



# POLIO

The beginning of the end



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• World Health Organization •

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Geneva 1997

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# Foreword

*by Dr Hiroshi Nakajima, Director-General of the World Health Organization*



**Dr Hiroshi Nakajima**  
Director-General of WHO

In 1988 the World Health Assembly adopted the resolution calling for the global eradication of poliomyelitis by the year 2000. During the last nine years the eradication initiative has expanded from one of WHO's Regions to all six of them. It has become one of the primary goals of WHO and each of its Member States. We are proud of this initiative, which has mobilized and united so many people around the world in a common cause.

Polio eradication has been achieved and certified in WHO's Region of the Americas. In the European and Western Pacific Regions, the incidence of wild poliovirus infection has been reduced to extremely low levels. We hope that both Regions will be able to bring transmission to a halt during the next year, and we challenge all the countries of these Regions to continue to strengthen their surveillance systems so that eradication can be certified by the year 2000. In the Regions of Africa, the Eastern Mediterranean and South-East Asia the fight against polio is being fought with energy and determination, but significant obstacles remain to be overcome. The goal of global eradication is of the utmost concern to all countries because until every country in the world is free from polio, no country is free from the risk of it.

I want to thank all our partners in this initiative for their steadfast and invaluable support. Rotary International, UNICEF and the Centers for Disease Control and Prevention have worked tirelessly with us and made an enormous contribution to the campaign. The Governments of Australia, Canada, Denmark, Italy, Japan, Norway, Sweden, the United Kingdom and the United States have been particularly generous in their support, and contributions have been received from many other sources. Most of all, I want to thank the countless

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health workers and others in communities and governments around the world who have participated and continue to participate in the day-to-day work of polio eradication. While others plan and provide support, it is they who turn those plans into reality. Without their continued dedication we could not have come so far, and we could not hope to sustain the progress we have so far achieved.

A handwritten signature in black ink, appearing to read 'H. Nakajima', with a horizontal line underlining the name.

Dr Hiroshi Nakajima  
Director-General of the World Health Organization (WHO)



**Oral polio vaccine is recommended by WHO for use in global efforts to eradicate polio.**

Photo: UNICEF/Adrian Pennink (93-BOU1104)

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# Preface

*by Dr J.W. Lee, Director, Global Programme for Vaccines and Immunization, WHO*

*Dr B. Melgaard, Chief, Expanded Programme on Immunization, WHO*

*Dr H. Hull, Medical Officer, Expanded Programme on Immunization, WHO*



Dr J. W. Lee  
Director, GPV



Dr B. Melgaard  
Chief, EPI



Dr H. Hull  
Medical Officer, EPI

This book is intended to give both the scientist and the interested layman a sense of what has been achieved so far in the global efforts to eradicate polio. It provides an overview of the scientific basis for polio eradication and the strategies which have been designed to outwit the poliovirus and drive it into oblivion. It documents the progress of the initiative from the very beginning, highlighting the successes and reviewing some of the setbacks. We hope it conveys to the reader a sense of some of the monumental tasks which have been successfully completed or are in progress. But most of all, we hope that the reader understands the collaboration which is required to conduct and complete a global undertaking. Polio eradication is simply too big for any one organization. From the outset, Rotary International, UNICEF, WHO and the governments of donor nations have worked together to support the work of the polio-endemic countries. With the passage of time and the expansion to all continents, that partnership was expanded to include the Centers for Disease Control and Prevention, other major donor nations and the governments of many more polio-endemic countries. We hope that the reader will appreciate the global partnership which underlies the progress achieved. When polio eradication is eventually certified, it will be seen as a cooperative venture of all people and nations of the world.

The last chapter of the book is about the benefits of polio eradication. Some are obvious—reduction of disease and disability, and cost savings. Others—truces and days of tranquillity, building of health infrastructure—are wonderful bonuses, but

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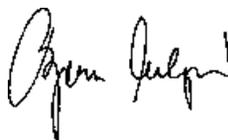
also necessary components of programme activities. Different nations will benefit from the eradication of polio in different ways, but it is clear that all nations and all people will benefit. However, we must emphasize that the full benefits of polio eradication cannot be achieved until polio is eradicated from every nation on earth. We anticipate that, by the end of 1997, the polio eradication initiative will be active in almost every polio-endemic country in the world. An increasing number of countries which are apparently free of polio are now moving to provide the data which will allow them to be certified as free from wild polioviruses.

The countries which now remain endemic for polio include the most difficult countries, which, because of their civil strife, war, dispersed population, difficult geography and/or impoverished state will require exceptional support. Both the numbers of countries involved and the additional level of support required in the most difficult countries call for an expansion of the partnership. Our hope is that this book will serve as an inspiration and invitation to those who are not yet involved in polio eradication to consider how they could contribute to the initiative and the partnership. To those individuals and organizations who are already committed, we trust that you will gain a sense of satisfaction from what has been done, but then take the next step on the road which lies ahead.

Finally, we note that this book should not be seen as a history of polio eradication. That book cannot be written until the final declaration has been accepted by the World Health Assembly at some point in the future. It will contain many more chapters about the difficulties which will have been overcome and the challenges which have been met.



Dr J. W. Lee  
Director  
Global Programme for  
Vaccines and  
Immunization



Dr B. Melgaard  
Chief  
Expanded Programme  
on Immunization



Dr H. Hull  
Medical Officer  
Expanded Programme  
on Immunization



Throughout history polio has lamed millions of people—most of them young children.

Photo: Liba Taylor



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## INTRODUCTION:

# Making history

In 1996 the world moved a giant step closer to eradicating polio—giving hope that future generations of children will learn of the disease from history books, never again at first hand. During that year, 420 million children—almost two thirds of the world's children under five—were immunized during mass campaigns against polio. In addition, over 80% of babies received at least three doses of oral polio vaccine during their first year of life, through routine immunization programmes.

Never before have so many children been immunized in so short a time against a single disease. This was not the end but the beginning of the end of polio. Throughout history, polio has lamed millions of people—most of them young children who had barely learned to walk. Others have died from suffocation after contracting the severest form of polio paralysis, which impedes normal breathing. Today, it is estimated that as many as 10-20 million people of all ages are living with polio paralysis. Since 1988, the World Health Organization has spearheaded global efforts to eradicate the disease by the year 2000.

In December 1996, and again in January 1997, over 250 million children were immunized against polio during coordinated national immunization days in nine countries in Asia—Bangladesh, Bhutan, China, India, Myanmar, Nepal, Pakistan, Thailand, and Viet Nam. India succeeded in immunizing 127 million children on a single day in January 1997—the largest health event ever organized by an individual country. In India, which until recently accounted for over half the world's polio cases every year, the number of cases was slashed by 75% as a result of the massive number of children immunized during 1995 and 1996.

Earlier in the year, about 58 million children were immunized in the Middle East, Caucasus, Central Asian Republics, and Russia. This cam-

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**Polio has been eradicated throughout the western hemisphere but the virus is still circulating in all other regions of the world.**

paign—Operation MECACAR—was first conducted in 1995 to provide a coordinated onslaught on polio in 19 adjoining countries. Russia joined the campaign for the first time in 1996.

In August 1996, South African President Nelson Mandela, Chairman of the Committee for a Polio-free Africa, launched a three-year campaign—Kick Polio out of Africa. By the end of 1996, 28 African countries had carried out national immunization days, reaching over 58 million children.

During the final months of 1996, demand for oral polio vaccine was so great that it almost outstripped the production capacity of the major manufacturers. Although there is a large global excess production capacity for the vaccine, unforeseen delays in receiving funding for vaccine for national immunization days resulted in several last-minute orders for vaccine. In the end, none of the planned national immunization days had to be delayed, but in some countries, deliveries of vaccine often arrived only days before the launch of the campaign and had to be airlifted to immunization posts by helicopter.

As the number of countries conducting national immunization days increases—and probably peaks—during 1997 and 1998, an even larger volume of polio vaccine will be needed. Vaccine manufacturers were advised that they would need to produce almost 1.5 billion doses of the vaccine in 1997 to satisfy world demand.

It is too early to say whether polio will be eradicated on target by the year 2000. So far, the global initiative to eradicate the disease has slashed the number of cases by 90%—from over 35 000 reported cases in 1988 to less than 4000 today. Polio has been eradicated throughout the western hemisphere but the virus is still circulating in all other regions of the world. And about 100 countries are still carrying out mass immunization campaigns in addition to routine immunization against polio.

The final stages of polio eradication are expected to be the most difficult. The countries where polio is still endemic include some of the poorest countries in the world. Many are unable to reach the majority of their population with even basic health services. In some, health infrastructures have been destroyed by war and neglect, vaccine supply lines cut off, and immunization programmes suspended—setting the stage for an upsurge in polio and other vaccine-

preventable diseases. Despite the success of a number of negotiated ceasefires for immunization, children become difficult to reach when conflict erupts. War-related outbreaks of polio occurred in Chechnya in the Russian Federation in 1995, in Iraq (1992-93), and in Sudan (1993). Today, emerging polio-free areas are threatened by continuing political unrest in Afghanistan, Angola, Congo, Democratic Republic of Congo, Iraq, Liberia, Sierra Leone, Somalia, and Sudan.

Donor fatigue and the competing need for funds to combat other infectious diseases—some both more life-threatening and more widespread than polio—pose continuing threats to the eradication of polio. Pneumonia, diarrhoea, measles, and malaria together kill about eight million children a year. And many of these deaths occur in the poorest countries—including those where polio is still endemic.

The danger is that, as the number of polio cases continues to fall and the risk of infection recedes, people will become complacent about polio and let their guard down—enabling the disease to stage a comeback. Both donors and cash-strapped governments may be less willing to spend millions of dollars a year on polio eradication when very few cases are occurring. But without adequate donor funding and high-level political commitment to polio eradication in the poorest developing countries, poliovirus will continue to circulate—both in those countries and beyond. And unless the polio-free countries continue to maintain high routine immunization coverage, there is a risk that polio could be re-established in those countries through importation of the virus from a polio-endemic country.

Other constraints include vaccine shortages during periods of political and economic transition, and the need to raise at least US\$ 800 million altogether—if polio is to be eradicated as planned by the turn of the century.



In the 1940s and 1950s “iron lungs” were used to regulate breathing and keep polio patients alive.

Photo: WHO (1669)

## Polio paralysis

Polio is an infectious disease caused by poliovirus. The disease can strike at any age but affects mainly children under three (50-70% of all cases) and causes paralysis. It follows infection with any one of three related enteroviruses: poliovirus type 1, type 2, or type 3. The virus usually enters through the mouth and then multiplies inside the throat and intestines. The incubation period is 4-35 days and the initial symptoms include fever, fatigue, headache, vomiting, constipation (or less commonly diarrhoea), stiffness in the neck, and pain in the limbs.

Once established, poliovirus can enter the bloodstream and invade the central nervous system—spreading along nerve fibres. As it multiplies, the virus destroys the motor neurons which activate muscles. These nerve cells cannot be regenerated and the affected muscles no longer function. Muscle pain, spasms, and fever are associated with the rapid onset of acute flaccid (floppy) paralysis.

Polio paralysis is almost always irreversible. The muscles of the legs are affected more often than the arm muscles. More extensive paralysis, involving the trunk and muscles of the thorax and abdomen, can result in quadriplegia. In the most severe, often fatal, cases, poliovirus attacks the motor neurons of the brain stem—reducing breathing capacity and causing difficulty in swallowing and speaking ("bulbar polio"). Without adequate respiratory support, bulbar polio can result in death by asphyxiation. During the polio epidemics of the 1940s and 1950s in the industrialized countries, people with this form of the disease were immobilized inside "iron lungs" to regulate their breathing and keep them alive. Today, the iron lung has largely been replaced by the positive pressure ventilator, but it is still in use in some countries.

Although polio paralysis is the most visible sign of polio infection, less than 1% of polio infections ever result in paralysis. Most cases—as many as 90%—produce no, or very mild, symptoms and usually go unrecognized. The remaining cases ("abortive polio") involve mild flu-like symptoms common to other viral infections—mild fever, sore throat, abdominal pain, and vomiting—but do not result in paralysis. About 5% to 10% of all polio infections result in aseptic meningitis, a viral inflammation of the outer covering (meninges) of the brain.

No one knows why only a small percentage of infections lead to paralysis while the rest do not. But several key risk factors have been identified which increase the likelihood of paralysis in a person infected with polio. They include:

- immune deficiency
- pregnancy
- tonsillectomy
- intramuscular injections
- strenuous exercise
- injury.



Photo: WHO

The problem is that most people infected with poliovirus are never aware of it. They have no signs of illness and are not seen by any health worker. However, they can spread poliovirus to close contacts. The virus is shed intermittently in faeces for several weeks. This enables the rapid spread of poliovirus—especially in areas where hygiene and sanitation are poor, but also in any environment where young children, not yet fully toilet-trained, are a ready source of poliovirus transmission. Polio can also be spread when food or drink is contaminated by faeces. There is also evidence that flies can passively transfer poliovirus from faeces to food.

Poliovirus circulates "silently" at first—possibly infecting up to 200 people before the first case of polio paralysis emerges. Because of this silent transmission and the rapid spread of poliovirus, WHO considers a single confirmed case of polio paralysis to be evidence of an outbreak—particularly in countries where very few cases are occurring and the disease is close to being eradicated.

## Polio vaccines

Protective immunity against polio is established through immunization or as a result of natural infection with poliovirus. Polio infection provides lifelong immunity to the disease but the protection is limited to the particular type of poliovirus involved. Unfortunately it fails to provide cross-protection against the other two types of poliovirus.

Two different kinds of polio vaccine are available—an inactivated (killed) injectable polio vaccine (IPV) originally developed in 1955 by Dr Jonas Salk, and a live attenuated (weakened) oral polio vaccine (OPV) developed by Dr Albert Sabin in 1961. Both vaccines are highly effective against all three types of poliovirus. But there are significant differences in the way each vaccine works.

Oral polio vaccine works by inducing not only serum immunity but also secretory immunity, particularly inside the intestines—the primary site for poliovirus multiplication. As well as inducing individual protection against polio, OPV also limits the multiplication of "wild" (naturally occurring) virus inside the gut. Immunization with OPV therefore creates an effective barrier against circulation of wild poliovirus by reducing faecal excretion of the virus. However, a "helpful" outcome of immunization with OPV is the short-term shedding of vaccine virus in the stools of recently immunized children. In areas where hygiene and sanitation are poor—and the incidence of polio is highest—immunization with OPV can result in the passive immunization of close contacts through the spread of vaccine virus shed in stools.

An added advantage is that OPV is an oral vaccine. It does not have to be administered by a trained health worker and—unlike most other vaccines—does not require sterile injection equipment. It is also relatively inexpensive (available at 8 US cents a dose through the UNICEF vaccine purchasing system)—a major consideration when governments have to purchase massive quantities of vaccine for use in national immunization days. For these reasons OPV is the vaccine of choice for the eradication of polio. The downside is that, although OPV is safe and effective, very rarely (in about one in every 2.5 million doses administered) the live attenuated vaccine virus can cause paralysis—either in the vaccinated child or in a close contact.

Inactivated polio vaccine (IPV) works by producing protective antibodies in the blood—thus preventing the spread of poliovirus to the central nervous system. However, it induces only very low-level immunity to poliovirus inside the gut. As a result, it provides individual protection against polio paralysis but only marginally reduces the spread of wild poliovirus. In a person immunized with IPV, wild virus can still multiply inside the intestines and be shed in stools. Because of this, IPV could not be used to eradicate polio.

Other disadvantages include the price (over five times the cost of OPV), the cost of the needle and syringe, and the need for trained health workers to administer the vaccine using sterile injection procedures. However, IPV does not carry the risk of paralysis associated with OPV, and a number of industrialized countries have implemented, or are now considering implementing, a combined IPV/OPV schedule in their routine immunization programme. The aim is to reduce the risk of vaccine-associated polio while maintaining the benefits of the high levels of intestinal immunity produced by OPV.

