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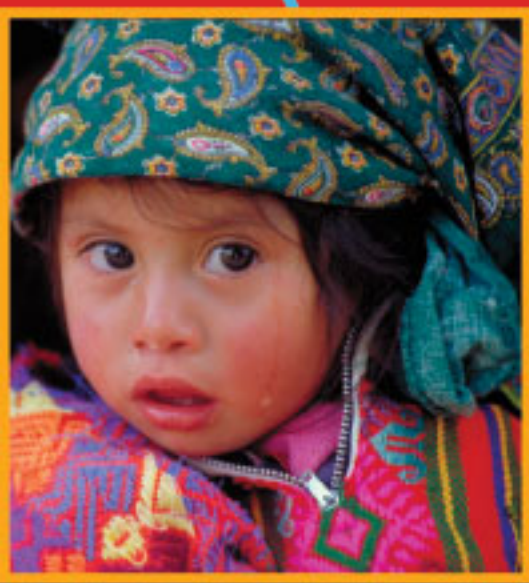

Poliomyelitis Eradication

Field Guide

Third edition

Pan American Health Organization
Regional Office of the World Health Organization

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ABOUT THE IMMUNIZATION FIELD GUIDES

The Expanded Program on Immunization is viewed as one of the most successful public health experiences in the Americas because it has played a pivotal role in reducing infant mortality from vaccine-preventable diseases in the Region. In fact, since the program was launched the countries stopped the transmission of wild poliovirus in the Region in 1991 and interrupted indigenous measles transmission in November 2002; they also are making significant gains in the battle to eliminate rubella and congenital rubella syndrome. In addition, national immunization programs are undertaking extraordinary efforts to identify at-risk populations and overcome inequities in vaccination. To maintain these advances and to cope with new challenges, such as the introduction of new vaccines, partnerships will have to be strengthened among governments, donor agencies, the private sector, scientific associations, and society as a whole.

To this end, PAHO is promoting the best technical quality by issuing these practical field guides, which have been prepared by the Immunization Unit in the Family and Community Health Area. The most recent techniques presented in the field guides, coupled with useful illustrations, will help health workers in their efforts to control, eliminate, or eradicate diseases such as poliomyelitis, neonatal tetanus, yellow fever, diphtheria, pertussis, tetanus, *Haemophilus influenzae* type b infections, hepatitis B, measles, and rubella. The field guides also include standardized methods and procedures for conducting epidemiologic surveillance and maintaining an up-to-date information system that makes it possible to take timely and effective decisions.

These field guides are based on the latest scientific information and they bring together the experience of prominent health professionals in the field. As a result, they are particularly suitable for promoting strategies that have already proven to be effective. The strengthening of prevention activities, the reduction of health inequities, and the promotion of technical expertise in vaccination services were the principles that guided the preparation of the guides.

The Expanded Program on Immunization, a joint effort of all the countries of the Americas, effectively contributes to the attainment of the Millennium Development Goals.

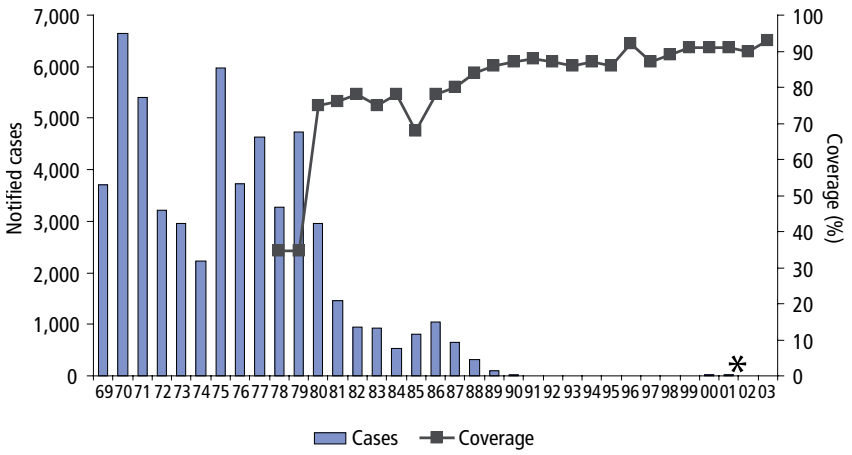
Dr. Mirta Roses Periago
Director
Pan American Health Organization

PREFACE

This Poliomyelitis Eradication Field Guide presents information and strategies that health workers in the Americas should be familiar with in order to keep the hemisphere polio-free. Perhaps a more appropriate title would be "Field Guide for the Maintenance of Polio Eradication," since the last case of this disease caused by wild poliovirus in the Region was detected in 1991 (see Figure 1). In 1994, the International Commission for the Certification of Poliomyelitis Eradication in the Americas (ICCPE) reviewed the evidence available in all the countries and territories of the hemisphere and concluded that the indigenous circulation of wild poliovirus in the Americas had been interrupted. As can be seen in Figure 2, this goal was achieved in a continent where endemic poliomyelitis was present in most countries.

The strategies that allowed the eradication of polio in the Americas are the same as those currently being used globally, and are essentially the same strategies that will make it possible to keep countries disease-free. They consist in reaching and maintaining high levels of vaccination coverage (through vaccination campaigns, if necessary) and ensuring adequate epidemiologic surveillance, which in the present context means the immediate investigation of cases and aggressive control of outbreaks (see Figure 2).

Figure 1. OPV3 coverage and incidence of poliomyelitis in the Region of the Americas, 1969–2003



* Type 1 vaccine-derived poliovirus (VDPV) in 2000 and 2001: 21 cases

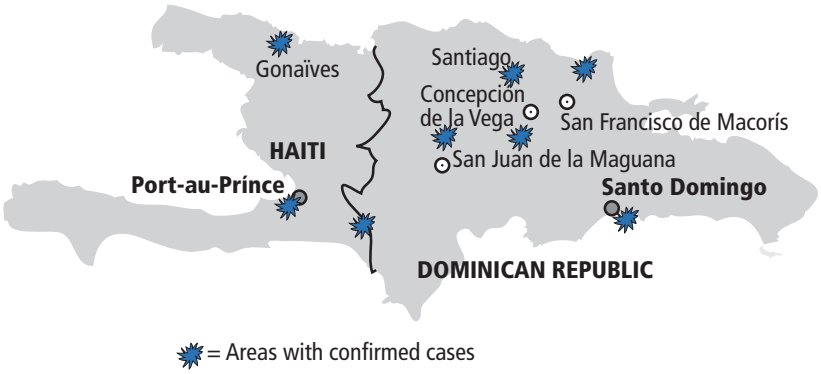
Note: Coverage data are for children under 1 year of age.
Source: PAHO, Family and Community Health, Immunization Unit.

These are the same strategies that were applied to combat the polio outbreak that occurred in the Dominican Republic and Haiti in 2000 and 2001 (see Figure 3). This outbreak, which was caused by a virus derived from the Sabin vaccine itself, showed that reversion of the vaccine virus to neurovirulence is a constant threat unless countries ensure adequate vaccination coverage. It also showed that surveillance for flaccid paralysis should be maintained at an optimal level, not only during eradication efforts but also afterwards. Finally, it demonstrated that the vaccination strategies used during the eradication campaign continue to be valid. The outbreak was controlled using live attenuated oral poliovirus (OPV) vaccine. Given the importance of this outbreak for countries that have already eradicated poliomyelitis, details of the outbreak are provided in Annex 1.

Figure 2. Polio cases in the Americas, 1985

1 point = 1 case
Source: Pan American Health Organization, Family and Community Health, Immunization Unit.

Figure 3. Areas in Haiti and the Dominican Republic with confirmed cases of polio, 2000–2001



Source: PAHO, Family and Community Health, Immunization Unit, PESS/HVP. Data through 30 May 2001.

1. INTRODUCTION

1.1 Background

On 14 May 1985, the Director of the Pan American Health Organization (PAHO) announced the goal of eradicating wild poliovirus in the Americas. At the XXXI Meeting of the PAHO Directing Council in September 1985, the Member Governments unanimously approved a resolution to adopt this goal. When the ICCPE met in 1994, poliovirus had not been detected in the Americas for three years, despite intensive surveillance by more than 21,000 health units that submitted weekly reports and the investigation of over 3,800 probable cases, which on close study were discarded as not being poliomyelitis. The eradication effort also dramatically strengthened vaccination services for other preventable diseases included in the Expanded Program on Immunization (EPI).

