until the campaign was drawing to an end. Each smallpox patient found could be isolated and all contacts vaccinated, thus erecting a barrier against further spread even when as few as half of the population was vaccinated. These were the elements of the important surveillance-containment strategy.

We cannot detect and contain the spread of polio virus as readily as we did smallpox. Of those infected with poliovirus, fewer than 1 in 100 children develop paralysis. The others have no symptoms. So a patient paralysed with poliomyelitis represents only the tip of the iceberg of infection in the community. If one case is discovered, it must be assumed that there are many other infected children. Laboratory studies would be time-consuming and impracticable as they would require examining hundreds, if not thousands, of contacts. So the simple technique of contact-tracing of cases and containment of outbreaks, which proved so effective in smallpox eradication, is not feasible for polio. In addition there are some paralytic illnesses which mimic the disease but are not caused by polio virus. To be certain that a paralytic illness is caused by polio virus, the virus must be isolated from a stool specimen. This requires moderately sophisticated laboratories which can not only isolate the virus but can determine whether it is a vaccine virus or a so-called "wild" virus.

WHO

WHO/M. Jacot

Known in the 1950s as "infantile paralysis," polio was a universal problem. But few people then appreciated its catastrophic effects in the Third World.
Right: ***Quite modest laboratories, like this one in Yemen, will help to bring about polio eradication.***

The countries of the Americas, which began a hemisphere-wide campaign in 1985, are using new strategies for polio surveillance and containment. So far, they appear to be working. Each health centre and hospital is required to report promptly every case of flaccid paralysis in children less than 15 years old. An epidemiologist visits each case within 48 hours and collects a stool specimen. If there is no other apparent diagnosis, the case is called a "probable" polio case and intensive vaccination is immediately performed throughout that community. Specially equipped laboratories require between 30 and 60 days to examine each specimen and confirm the diagnosis. During 1988, more than 6,000 stool

specimens were examined – a very large task indeed.

Progress in the Americas is encouraging. During 1988, fewer than 50 wild polio viruses were isolated and polio cases were found in less than two per cent of all counties or districts. Even fewer cases are being discovered in 1989. Epidemiological evidence so far suggests that the wild polio viruses, like smallpox, do not spread readily over great distances and that the principal reservoirs for transmission are the more densely populated and lower socio-economic areas. It is here that special house-to-house vaccination campaigns are now being conducted.

The second major problem in the polio campaign is the vaccine. The freeze-dried smallpox vaccine was very stable even under tropical conditions; a successful vaccination always caused a pustule to form on the arm and subsequently a scar. Moreover, a single vaccination conferred nearly complete protection for at least five to ten years. The success of the vaccination programme and the immune status of a population could therefore be readily determined by surveying scars and/or pustular responses following vaccination.

For a number of reasons, including cost, the oral polio vaccine is being used. It has the advantages of being inexpensive and easily administered even by lay persons – a few drops being placed in the mouth. The vaccine virus, a greatly weakened polio virus strain, grows in the intestine and causes protective antibodies to be produced. It can spread to contacts of the vaccinee and immunize them as well. However, the vaccine is rapidly destroyed by high temperatures, so refrigerators and ice-boxes are needed to transport it into the field. High levels of protection require as many as four or five doses but, even then, other viruses growing in the intestinal tract may prevent its growth and limit the protection that children need. Finally, there is no simple way to determine whether or not a child is protected. If, for example, the vaccine has been destroyed by heat, it will appear perfectly normal but will be of no more value than a few drops of water.