### WHO-recommended immunization schedule for polio

All children should be fully immunized against polio during their first year of life. WHO recommends four basic doses of OPV, to be administered at:

- birth
- 6 weeks
- 10 weeks
- 14 weeks
- 9 months (for children not immunized at birth).



Photo: WHO (21846)

In the United States, where wild poliovirus has already been eradicated, the only source of polio paralysis—apart from importations of wild poliovirus—is now OPV. Every year 5-10 people become paralysed following immunization with OPV—half of them children recently immunized and the rest non-immunized or partially immunized contacts.

Studies carried out in the United States suggest that vaccine-associated paralysis occurs at a rate of approximately one case for every 2.5 million doses of vaccine distributed. The risk is highest—both for vaccine recipients and contacts—following the initial dose of oral polio vaccine. A 1987 study of the period 1973-1984 by researchers at the US Centers for Disease Control and Prevention (CDC) estimated that the overall rate of paralysis after the first dose—taking into account the number of children not known to be immune-deficient when they were immunized—was one case for every 520 000 initial doses of OPV, compared with one case for 12.3 million subsequent doses.

In response to public concern in the United States, the US Advisory Committee on Immunization Practices decided to draw up new guidelines on polio immunization. In October 1995 the Committee recommended the introduction of a combined IPV/OPV schedule in the United States—an initial two doses of IPV (at two months and four months) to be followed by two doses of OPV (at 12-18 months and 4-6 years). The new strategy, which was endorsed by the Centers for Disease Control and Prevention, was introduced in early 1997. It will be expensive—adding another US\$ 20 million a year to the US\$ 230 million spent on polio immunization—but is expected to halve the number of vaccine-associated cases in the United States.

In November 1995, after the US Advisory Committee on Immunization Practices announced its decision, the Centers for Disease Control and Prevention, Rotary International, and UNICEF issued a joint statement endorsing the WHO eradication strategy and the exclusive use of OPV elsewhere. The move reflected the concern of public health experts that the US decision may signal to other countries that OPV alone is not enough to control polio or that it is an unsafe vaccine. It could also lead to pressure for a switch to IPV in developing countries as well—undermining eradication efforts in areas where polio is still endemic. The use of funds from limited immunization budgets to purchase IPV could even increase the incidence of polio by reducing the number of doses available to the highest risk—and poorest—children. It could also set back the introduction of vaccines against other priority diseases such as hepatitis B. The members of the US Advisory Committee on Immunization Practices acknowledged these risks. They stressed that the IPV/OPV schedule applies only to the United States and have strongly endorsed their commitment to WHO's global eradication strategy.

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**The introduction of vaccine vial monitors is expected to save about US\$ 20 million a year.**

## Reducing vaccine wastage

Until recently over 50% of oral polio vaccine used in routine immunization was thrown away at the end of the day to avoid the risk of loss of potency due to possible exposure to heat. Once a multiple-dose vaccine vial had been taken out of a refrigerator or ice-box and opened for use, a health worker had no way of knowing whether the vaccine was still potent after several hours at a higher temperature. Because of this uncertainty, all partly used vaccine vials were thrown away at the end of the clinic session. And despite a switch to smaller—relatively more expensive—vaccine vials, wastage remained high.

Now a new device, the vaccine vial monitor (VVM)—together with new safety rules for handling opened vials of vaccine—has put an end to the uncertainty about possible exposure to heat. The technological breakthrough, after almost two decades of research, indicates whether vaccine is still potent, and is expected to slash overall wastage on OPV and other liquid vaccines by 25% by the year 2000—saving an estimated US\$ 20 million a year on vaccine purchase for immunization. The use of VVMs will enable national immunization programmes to revert to the use of larger, less expensive multiple-dose vaccine vials.

The vaccine vial monitor—a coloured disc calibrated according to the heat stability of each vaccine—changes colour to indicate when the vaccine vial has been damaged by excessive exposure to heat. As well as indicating the state of unopened vials of liquid vaccine, the monitor can also be used to determine whether vaccine that has been opened and stored for several days is still potent.

While reconstituted vaccines such as BCG, measles, and yellow fever will still have to be discarded (because of the risk of bacterial contamination), liquid vaccines like OPV can now be safely kept after opening—provided they meet rigorous safety requirements including storage in the cold chain and strict adherence to the expiry date. Maintenance of the cold chain is still essential to ensure that vaccine is kept at the correct temperature from the moment it leaves the manufacturer, right through its shipping and storage to the moment it is administered to a child.

Research and development of the vaccine vial monitor was carried out by a public-private sector partnership involving WHO, UNICEF,

USAID, the US-based Program for Appropriate Technology in Health (PATH), the 3M Corporation and Lifelines Technology Inc. in the US, and Rexam Labels in the UK. The monitor was first introduced on all vials of UNICEF-supplied OPV in early 1996. Eventually the device will be used on other liquid vaccine vials as well. Studies on the impact of VVMs are now under way in Bhutan, the Gambia, Ghana, Nepal, South Africa, and Yemen. Studies in Tanzania and Viet Nam have now been completed.



**Immunity against polio is lifelong.**

Photo: WHO/H. Anenden

Polio is one of only a limited number of diseases that can be eradicated. This is because polio only affects humans, an effective vaccine is available, and immunity is lifelong. There are no long-term carriers of the disease, no animal or insect reservoir, and the virus can only survive for a very short time in the environment. Like other viruses, poliovirus can only multiply by invading a cell and hijacking the cell's own mechanism for replication. Once the virus is deprived of its human host—through immunization—it will rapidly die out.

As the level of routine immunization coverage increases, the circulation of wild poliovirus is reduced but does not stop altogether. When the goal is to eradicate rather than control the disease, a more aggressive strategy is needed. WHO adopted a polio eradication strategy that involves mass immunization campaigns, door-to-door immunization, rapid response to suspected polio cases, investigative work to identify cases that may have been missed, and viral detective work in the laboratory to isolate poliovirus and pinpoint the original source. In areas where polio is no longer occurring, the same investigative methods are needed to provide conclusive evidence that wild poliovirus is no longer in circulation.

The strategy is four-pronged. It comprises high routine immunization coverage with OPV; supplementary immunization in the form of national immunization days or mass campaigns; effective surveillance; and in the final stages, when very few or no cases are occurring, door-to-door immunization campaigns ("mopping up") in areas where the virus persists.

## Routine coverage

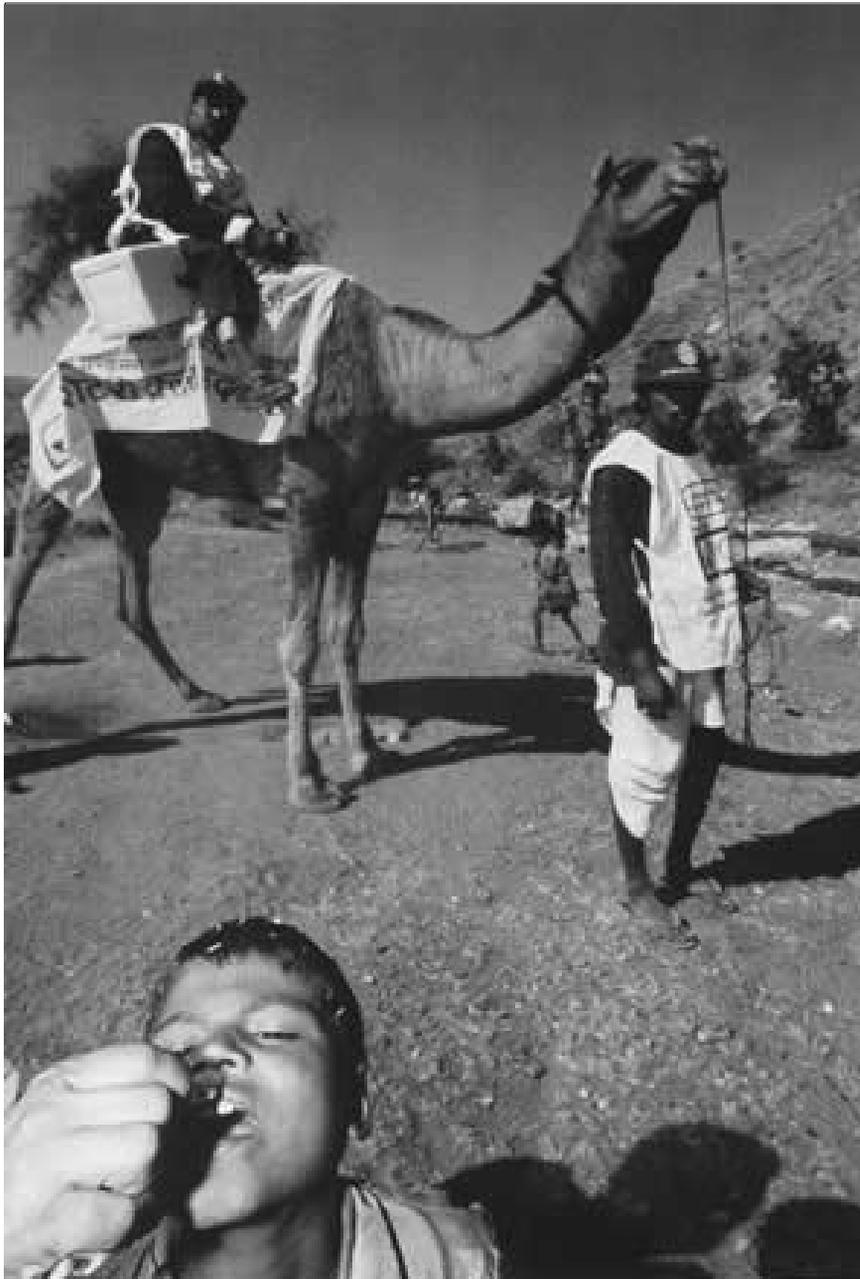
A cornerstone of the polio eradication strategy is the need to ensure a consistently high level of routine immunization coverage with oral polio vaccine among children under one—reaching children even in the most difficult places. This reduces the incidence of polio and makes eradication feasible. Unless high immunization coverage is maintained, pockets of non-immunized children build up—creating the ideal conditions for the spread of poliovirus. WHO has established a global target of at least 90% immunization coverage for all vaccines used in the Expanded Programme on Immunization, including oral polio vaccine, by the year 2000.

By 1995, global immunization coverage for polio was over 80% but coverage in some countries—especially those affected by war—was much lower. In Afghanistan, fewer than 25% of children were immunized and fewer than 20% in Chad. In Chechnya, in the Russian Federation, a bitter conflict succeeded in halting immunization for three years and in 1995 there was an outbreak of polio involving over 150 cases. Elsewhere, even short-term drops in immunization coverage—in Albania, Azerbaijan, Bulgaria, and Tajikistan, for example—have helped fuel epidemics of polio.

When polio has been eradicated globally, immunization against polio will no longer be needed. In the meantime, countries in the Americas, where polio has been eradicated since 1991, must continue to ensure high levels of routine immunization coverage to prevent the re-establishment of poliovirus if it is re-introduced from other countries.

## Mass campaigns

The second part of the strategy involves supplementary immunization in the form of mass campaigns. National immunization days are intended to complement, not replace, routine immunization. The aim is to interrupt the circulation of poliovirus by immunizing every child in the highest risk age group (normally the under-fives) as rapidly as possible. In countries where polio is endemic, this usually involves organizing two rounds of national immunization days a year—one month apart—over a period of at least three years. The aim is to catch children who are non-immunized, or only partially protected,



**Reaching children with routine polio immunization—even in the most difficult places.**

Photo: Rotary International/Marcus Oleniuk

and boost the immunity of children already immunized. This way, every child in the most susceptible age group is protected against polio at the same time—instantly depriving the virus of the fertile seedbed on which it depends.

1995 and 1996 were both record years for mass immunization campaigns against polio. During 1995, almost half the world's children under five—300 million children—were immunized during national immunization days. In December alone, 160 million children were given oral polio vaccine during campaigns in China and India. In China, the number of reported cases dropped from over 5000 in 1990 (an epidemic year) to only 3 in 1996—all of them classified as cases imported from another country. In India, which had accounted for more than half the world's polio cases, over 93 million children under three were immunized in the country's first national immunization day in December 1995. A year later, when the target group was extended to include all children under five, 127 million children were immunized on a single day. During 1996, over 420 million children were immunized during national immunization days—almost two thirds of the world's children under five.

## Surveillance

The third part of the strategy is surveillance—the intelligence network that underpins the entire eradication initiative. Without this investigative framework, it would be impossible to pinpoint where and how wild poliovirus is still circulating or to verify when it has been eradicated.

Effective polio surveillance requires an expert team of virologists, epidemiologists, clinicians, and immunization staff, backed up by a global network of laboratories. The first link in the chain are field workers in health centres. They are asked to report promptly every case of acute flaccid (floppy) paralysis in any child under 15. In addition, a health officer is expected to visit hospitals and rehabilitation centres to search for any AFP cases that may have been misdiagnosed, overlooked, or never reported. This involves reviewing both inpatient and outpatient records, as well as interviewing key staff. Contacts are also established with community leaders, teachers, and social workers to inquire about cases of recently paralysed children.

WHO stresses that all cases of acute flaccid paralysis (AFP) should be reported. AFP cases occur at all ages, due to causes other than polio. The number of cases reported each year is used as an indicator of the sensitivity of a country's surveillance system—even in countries where the disease is no longer occurring. A country's surveillance system should be sensitive enough to detect at least one case of AFP for every 100 000 children under 15—even in the absence of polio.

In the early stages, polio may be difficult to differentiate from other forms of acute flaccid paralysis. For this reason, doctors are urged to report every case of AFP—even when they are confident, following a clinical examination, that the case is not polio. Demonstrating that these children are not paralysed by wild poliovirus is crucial evidence for documenting the eradication of polio. As polio disappears under the pressure of national immunization days, almost all AFP cases will be due to other causes. At least half of all AFP cases will be due to Guillain-Barré syndrome—a disease of unknown origin which affects people of all ages but occurs mainly in adults. Guillain-Barré syndrome is usually a symmetrical form of paralysis (affecting both sides equally) which results in complete recovery in most cases. Polio usually results in asymmetrical, permanent paralysis. Among the many other causes of acute flaccid paralysis are transverse myelitis, traumatic neuritis, and infections caused by other enteroviruses.

To exclude the possibility of polio, faecal specimens have to be obtained and tested for the presence of poliovirus. Because shedding of the virus is variable, two specimens—taken at least 24 hours apart—are taken for analysis. Speed is essential as the highest concentrations of virus are found during the first two weeks after the onset of paralysis.

Stool specimens have to be carefully sealed in clean containers and stored immediately inside a refrigerator or packed between frozen ice packs at 4-8°C in a cold box, ready for shipment to a laboratory. Undue delays or prolonged exposure to heat on the way to the laboratory may destroy the virus. Specimens should arrive at the laboratory within 72 hours of collection. Otherwise they must be frozen (at -20°C), and then shipped frozen, ideally packed with dry ice or cold packs also frozen at the same temperature. The procedure is known as the "reverse cold chain".

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**Surveillance is the intelligence network that underpins the entire eradication initiative.**



**In the early stages it may be difficult to differentiate polio from other forms of acute flaccid paralysis.**

Photo: WHO/PAHO/Carlos Gaggero (20723)

At the laboratory, specimens are inoculated onto cell culture and virologists begin the task of isolating poliovirus and identifying which, if any, of the three types is involved. If viruses grow in the cell culture, the next step is to differentiate poliovirus from any other viruses that may be present. To do this, antibodies specific to individual viruses are introduced to block the growth of these viruses—enabling virologists to single out poliovirus.