A number of public and private agencies joined forces with PAHO to achieve the eradication goal, including the United Nations Children's Fund (UNICEF), the Inter-American Development Bank (IDB), the United States Agency for International Development (USAID), the United States Centers for Disease Control and Prevention (CDC), the Canadian Public Health Association (CPHA), Rotary International, and others.

2. EPIDEMIOLOGY

2.1 Infectious Agent

The poliovirus is an enterovirus, and it has three antigenic types: 1, 2, and 3. Although all three types can lead to paralysis, type 1 is most frequently responsible, type 3 plays a lesser role, and type 2 is only rarely involved. Most epidemics are caused by type 1. Cases associated with the vaccine, which contains all three types, are usually caused by types 2 or 3.

Poliovirus derived from the Sabin vaccine, which has caused outbreaks in the Dominican Republic, Egypt, Haiti, Madagascar, and the Philippines, is a virus that has mutated from the original Sabin strain by more than 1% and reverted to neurovirulence. Two types of vaccine-derived poliovirus (VDPV) have been recognized: iVDPV (i stands for immunodeficient), which is isolated from immunodeficient individuals, and cVDPV (c stands for circulating), which is isolated from outbreaks and shown to have the same epidemiological and biological characteristics as the wild viruses.

2.2 Distribution and Frequency

Poliomyelitis existed worldwide before the eradication initiative was undertaken, first in the Americas and then globally. At the time of writing this field guide (Sep-

tember 2005), three Regions of the world were certified as free from the indigenous circulation of the wild poliovirus: the Region of the Americas in 1994, the Eastern Pacific in 2000, and Europe in 2002. The transmission of the wild virus only persists in 10 countries of the world, four of which (Indonesia, Nigeria, Sudan, and Yemen) accounted for 91% of the cases reported during 2005. The annual number of cases of polio reported was 719 in 2000 (in 23 countries), 483 in 2001 (in 15 countries), 1,918 in 2002 (in 9 countries), 784 in 2003 (in 15 countries), 1,255 in 2004 (in 18 countries), and 1,469 in 2005 (16 countries) (see Figure 4). The dramatic increase in cases in 2004 was due to the fact that Nigeria interrupted its national vaccination campaigns, which caused not only an increase in the number of cases in that country, but also led to the emergence of cases in countries that previously had eliminated polio but that had pockets of susceptibles, such as Botswana, Ethiopia, Guinea, Mali, Saudi Arabia, and Sudan (see Figure 5). This experience reveals the risk of imported cases to countries and regions of the currently polio-free world. It also highlights the importance of maintaining high immunization coverage, conducting national immunization days, sustaining good epidemiologic surveillance of acute flaccid paralysis, and taking measures to contain wild poliovirus in laboratories.

2.3 Transmission

Fecal-oral transmission of the poliovirus is the predominant mode in the developing countries where sanitation is poor, whereas oral-pharyngeal transmission is more likely to predominate in industrialized countries and also during outbreaks. One week after onset, little virus remains in the throat, but it continues to be shed in stools for six to eight weeks. Cases are probably most infectious during the first few days before and after the onset of symptoms.

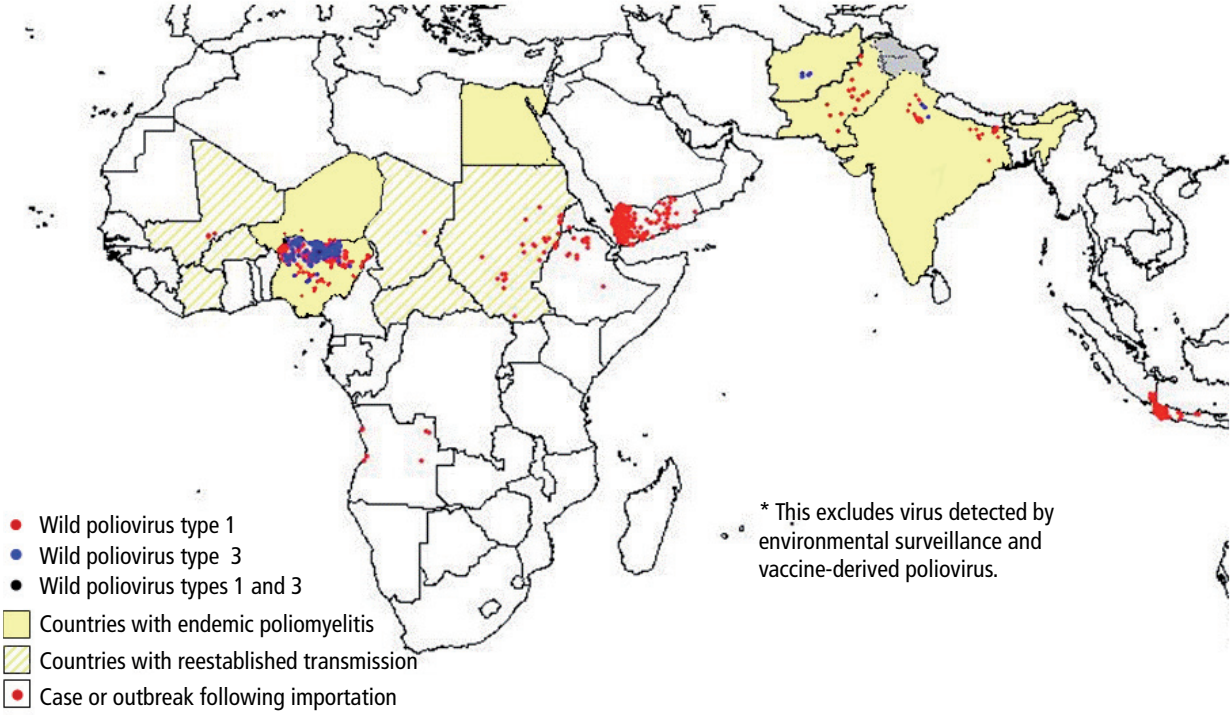
2.4 Reservoir

Humans are the only reservoir of poliovirus, and infection is spread from person to person. Given the large number of inapparent infections, it is sometimes difficult to find the source of a case. A long-term carrier state is not known to occur, except for rare cases in which the virus has been isolated repeatedly and over long periods in immunodeficient individuals. Those cases have not been associated with polio outbreaks.

2.5 Incubation

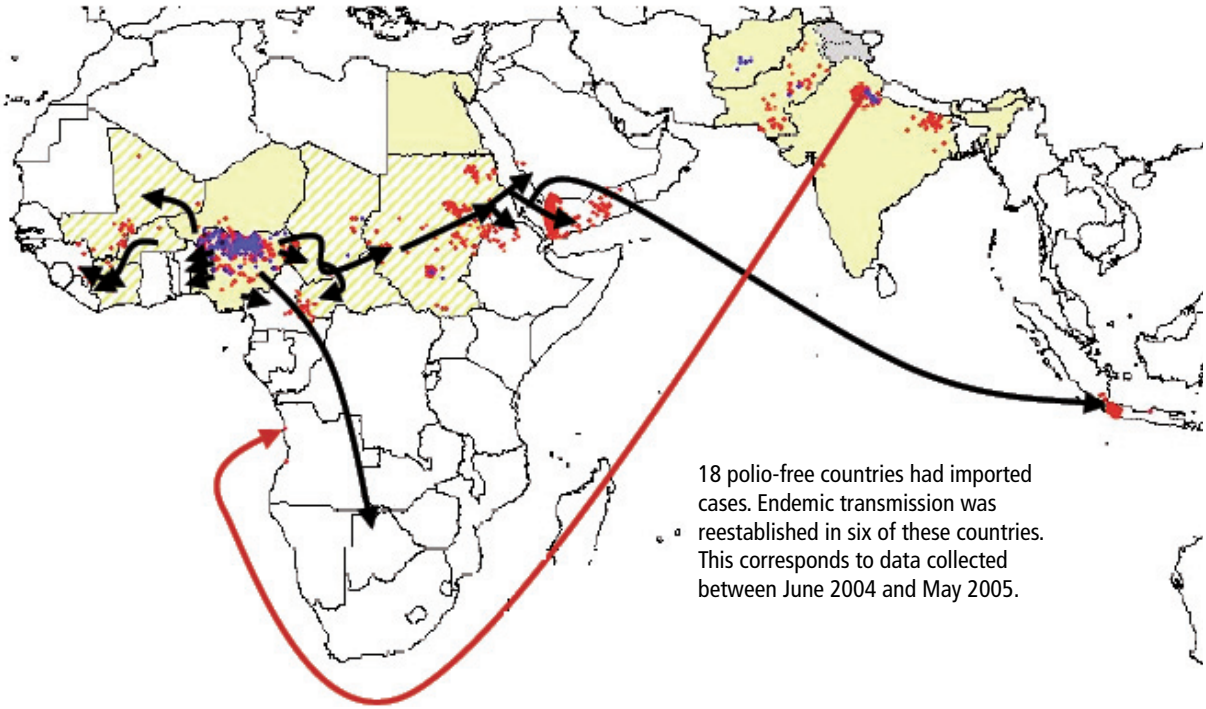
On average, the incubation period from exposure to the virus to the onset of the first symptoms is 7 to 10 days, with an overall range of 4 to 40 days. The initial illness is followed by a few days relatively free of symptoms before the onset of paralysis.