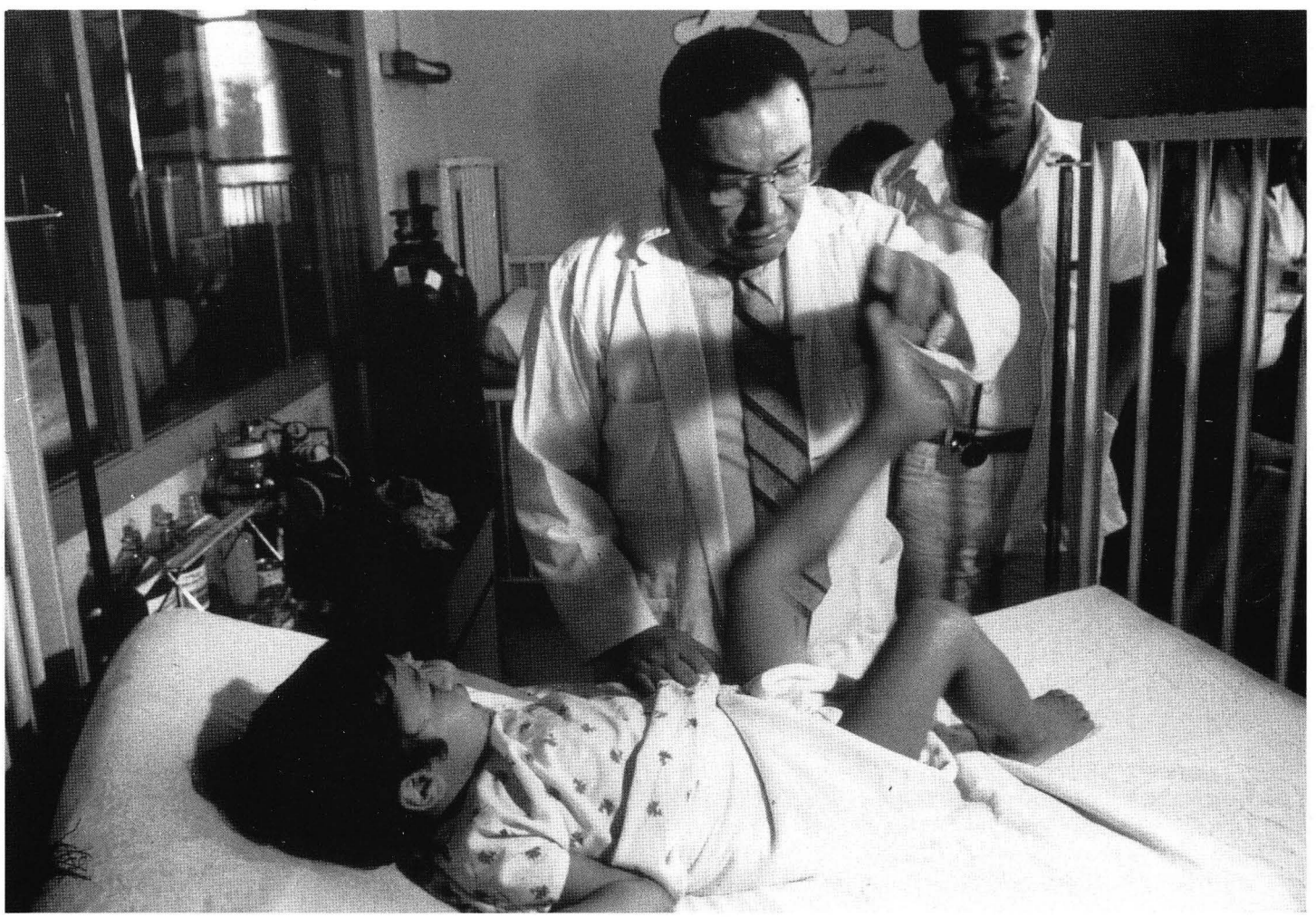
Despite the drawbacks of the vaccine, it can serve to stop the spread of polio. In the USA, for example, wild virus transmission stopped in the early 1970s at a time when only about 70 per cent of pre-school-age children were vaccinated. Similarly, in South America, intensive one to two day vaccination campaigns with good coverage have served to reduce polio incidence dramatically, and in some countries to stop transmission within a matter of a few years.

Detection and diagnosis of polio cases calls for special skills on the part of health workers.

Heat-stable vaccine

The prospects for polio eradication would be greatly enhanced if we had a more heat-stable vaccine producing higher levels of immunity with fewer doses, and if we had simpler, more rapid laboratory diagnostic tests. Scientists now believe that these problems could be solved comparatively quickly, but additional funds for research will be necessary to do so.

The achievement of global polio eradication by the year 2000 is by no means a certainty. It will require a high level of sustained commitment and resources, and close collaboration between politicians, public health field staff and laboratory workers. Strategies will need to be continually adapted and modified as more is learned. Yet the success of polio eradication could well be the most significant step toward guaranteeing a high quality of life for all children. ■



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