If poliovirus is isolated, the next step is to distinguish between wild (naturally occurring) and vaccine poliovirus. One way of doing this is to introduce antibodies specific to either vaccine or wild strains of the virus to detect subtle differences in their surface properties (an Elisa test). Another way is to introduce a special "probe" which identifies a virus by binding to its genetic material when it is exactly matched—a technique that has been compared to zipping up a zip fastener when the sequence of teeth is correctly aligned on either side.

Once it has been established that a wild virus is involved, immunization staff are notified immediately. Then further tests are carried out to determine how closely related it is to other strains of wild poliovirus—and where it originated. To do this, virologists remove a segment of genetic material from the virus and multiply the segment a millionfold in order to study the sequence of the genetic building blocks. By determining the exact sequence of "bases" in the genetic make-up of the virus, wild viruses can be classified into genetic families which cluster in defined geographical areas. The virus is then checked against a reference bank of known polio-viruses. Virologists have shown that mutations occur in the genetic material of the poliovirus each time it is transmitted from one person to another. Over a year, the genetic make-up of the virus often changes by up to 2%. When differences of greater than 10% are identified between viruses, they are no longer considered to belong to the same genetic "family". Once polio has been traced to its "family tree" it can often be pinpointed to a precise geographical area. Is the virus of local (indigenous) origin or was it imported from elsewhere? Genetic fingerprinting helps identify the source of importations of poliovirus—both long-range and cross-border—and is crucial in determining the most appropriate immunization strategy.

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**Today there is an urgent need to step up the quality of surveillance in many countries.**

Precise information on the patterns of poliovirus circulation is essential in drawing up the most cost-effective strategies for global eradication. Where the geographical zone identified extends across national borders or regions, inter-regional action may be needed to synchronize national immunization days and maximize their effectiveness. In the Mekong delta region of Viet Nam and Cambodia, for example, polio cases occurring in both countries are caused by closely related polioviruses. Because of this, national immunization days were coordinated on both sides of the border to maximize their impact. Elsewhere, China and Myanmar are also coordinating cross-border polio eradication activities. And in April 1995, WHO launched a regionally coordinated mass immunization campaign—Operation MECACAR—reaching 56 million children that year in 18 adjoining countries in the Middle East, Caucasus, and the Central Asian Republics. And in one week in December 1996, over 250 million children were immunized in a coordinated campaign in Bangladesh, Bhutan, China, India, Myanmar, Nepal, Pakistan, Thailand, and Viet Nam. Until recently, two thirds of all polio cases occurred in South East Asia and viruses originating in this region were also responsible for seeding many outbreaks in other regions of the world. During 1992 and 1993 alone, viruses from the Indian subcontinent are believed to have been responsible for importations of wild virus in countries as far afield as Canada, Germany, Jordan, Malaysia, the Netherlands, Norway, Oman, Sweden, and the United Arab Emirates.

WHO, in collaboration with national governments, has established a network of over 80 laboratories to provide virological surveillance. There are three tiers, each providing specialized services: over 60 national laboratories, 14 regional reference laboratories, and six global specialized laboratories. The laboratory network provides the only means of identifying where poliovirus persists and where eradication activities should be targeted. When no cases of polio are occurring, the laboratory network will play a crucial role in certifying the eradication of polio—by establishing the absence of wild poliovirus. At this stage, surveillance may also entail analysis of stool specimens from healthy children in high-risk areas and possibly of sewage and waste water as well. In Colombia, this approach was used in 1991 in Cartagena, a high-risk area where AFP cases were not being properly investigated and very few polio cases were being reported. Tests revealed that wild poliovirus was present in 8% of faecal samples from healthy children and in over 20% of sewage water. As a result,



**Door-to-door immunization is carried out in high-risk areas when very few or no cases of polio are occurring.**

Photo: WHO/PAHO/Carlos Gaggero (20710)

children in high-risk areas in Cartagena and along the entire Pacific coast of the Americas were immunized in door-to-door campaigns—and polio was eradicated from Colombia.

Today there is an urgent need to step up the quality of surveillance in many countries. During 1996, of the 116 countries where polio is still—or was until recently—endemic, only 25% met the essential criterion of reporting at least one case of acute flaccid paralysis for every 100 000 children under 15. To make matters worse, by the end of 1996, 15 of the recently endemic countries had still not officially established surveillance systems for acute flaccid paralysis—a crucial requirement for assessing the impact of national immunization days and for the certification of polio eradication. Unless surveillance systems are rapidly established in these countries, regional and global certification of polio eradication by the year 2000 could be in jeopardy.

## Mopping up

When very few or no cases of polio are occurring, the final strategy is implemented. This involves door-to-door immunization ("mopping up") in high-risk districts where the virus is known or suspected to be still circulating. Priority districts include those where polio has occurred in the previous three years and where access to health care is difficult. Other criteria include overcrowding, high population mobility, poor sanitation, and low routine immunization coverage. In Peru after the last reported case of polio in 1991, almost two million children were immunized in a one week door-to-door campaign.

## Transgenic mice

Scientists working on a WHO-coordinated research project have succeeded in genetically engineering a mouse that is susceptible to polio. "Transgenic" mice will help dramatically reduce the very high cost of polio vaccine quality control tests, and cell lines derived from them will speed up the identification of poliovirus from stool specimens .

The "transgenic" mice were developed following identification of the gene that makes humans susceptible to polio. This gene—encoding for a receptor for poliovirus on the surface of a human cell—was isolated from the human genome and inserted into the genome of a mouse.

Until now, laboratories have relied on human cell lines for the culture and isolation of poliovirus from stool specimens. But this is often a lengthy process as human cells are also susceptible to over 70 other entero-viruses—all of them similar to poliovirus. The new genetically engineered mice are susceptible to just one enterovirus—poliovirus. The use of cell lines from these mice could speed up the identification process.

The cell lines—developed in Japan and in the United States—have undergone preliminary testing at the National Institute for Biological Standards and Control in London and are now undergoing comparative field trials at laboratories in Egypt, India, and Tunisia. The results available in early 1997 indicate that these cells will fulfil the promise of rapid detection of poliovirus in the presence of other enteroviruses.

Elsewhere, researchers are studying the possibility of using the mice to carry out initial screening tests to check the consistency of vaccine production lots. This would enable vaccine manufacturers to step up the size of each production lot and lead to a reduction in the number of expensive and increasingly scarce monkeys now used for this purpose. The mouse model would be especially useful for large vaccine producers in countries which currently produce a large volume of vaccine for use in mass immunization campaigns. The mice won't replace monkeys altogether, but they will reduce the number of monkeys needed. At present at least 20 new monkeys are needed to test each lot of polio vaccine produced. Transgenic mice could be bred and supplied for a fraction of the cost.

Six laboratories were involved in the initial two-year research project. A more extensive follow-up study is now under way, involving additional research laboratories, manufacturers, and vaccine regulatory authorities. The initial promising results were confirmed, and the cells from these transgenic mice will be introduced by mid-1998.



Unlike polio, virtually every case of smallpox was clinically apparent and easily recognized—even by a layman.

Photo: WHO (15416)

## Certification

A 13-member Global Commission has been appointed to certify the global eradication of polio. Its members were selected on the basis of their scientific expertise and objectivity. While none is working directly within the polio eradication initiative, all are eminent doctors, scientists, and academics working in related fields. The Commission members share responsibility for verifying that polio has been eradicated globally. In this, their scientific reputations—as well as the health of millions—are at stake.

Certification will be carried out on a regional basis by six Regional Commissions. At national level, each country is requested to establish a National Committee with responsibility for assessing and verifying polio surveillance data before their submission to the Regional Commission. Final certification will not be considered in any region until at least three years after the last virologically confirmed case of polio involving wild poliovirus. The Global Commission, which met for the first time in February 1995, has produced standard guidelines for data collection, drawn up a timetable for the certification process, and established the criteria on which certification will be based. It has been able to draw on the experience of the International Certification Commission on Polio Eradication in the Americas, which certified in August 1994 that polio had been eradicated from every country in the western hemisphere—three years after the last case occurred in Peru.

Surveillance for both acute flaccid paralysis cases and wild polio-viruses forms the basis of the documentation needed for certification. The Commission must be satisfied that, if polio cases had occurred, they would have been detected, reported, and rapidly and thoroughly investigated. Performance indicators for surveillance have been established to help confirm this. Where reports are not submitted, the reasons must be clearly documented and analysed. No grey areas will be accepted.

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**Polio network laboratories must undergo regular proficiency testing.**

Surveillance for acute flaccid paralysis must meet four stringent criteria before certification can be considered: surveillance should be sensitive enough to detect at least one case of acute flaccid paralysis for every 100 000 children under 15; adequate stool samples should be collected from at least 80% of these cases; detailed investigation of suspected polio cases should include clinical, epidemiological, and virological examination as well as a follow-up examination for residual paralysis after 60 days; a final classification of the case should be made by a committee of experts on the basis of these examinations; and at least 80% of monthly surveillance reports (including zero reporting) should be submitted on time.

Virological surveillance is also tightly regulated. The results of virus isolation tests will only be accepted from network laboratories, and these laboratories must undergo regular proficiency testing. Specimen collection, transport, and testing procedures are monitored through the use of performance indicators and proficiency testing. Stool specimens from close contacts under the age of five may also need to be tested in some areas—particularly those with poor surveillance systems. After the last case of polio in the Americas in 1991, over 25 000 stool samples were collected from about 6000 paralysed children and their contacts over three years to test for the presence of wild poliovirus. Eradication could not be certified without the proof that no more indigenous polioviruses were circulating in the region.

Environmental testing for poliovirus through sampling sewage and waste water may only be feasible in countries with organized sewerage systems. However, the Global Commission decided that environmental sampling could be used to provide supporting evidence of the absence of wild poliovirus. Researchers are now trying to develop sensitive and practical sampling and detection methods that can be used even in countries with no organized sewerage system or sophisticated laboratories. In mid-1997, WHO launched a comparative study of poliovirus detection through existing surveillance systems and through environmental sampling.

## Smallpox eradication

When the global smallpox eradication programme was launched in 1967, there were an estimated 10-15 million cases of smallpox a year, although only 1% of them were ever reported. Of these, at least two million died and a further 100 000 were blinded by the disease. More than 10 million remained severely disfigured.

The global onslaught on smallpox ended in 1979—two years after the last case involving naturally occurring wild virus was reported in the town of Merca in Somalia. On 22 October 1977, 23-year old Ali Maow Maalin developed smallpox—and survived. (The last two cases of smallpox occurred in Birmingham, England, in 1978, after the virus escaped from a laboratory.)

The 12-year smallpox eradication campaign and the global certification of the eradication of the disease in October 1979 established many of the basic principles now being used for the certification of the eradication of polio. In many ways variola (smallpox) virus was similar to poliovirus. It caused a disease that only affected humans, immunity was lifelong, there was no long-term carrier state, no animal or insect reservoir, and the disease could be prevented by a vaccine. But there were several very significant differences.

For a start, smallpox vaccine was thermostable and only a single dose was needed to produce immunity. Although the polio vaccine used has the advantage of oral administration, it is heat sensitive and children need four doses, preferably during their first year of life.

More importantly, although smallpox was a highly infectious disease, it did not involve symptomless infections, as polio does. Virtually every case of smallpox was clinically apparent. Infection with variola virus was highly visible, involving a characteristic rash that was easily recognized—even by a layman—and not likely to be confused with other diseases. Because of this, the smallpox eradication team was able to produce a smallpox recognition card that could be shown to people to help speed up the search for cases. Smallpox also left distinctive, permanent scars on the faces of as many as two thirds of its victims. During the certification stage, scar surveys of young children were carried out to confirm that variola virus was no longer in circulation. If it was, there would be evidence of recent cases among the youngest children.

Finding evidence of recent polio cases is far more difficult. Although polio paralysis is highly visible, some cases of polio can be confused with other forms of paralysis—even by expert neurologists. And while recent cases of polio paralysis indicate where polio is occurring, the absence of cases does not necessarily prove that poliovirus is no longer in circulation. Wild poliovirus can circulate "silently"—producing recognizable clinical disease (polio paralysis) in fewer than 1% of children infected. For every child who is paralysed by polio, about 200 other children will either appear well or have an illness not easily recognized as polio—despite being infected with poliovirus. As a result, exhaustive surveillance work is required to ensure that, if cases are occurring at a low level, they will be detected, and that wild poliovirus is not still circulating at a low level among healthy children.



In 1988, the World Health Assembly envisaged that polio eradication would be a gift from the 20th to the 21st century.

Photo: Liba Taylor

## A gift from the 20th to the 21st century

In 1988, the year in which the World Health Assembly resolved to eradicate polio by the year 2000, about 35 000 cases of polio were reported worldwide. But most polio cases are never reported and WHO estimates that the number of cases reported each year represents no more than 10% of the cases that actually occur. In the Americas, where the eradication campaign got under way in 1985, the number of reported cases had already been reduced to about 300 cases.

By 1988, over 60% of children throughout the world were fully immunized against polio, diphtheria, whooping cough, tetanus, measles, and tuberculosis before their first birthday—more than ten times the number immunized in 1974 at the start of the Expanded Programme on Immunization (EPI). As a result, WHO estimated that national immunization programmes were preventing over a million deaths a year from measles, neonatal tetanus, and whooping cough, and almost 200 000 cases of polio paralysis.

Buoyed by the global success of the Expanded Programme on Immunization (EPI), and by the effectiveness of the polio eradication strategy developed in the Americas, 166 Member States committed themselves at the World Health Assembly in May 1988 to eradicate polio globally by the year 2000. It was to be "an appropriate gift, together with the eradication of smallpox, from the twentieth to the twenty-first century."

To bring this about, WHO forged a global partnership involving Rotary International, the United Nations Children's Fund (UNICEF), the US Centers for Disease Control and Prevention, non-governmental organizations, donor governments, and ministries of health in the polio-endemic countries. Over the past decade, these partner agencies have provided not only funding but technical expertise, advocacy, and volunteers.

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**In the Americas,  
about 80% of the  
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countries.**

Rotary International has funded the purchase of huge quantities of vaccine for mass campaigns and routine immunization, and Rotary volunteers throughout the world have helped implement national immunization days and even given polio drops to children. Rotary also plays a significant advocacy role—urging governments and donor agencies to increase both their commitment to polio eradication and the level of funding. A large proportion of the massive quantity of vaccine needed is supplied through the UNICEF vaccine purchasing system, through which high quality vaccine can be procured on the international market at competitive prices. The UN children's agency has also played a key role in helping negotiate a series of ceasefires in conflict zones to enable children to be immunized. Elsewhere, a wide range of technical expertise is provided by the US Centers for Disease Control and Prevention. This includes the use of state-of-the-art virological surveillance methods to identify poliovirus and pinpoint its geographical origin. Major funding for polio eradication has been provided by donor governments and other agencies—mostly for the poorest countries. However, many countries continue to shoulder the cost of polio eradication themselves. In the Americas, for example, it is estimated that 80% of the costs of polio eradication were met by individual countries.

By 1990—when the polio eradication goal was endorsed by the World Summit for Children in New York—the global target of routinely immunizing at least 80% of children before their first birthday had already been surpassed and less than 25 000 polio cases were reported that year.

During 1991, the number of polio cases dipped below 13 500—down by 60% in only three years. Most polio cases were concentrated in a few countries and a number of emerging polio-free zones could already be identified. They included the Pacific Rim, southern and eastern Africa, North Africa, the Middle East, and Western Europe. In the Americas, the last case of polio occurred in a three-year-old boy in Peru.

In Africa, more than half the reported cases were in Nigeria that year, while in the Eastern Mediterranean Region, just two countries—Egypt and Pakistan—accounted for almost 90% of cases. In the European Region, most cases were in the newly independent republics of the former USSR. India accounted for 90% of cases in the South East Asia

Region, and China and Viet Nam for over 95% of polio cases in the Western Pacific Region.