Figure 4. Wild poliovirus, 2004–2005



Source: World Health Organization, September 2005.

Figure 5. Spread of wild poliovirus, 2004–2005



Source: World Health Organization, May 2005.

2.6 Immunity

All unimmunized persons are susceptible to poliomyelitis. Epidemiologic evidence shows that infants born to mothers with antibodies are protected naturally against paralytic disease for a few weeks. Immunity is acquired through infection with the wild virus and through immunization. Immunity following natural infection (including inapparent and mild infections) or administration of a complete series of live oral polio vaccine (OPV) results in both humoral and local intestinal cellular responses. Such immunity is thought to be lifelong and can serve to block infection with subsequent wild viruses, thereby interrupting the chain of transmission. The inactivated poliovirus vaccine (IPV) confers humoral immunity but relatively less intestinal immunity. Thus, vaccination with IPV does not provide resistance to carriage and spread of the wild virus in the community. There is believed to be little or no cross-immunity between the poliovirus types.

2.7 Changes in Epidemiology

The Global Polio Eradication Initiative has significantly reduced the number of cases in the world, from an estimated 350,000 in 1988 to only 1,469 reported as of November 2005. The disease continues to follow the same epidemiologic pattern that it had when incidence was high: it particularly affects poorer, non-immune populations and retains the same epidemiological characteristics. On the other hand, the emergence of outbreaks caused by vaccine-derived virus is a relatively recent phenomenon that bears out the importance of achieving global eradication as soon as possible.

3. CLINICAL ASPECTS

3.1 Pathogenesis

The mouth is the usual site of entry, and the virus first multiplies in the lymph nodes of the pharynx and the gastrointestinal tract. It is usually present in the pharynx and in the stool before the onset of paralytic illness. Once the virus has entered the body, it invades local lymphoid tissue, enters the bloodstream, and then may invade certain types of nerve cells. As it multiplies intracellularly, the virus may damage or destroy the nerve cells completely.

3.2 Clinical Features

For reporting purposes, surveillance is chiefly concerned with identifying paralytic cases. Many people infected with the wild poliovirus have only a mild illness that cannot be distinguished clinically from illnesses due to a large number of other causes. Symptoms associated with these minor illnesses include mild fever, muscular

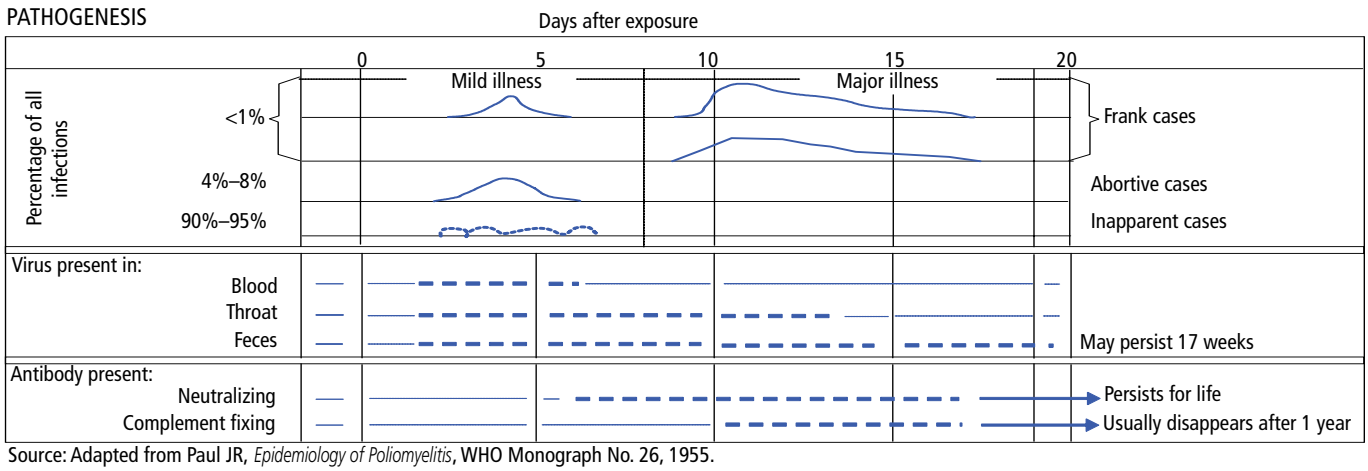
pain, headache, nausea, vomiting, stiffness in the neck and back, and, less frequently, signs of aseptic (nonbacterial) meningitis. Inapparent (subclinical) infections are common: depending on the strain of poliovirus, the ratio between subclinical and clinical infections is estimated to range between 100:1 and 1,000:1 (see Figure 6).

Older children and adults run a greater risk of developing paralytic illness. The case-fatality rate ranges between 2% and 20% among persons who do develop the paralytic form of the disease. However, if there is bulbar or respiratory involvement, the case-fatality rate may be as high as 40%. Most deaths occur within the first week following the onset of paralysis.

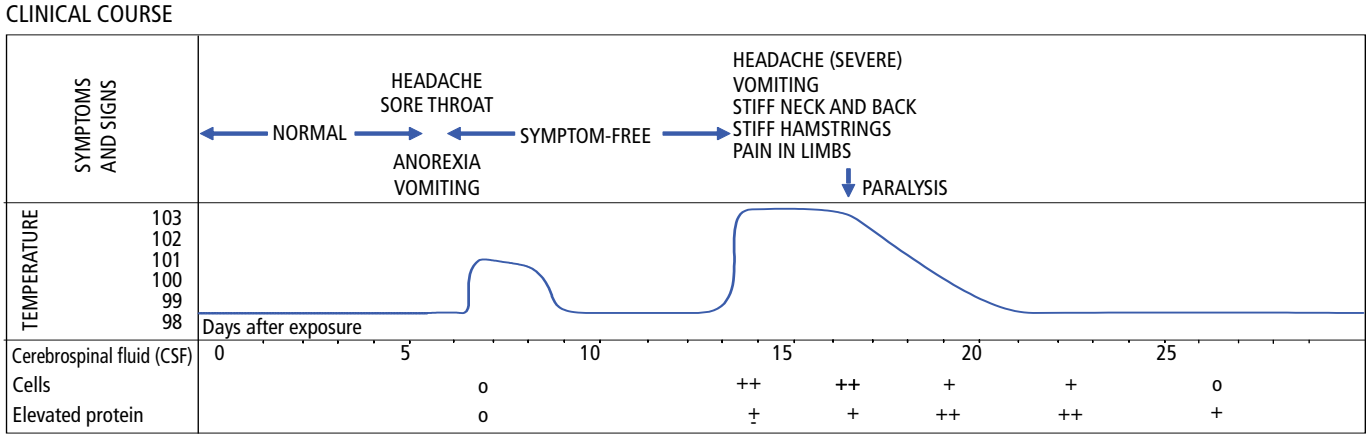
3.3 Differential Diagnosis

Every case of acute flaccid paralysis (AFP) in persons under 15 years old that is clearly not due to severe trauma should be investigated. If there is a strong suspicion of polio in persons over 15 years of age, such cases should also be thoroughly investigated.

Figure 6. Pathogenesis and clinical course of acute poliomyelitis



Source: Adapted from Paul JR, *Epidemiology of Poliomyelitis*, WHO Monograph No. 26, 1955.