Despite the encouraging reduction in the number of cases, and improvements in both polio surveillance and case reporting, very few countries outside the Americas were conducting national immunization days at this time. While routine immunization coverage was now consistently over 80% in many countries, that still left almost 20% of newborn infants not fully immunized. To make matters worse, some countries—especially in Africa—were failing to routinely immunize even 50% of their children each year. Mass campaigns enabled health workers to reach not only the youngest children who missed out on immunization each year, but also older children who remained susceptible to polio because they had never been fully immunized.

In 1992, immunization coverage rates remained unchanged and the global number of cases increased slightly—due to a 45% increase in polio cases in India. Meanwhile importations of wild poliovirus from the Indian subcontinent helped seed outbreaks in countries as far afield as Jordan, Malaysia, and the Netherlands. A revised plan of action was drawn up by WHO's EPI Global Advisory Group and endorsed a year later by the World Health Assembly. The plan highlighted the need for greater political commitment to polio eradication at all levels. Without this, adequate funding could not be secured for the purchase of massive quantities of vaccine for national immunization days. It was estimated that over 10 billion doses of vaccine would be needed up to the year 2000. The plan also called for national surveillance systems to be improved so that the incidence of the disease could be more closely monitored. This would enable national immunization programmes to move from a service delivery approach—providing individual protection—to a disease control initiative designed to protect entire populations.

During 1993, polio resumed its downward trend. About 10 500 cases were reported and more than half the countries reporting to WHO had recorded zero cases for the past three years. In the Americas, which had been polio-free for two years, wild poliovirus imported from the Netherlands was detected in Canada, among a religious group which refused immunization. But no cases of paralysis occurred. Elsewhere, polio flared up in Azerbaijan and Uzbekistan following a short-

age of vaccines immediately after independence. Other outbreaks occurred that year in the Central African Republic, Namibia, Pakistan, and Sudan. Meanwhile, China held its first national immunization days—immunizing 82 million children under four in December 1993 and 83 million children in January 1994. National immunization days also took place in the Philippines and Viet Nam.

By the end of 1994, as many as 36 countries had carried out national immunization days. They included first ever NIDs in Afghanistan, Iran, Lao People's Democratic Republic, Lebanon, Pakistan, Sudan, and Thailand. In Iran, 400 000 trained volunteers from the national youth organization were used to immunize nine million children on a door-to-door basis—all on a single day.

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**In Iran, nine million children were immunized on a door-to-door basis—all on a single day.**

A network of polio laboratories had been established at the global, regional, and national levels to examine stool specimens and identify polioviruses. And over 90 countries were now reported to be using surveillance to monitor the circulation of wild polioviruses. However, WHO warned that surveillance systems were still inadequate in many of the countries where polio was endemic.

In 1994, the number of cases was below 9000—75% of them in just three countries: Bangladesh, India, and Pakistan. On 29 August, three years after the last case in the Americas, an International Commission certified that polio had been eradicated throughout the western hemisphere. Almost 120 countries had now reported zero cases of polio for three years. And there was an encouraging drop in the number of cases occurring in countries which conducted NIDs in late 1993 or early 1994, including China, Pakistan, Sudan, and Viet Nam.

During 1995 there was a marked escalation in efforts to eradicate polio. On 7 April 1995, global media coverage of World Health Day helped refocus world attention on the polio eradication initiative. Its campaigning message—Target 2000: a world without polio—was a reminder to the polio-free countries of the world that tens of thousands of children a year were still being paralysed by polio, most of them in the poorest and most densely populated countries. WHO highlighted the need for top-level political commitment to eradicate polio and appealed for an additional US\$ 100 million a year to ensure that polio could be eradicated on target by the year 2000. To put this amount in context, WHO pointed out that it was less than

half what the United States alone now has to spend on polio immunization each year—to ensure that polio is not reintroduced from polio-endemic countries. So far, most of the cost of polio eradication had been shouldered by the countries themselves. However, as efforts shifted increasingly to the poorest and most difficult countries, a larger percentage of the cost would have to be provided by external sources. Once polio was eradicated, routine immunization could stop, and global savings would amount to US\$ 1.5 billion a year.

World Health Day helped encourage an increasing number of countries to organize national immunization days. By the end of 1995, 62 countries had conducted at least one NID—25 of them for the first time—and a record 300 million children (about half the world's children under five) had been immunized. WHO's Eastern Mediterranean and European Regional Offices organized Operation MECACAR to coincide with World Health Day—immunizing about 56 million children in 18 adjacent countries in the Middle East, Caucasus, and Central Asian Republics. Elsewhere, during the first two weeks of December, 195 million children were immunized during NIDs in China, India, and Pakistan—three countries which together had regularly accounted for most of the world's polio cases. Meanwhile in Africa, routine immunization coverage rose above 50% for the first time.

In 1995, despite outbreaks of polio in Chechnya (Russian Federation), Namibia, Pakistan, and in former Zaire, the number of cases reported was down to 7000—80% fewer than in 1988. Despite greatly improved surveillance, China, which only five years earlier had reported 5000 cases of polio, reported only one case of wild polio-virus, involving a child who had crossed the border from neighbouring Myanmar.

In February 1995, the Global Commission for the Certification of Poliomyelitis Eradication met for the first time in Geneva and established the criteria and procedures for certifying the eradication of polio. The polio eradication initiative was now entering a new phase. As the number of countries carrying out NIDs increased, and the number of cases fell dramatically, countries needed to have in place a highly sensitive surveillance system—capable of detecting the last remaining pockets of poliovirus circulation. Otherwise, they would not be able to move on to the final stage of door-to-door ("mopping up") immunization. And the NIDs—a far more costly strategy—would



**In 1995, routine immunization coverage in Africa rose above 50% for the first time.**

Photo: WHO (20725)

have to continue. By the end of the year, the number of countries conducting surveillance for acute flaccid paralysis (suspected polio) had increased to 120, but only 35 met WHO criteria for satisfactory surveillance.

During 1996, 86 countries carried out national immunization days and ten countries conducted sub-national immunization days. By the end of the year, the number of reported polio cases had dropped to 3995—the lowest on record. In April, polio resurfaced in Albania—almost two decades after the last known case caused by wild poliovirus. Low immunization coverage due to a shortage of vaccines, and weaknesses in the cold chain prior to 1993 were major contributing factors. The outbreak spread to neighbouring Greece and to the Federal Republic of Yugoslavia—reinforcing the need to maintain high levels of routine immunization coverage to avoid re-importations of polio into countries that are polio-free.

The poor quality—and in some cases the absence—of surveillance systems in many countries was a continuing problem during 1996. By the end of that year, 15 of the recently endemic countries had still not officially established a surveillance system for suspected polio. And of the 116 countries where polio is still—or was until recently—endemic, only 25% meet WHO criteria for a satisfactory standard of surveillance. Unless countries can gear themselves up to meet these criteria, they will be unable to supply the proof that polio has been eradicated by the year 2000.

## Highlights in the polio eradication initiative

### **1985**

- The Pan American Health Organization (PAHO) launched an initiative to eradicate polio in the Americas by 1990.

### **1988**

- In May the World Health Assembly resolved to eradicate polio by the year 2000.
- An estimated 350 000 polio cases occurred world-wide

### **1989**

- About 26 000 cases of polio reported world-wide.

### **1990**

- World Summit for Children in New York endorsed the polio eradication goal.
- 25 000 polio cases reported to WHO.

### **1991**

- Number of reported cases down to below 13 500.
- Emerging polio-free zones identified, including the Pacific Rim, southern and eastern Africa, North Africa, the Middle East, and Western Europe.
- Last case of polio in the Americas, involving a three-year old boy in Peru.

### **1992**

- Slight rise in global number of cases—due to a 45% increase in India.
- WHO Revised Plan of Action for polio eradication urged greater political commitment, increased funding, and improved surveillance systems.

### **1993**

- About 10 500 polio cases reported.
- Imported wild poliovirus from the Netherlands detected in Canada but no cases of polio paralysis occurred.
- Outbreaks of polio in Azerbaijan, Central African Republic, Namibia, Pakistan, Sudan, and Uzbekistan.

**1994**

- In January, China immunized 83 million children under four during a mass campaign.
- On 29 August an International Commission certified polio eradication throughout the western hemisphere.
- Number of reported polio cases below 9000 (75% of them in Bangladesh, India, and Pakistan).

**1995**

- In February, the Global Commission for the Certification of the Eradication of Poliomyelitis met for the first time in Geneva.
- On 7 April, World Health Day refocused world attention on the polio eradication initiative.
- 300 million children immunized during national immunization days—about half the world's children under five.
- Outbreaks of polio in Chechnya (Russian Federation), Namibia, Pakistan, and in former Zaire.
- Number of reported polio cases down to 7000—an 80% drop since 1988.
- China reported fewer than 200 polio cases, including only one caused by wild poliovirus (imported from Myanmar). Only five years earlier, 5000 cases were reported.

**1996**

- A record 420 million children immunized during national immunization days—almost two thirds of the world's children under five.
- In December, 118 million children immunized on a single day in India—the largest health event ever organized by an individual country.
- An outbreak of polio occurred in Albania and spread to Greece and the Federal Republic of Yugoslavia.
- Imported wild poliovirus from the Indian Subcontinent detected in Canada. No cases of paralysis involved.
- 3995 polio cases were reported during 1996—the lowest number on record.



**In 1994 polio was certified to have been eradicated throughout the Americas.**

Photo: WHO/PAHO/Armando Waak

### The Americas

In May 1985, the Pan American Health Organization (PAHO)—which also serves as WHO's Regional Office for the Americas—launched a five-year onslaught on polio. It was a bold move. The strategy of maintaining high routine immunization coverage and holding national immunization days had already succeeded in eradicating polio in individual countries—notably in Cuba in 1962—and the number of cases elsewhere in the region had dropped considerably. But could this kind of approach be made to work in densely populated countries like Brazil or in countries like El Salvador or Peru where armed conflict continued to disrupt everyday life and terrorize populations? And could individual governments—especially in the poorest countries—be persuaded to commit scarce health resources to a massive campaign against a single disease?

Over the next six years—up until the last case of polio in Peru in 1991—the Pan American Health Organization and its partner organizations worked with governments throughout the Americas to carry out a massive social mobilization campaign. An information campaign was launched to educate parents about the need for immunization. Millions of health workers and volunteers were mobilized for the immunization effort. Governments throughout the region were urged to make the necessary political and financial commitments. And partner agencies—including the Canadian Public Health Association, the Inter-American Development Bank, Rotary International, UNICEF, and USAID—were asked to provide financial assistance. The US Centers for Disease Control and Prevention provided support for the regional laboratory network. A major innovation was the establishment in every country of an Interagency Coordinating Com-

mittee (ICC), with representatives from major donor agencies and national governments, to ensure that activities were well coordinated.

In addition to organizing national immunization days and door-to-door campaigns, a network of 20 000 surveillance units was established throughout the western hemisphere to provide weekly data on any case of acute flaccid paralysis in a child under 15. A laboratory network was also set up to analyse stool samples and identify poliovirus.

In war-torn countries, negotiators worked with the warring factions to ensure that children's health was not allowed to become another casualty of the war. In El Salvador in 1985 lengthy negotiations were needed before the Government of President Napoléon Duarte and opposition guerillas would consent to a series of one-day truces for immunization. From then on, they were held every year until the war ended in 1991. And in Peru, PAHO organized a press conference to publicize the forthcoming NIDs and ensure that the Shining Path guerillas—as well as the civilian population—were aware of plans to immunize millions of children across the country. Despite uncertainty about the military situation, doctors, nurses, and volunteers ventured into guerilla-controlled areas to help immunize children.

There were many logistical problems too. One was the sensitivity of oral polio vaccine to heat. To retain its effectiveness, the vaccine has to be consistently stored under refrigeration at a temperature below eight degrees. In Peru after the last case of polio, massive quantities of vaccine were needed to immunize two million children at risk. In Lima alone more than 10 tons of ice were needed to preserve the vaccine. In response, local communities rallied round and offered to freeze ice packs in their own refrigerators overnight.

In Colombia in 1984, a massive social mobilization campaign generated a semblance of election fever during the national immunization day. The goal of protecting children against polio paralysis succeeded in uniting people throughout the country as never before. More than 120 000 volunteers were recruited from church organizations, the Red Cross, the police, trade unions, and a range of other organizations to help on the day, and the Colombian President, Belisario Betancur, sat in the operations room, monitoring the results as they were relayed from immunization posts.



**Luis Fermin Tenorio caught polio in 1991—just three years before the disease was certified to have been eradicated in the Americas. His was the last case.**

Photo: WHO/PAHO/Armando/Waak

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**Since August 1991,  
there have been no  
reported cases of  
polio in the Americas  
due to indigenous  
wild polio-virus.**

In 1985 when the eradication campaign was launched in the Americas, about 1000 cases of polio were officially reported in 11 countries within the region. By 1989, only six countries were still reporting cases of polio—Brazil (northeast), Colombia, Ecuador, Mexico (northwest), Peru, and Venezuela. Door-to-door immunization campaigns were carried out in these countries in a bid to reach the children never seen at health centres. In Colombia, for example, more than a million homes were visited between 1991 and 1992. The immunization campaign succeeded in reaching 80% of children in almost 200 counties.

In 1990 only 18 cases of polio were reported throughout the region and circulation of the virus was on the verge of being interrupted. A year later there were only nine cases—eight of them in Colombia and the last in Peru in August 1991. Since then there have been no reported cases of polio in the Americas due to indigenous wild poliovirus.

On 29 September 1994, the International Certification Commission on Poliomyelitis Eradication formally announced that transmission of wild poliovirus in the Americas had been interrupted. The certification was based on the submission of detailed surveillance data supplied by National Certification Commissions from every country throughout the Region.

By the time it was all over, the eradication campaign had cost about US\$ 540 million—80% of it covered by the countries themselves and the rest by donors. But, as the Certification Commission noted at the time, the eradication campaign may have ended, but a new stage—possibly even more difficult—was about to begin. In the long run, it might turn out to have been easier to eradicate polio-virus from the Americas than to maintain a polio-free state.

"There is some disadvantage to being number one", the Commission warned. ". . . being the first region in the world to interrupt wild virus transmission means that these efforts will need to be conducted for as long as the virus is circulating elsewhere."

Meanwhile, the Commission registered some concern about shortcomings in immunization programmes in a few countries. Unless immunization coverage was increased and surveillance systems strength-

ened in these countries, there was a risk that imported poliovirus could become re-established in the Americas.

The most recent detected importation of poliovirus in the Americas—in March 1996 in Canada—again alerted public health officials to the need for continued vigilance. In this case wild poliovirus was found incidentally during laboratory analysis of a stool specimen from a child suffering from diarrhoea and weight loss. The case involved a 15-month old boy from Ontario recently returned from a 3-month stay in India, where he visited the Amritsar District of Punjab State during a polio outbreak. The child had previously been immunized at 2, 4, and 6 months with inactivated polio vaccine (IPV). As a result, he was protected against paralysis but, because he had never been immunized with oral polio vaccine, remained capable of spreading wild poliovirus. Both the boy's immediate family and close contacts were advised to ensure that their polio immunization status was up to date. Surveillance was heightened and there was no further spread of the virus.

The poliovirus isolate was forwarded to the National Centre for Enteroviruses (NCEV) where it was classified as a wild strain virus. Additional sequencing carried out in collaboration with the US Centers for Disease Control and Prevention revealed that the virus was most closely matched to a wild virus from a 1993 case in New Delhi, India.

In an earlier importation to Canada in 1993, wild poliovirus was detected following an active search among a religious community which had contact with a similar group in the Netherlands affected by an outbreak of polio. Out of 45 stool samples, mainly from children, 21 were discovered to harbour wild poliovirus type 3. But there were no cases of paralysis. In 1978, contact between the two groups also resulted in the importation of poliovirus from the Netherlands and 11 cases of paralytic polio in Canada, followed by its spread to the United States.