Source: Horstmann DM, "Clinical aspects of acute poliomyelitis," *American Journal of Medicine*, 6(5), 598; copyright 1949, with the authorization of *Excerpta Medica, Inc.*

It is difficult to confirm paralytic poliomyelitis in the acute phase based on clinical symptoms and signs alone, since a large number of other diseases and conditions may cause similar symptoms. Laboratory confirmation is therefore critical to the final diagnosis. The two diseases most frequently confused with polio are Guillain-Barré syndrome (GBS) and transverse myelitis (see Table 1).

Other conditions that may present symptoms similar to those of paralytic poliomyelitis include traumatic neuritis, certain tumors, and, less frequently, meningitis/encephalitis, as well as illnesses produced by a variety of toxins. The most prominent difference between poliomyelitis and other causes of AFP is that for polio the paralytic sequelae are generally severe and permanent, whereas with other causes, the paralysis tends to resolve or improve within 60 days of onset. A record should be kept of the definitive diagnosis corresponding to all discarded cases of AFP (Annex 2). For a more detailed discussion of the differential diagnosis of poliomyelitis, see Annex 3.

When paralysis due to poliomyelitis occurs:

- It is typically flaccid (the muscles are not stiff or spastic).
- Patients usually have problems standing and walking.
- It is commonly preceded by symptoms of a minor illness, such as sore throat, headache, backache, fever, vomiting, etc.
- Paralysis develops rapidly, usually within four days.
- Fever is usually present at onset of paralysis.
- Most patients have limited or no sensory loss (for example, they will feel a needle prick). This sign may be difficult to determine in children.
- The legs are more commonly involved than the arms, and the large muscle groups are at greater risk than the small groups. The proximal muscles of the extremities tend to be more involved than the distal ones.
- It is asymmetric (not affecting both sides equally). Although any combination of limbs may be paralyzed, the most typical pattern is involvement of one leg only, and, less often, one arm. It is less common for both legs or both arms to be affected. Quadriplegia is rare in infants.
- Sequelae tend to last longer than 60 days after onset.

3.4 Complications

The complications are essentially related to the severity of the illness. Some people with paralytic poliomyelitis manage to recover partially or completely, but the large majority of patients have permanent sequelae in the form of paralysis of the affected members. Those who experience muscle weakness or paralysis for over 12 months will usually have permanent residual paralysis.

During the acute phase, the most severe complication is bulbospinal paralysis, which gives rise to paralysis of the respiratory muscles. The case-fatality rate for paralytic poliomyelitis is usually 2% to 5% in children and 15% to 30% in adults

Table 1. Criteria for the differential diagnosis of poliomyelitis

	Polio	Guillain-Barré syndrome	Traumatic neuritis	Transverse myelitis
Time from onset of paralysis to full progression	Usually from two to three days	From hours to 10 days	From hours to four days	From hours to four days
Fever	Fever with onset of paralysis, usually disappearing within three to four days	Not common	Commonly present before, during, and after flaccid paralysis	Rarely present
Flaccid paralysis	Acute, asymmetrical, principally proximal (upper part of arms and legs)	Generally acute, symmetrical, and distal (lower part of arms and legs)	Asymmetrical, acute, usually affecting only one limb	Acute, lower limbs affected symmetrically
Muscle tone	Reduced or absent in the affected limb	Reduced or absent	Reduced or absent in the affected limb	Deduced in lower limbs
Deep-tendon reflexes	Decreased or absent	Absent	Decreased or absent	Absent in lower limbs
Sensation, pain	Sensation usually normal; severe myalgia, backache	Cramps, tingling, reduced sensation on palms and soles	Pain in buttocks, reduced sensation to cold and heat	Anesthesia of lower limbs with sensory perception
Cranial nerve involvement	Only when bulbar involvement is present	Often present, low and high: Miller/Fisher variant	Absent	Absent
Respiratory insufficiency	Only when bulbar involvement is present	In severe cases, complicated by bacterial pneumonia	Absent	Often thoracic paralysis, with sensory perception
Autonomic signs & symptoms	Rare	Frequent blood pressure alterations, sweating, blushing, body temperature fluctuations	Hypothermia in affected limb	Present
Cerebrospinal fluid	Inflammatory	High protein content with relatively few cells	Normal	Normal or mild increase in cells
Bladder dysfunction	Absent	Transient	Never	Present
Nerve conduction velocity at 3 weeks	Abnormal: anterior horn cell disease (normal during the first 2 weeks)	Abnormal: demyelinization	Abnormal: axonal damage	Normal or abnormal, no diagnostic value
Sequelae at 3 months up to 1 year	Severe, asymmetrical atrophy; skeletal deformities appear later	Symmetrical atrophy of peroneal muscles (outer side of leg)	Moderate atrophy, only in affected lower limb	Atrophy, flaccid diplegia years later

Source: Alcalá H, Olivé J-M, de Quadros C. "The Diagnosis of Polio and Other Acute Flaccid Paralyses: A Neurological Approach." Document presented at the Ninth Meeting of the Technical Advisory Group on Vaccine-preventable Diseases, held in Guatemala City, Guatemala, 12–15 March 1991. (Doc. EPI/TAG/91-10).

(depending on the patient's age). This figure increases from 25% to 75% when there is bulbar involvement.

3.5 Treatment

There is no specific treatment for poliomyelitis. During the acute phase, the only medical care is life support to preserve vital functions. Once the acute stage has passed, physical therapy and other measures that facilitate the recovery of movement and locomotion are helpful.

4. VACCINES

There are two types of polio vaccine: (1) trivalent oral (live, attenuated) polio vaccine (OPV) and (2) inactivated or killed polio vaccine (IPV). This guide provides more detail on the use of the Sabin oral vaccine (OPV) because it is recommended by the Technical Advisory Group of the PAHO Immunization Program, and it has been and continues to be used in global campaigns to eradicate poliomyelitis.

The Sabin OPV vaccine is prepared using strains of different live viruses that have been attenuated for oral administration. Because it is replicative, it is the vaccine that more closely simulates the natural infection process. Also, it stimulates the production of secretory IgA antibodies and circulating IgGs. Today the trivalent form is used throughout the world (although it should be noted that vaccines have been made using a single virus type, ranging in color from pale yellow to light pink). Since the vaccine virus is live and the preparation is administered orally, imitating the natural route of infection, it also can be transmitted from a vaccinated person to close contacts who have not been immunized. Its circulation interrupts transmission of the wild virus by displacing it. This effect is greater if the vaccine is administered to entire communities on national immunization days.

OPV is usually provided in vials of 10 or 20 doses using a dropper. Each dose, usually two drops, contains:

- Poliovirus I 1,000,000 infective units
- Poliovirus II 100,000 infective units
- Poliovirus III 600,000 infective units

The vaccine contains small traces of streptomycin and neomycin, and it has no preservatives. The use of a live poliovirus vaccine spreads the vaccine viruses in the environment, resulting in transmission of the virus to other individuals, both vaccinated and unvaccinated.

The IPV, or Salk-type vaccine, is non-replicative. It is made with inactivated or killed viruses and inoculated either subcutaneously or intramuscularly. The virus is not shed in stools, and it does not colonize lymphoid tissue in the throat. The vac-

cine stimulates the production of circulating antibodies and suppresses pharyngeal excretion of the virus, but it does not prevent intestinal infection; consequently, it has not been used in the polio eradication campaign. It is available in monovalent form or combined with other vaccines, such as triple diphtheria, pertussis, tetanus (DPT), hepatitis B, or *Haemophilus influenzae* type b (Hib).

4.1 Immunity

Under ideal conditions, a primary series of three doses of OPV produces seroconversion to all three virus types in over 90% of vaccine recipients, and it is thought to have clinical efficacy of nearly 100%. Three properly spaced doses of OPV should confer long-term immunity. In some countries, especially in tropical climates, there have been reports of insufficient serologic response to OPV. This result may be due to interruptions in the cold chain, interference due to intestinal infection with other enteroviruses, or the presence of diarrhea that causes excretion of the virus before it can attach to the mucosal cells.