The early discovery of the two most recent importations of poliovirus (1993, 1996)—in the absence of paralytic illness—highlights the sensitivity and effectiveness of the surveillance system in Canada. But it also underscores the dangers of complacency in the absence of cases and the need for heightened vigilance.

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**The entire Western Pacific Region of WHO is poised to eradicate the disease.**

Today there is concern at the drop in performance of surveillance systems elsewhere in the Americas. During 1996, seven countries in the region failed to meet the minimum requirement of reporting at least one case of acute flaccid paralysis for every 100 000 children under 15. To make matters worse, immunization coverage has declined in some countries in the region—creating pockets of un-immunized children. There remains a question mark over whether these countries would be able to detect a case of imported poliovirus before it was able to spread further afield. Because of this, WHO's Regional Office for the Americas is urging health officials to ensure that their polio surveillance systems are not just good but watertight.

## China

The eradication of polio in the Americas proved conclusively that the eradication strategy worked. But could this regional success story be repeated on a global scale? During 1995, the People's Republic of China—the most populous country in the world—was to prove that it could. As a result, the entire Western Pacific Region of WHO—with a population of 1.6 billion—is now poised to eradicate the disease. Circulation of wild poliovirus is now confined to the Mekong Delta in Cambodia, Laos, and Viet Nam.

During 1989 and 1990, about 10 000 Chinese children were paralysed in a nationwide epidemic. Almost a third of them were under one year old, and over 90% had not been fully immunized. As a result, provincial health departments were given the go-ahead to start supplementary immunization during the winter of 1990. There was insufficient polio vaccine to immunize every child under four each year, so it was left to provincial health departments to decide which counties and age groups to target, as well as the timing and number of immunization days.

Starting in 1990, the Government of Japan provided strong support for the polio eradication initiative in China. This has been provided through the Japan International Cooperation Agency (JICA) in the form of technical experts, supplies and equipment for surveillance and laboratories, and funding of services.

The number of provinces carrying out supplementary immunization increased from 6 out of 30 during the winter of 1990 to 25 by 1992. As a result, the number of cases started to come down each year—

but not enough to interrupt the circulation of the virus. During 1992, China reported almost 1,200 cases of polio—down from almost 25% of the world's cases in 1990 to under 10% within two years. By 1993, 538 cases were reported. In September that year, China's State Council decided that the time had come to hold national immunization days. The target group was to be every child under four.

The logistical challenges were immense. China has a population of 1.2 billion people and about 23 million children are born each year. Today children account for more than a quarter of the population. The Chinese people are spread out over a vast area of 9.6 million square kilometres—including large stretches of difficult terrain. Two thirds of the land comprises mountainous areas, highlands or plateaus. The country is administratively divided into 30 provinces and autonomous regions, with populations ranging from two million to 119 million.

In December 1993, almost a year before the official certification of polio eradication in the Americas, China launched its first ever national immunization day, followed by a second round a month later.

International donors provided about 150 million doses of OPV a year for national immunization days and outbreak response. China supplied a further 100 million doses from local funds for national immunization days—in addition to the 160 million doses it supplies for routine immunization. Most of the vaccine used was produced in China, which has the capacity to produce about 300 million doses a year. Over 90% of the overall cost of national immunization days was met by China itself—with polio vaccine accounting for less than 10% of these costs.

Despite a shortage of cold chain equipment, existing facilities proved adequate to cope with the additional vaccine storage—especially in the north of China where temperatures in winter are below freezing. Even in very remote areas, where village doctors ferried vaccine for several days without ice packs, low temperatures ensured that the vaccine remained potent.

A massive social mobilization effort was launched using the mass media and education campaigns involving volunteers from village committees, women's organizations, and schools. Radio, TV, print and other media were used to get the message across. Every child under



**A health worker on horseback carries polio vaccine to immunize children in sparsely populated areas.**

Photo: WHO/J. Littlewood

four was to be immunized—regardless of their prior immunization status. And it worked. On the morning of 5 December, parents began bringing their young children to immunization posts, and they kept on coming—82 million of them.

In Beijing in December 1993, President Jiang Zemin underlined China's high-level political commitment to polio eradication by administering polio vaccine to some of the children. Many of the children in the first NID—including almost a third of the children under one—had never been immunized against polio before. A month later, in January 1994, when the exercise was repeated, there was an even bigger turnout and a record 83 million children were immunized. The two rounds of immunization days were repeated in December 1994 and January 1995, although this time fewer children were involved (65.6 million targeted in the first round and 66.6 million in the second). Each round was carried out over two days, but in remote areas with difficult terrain, this had to be extended by a few days to enable doctors to reach all the children. In addition, mobile teams carried out door-to-door immunization in remote areas and in areas with migrant communities.

The impact of the national immunization days was both swift and dramatic. During 1994, there were 261 cases of polio, most of them clinically confirmed. A year later 189 cases were reported. But only one of these was found to be caused by wild poliovirus, imported from neighbouring Myanmar. And in 1995, for the first time ever, there was not a single case of indigenous wild poliovirus in China. During 1996, only three cases were reported—all of them imported from Myanmar.

The first imported case of polio in 1995 involved an un-immunized boy of 16 months from Myanmar. His parents brought him across the border into Yunnan Province in southwestern China for hospital treatment after his leg became paralysed. Yunnan Province has a population of 40 million people, including many economic migrants who cross back and forth between China and Myanmar, using both official and unofficial crossing sites along the border. Villages in this northern border area have low routine immunization coverage. To prevent the spread of imported poliovirus in Yunnan Province, about a million children living along the border were given oral polio vaccine during two rounds of supplementary immunization during March and April 1996. Although Myanmar has begun polio eradication activities and



**President Jiang Zemin underlines China's high-level commitment to polio eradication by administering polio drops during a national immunization day.**

Photo: Ministry of Health, People's Republic of China

conducted the country's first national immunization day in 1996, China and Myanmar have launched a special programme to coordinate polio eradication activities across the border between Myanmar and China's Yunnan Province.

Despite China's dramatic success in interrupting transmission of wild poliovirus, there is some concern about the failure to sustain the high turnout of the 1993-94 NIDs a year later, and at the number of children who are believed to have slipped through the immunization net. In May 1996, a WHO review of polio surveillance in 10 provinces in China suggested that the drop in the number of children immunized may have been too readily attributed to a falling birth rate. On top of this, there was concern that some children living among China's numerous large migrant groups may not have been accurately identified and never registered for routine immunization or NIDs. It was found that 10%-20% of eligible children under twelve months consistently failed to be immunized during NIDs. And with an annual birth cohort of about 23 million children, even a 10% failure rate would leave at least 2.3 million children with no protection against polio. The risk is that imported poliovirus could seed itself among this large group of unimmunized children and re-establish the disease in China. To safeguard against this, the review team recommended that, in addition to maintaining high levels of routine immunization, each province should plan to carry out supplementary immunization for at least three years. They also recommended that special efforts be made to immunize children not yet reached by routine or supplementary immunization, especially children from migrant populations. Following three series of national immunization days during 1993-95, China conducted large sub-national immunization days during the winter season of 1996-97 in 25 provinces, targeting 80% of children under four.

The review team also highlighted the need to strengthen surveillance now that the eradication initiative in China has entered a new phase. From now on, a single case of virologically confirmed polio will become a major public health emergency. Although AFP surveillance and the collection of stool samples have improved considerably, there is an urgent need to upgrade the performance of the National Laboratory Network. The team pointed out that while the network has outstanding human resources, there is a serious shortage of supplies and equipment to carry out virus identification and differentiation. In many laboratories, for example, virus identification and



**Following a series of polio national immunization days in China, the disease is on the verge of eradication throughout the country.**

Photo: UNICEF/Sean Sprague (2270/86)

typing is hampered by the lack of high quality antisera. The review team recommended that laboratories at both national and provincial levels should undergo an annual accreditation process. JICA and Rotary International have provided funds to upgrade the polio laboratories, and these are being used for staff training and to purchase equipment and supplies. The Ministry of Health is also working to upgrade the performance of laboratory staff and to obtain funds and equipment. Meanwhile, after the WHO review, surveillance was stepped up and no cases of polio have been reported in China since early 1996.

Another problem is the shortage of cold chain equipment as refrigerators and freezers acquired more than a decade ago begin to deteriorate and eventually break down. To plug these gaps, the World Bank is replacing a large percentage of cold chain equipment in 10 provinces over the next five years. The Government of Luxembourg is also funding an additional US\$ 1.3 million of equipment in five provinces. Meanwhile, the national cold chain equipment testing centre in Beijing, established in 1995, has now been certified as a WHO designated global cold chain testing centre. The testing centre is expected to help improve the range and quality of cold chain equipment in China.



The common factor in outbreaks of polio is a failure to immunize.

Photo: Liba Taylor

## A failure to immunize

The common factor in outbreaks of polio—highlighted by recent epidemics in Albania (1996), Pakistan (1995), Sudan (1993), and in former Zaire (1995)—is a failure to immunize. The reasons for this vary from one outbreak to another, but in each case the existence of a group of non-immunized individuals has enabled poliovirus to seed itself and spread widely. The size of the group can range from a small isolated group which refuses vaccine on religious or cultural grounds to entire birth cohorts in countries bereft of vaccines.

In some of the poorest countries, low immunization coverage is often due to poor health infrastructure development and a failure to reach the majority of the population with basic health services. It may also be the result of a drop in donor support for vaccines (Pakistan, Sudan), or a political upheaval that disrupts existing health systems and interrupts the supply of vaccine (Albania). Elsewhere, in countries beset by civil war, immunization rapidly becomes a low priority and vaccine supplies may dry up. Even when emergency supplies of vaccine are made available (in Afghanistan and Sudan, for example), children on the move or trapped inside the conflict zone become increasingly difficult to reach—with not just one but a full complement of four doses of oral polio vaccine before their first birthday.

In Albania, a drop in immunization coverage in the early 1990s was compounded by a build-up of children who were given vaccine that turned out to be ineffective due to breaks in the cold chain. Maintenance of the cold chain can be thwarted by war, neglect, political upheaval, or by a sudden drop in donor support.

Low immunization coverage may also be the result of missed opportunities for immunization in countries where doctors subscribe to a list of unnecessary contraindications. In Azerbaijan, for example, which had an outbreak of over 70 cases of polio in 1993, a seven-month stoppage in vaccine supply, following independence, is believed to

have been compounded by needless delays in immunizing children due to false contraindications.

When one or more of these conditions is in place, the introduction of poliovirus is the final spark that is needed for an outbreak of polio. The source of the virus may be indigenous, as in the case of Pakistan, or imported—possibly by a visitor from another country—into a polio-free country like Albania.

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**Outbreaks of polio can be caused by the importation of poliovirus—possibly by a visitor from another country.**

### Sudan, May 1993

In May 1993, polio cases were reported in Nyala, a large town of over 220 000 people in western Sudan. By the end of the year the outbreak had spread throughout Sudan—with over 250 cases reported in all but one of the country's (then) nine states. Hardest hit was Darfur State where the first cases occurred. The region was still reeling from the effects of a recent drought and a large influx of people displaced by the civil war. Only 20% of children were fully immunized against polio.

Of the 252 confirmed cases nationwide, almost 40% were vulnerable to infection because they had received only one dose of OPV. Information on injection history—which was available for 65 of the children—revealed that as many as 52 (80%) had received an intramuscular injection (most commonly chloroquine to combat malaria, or penicillin) around the time they became infected with polio. Intramuscular injections are believed to heighten the risk of paralysis during infection with poliovirus.

Stool specimens from suspected cases were sent to the National Health Laboratory in Khartoum and poliovirus type 1 was isolated from 19 out of 23 specimens. The poliovirus isolate was then sent on to a WHO-accredited regional reference laboratory in Cairo where it was confirmed as a wild virus. Finally, studies of the genetic sequencing of the virus at the Research Laboratory for Infectious Diseases (RIVM) in the Netherlands and at the Pasteur Institute in Paris revealed that the virus was most closely related to one found during a concurrent polio outbreak in the Central African Republic.

Each of the affected provinces carried out limited immunization among high risk groups of children after the outbreak began, but records of the coverage achieved were usually not kept. In Nyala, where the

first cases occurred, 82% of children under five were immunized in June 1993 but only 27% received a second dose a month later.

In early 1994, two rounds of national immunization days were implemented throughout Sudan. In conflict zones in the troubled South of the country, safe areas or "corridors of peace" had to be negotiated before immunization could go ahead in contested areas. In the first round of national immunization days, 88% of under-fives were immunized against polio and 65% in the second. Measles vaccine and vitamin A were also given in the second round. The following year the mass campaign had to be suspended due to the lack of funds for vaccine purchase. National immunization days were resumed in 1996 after donations of vaccine from Rotary International and the US Centers for Disease Control and Prevention. Immunization coverage was reported to be over 90% for both rounds in the northern provinces but as low as 17% and 10% in the South.

The main reason for the 1993 outbreak was continuing low immunization coverage and a build-up of children susceptible to polio. Coverage with three doses of OPV had dropped from a peak of only 62% nationwide in 1990 to 52% by 1993. In Darfur State, only one in five children was fully immunized. The declining coverage was blamed on a drop in donor funding for immunization, failure to sustain a resource-intensive strategy of mobile teams, and poor management. As a result, the vaccine delivery system—involving resource-intensive mobile teams of health workers—could no longer be sustained. The situation was compounded by a recent drought and by large movements of people displaced by the war.

In response to the 1993 polio epidemic, the Sudanese Government has reorganized its national immunization programme. Fixed immunization posts have been established, using local health posts and health centres that are within walking distance of communities. A social mobilization campaign was mounted to inform communities about the change of strategy—carried out by the mass media, Sudanese Red Crescent Society, women's organizations, youth clubs, and non-governmental organizations. Meanwhile, responsibility for health services was devolved from national to state level as 17 additional states were established. This ensured that immunization programme staff at state level were responsible for managing smaller areas.



The 1993 outbreak of polio in Sudan was the result of low routine immunization coverage.

Photo: WHO/UNICEF/R. Lemoyne (21852)

To ensure that all vaccines used are effective, a network of 230 solar refrigerators for cold storage of vaccines was established throughout the country—donated by USAID, GTZ (the German Technical Agency for Development Cooperation), Save the Children, and UNICEF. The solar-powered refrigerators replaced aging kerosene or gas refrigerators and helped establish a cold chain for the first time in areas with no electricity, kerosene, or gas.

## Pakistan, May 1995

Between May and August 1995, there was a sharp increase in the number of polio cases reported among young children in the Lahore and Sheikhpura districts of the Punjab in Pakistan. The outbreak was unexpected because Pakistan had just completed its second round of NIDs. A year earlier after the first round of NIDs the number of cases had fallen by 70%.

Of the 70 children involved in the latest outbreak, almost 80% were under two, and only one was over five. Over half of them had received two doses of polio vaccine during the recent NIDs, in each case at least three weeks before the onset of paralysis. Was it possible that the children had been given a vaccine of reduced potency? Had there been a break in the cold chain somewhere along the line?

As the Centers for Disease Control and Prevention in Atlanta analysed stool samples to identify the virus, WHO sent a fact-finding mission to the Punjab to determine the cause of the outbreak. This included detailed investigations of suspected polio cases, including interviews with parents to review medical histories and immunization records. It also involved a detailed review of hospital records, immunization coverage, the vaccine supply, and surveillance data over the past three years.

Logistical problems in delivering the vaccine during the NIDs were quickly ruled out. Vaccine lots for each of the two rounds had arrived in Pakistan less than a week before the scheduled date for each NID and breaks in the cold chain were unlikely. Moreover, detailed analysis of patient records and surveillance data revealed that the polio outbreak had started not immediately after the NIDs but several weeks before. It was highly probable that some of the children were already incubating the disease when they were immunized during the NIDs. The data also showed an increase in polio cases in other districts

immediately before the NIDs—indicating that wild polio virus transmission had never been interrupted in the Punjab.