4.2 Vaccination Schedule, Contraindications, and Adverse Events

Although the schedule may vary in some countries, in routine circumstances it is recommended to give three doses of trivalent OPV at four-to eight-week intervals starting at 6 weeks of age or 2 months, if so specified in the national immunization schedule. A dose at birth is highly recommended in endemic areas, although it is not counted as part of the primary series and is referred to as "OPV zero." In the case of intervals between doses that are longer than the recommended four to eight weeks, it is not necessary to restart the schedule. Polio vaccine may be given simultaneously with any other childhood immunization.

There are no contraindications to vaccination with OPV. Although diarrhea is not a contraindication, a dose administered to a child with diarrhea should not be counted as part of the series, which should be completed as soon as the diarrhea has passed.

On rare occasions, OPV has been associated with paralysis in vaccine recipients or their contacts. In the United States, the overall frequency of OPV vaccine-associated paralysis is 1 case in 2.6 million doses distributed. The relative frequency of paralysis varies depending on the number of doses received in the series. For recipients of the first dose, the frequency is 1 case in every 1.4 million doses, while for subsequent doses the frequency is 1 case in every 27.2 million doses.

In countries where human immunodeficiency virus (HIV) is widespread, children should be immunized following the regular schedule, using antigens provided by the Expanded Program on Immunization. This recommendation also applies to persons with HIV infection. Unvaccinated individuals with clinical (symptomatic) AIDS living in countries where poliomyelitis still poses a serious threat should also receive OPV according to the regular established schedule. In this regard it should be noted that

the American Academy of Pediatrics recommends the use of IPV (inactivated polio vaccine) for patients with immunodeficiencies. It should be made clear that these patients cannot be guaranteed an adequate immune response from the IPV.

4.3 Dosage and Administration

The basic schedule calls for three doses of OPV, given either at 6, 10, and 14 weeks of age or at 2, 4, and 6 months. In areas where polio is still endemic, a dose for newborns is also recommended. OPV should be administered orally (that is, directly in the mouth). Each dose consists of two drops of live oral poliovirus vaccine (the manufacturer's instructions should be reviewed). It is given by drops in the child's mouth, making sure that the dropper does not contaminate the mucosa; if the child spits out the vaccine, he or she should be vaccinated again.

4.4 Cold Chain and Supply

OPV is one of the most heat-sensitive vaccines in common use. It can be stored for up to 1 year, and it should be kept frozen whenever possible. Otherwise, at the local level it should always be kept at temperatures no higher than 8 °C (i.e., from 0 °C to +8 °C). In regional facilities at the central level it is recommended to store the vaccine at –15 °C to –25 °C.

Sealed vials of polio vaccine can be kept at 0 °C to 8 °C for up to six months, and they can be thawed and refrozen without damage. However, the EPI recommends that they be stored for a maximum of three to six months in regional facilities, and for one to three months at facilities at the local level.

Vials of polio vaccine that have been transferred from the refrigerator to a vaccine carrier for local outreach activities (e.g., for use at mobile clinics or in house-to-house vaccination) should be discarded at the end of the day if they were opened. Unopened vials should be returned to the refrigerator and used as soon as possible. Annex 4 shows a sample of a form that can be used to record temperature and other basic aspects of refrigerator maintenance in order to ensure proper conservation of the vaccines.

4.5 Vaccine Efficacy

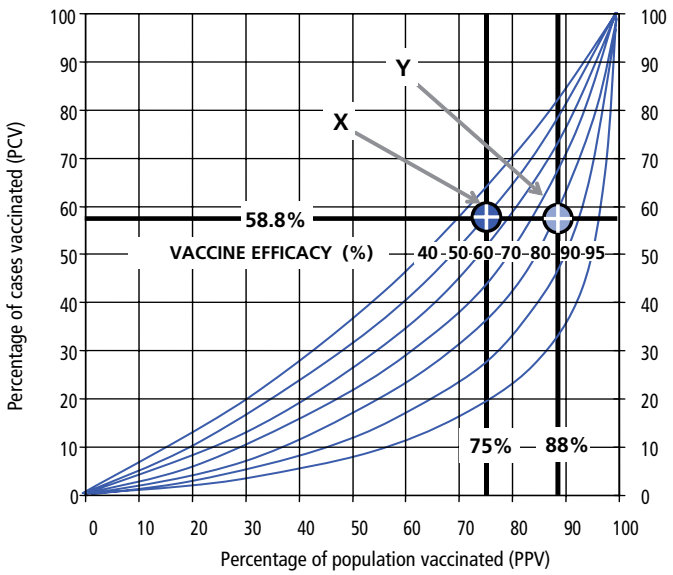
Since no vaccine is 100% effective, not all persons given polio vaccine are necessarily protected against the disease. The best way to determine whether the number of vaccine recipients who develop poliomyelitis is too high is to calculate the vaccine's efficacy. Low efficacy (for example, less than 80%) may indicate that there are problems with the cold chain, the manufacturing process, application techniques, or use of vaccine lots of different origin that affect the vaccine's protective capacity.

There are several ways to calculate vaccine efficacy, including the use of coverage

data and the investigation of outbreaks using case-control studies. These methods are too detailed to describe here. A preliminary assessment is outlined below to quickly determine whether the efficacy is within expected limits.

Vaccine efficacy can be estimated if the two following variables are known: (1) the proportion of cases occurring in vaccinated individuals (PCV) and (2) the proportion of the at-risk population that is vaccinated (PPV). The curves in Figure 7 indicate theoretical vaccine efficacy levels based on these two variables (PCV and PPV). In this example, the proportion of cases with three or more doses of polio vaccine (PCV) is 58.8%. Based on prior coverage estimates, the at-risk population (children under 5 years of age) that was vaccinated (PPV) was 75%. Figure 7 shows the intersection of these two values (point x). Since x is to the left of the 60% curve, vaccine efficacy in this case is estimated to be less than 60%. In another example with the same percentage of individuals receiving three or more doses of vaccine (PCV = 58.8%) but a higher proportion of individuals vaccinated (PPV = 88%), the intersection of these values on the graph (point y) is located to the right of the 80% curve, indicating vaccine efficacy that is higher than 80%. This method does not give precise estimates of vaccine efficacy, but it does provide a rough guide as to whether further evaluation is necessary.

Figure 7. Vaccine efficacy



Source: Orenstein WA et al., "Field evaluation of vaccine efficacy" *Bull WHO* 1985; 63(6): 1055–1068.

The efficacy of routine immunization activities can be monitored by monthly reviews of the vaccination records of the 1-year-old population (12 to 23 months of age) to determine whether or not the children were fully immunized by the end of their first year of life. Reasons for noncompliance with the vaccination schedule should be identified and strategies should be adjusted accordingly (see Annexes 5 and 6).

5. IMMUNIZATION ACTIVITIES

5.1 Routine Immunization

Systematic or routine immunization is conducted by the permanent health services on an ongoing basis. The objective is to ensure that all new cohorts entering the population are immunized as early as possible to prevent pockets of susceptibles from developing. The success of routine immunization depends on the following:

- Integration of immunization within routine health services delivery;
- Activities aimed at reducing missed opportunities;
- Improved outreach activities conducted by the health services;
- A high level of cooperation between the health services and the community in finding the most effective means of reaching groups that are in remote areas or are less receptive to immunization.

5.2 Mass Campaigns

Conducting national immunization days is an integral part of the strategy, and without such campaigns polio cannot be eradicated. Widespread vaccination produces extensive dissemination of the vaccine virus, which competes with the wild virus and can quickly interrupt its transmission. Such campaigns are intended to supplement routine immunization programs and can be held at the local or national level.