A closer look at 64 of the children's immunization records revealed that, although just over half had been immunized during the national immunization days, less than a third of them had received at least three doses of polio vaccine during routine immunization, and almost half had never been immunized against polio. Routine immunization coverage data indicated that the problem was widespread in the Punjab. Between January 1993 and June 1995, coverage with three doses of OPV among children less than one, plummeted from 80% to 25% in Sheikhpura district and from 79% to 59% in Lahore. Throughout the Punjab as a whole, polio immunization coverage dropped from 81% in 1993 to 40% in 1995.

The reason for this drop in coverage was not difficult to work out. Records of the supply of oral polio vaccine for routine immunization in the Punjab revealed that supplies had been frequently interrupted—partly due to a drop in donor funding. Between July 1994 and June 1995, Punjab received only 13% of the total number of doses that the provincial health authorities had requested. As immunization coverage fell, the scene was set for the build-up of a group of unimmunized children large enough to seed an epidemic. The national immunization days had not been enough to halt the epidemic—possibly because they were carried out during the high season for polio transmission, and at a time when an outbreak was already under way. The final piece of the puzzle fell into place when the Centers for Disease Control and Prevention completed the genetic sequencing of the poliovirus involved in the epidemic—confirming that it was wild poliovirus type 1 and indigenous to the India-Pakistan subcontinent.

Since this outbreak, Pakistan has continued to conduct national immunization days and circulation of wild poliovirus has been reduced.

## Albania, April 1996

There was a massive turnout on 8 April 1996 when almost every child under five was immunized against polio during Albania's first national immunization day. It was a precautionary measure. For over a decade the country had experienced no confirmed cases of indigenous polio. The last clinically confirmed case occurred in 1983 but the virus involved was never identified. Indigenous "wild" virus had not been found in Albania since the last epidemic in 1978.

But epidemiologists from WHO and national authorities were aware that while Albania had succeeded in closing the door against polio, the door had not yet been securely bolted. Political and social upheaval during the early 1990s had created the ideal conditions for a re-emergence of the disease.

After the fall of communism, Albania opened up its once hermetically-sealed borders to the rest of the world—introducing the risk of imported disease. Internally, the lifting of travel restrictions sparked off large population movements to urban centres—placing additional strain on already poor hygiene and sanitation systems. To make matters worse, routine immunization coverage in some areas had plummeted when the supply of vaccines was interrupted during the political upheavals of the early 1990s—leaving many young children vulnerable to polio and other infectious diseases. There was also evidence that, up until 1993, heat-sensitive polio vaccine had not been consistently stored under refrigeration—and children may have been given heat-damaged vaccine. Small clusters of children with unexplained paralysis added to the growing unease.

If poliovirus was reintroduced into Albania, epidemiologists knew that it could circulate rapidly among the sizeable pool of children who weren't fully immunized. By the time the first case of polio paralysis emerged, the virus would be already well established.

To close this gap in immunity, the Albanian Ministry of Health organized two national immunization days in consultation with WHO and UNICEF. But it was already too late. Little more than a week after the national immunization days, the first case of polio paralysis was reported—in a child of 12 months. Three more cases were reported during May and a further eight cases in June.

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**In 1978, Albania succeeded in closing the door against polio ... but the door had not yet been securely bolted.**

Virologists at the Institute of Public Health in Tirana collected faecal samples from suspected polio cases and succeeded in isolating poliovirus type 1. These findings were later confirmed by the regional reference laboratory network (the Istituto Superiore di Sanità in Rome, the National Institute of Public Health and Environmental Protection (RIVM) in Bilthoven in the Netherlands, and the National Institute of Public Health in Helsinki). But where had the poliovirus originated?

The laboratory search was initially hampered by the presence of vaccine virus in some of the original samples—a normal finding after NIDs. The first two cases involved young children who had been immunized during the recent national immunization day. At first virologists weren't sure whether they were dealing with individual cases of polio caused by a vaccine virus or by a wild virus. But when the number of cases increased during the summer months (13 cases in July, and 27 cases in August), it became clear that most were in the 10-30 age group—not among recently-immunized children. In this case it was highly improbable that a vaccine virus was to blame. As more faecal samples were made available, virologists succeeded in identifying both the type and most likely source of the virus. It was a wild poliovirus with a genetic make-up that revealed it originated in Asia, most probably in the India-Pakistan subcontinent. The NID on 8 April had been coincidental and not the catalyst for the outbreak. And it had succeeded in protecting the youngest children. Re-analysis of samples from the early cases confirmed that both wild and vaccine virus were present.

By early October there were 109 confirmed cases of polio in Albania and 12 people had died. The ages of those affected ranged from four months to 47 years but most cases (almost 70%) were among teenagers and young adults. By July the outbreak had spread to neighbouring Greece (5 cases), and over the next three months 24 cases were confirmed among children under three in the Kosovo-Metohija area of the Federal Republic of Yugoslavia (Serbia and Montenegro). Concern grew over the possible spread of poliovirus by the large number of migrant workers who travel back and forth to Albania. An estimated 700 000 Albanians live in neighbouring countries—mainly Italy, Greece, the Federal Republic of Yugoslavia, and the Former Yugoslav Republic of Macedonia.



**Over three million people were targeted in a mass immunization campaign against polio launched after the 1996 outbreak in Albania.**

Photo: UNICEF/Eileen Kovchok (HQ96-0675)

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**In WHO's European Region there have been outbreaks of polio every year for the past five years.**

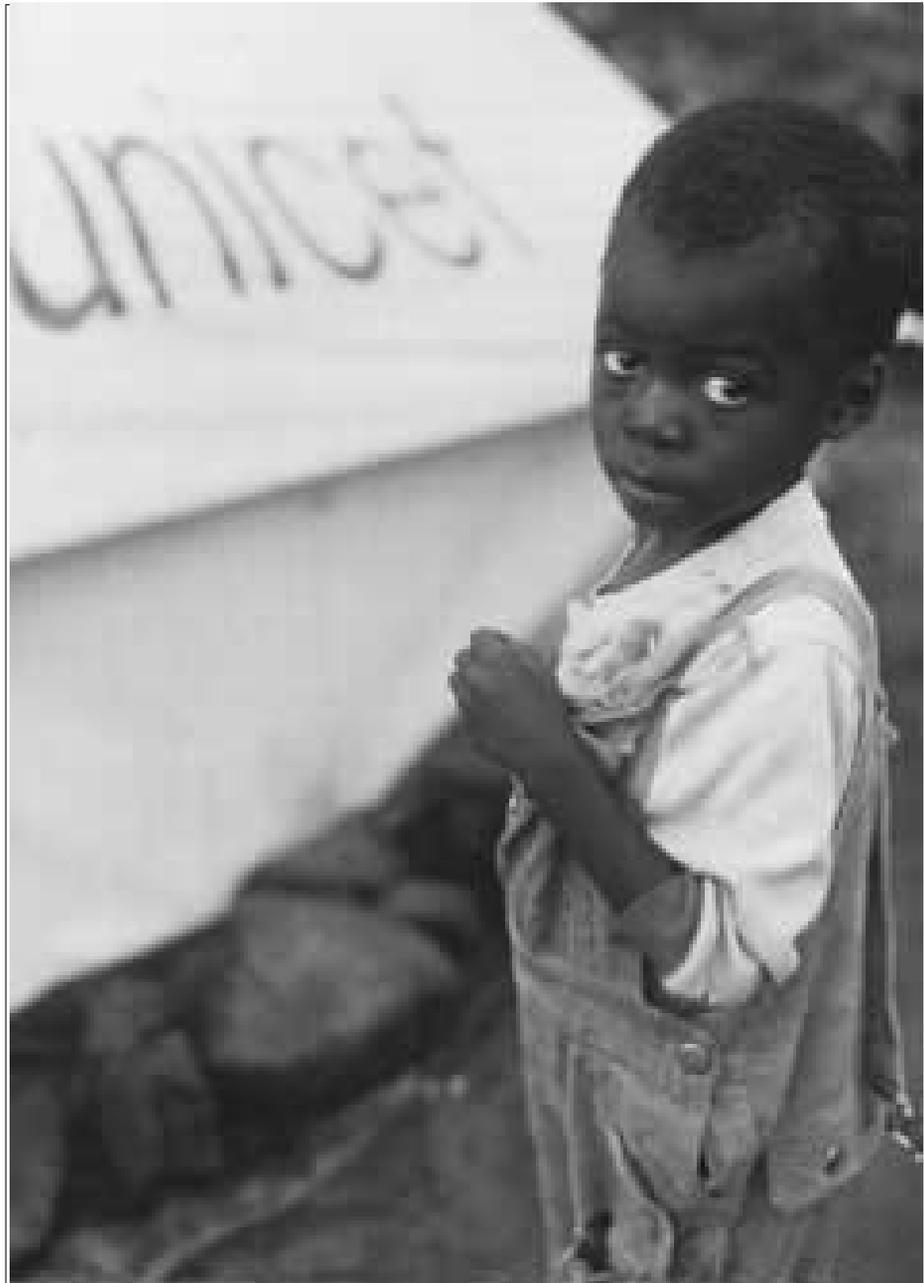
As donated polio vaccine began arriving in Albania in October for the first round of a mass immunization campaign targeted at the entire population under 50 (over three million people), a joint appeal was launched by WHO and UNICEF for US\$ 1.3 million to help fund a second round a month later. Some of the money was also earmarked for efforts to improve early detection of new cases and strengthen local case management capacity, as well as to stop the possible spread of the virus to other countries. Meanwhile WHO advised all neighbouring countries to review contingency plans for dealing with possible outbreaks in the region.

In September and November, over 200 000 children under five were immunized during mass campaigns in the Kosovo and Metohija regions of neighbouring Yugoslavia, and a further 460 000 children aged 5-14 were immunized in school-based programmes. In Greece, the five cases of polio were among non-immunized children from a minority ethnic group living in the Salonika and greater Athens areas. Supplementary immunization was made available to this group of people, who are known to have had very low immunization coverage. Elsewhere, supplementary immunization was also carried out in Bosnia and Herzegovina and in the former Yugoslav Republic of Macedonia. To prevent any further importations of wild poliovirus, national immunization days are scheduled for spring 1997 in six countries in the region.

By the end of 1996, 139 cases of polio had been reported in Albania and 16 people had died. The outbreak in the Federal Republic of Yugoslavia involved 24 cases and there were five cases in Greece. The polio outbreaks in the three neighbouring countries were a sharp reminder of the ease with which poliovirus can be reimported into a country and seed itself among vulnerable groups with no immunity to the disease. Although WHO's European Region has high levels of immunization coverage overall and a low incidence of polio, there have been outbreaks every year for the past five years. Political and economic change, with or without armed conflict, have triggered outbreaks in Tajikistan (1991), Azerbaijan (1993), Uzbekistan (1994), and Chechnya in the Russian Federation (1995). Elsewhere, low immunization coverage among minority populations and religious "refusers" helped seed outbreaks in Bulgaria (1991) and the Netherlands (1992). Each of these outbreaks was caused by the importation

of a virus that originated in Asia. In 1995, 210 cases of polio were reported in WHO's European Region, and 188 cases in 1966.

The current programme of national immunization days in Bangladesh, India, and Pakistan is expected to lead to a dramatic reduction in the number of cases and lower the risk of exportation of wild polio-virus from South Asia. Meanwhile, the continuation of Operation MECACAR in 18 neighbouring countries in the Middle East, Caucasus, and Central Asian Republics should interrupt the circulation of the virus within these countries as well as its export to other European countries.



**UNICEF has played a key role in helping negotiate ceasefires in conflict zones to enable routine immunization of children to be carried out.**

Photo: UNICEF/Giacomo Pirozzi (00196-0110)

## A ceasefire for children

One of the greatest threats to polio eradication is armed conflict. And it is on the rise. Since the end of the Second World War, there have been more than 150 major conflicts—most of them civil wars and the majority in developing countries. As the number of internal conflicts has escalated, civilians have been increasingly targeted and millions of refugees and displaced persons forced to take flight. Children are especially vulnerable. Thousands are killed or maimed every year by bombs, bullets, and landmines. But many more children fall victim to a war-related upsurge in malnutrition and vaccine-preventable diseases.

In Afghanistan, a survey in Kandahar province, one of the most heavily mined areas in the country, revealed that the most frequent cause of disability among children was not landmines—which kill more often than they maim—but polio. The 1996 study, by Handicap International and the Catholic University of Louvain in Belgium, found that one in 200 children under 15 was disabled by polio paralysis. A parallel survey on the level of routine polio immunization coverage among children aged 1-3 years in Kandahar found that only 13% were fully immunized.

In some regions, countries have been literally gutted by years of bloody conflict and neglect. Roads, vehicles, hospitals, health centres, and vaccine-storage refrigerators have been destroyed or fallen into disrepair—making it impossible to deliver routine immunization. Transportation systems grind to a halt when supplies of fuel and spare parts dry up. Water and sanitation systems no longer function—adding to the risk of transmission of disease. In Peru in 1991, the last case of polio in the Americas involved a three-year-old boy, Luis Fermin Tenorio, who was unable to complete his polio immunization after the local health centre was destroyed by guerillas. In a number of countries, the disruption of immunization services has triggered out-

breaks of polio and other vaccine-preventable diseases. In war-torn Chechnya in the Russian Federation there were 150 cases of polio in 1995—following a 3-year stoppage in immunization. In Iraq, there was an upsurge in polio cases in the aftermath of the Gulf War. The number of cases leaped from 10 in 1989 to over 120 in 1992. But the number of cases may have been even higher in 1992 as many cases went undetected following the collapse of the surveillance system. The imposition of long-term sanctions on Iraq by the international community also had an unintended detrimental effect on child health. Although medical supplies were exempted, political disputes and administrative delays resulted in critical shortages of essential drugs and vaccines.

Elsewhere, the mobility of refugee populations and internally displaced persons continues to hamper efforts to organize and follow-up both routine immunization and national immunization days—leaving many children only partially immunized and therefore unprotected. The United Nations High Commissioner for Refugees (UNHCR) estimates that in 1996 as many as 50 million people throughout the world had been uprooted from their homes—almost 1% of the world's population. The UN refugee agency is today assisting 26 million refugees and returnees—the victims of war and persecution. About 80% of them are women and children. In Mozambique, during a decade of conflict that ended in 1993, 800 000 children were internally displaced and 450 000 fled to neighbouring countries. At least 200 000 were orphaned or separated from their families. The carnage in Rwanda in 1994, which claimed up to one million lives, prompted one of the largest refugee movements in history. Over two million people fled their homes—many escaping to neighbouring countries. Hundreds of thousands of people returned to Rwanda in late 1996—too late to benefit from polio national immunization days held in June that year. By the beginning of 1997, many Rwandans were still on the move and unaccounted for—the immunization status of their children unknown.

Polio will be eradicated globally only when transmission of polio-virus has been halted in every country throughout the world. This strategy allows for no exceptions—including countries at war. If the polio eradication target is to be met on time by the year 2000, immunization must be carried out in conflict zones. The polio eradication initiative does not have time on its side.



**The mobility of refugee populations continues to hamper efforts to organize and follow up both routine immunization and national immunization days.**

Photo: UNICEF/Betty Press (DO194-0175)

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**In 1985 in El Salvador the number of children dying from vaccine-preventable diseases surpassed the number of people killed in the war.**

For more than a decade, efforts have been made to provide routine immunization for children caught up in the midst of wars. The need for this humanitarian intervention—not just for routine polio immunization but for other vaccine-preventable diseases as well—was first highlighted in 1983 by Nils Thedin, former head of Rädde Barnen, the Swedish Save the Children organization, and a member of the Executive Board of UNICEF.

At a time when children were affected by over 70 conflicts worldwide, Nils Thedin urged UNICEF to promote the idea of children as a "conflict-free zone in human relations". His idea took root and was the inspiration behind a series of negotiated ceasefires and "days of tranquillity" when children could be immunized. For one day at least the shots would be for protection, not slaughter. Elsewhere the idea was translated into the creation of demarcated safe zones or "corridors of peace".

The first time the strategy was attempted was in El Salvador in 1985, where—despite an ongoing war between government forces and rebel guerillas—President Napoléon Duarte was keen to boost routine immunization coverage from an all-time low of only 3%. At the time, the number of children dying from vaccine-preventable diseases in El Salvador surpassed the number of people killed in the war. But to achieve this goal, immunization would have to be extended to rebel-held areas of the country as well. UNICEF asked the Vatican to intervene and appoint an intermediary who could negotiate with the rebels and initiate a temporary ceasefire.

What followed was a three-month period of Church-sponsored, often tortuous negotiations involving the government, army, guerilla groups, the International Committee of the Red Cross (ICRC), the Salvadoran Red Cross, and WHO's Regional Office for the Americas. At first there was distrust among guerilla leaders who feared that a ceasefire would be used by the government to pinpoint guerilla strongholds and flush out rebel forces. In the end trust prevailed and the immunization campaign went ahead—not just in 1985 but each year until the war ended in 1991. On three days a year in consecutive months as many as 20 000 health workers and volunteers—including some from the guerilla forces—immunized 250 000 children against polio, measles, diphtheria, tetanus, and whooping cough. By the time the six-year campaign had ended, immunization coverage had surged from 3% to 80%.

Over the next decade, as more and more children were caught up in the stranglehold of war, the strategy of negotiating a ceasefire for children took hold. In 1986 it was tried again, this time in Uganda, where the Ugandan Government's National Liberation Army was engaged in a bitter conflict with President Yoweri Museveni's National Resistance Army. After lengthy negotiations, a geographical zone or "corridor of peace" was established for the first time ever—to allow the safe passage of vaccines, personnel, and equipment.

A year later it was Lebanon's turn to organize days of tranquillity and immunize its children. UNICEF worked for more than a year to negotiate a three-day ceasefire across the country—involving more than 120 groups to ensure that every possible faction was on board and agreed to participate. Immunization posts were established throughout the country. Vaccines, syringes, and cold chain equipment were supplied by UNICEF and the World Health Organization, the warring factions provided transportation and logistics, and health workers were provided by the International Committee of the Red Cross.

The success of these earliest attempts to negotiate a way to immunize children in the midst of war paved the way for a major humanitarian relief effort in Sudan in 1989. The country's civilian population was reeling from the effects of a protracted civil war and by a drought in 1988 that claimed 250 000 lives and uprooted nearly three million people. Between 1986 and 1988 as many as 500 000 people are believed to have died from disease and starvation. Many of the attempts by humanitarian agencies to provide relief were regularly blocked by the warring factions. But in 1985, the World Council of Churches had helped negotiate a temporary ceasefire to enable relief supplies to be delivered to children trapped for seven months inside the besieged city of Malakal in the south.

In early 1989, a UN-sponsored meeting in Khartoum, involving Sudanese officials, donors, and international organizations, drew up a plan of action. The aim was to provide over 100 000 tons of food, immunization, and essential drugs. The difficult task of "selling it" to both sides went to the UN-appointed lead agency, UNICEF. The rebel groups rejected outright any idea of a ceasefire but agreed to the establishment of eight corridors of peace in the conflict zone. They would guarantee the safe passage of food and medical supplies for an initial period of one month (later extended). In the end, Operation Lifeline Sudan completed this first stage of the relief effort within six



In El Salvador from 1985 to 1991, one-day truces were negotiated for immunization against polio and other diseases.

Photo: UNICEF/Balazar, 1983

months—making use of some of the distribution systems already built up by non-governmental organizations. Immunization posts were established in every garrison town and more than 90 000 children immunized in areas controlled by the Sudan People's Liberation Army (SPLA).

Significantly, in 1995, the SPLA became the first rebel army in dispute with a recognized government to commit itself to abide by the provisions of the 1989 Convention on the Rights of the Child which includes a commitment to "take all feasible measures to ensure protection and care of children who are affected by armed conflict." The success of Operation Lifeline Sudan, a massive US\$ 400 million international relief effort, led to the creation of relief corridors in other war-torn countries in Africa, including Ethiopia, Angola, and Liberia.

By 1990 the concept of a ceasefire for immunization and other relief services for children was an idea that had arrived. At the World Summit for Children in New York in September that year 159 nations put their weight behind a declaration and plan of action that endorses the need for days of tranquillity and relief corridors. The World Declaration on the Survival, Protection and Development of Children states that:

"The essential needs of children and families must be protected even in times of war and in violence-ridden areas. We ask that periods of tranquillity and special relief corridors be observed for the benefit of children, where war and violence are still taking place."

The World Summit Plan of Action also endorses special measures such as days of tranquillity and corridors of peace, adding that:

"Resolution of a conflict need not be a prerequisite for measures to explicitly protect children and their families to ensure their continuing access to food, medical care and basic services, to deal with trauma resulting from violence and to exempt them from other direct consequences of violence and hostilities."

This was formal international recognition at last for groundbreaking efforts to mediate between warring factions to ensure that children were not spared the gun only to succumb to a vaccine-preventable disease. The mediators included UNICEF, the World Health Organization, the International Committee of the Red Cross, national Red Cross societies, church leaders, trade unions, and a wide range of other groups.

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**During the assault on Jaffna in 1995, polio vaccine was passed across the front lines so that children on both sides could be immunized.**

And the work goes on ... In 1993 in the Philippines, rebel groups agreed to a ceasefire and brought their children to be immunized during a national immunization day. The Department of Health spent four months planning the logistics and social mobilization for the nationwide campaign, which also provided opportunities for immunization against measles for children aged 9-24 months, as well as the country-wide distribution of six million doses of vitamin A. Some children were also given other EPI vaccines (BCG, DTP) to catch up on missed immunizations, and women aged 15-44 were offered tetanus toxoid vaccine. Over nine million children were immunized against polio in two rounds of NIDs in April and May. Coverage for both NIDs was about 90%, and even in the areas with continuing rebel activities, over 80% of children were reached. Further NIDs were conducted in 1994 and 1995 and no cases involving wild virus have been identified since 1993.

In Sudan in 1994, relief corridors were again used to transport vaccines and other medical supplies to children on both sides of the conflict, following outbreaks of polio and measles. And in November 1994 in war-torn Afghanistan, where fewer than 25% of children were immunized against polio, the World Health Organization announced a jihad to fight vaccine-preventable diseases. WHO worked in collaboration with the Ministry of Health, UNICEF and non-governmental organizations to broker a one-week truce for immunization. Polio and other vaccines were provided in the provincial capitals, but elsewhere were only available in districts with an established cold chain. During 1997, Afghanistan is to hold its first nationwide mass immunization campaign against polio. In 1996 relief corridors were again used to deliver vaccines in southern Sudan. And in 1995 and 1996, the Sri Lankan Army and Tamil Tigers suspended hostilities to allow their children to be immunized. During the assault on Jaffna in November 1995, polio vaccine was passed across the front lines so that children on both sides could be immunized.

Although internationally brokered truces to boost routine immunization coverage are the ones that have been best documented, most of the ceasefires for polio eradication activities have been both low profile and unofficial. In Cambodia, Iraq, India, Myanmar, Turkey, several Latin American countries, and elsewhere, polio vaccine was made available as a result of unofficial truces in areas with rebel activities. In some cases health workers agreed to hand over polio vaccine in cold boxes so that rebel groups could immunize their own children. This pragmatic approach to Nils Thedin's visionary idea of days of tranquillity has enabled health workers not only to immunize against polio inside a conflict zone but also to provide access to additional health services not otherwise available to insurgent groups.

There is no firm evidence that a truce for immunization has been the spark that led to lasting peace in any of the conflicts involved. But on each occasion combatants have been united in one thing—a need to secure their children's future. And even a fleeting glimpse of peace must serve to highlight the futility of war—if only for a day.



**Rotary has organized social mobilization campaigns for polio immunization.**

Photo: Rotary International/Richard Franco

## The Rotary crusade

In 1985, when Rotary International launched its 20-year crusade to help immunize every child against polio, the public health community doubted Rotary's long-term commitment as well as its ability to do the job. At the time, this private sector service organization had scant experience of operating within the public health sector. Most projects were community-based and organized by individual Rotary clubs. Apart from youth exchanges and educational programmes, Rotary had never orchestrated anything on a global scale.

Today, Rotary has confounded the early sceptics and enhanced its international reputation as a private sector service organization. It enjoys consultative status with the World Health Organization and in 1993 was awarded WHO's prestigious "Health for All" Gold Medal. In December 1996, Rotary was the first to receive the Children's Vaccine Initiative (CVI) Jenner Award for recent outstanding contributions to immunization. The CVI award was in recognition of the fact that Rotary has not only provided major funding for the polio eradication initiative, but also mobilized millions of volunteers to help carry out mass immunization campaigns.

For over a decade, Rotary International has funded the purchase of massive quantities of polio vaccine for both routine immunization and national immunization days, carried out social mobilization campaigns at community level and provided critically needed organizational skills for immunization campaigns. Rotary volunteers have also helped equip and maintain a refrigerated cold chain for vaccine transport and storage for national immunization days and mobilized millions of volunteers to man immunization posts and even administer polio drops to children. Today Rotarians are increasingly involved in advocacy work and in the development of effective surveillance systems.

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**Over the past decade,  
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nized against polio ...**

During India's first ever national immunization days in December 1995 and January 1996, Rotary contributed US\$ 5 million for vaccine costs and mobilized 100 000 of the two million volunteers who helped operate 500 000 immunization posts throughout India over the two days. As many as 87 million and 93 million children were immunized on the two days. In Peru, a decade earlier, 11 000 volunteers offered their services as home visitors, vaccinators, drivers, cooks, data analysts, and publicists. Rotarians also estimated that they secured US\$ 440 000 worth of free advertising, transport, and supplies for national immunization days in Peru. Elsewhere, in China, where there are no Rotary clubs, the organization gave a US\$ 15 million grant for the construction of a factory for the local manufacture of polio vaccine. More recently, Rotary has provided funds for the global polio laboratory network—supplying equipment and training laboratory workers.

Over the past decade, Rotary International has worked with WHO, the US Centers for Disease Control and Prevention (CDC), UNICEF, and other partners in helping immunize over a billion children against polio. As a result, an estimated 2-3 million children who would otherwise have been disabled by polio are now able to run, walk, and play normally.

Rotary's involvement began in the late 1970s with a five-year commitment to immunize six million children in the Philippines. The campaign was the first project under Rotary's newly launched Health, Hunger, and Humanity Programme (the 3-H programme) and paid for out of a US\$ 7.5 million 75th Anniversary Fund. The 3-H programme was designed to meet the growing need for humanitarian assistance throughout the world, on a scale that individual Rotary clubs or even districts could not undertake. In the Philippines, Rotary International proved—not just to its own membership but to the international community as well—that it could successfully work with a national Ministry of Health to immunize children. Within four years, additional polio projects had been approved in Haiti, Bolivia, Morocco, Sierra Leone, and the Gambia. Each was a five-year project—providing protection against polio for a total of seven million children.

From then on there was no looking back. In 1982, Rotary International began planning its most ambitious programme ever—to immunize all the world's children against polio by the year 2005, the organization's 100th anniversary year. Rotary had no illusions that it

could do the job single-handedly. The idea was to work in collaboration with international, national, and local health agencies to promote this global immunization effort and help carry it out.

Rotary International was well placed to launch its ambitious plan. Founded in the United States in 1905, its 1.2 million members are business and professional men and women with a commitment to volunteer service. With a global network of over 28 000 Rotary clubs in 155 countries, it has the capacity to mobilize both funds and volunteers and to galvanize public opinion behind efforts to eradicate polio. Over the years it has exercised these skills to the full.

With advice and support from the late Dr Albert Sabin, Rotary International established its new programme—PolioPlus—in 1985. A US\$ 120 million fund-raising effort was launched to fund the purchase of vaccine for a five-year immunization campaign. Nothing was left to chance. A firm of fund-raising consultants was engaged, over 40 fund-raising committees established, and almost 4000 Rotary volunteers mobilized to brief other Rotarians on the need to raise funds for polio eradication. For the first time ever, Rotarians looked beyond their own membership circle to raise funds. And even they were astounded at how successful they were. Within two years they had raised more than twice the original target—US\$ 247 million.

In the meantime, Rotarians continued to help immunize children against polio. Rotary International established a five-member Immunization Task Force which worked with professional staff to create immunization manuals that could be used by community volunteers throughout the world. To convince WHO that it could be an effective partner in immunization, Rotary organized NIDs in Paraguay—a small country with about 100 cases of polio a year. Within five years Paraguay was polio-free. Next, Rotary set out to prove that it could repeat this success on a much bigger scale. In Mexico in 1987, more than 200 000 volunteers were mobilized by Rotary International to help with a national immunization day which succeeded in reaching 13 million children. Within four years polio had been eradicated in Mexico. In 1988, as global immunization coverage increased and the strategy of polio eradication was shown to be working in the Americas, 166 nations committed themselves at the World Health Assembly to the goal of polio eradication by the year 2000.

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**... As a result, an estimated 2-3 million children who would otherwise have been disabled by polio are now able to run, walk, and play normally.**



Rotary International has helped organize mass immunization campaigns against polio.

Photo: Rotary International

Between 1988 and 1990, Rotary worked closely with the Pan American Health Organization (PAHO) in supporting national immunization campaigns in 27 countries in South and Central America and the Caribbean. In Colombia in 1989, Rotarians launched a social mobilization campaign, working with UNICEF and the Pan American Health Organization, to inform local government officials of the crucial importance of polio immunization campaigns. And a year later Rotarians in Ecuador negotiated with local health workers to avert a threatened strike that would have prevented national immunization days.

Because of its non-governmental status, Rotary has played a key role in cross-border immunization efforts (Colombia-Venezuela and Ecuador-Peru) and in the delivery of vaccine in no-go areas during conflicts in El Salvador, Nicaragua, and Peru. Elsewhere, in both Bulgaria and Romania, Rotary volunteers succeeded in convincing minority ethnic groups to participate in national immunization days—despite these groups' deep-seated distrust of government programmes.

Meanwhile Rotary volunteers from one country have made themselves available to provide advice as well as practical assistance to Rotarians elsewhere. In 1985, Paraguayan Rotarians with experience of door-to-door ("mopping up") immunization campaigns in their own country taught these skills to Rotarians in Brazil.

More recently, in 1995, Rotary provided most of the vaccine needed for the first year of Operation Mecacar—a 3-year campaign to immunize 58 million children in 19 adjacent countries in the Middle East, Caucasus, and Central Asian Republics.

However, over the past two years, Rotary's support for polio eradication has focused less on vaccine supply (although it continues to provide large quantities of vaccine for NIDs) and more on advocacy work, social mobilization, and surveillance. The change of emphasis is a pragmatic one—based on a need to make the best use of available funds. In 1995, WHO estimated that an additional US\$ 120 million a year would be needed over the next five years—over and above the existing contributions of governments and donors—in order to eradicate polio by the year 2000. Almost 70% of this money was earmarked for vaccine purchase. With Rotary committed to providing US\$ 20 million a year out of its remaining PolioPlus funds, that left

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**By the time polio is eradicated, Rotary estimates that it will have spent US\$ 400 million on the campaign.**

a gaping hole of US\$ 500 million. To make matters worse, the money was needed urgently to buy vaccine for imminent NIDs.