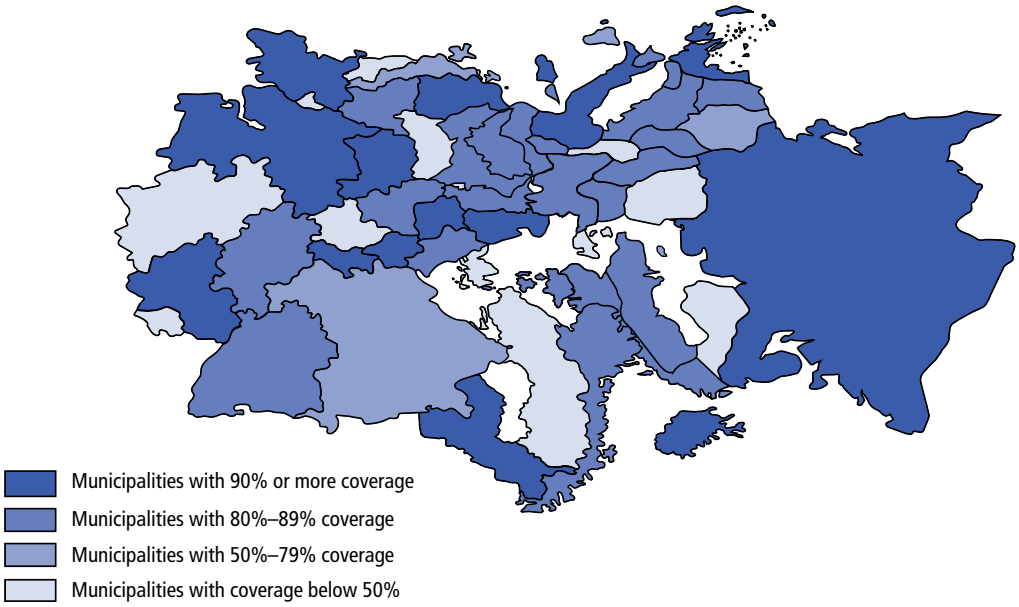
During these mass campaigns a single dose of trivalent OPV should be given, regardless of immunization status. Two vaccination rounds should be conducted each year, allowing an interval of at least four weeks and no more than eight weeks. Although the experience in Latin America has shown that in general it is sufficient to conduct two well-executed vaccination campaigns, elsewhere in the world (especially in Asia), in densely populated countries with poor health conditions and with very low coverage, it is necessary to carry out several national immunization days before managing to interrupt the circulation of the wild poliovirus. Children who have missed another vaccination (for example, measles) should be referred to the nearest health center for additional immunization if the missing vaccination cannot be given at the time of the polio campaign for logistical reasons. The opportunity should also be taken to offer other health services, such as the provision of vitamin A or parasiticides, health education, and case referral.

Countries that have failed to interrupt transmission, that are still experiencing coverage deficits, or that are facing a reduction in coverage should consider holding more immunization days. The aim is to vaccinate as many children under 5 years of age (including newborns) as possible, regardless of their previous vaccination history. The simultaneous administration of multiple antigens (including tetanus toxoid for women of childbearing age who live in high-risk areas) is encouraged.

The most effective immunization campaigns are organized at the national level, thus enabling many resources (educational, military, religious, private enterprise, and community) to be mobilized nationwide for one to three days (in remote areas, the campaign may need to last as long as one week). Such campaigns should be conducted at least twice each year, and not less than four to six weeks apart, or two months apart at a maximum. This approach aims at 100% coverage of the under-5-year-old population in the target area of the campaign (see Figure 8).

The participation of local community leaders is key to the success of the campaign. Mass media attention needs to be focused on the event. The decentralization of financial resources for direct administration by health officials at the lowest level of the health system is essential, so that the funds are closest to where the expenditures will take place. Logistic, geographic, or demographic factors may prompt some countries to conduct immunization days in smaller geopolitical units, such as single provinces or regions.

Figure 8. Map displaying OPV coverage by municipality in children less than 1 year of age. January–December 2003 (fictitious)



5.3 Coverage of At-Risk Groups

During the organization of these immunization days, special attention needs to be paid to areas and municipalities where coverage rates are below the national average. This is particularly true in areas with deficient health services, and where additional human and logistical resources may need to be allocated. Furthermore, in the periods between immunization days, special programs should be organized in those areas where coverage continues to be low.

The groups at special risk for infection tend to be found in localities or municipalities that have been defined as "at risk" by surveillance and other indicators. Accordingly, target areas should be identified for "mop-up" vaccination campaigns and, within these areas, a specific number of households should be visited. The following criteria are generally used to define areas in need of mop-up vaccination:

- Detection of an imported case;
- Deficient surveillance information;

- Poor vaccination coverage;
- Low economic status;
- Limited access to health services;
- Urban areas with a large poor population, particularly one that is transient;
- Areas of heavy migration across borders.

During "Vaccination Week in the Americas," each country in the region carries out promotion, vaccination, and health services delivery to groups selected in relation to their levels of risk. This is an example of the concerted way in which countries can carry out health interventions to reduce inequity and protect their communities. These continent-wide campaigns were launched in 2003 and reach nearly 40 million people annually.

5.4 Missed Vaccination Opportunities

An opportunity for immunization is considered missed when a person who is eligible for it and who has no contraindication to immunization visits a health service and does not receive all the needed vaccines. Missed opportunities mainly occur in two settings: during visits for preventive services, including other vaccinations, and during visits for curative services. In both settings, eliminating missed opportunities can raise coverage levels in a population.

Studies of missed opportunities for immunization indicate a continuing need to ensure that health personnel know about the limited contraindications for administering vaccines and do not impose unwarranted barriers to immunization. Necessary steps should be taken to ensure that vaccines are offered to all women and children every time they have contact with the health system. Rates of missed opportunities are generally highest in children under 1 year of age, who are the primary targets of vaccination programs. Opportunities for immunization are missed for the following reasons:

- False contraindications, such as fever, diarrhea, vomiting, colds, and coughing, are the major causes of missed opportunities. Despite the fact that national program standards are clear on the definition of contraindications, health workers often fail to vaccinate because of erroneous beliefs. For example, they may believe that vaccination would produce adverse reactions or exacerbate a problem, would be inadequate, or would not be absorbed by the body. Contrary to common beliefs, malnutrition is not a contraindication to vaccination.
- The attitude of many health services providers is another major cause of missed opportunities. They might fail to mention vaccination during routine

patient visits, might not offer it, or might not ask their patients about their vaccination status. Some health workers avoid offering vaccination in order to economize on biologicals, since they are reluctant to open a multidose vial of vaccine for a single child.

- Inadequate supply and distribution of vaccines.
- Another cause of failure to vaccinate relates to lack of organization and availability of services. Problems often cited include waiting to gather a large number of children before starting to vaccinate, providing services during limited hours or on limited days, or scheduling only specific days of the week or month for vaccinations.

Following are some approaches for reducing missed opportunities:

- Develop in-service training programs for all professional and technical health personnel to ensure that they are up to date on national immunization standards and prepared to help change attitudes about false contraindications.
- Arrange for meetings and visit operations and personnel on-site to review the performance of the programs and to discuss with health workers alternatives that will allow them to take advantage of every vaccination opportunity.

To reduce missed opportunities for vaccination, health services should:

1. Check the vaccination status of all persons seeking services at health facilities, regardless of their reason for attendance. Patients should be encouraged to bring their vaccination card every time they visit a health center, and any vaccination that is missing should be given immediately.
2. Carry out routine health and vaccination education activities in waiting rooms and emergency rooms, as well as for hospitalized patients.
3. Offer all vaccines on a daily basis. Do not hesitate to open a vial even when only a few children will be vaccinated. Vaccinate all children in need of immunization, whether or not they are ill.
4. Set up convenient vaccination posts with extended hours of operation.

Program managers should:

1. Ensure an adequate stock of biologicals and supplies.
2. Decentralize immunizations to the health units or areas.
3. Evaluate activities being carried out to reduce missed opportunities for vaccination.

Communities should:

1. Increase awareness and inform parents about the need for vaccination.
2. Get private health providers involved.
3. Develop a training program for community leaders.
4. Carry out activities with the mass media to promote immunization.
5. Link the provision of other services (such as milk or food supplements) to the presentation of an up-to-date vaccination card.

6. EPIDEMIOLOGIC SURVEILLANCE

6.1 Case Definitions

For purposes of the polio eradication program, the Technical Advisory Group on Polio Eradication has adopted the following case definitions (see also Figure 9):

Probable case

A probable case is any case of acute flaccid paralysis in a person under 15 years of age for any reason other than severe trauma, or paralytic illness in a person of any age in whom polio is suspected.

Confirmed case

A confirmed case is acute flaccid paralytic illness, with or without residual paralysis, associated with the isolation of wild poliovirus (or circulating vaccine-derived poliovirus—cVDPV).

Polio-compatible case

A polio-compatible case is a case in which a stool sample was not collected within 15 days of the onset of paralysis and the patient also presents an acute paralytic illness with polio-compatible residual paralysis at 60 days, or death takes place, or the case is lost to follow-up. If epidemiologic surveillance is adequate, the proportion of these cases should be small.