Rotary's response was to establish an eight-member high-level Task Force on International Advocacy. Its role is to encourage governments to increase their commitment to polio eradication and raise the level of funding. Its initial success was in the United States, where in 1995 and 1996, Rotarians testified before the US Congress and were influential in securing substantial increases in government allocations for polio eradication. The 1995 budget request of US\$ 11.3 million for polio eradication was boosted in 1996 to US\$ 47.1 million (US\$ 27.1 million channelled through the Centers for Disease Control and Prevention and US\$ 20 million through the US Agency for International Development (USAID)—mainly for vaccine purchase and delivery). A year later, the US Congress agreed to an even larger increase—a total of US\$ 72 million.

Over the next 18 months, the Task Force is now holding talks with representatives of the European Union in Brussels and with almost 40 potential donor governments. Not all of them are rich industrialized countries. They also include some of the countries in Latin America, for example, where polio has been eradicated. The Rotary Task Force is also approaching vaccine manufacturers to encourage donations of oral polio vaccine for NIDs in polio-endemic countries.

Another change is Rotary's increasing emphasis on support for laboratories and surveillance systems—a shift prompted by an increase in the number of alternative donors willing to provide vaccine. Most donors prefer to support vaccine purchase because it has a tangible, visible outcome—readily measured by a head-count of children immunized. But donors are reluctant to pay for less attractive programme areas such as surveillance, where funds are now critically needed. Unless national surveillance systems are improved, recently endemic countries will be unable to pinpoint the final chains of transmission of poliovirus and target door-to-door ("mopping up") immunization. And countries that are polio-free will be unable to prove that circulation of wild poliovirus has stopped—making it impossible to certify that polio has been eradicated globally.

Because Rotary is less constrained than other donors in the way it channels the remaining US\$ 100 million of its PolioPlus funds, it is willing to use them to plug these and other gaps identified by WHO.

Rotary funds surveillance systems, pays doctors' salaries, and meets the cost of training laboratory technicians. Meanwhile individual Rotary clubs have launched smaller-scale projects in individual countries—under Rotary's PolioPlus Partners scheme—providing funds to equip laboratories and to assist medical officers in the field by providing computers, software, motorcycles, and other equipment. During 1995 PolioPlus Partners—designed to foster partnerships between polio-free and polio-endemic countries—raised an additional US\$ 1 million for polio eradication.

Rotary continues to play a crucial role in social mobilization for immunization—preparing publicity and promotional material for NIDs, and providing transport to ensure that children in remote areas have access to immunization posts.

The PolioPlus programme has highlighted the potential impact of applying private sector skills and know-how to social needs. By the time polio is eradicated, Rotary estimates that it will have spent a total of US\$ 400 million on the campaign—most of it from the investment of the original US\$ 247 million. But no one will ever be able to put an exact figure on the hundreds of thousands of hours of volunteer service put in by Rotarians throughout the world in their attempt to turn the dream of polio eradication into reality.



**Polio paralysis can create lifelong dependency and loss of productivity among survivors.**

Photo: WHO/Thierry Geenan

## Benefits of polio eradication

Over the years polio has taken a heavy toll on the lives of both children and adults. Before the development of polio vaccines, about 500 000 people a year were paralysed or died after contracting the disease. In the United States, which endured severe epidemics of polio in 1916 and in the 1940s and 1950s before the development of polio vaccine, this panic-generating disease became known as "the crippler". Today, polio has been eradicated in the Americas and large areas of the world are becoming polio-free, but the disease continues to maim and kill in some of the poorest and most densely populated countries. In addition to the physical suffering involved, polio paralysis can create lifelong dependency and loss of productivity among survivors—placing a heavy burden on the poorest families.

While the humanitarian benefits of global polio eradication will be immeasurable, efforts have been made to quantify the financial savings that can be anticipated. WHO estimates that once polio is eradicated and immunization halted, global savings from immunization, treatment costs, and rehabilitation will amount to over US\$ 1.5 billion a year. But there is no way of knowing how much of that money will be redirected to other health programmes.

The reduction in human suffering and death will be felt most in the poorest and least developed countries, where the disease is still endemic. But many of these countries are now also paying an increasing share of the cost of national immunization days—representing a relatively higher proportion of GNP than in the richer industrialized countries. At face value, the financial savings will be greatest in the countries where the costs of polio immunization, treatment, and long-term rehabilitation are highest. The European Union countries, for example, will together save an estimated US\$ 333 million a year once polio has been eradicated. In the Netherlands, the cost of controlling the 1991-92 outbreak of polio involving over 70 members of a religious community, amounted to US\$ 10 million—without

taking into account the long-term costs of hospital care and rehabilitation for the 66 survivors. Meanwhile, in the United States, three years after polio eradication was certified in the Americas, the Government continues to spend over US\$ 230 million a year maintaining high levels of routine immunization coverage to prevent the reintroduction of poliovirus from polio-endemic countries. The supply of polio vaccine alone costs over US\$ 105 million a year. In addition, the US Government is still contributing towards the costs of treatment and rehabilitation for polio survivors—including many who contracted the disease during the epidemics of the 1940s and 1950s.

The United States will be a major beneficiary once the disease has been eradicated globally and polio immunization can be stopped. And there is a precedent for this. It has been estimated that, ever since the global eradication of smallpox was certified in 1979, the United States—the largest donor—has recouped its entire contribution every 26 days.

The 1993 World Bank Development Report, *Investing in Health*, estimated that in one year alone—1968—the global amount spent on smallpox immunization, quarantine, and treatment was over US\$ 300 million—more than the direct financial contributions during the entire 12-year eradication programme. The eradication programme had "saved hundreds of millions of dollars a year in direct, measurable costs, as well as unquantifiable amounts of human suffering. Few investments of any kind generate human and financial benefits on that scale."

In addition to the humanitarian and financial benefits, polio eradication is having a positive impact on health services and on the development of health infrastructures throughout the world. In 1988 when the World Health Assembly resolved to eradicate polio by the year 2000, Member States were determined to ensure that health service provision was strengthened and not neglected at the expense of a "vertical" programme focused on a single disease. The Resolution emphasizes that "eradication efforts should be pursued in ways which strengthen the development of the Expanded Programme on Immunization as a whole, fostering its contribution, in turn, to the development of the health infrastructure and of primary health care."



The World Health Assembly emphasized that global efforts to eradicate polio should also contribute to health infrastructure development and primary health care.

Photo: UNICEF/Maggie Murray-Lee (2983/89)

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**Polio eradication has helped raise public awareness of the importance of routine immunization—not just for polio.**

To what extent have these demands been met? The only formal study carried out so far—by the Taylor Commission—has reported positively on the impact of the polio eradication campaign on health systems in the Americas. However, the Commission's report, published in 1995, pointed out that most countries in the Americas already had a well-organized health system and infrastructure when the polio eradication campaign started. And it cautioned against applying the findings of the report too closely to countries where health services had not yet reached the majority of the population.

The independent commission, established in 1992 by the Pan American Health Organization, based its findings on a sample of six Latin American countries where polio was still occurring at the start of the eradication campaign: Bolivia, Brazil, Colombia, Guatemala, Mexico, and Paraguay. The Commission found that the greatest positive impact of polio eradication was on social mobilization and intersectoral cooperation, twin pillars of primary health care, and two strategies that until then had proved the most difficult to implement.

The social mobilization strategy involved strengthening existing community organizations, the widespread use of education campaigns involving the mass media, and efforts to involve political and community leaders—a joint strategy that has now been successfully adopted by other health programmes both in this region and elsewhere. The approach ensured that communities were not only motivated to bring their children to be immunized during national immunization days, they also became actively involved in the campaign—helping deliver vaccines and maintaining the cold chain, often making available their own vehicles, refrigerators, and ice-boxes. Elsewhere, in the Western Pacific Region, NIDs carried out in the Philippines from 1993 to 1996 were heavily supported by the business community. More than 150 businesses provided funding, and immunization posts were established in over 150 fast-food outlets, over 400 petrol stations, and hundreds of company clinics. Children were immunized in shopping malls, radio and television stations, bus and railway stations, government offices, and schools.

The Taylor Report also maintained that the eradication campaign had established a "culture of immunization", and improved communications between health services staff and local communities. In the Americas, and elsewhere, polio eradication has helped raise public

awareness of the importance of routine immunization—not just for polio. In the Western Pacific Region, for example, where national and sub-national immunization days were carried out in polio-endemic countries from 1991 to 1994, there was a marked increase in routine immunization coverage with other EPI vaccines. In the polio-endemic countries with the lowest immunization rates in the region—Cambodia and Laos—immunization coverage with BCG, DTP, and measles vaccine increased by 30% and 100% respectively. In Laos, BCG coverage rose from 26% to 69% between 1990 and 1994, DTP coverage from 18% to 48%, and measles coverage from 32% to 73%. (See Annex.)

In addition, national immunization days for polio, particularly those involving negotiated ceasefires, have often included other vaccines and nutrients as well—most commonly measles and vitamin A for children, and tetanus toxoid for women of childbearing age. During NIDs in Myanmar and Nepal, posters were used to inform parents of the need for routine childhood immunization against other diseases. In Iran, routine immunization cards were checked and, where necessary, children were referred to other health services.

Together with the upsurge in immunization against other diseases, there has been a marked increase in the proportion of EPI vaccines paid for out of national resources, and a corresponding drop in the amount of donor support needed for vaccines for routine immunization. This trend has been actively promoted by UNICEF and WHO in all countries in an effort to ensure that all but the poorest countries are self-sufficient in vaccines. The successful eradication of polio in the Americas helped raise the profile of childhood immunization and helped motivate governments to take on a greater share of vaccine costs. By 1995 the bulk of vaccine costs were being met by governments throughout the Americas region. Requests for external assistance for vaccine purchase were 25% lower for the five-year period 1992-1996 than in the previous five-year period. In Guatemala, vaccine self-sufficiency surged from below 5% in 1990 to 100% within five years, and in Nicaragua from zero to almost 80% over the same period. In the Philippines, following the successful NIDs in 1993, the government almost tripled its vaccine budget, making vaccine a regular budget line item from then on.



**National immunization days for polio have often included other vaccines such as measles.**

Photo: WHO/Hubley

The Taylor Report maintained that the polio eradication campaign in the Americas had played a key role in demonstrating new approaches to health service delivery. Other programmes had been encouraged to adopt its inter-agency and intersectoral cooperation strategies, media strategies, information systems, surveillance systems, and evaluation methods. The development of polio surveillance systems, for example, has already been used to help combat other diseases including measles, neonatal tetanus, and cholera. During the cholera epidemic in Peru in 1991, the surveillance system that had been built up to support polio eradication proved invaluable in efforts to ensure rapid reporting of suspected cholera cases. "It is very likely," the Taylor Report pointed out, "that the health systems of the Americas would not have had the capability to respond as they did to the cholera epidemic without the EPI/Polio experience."

In the Americas, where governments are now committed to eliminating measles by the year 2000, the surveillance and laboratory system established during the polio eradication campaign is now being used to monitor and detect measles cases as well. Meanwhile, in Egypt, from 1992, reporting of neonatal tetanus cases has been successfully linked to the surveillance system for acute flaccid paralysis. The system has also helped promote case investigation skills and target immunization to unreached populations—providing access to routine immunization services as well.

The Taylor Report also noted that the polio eradication programme developed management strategies and systems that could be readily transferred to the delivery of other health services. These management strategies "worked and contributed to other programs, either by sharing them or setting the example and becoming a model to learn from". A key element in the campaign strategy was the establishment in 1985 of an Interagency Coordinating Committee (ICC) to draw up a regional plan of action. Membership included the Pan American Health Organization, the Inter-American Development Bank, Rotary International, UNICEF, USAID, and (from 1987) the Canadian Public Health Association. In addition, national Interagency Coordinating Committees were established in every country under the leadership of Ministries of Health to develop five-year plans of action for polio eradication. All countries now prepare annual and five-yearly national plans of action with clearly defined objectives, activities, costings, and identified sources of funding. This has resulted in im-

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**Even the poorest countries are making a sizeable contribution to the cost of polio eradication.**

proved health planning, and monitoring and evaluation of the implementation of health programmes. The Interagency Coordinating Committees have now extended their remit to include other aspects of maternal and child health—especially the goals of the 1990 World Summit for Children—and helped boost the efficiency of funding health initiatives.

An additional benefit is that the development of logistical support for polio eradication—transport and communication systems, and the cold chain, for example—can be used for other primary health care needs. And the development of new technologies—vaccine vial monitors, for example—can be used in efforts to combat other diseases as well.

Not all the responses obtained in interviews by the Taylor Commission were positive. A major criticism was that both funds and personnel were being diverted to polio eradication while other programmes competed for scarce resources—one of the most frequently voiced criticisms of eradication programmes. But is it true?

In the Americas, about 80% of the cost of polio eradication was met by national governments. Elsewhere, even the poorest countries, which rely heavily on donor support, are making a sizeable contribution to the cost of polio eradication. But many of these costs are in the form of opportunity costs, not direct financial contributions. They include regular staff salaries, maintenance, transport costs, or assistance from the military. And while it is clear that external funds for polio eradication could have been used for other health programmes, there is little evidence to suggest that this level of funding would otherwise have been available. Donor funding for polio eradication is not necessarily money that was earmarked for spending on health. Rotary International—the largest single donor—brought substantial private sector resources and volunteer manpower into the health sector for the first time. The US\$ 400 million donation over 20 years is the largest single contribution ever from the private sector for a public health programme. Other agencies and donor governments have made similar long-term commitments to polio eradication. But this level of funding is easier to obtain for global campaigns like polio eradication that are time-limited and have a proven track record of success than for routine open-ended health programmes.

Other complaints included the failure to integrate polio eradication with other health programmes, and concern that door-to-door immunization might establish a paternalistic attitude to health services and reduce attendance in health centres. Meanwhile, in some of the poorest and least developed areas in Colombia, Mexico, and Brazil, there were reports of resistance to immunization due to repeated home visits to immunize children.

Despite these and other such criticisms, the polio eradication initiative is clearly making a major contribution to health systems in the way envisaged by the World Health Assembly in 1988. The eradication strategy embraces all five principles of primary health care: equitable distribution of resources, community involvement, a focus on prevention, the use of appropriate technology (introduction of vaccine vial monitors, for example), and a multisectoral approach.

Meanwhile other areas within the Expanded Programme on Immunization and other health programmes as well have been strengthened as a result of new, innovative approaches to health service delivery. Polio eradication has helped raise the profile of the public health sector and created a renewed demand for immunization that has resulted in higher immunization coverage with other vaccines.

Far from poaching scarce resources, polio eradication has helped pinpoint gaps and weaknesses in health service provision and in many cases helped to fill these gaps. These include a strengthened cold chain, improved management capacity, strategies for social mobilization and intersectoral cooperation, the development of disease surveillance systems, improved communications systems, and the ability to target and reach entire populations. And like the smallpox eradication campaign before it, global efforts to eradicate polio have succeeded in bringing health services to some of the most under-served populations in the world—including children trapped inside war zones.

Other benefits are less tangible but equally important. In some of the least developed countries, routine health services have been revitalized through the focus on polio eradication. And through their ability to organize immunization campaigns on such a vast scale, governments have acquired the will and capacity to tackle other public health problems as well—measles, in the Americas, for example.

Meanwhile, health workers throughout the world have been motivated by achievements in their own countries and elsewhere.

In peacetime, there are few humanitarian efforts that can fire the imagination and unite people around the globe. Polio eradication is one of these. WHO has succeeded in bringing together an unprecedented range of contributors: governments throughout the world, other UN agencies, non-governmental organizations, community groups, the business community, religious organizations, and many others from both the public and private sector. When polio is eradicated, future generations will be heavily indebted to all those who over the years have helped ensure that they could inherit a world without polio.

Annexes originally part of this publication are now contained in a separate file named Annx9750.PDF.