Vaccine-associated case

A vaccine-associated case is acute paralytic illness in which the vaccine virus is believed to be the cause of the disease. Vaccine-associated cases should be distinguished from those caused by wild poliovirus or circulating vaccine-derived poliovirus. In order to classify a case as vaccine-associated, the following criteria must be met:

- It must be a typical clinical case of poliomyelitis (including sequelae);
- OPV must have been received between 4 and 40 days prior to onset of the paralysis;
- The vaccine virus must have been isolated from a stool sample; and
- The dose in question should preferably be the first one administered in a series (see Section 4.2).

In this classification, the word “associated” should be emphasized, since the definitive causal relationship can only be established by isolating the virus from the site of the lesion.

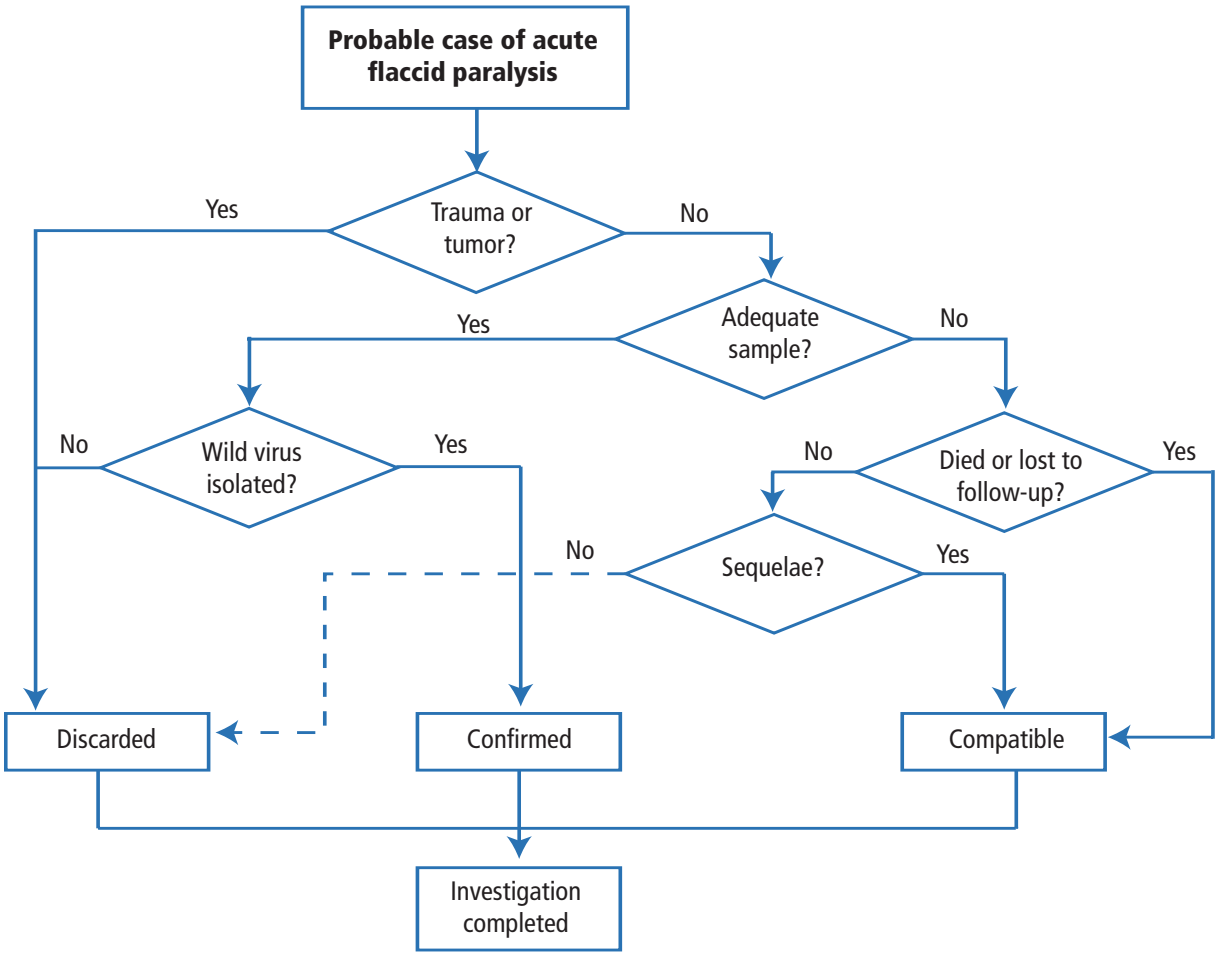
Discarded case

A discarded case is a case of acute paralytic illness for which an adequate stool sample was obtained within two weeks after onset of paralysis and was negative for poliovirus. Small amounts of the original specimen should be kept in the laboratory for future reference. In the case of a patient who presents residual paralysis at 60 days, has died, or has been lost to follow-up, aliquots of the specimens should be examined in two additional network laboratories using appropriate techniques to ensure the accuracy of this classification. If the specimens were adequate and the results are all negative, the case should be discarded.

6.2 Detection and Notification of Probable Cases

Detection of probable cases should be done mainly through health services that are linked to surveillance systems. At the same time, active searches should be carried

Figure 9. Investigation of a probable case of poliomyelitis



out; the support of community leaders is essential for these activities. All health services personnel should know the definition of a probable case of poliomyelitis and, if such cases are found, they should immediately submit a report to the next higher level and institute control measures, including the collection of stool samples from the patient.

Every country should have a system for reporting probable cases of acute flaccid paralysis. Within this system, health centers report the presence or absence of cases once a week to the next higher level. Door-to-door or community-wide searches are an effective way to find additional cases once an initial case is found, or to investigate districts or municipalities where the health centers have not reported a case in a long time, particularly in areas where persons with illness are not likely to seek medical care.

If a polio outbreak is suspected in a community, a list should be drawn up of all churches, preschool centers, schools, hospitals, clinics, pharmacies, and rehabilitation facilities in the affected area. A minimum of one visit should be made to each site, but weekly contact is encouraged, depending on the extent of the outbreak and the personnel available (volunteers can be used). During the first visit, the health workers should be asked if any case of paralytic illness has been seen or diagnosed within the last six months. If such cases occurred, the health worker's immediate superior responsible for the center or the coordinator of epidemiologic surveillance should be notified immediately, and the patient's medical record must be reviewed to determine if there is any possibility that the case was polio. If there is this possibility, the patient's home should be visited next.

In health centers that serve larger populations, contacts may also include selected medical professionals such as neurologists and pediatricians. Efforts to identify additional cases should extend well beyond the neighborhood or community in which the probable case was found. Because the Region of the Americas has been free of wild poliovirus since 1991, every probable case of polio should trigger immediate notification, the collection of stool samples from the patient, and an investigation that will confirm the presence or absence of other cases in the community.

6.3 Case Investigation

All reported cases of AFP should be investigated within 48 hours of being reported. Outbreak control should begin as soon as one or more of these cases fit the definition of a probable case—that is, AFP is observed and no other cause of the paralysis can be determined. The outbreak should be publicized and immunization activities set up immediately so that transmission can be stopped. Mop-up operations should be initiated to obtain the most effective results as quickly as possible. At the same time, it is important to intensify surveillance in order to find additional cases.

Health authorities at all levels and in neighboring jurisdictions should be informed and become involved in all aspects of outbreak control. If a probable case has traveled or had close contact with individuals from other parts of the country in the 40 days prior to the onset of paralysis, the regional or district-level surveillance coordinators in those areas should be notified immediately. When appropriate, other countries should be notified as well. The public should also be informed through the mass media.

For each probable case, the patient's home should be visited and a case investigation form completed (see Annex 7). Also, a line-listing of probable AFP cases should be maintained (see Annex 8). In addition, it should be determined whether other AFP cases have turned up in any places visited by the patient during the month prior to onset of paralysis, such as a preschool center or school, or another town or village. For cases from rural areas, the investigator should check the nearest large urban center or other sites such as a marketplace or tourist centers that might be a reservoir. All investigations should be the responsibility of specially trained epidemiologists who work for state or national agencies. The following sections outline the required measures in the investigation of probable cases.

A decision should be made to classify a case as either AFP or as "discarded" within 48 hours of notification. The definitions given earlier in this chapter (Section 6.1) should be followed strictly, regardless of vaccination history or the opinion of attending clinicians.

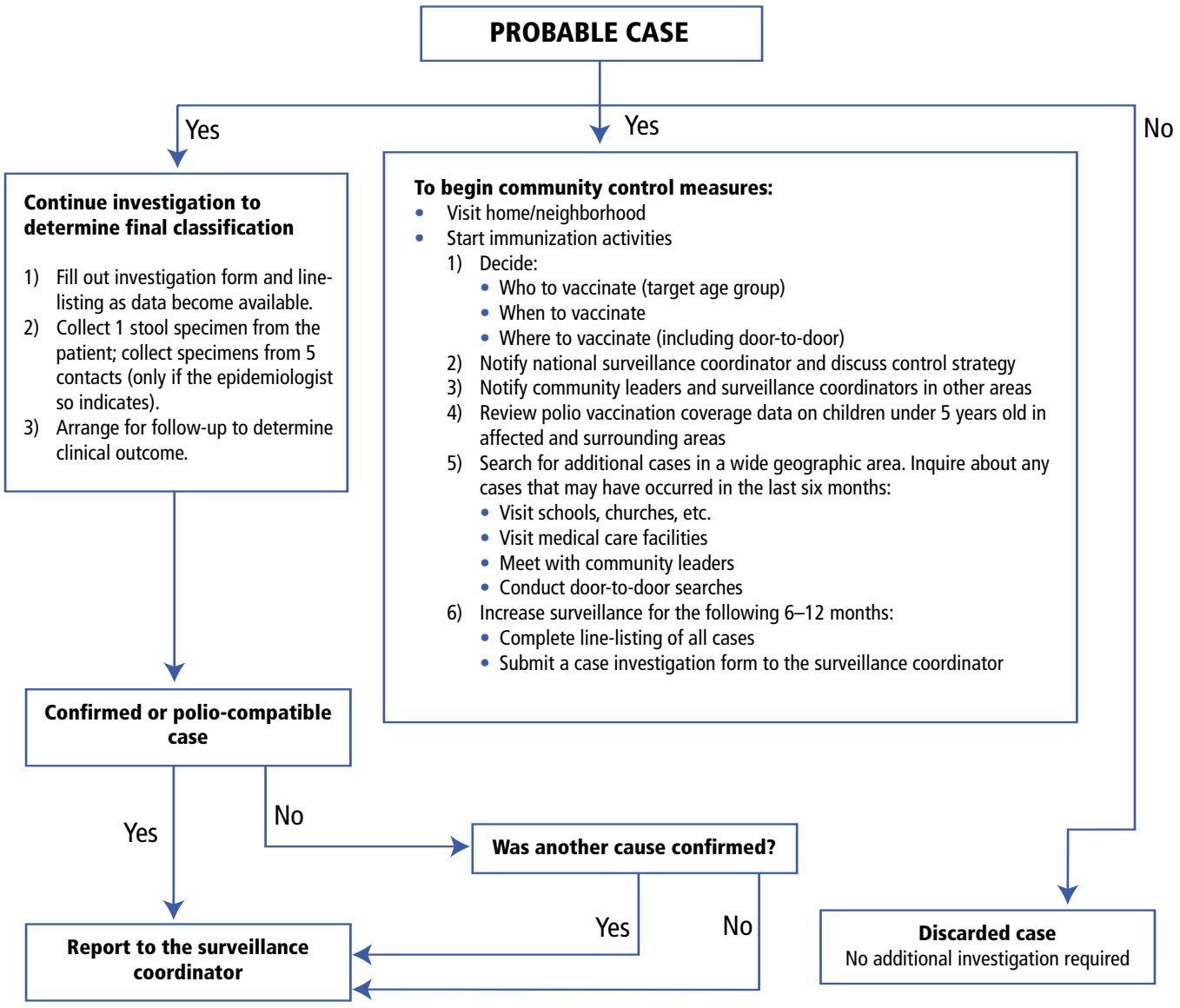
Probable cases (AFP)

After a case is classified as "probable," the following actions should be taken (see Figure 10):

- Collect all available demographic and clinical information on the case (see Annexes 7 and 9);
- Fill out the Line-Listing of Probable Cases (AFP) (see Annex 8);
- Immediately collect a stool sample from the patient. The epidemiologist in charge of the investigation should determine whether samples should be taken from individuals who were in contact with the initial case. Samples from contacts are not routinely collected. If it is decided to collect samples from contacts, they should be taken from children under 5 years of age who did not receive the oral polio vaccine within the last 30 days. A date and place must be set for further follow-up in order to: (1) collect additional stool samples, if necessary, and (2) determine whether residual paralysis is present after 60 days;
- Inform surveillance site coordinators in the surrounding areas that a case of AFP has been identified;

- If the onset of paralysis occurred less than six months earlier, initiate an investigation in the community to identify additional cases and institute widespread control measures regardless of coverage levels; and
- If the onset of paralysis occurred more than six months earlier, start mop-up vaccination activities as soon as the low transmission season begins.

Figure 10. Case investigation decision tree



Case-finding during an outbreak. In the Americas, where poliomyelitis has already been eliminated, the presence of a single confirmed case of the disease constitutes an outbreak. To detect additional cases, procedures similar to those described elsewhere in this chapter should be used, and the support of community leaders should be enlisted.

Target group for vaccination in the event of a polio outbreak. In general, children under 5 years of age should receive the highest priority. However, if cases occur in children 5 years of age or older, the older children should be vaccinated as well. All should receive a single dose followed by a second dose four to six weeks later, irrespective of documented polio vaccine history.

Concept of high-risk communities. Each case of paralysis probably represents 100 to 1,000 infected people. Consequently, it is likely that the virus may have spread beyond the local area in which the case resides. It has been shown that mass immunization programs with OPV quickly interrupt the transmission of poliovirus. Thus, immunization activities should cover a wide geographic area, particularly if there is any doubt about the quality of surveillance or the data on vaccine coverage. Adjacent areas may have coverage levels similar to that of the affected village or city, or there may be frequent or large-scale population movements. If so, vaccination campaigns may need to be conducted in those areas as well. Such immunization activities should be organized promptly and publicized extensively.

6.4 Laboratory Confirmation

The laboratory plays a critical role in surveillance, since eradication focuses on eliminating the wild poliovirus itself and not just the clinically apparent disease. Viral culture of stool specimens collected from both AFP cases and their contacts is the most sensitive and effective way to rule out transmission of either wild poliovirus or vaccine-derived virus (see Table 2). Since it is impossible to be sure that a patient will be available for follow-up, clinical information and specimens should be taken during the first consultation.

To ensure that stools from cases and contacts (if collection of the latter has been indicated) are tested without delay, and to solve any other problems, there should be good communication and coordination between the epidemiologist and the virologist. For probable cases, all available specimens from both the probable cases and contacts should be examined.

Type of specimen

Although the following list includes all types of specimens that could be used for laboratory diagnosis, for purposes of AFP surveillance it is recommended that only ONE stool specimen be taken from the patient as soon as it is determined that it is a probable case.

Table 2. Specimens for poliovirus detection

	Feces	Autopsy material (tissue and intestinal contents)
When to collect	As early as possible in the course of the illness; collect one sample each from cases and contacts (if so indicated).	Within 24 hours of death.
Collection technique	Use a clean, empty container to collect 8 g of feces (approximately the size of two thumbs).	Avoid contamination of nervous system tissue with intestinal contents. Tissues should be collected using sterilized instruments and placed in individual, sterile containers. Use separate instruments and containers for different tissue types.
Storage	If possible, keep specimens refrigerated from the time of collection.	Keep specimens refrigerated from the time of collection.
Labeling	Label all specimens clearly with name of case or contact, case number, date of collection, and date of onset of paralysis.	Label all specimens clearly with name of case or contact, case number, date of collection, and date of onset of paralysis.
Shipping of specimens	Ship specimens wrapped in a well-sealed plastic sack in a thermos or cooler with ice. Use dry ice if available. Include appropriate laboratory slips, and inform laboratory when specimen will arrive.	Ship specimens wrapped in a well-sealed plastic sack in a thermos or cooler with ice. Dry ice is strongly recommended. Include appropriate laboratory slips, and inform laboratory when specimen will arrive.
Type of exam	Virus isolation and characterization.	Virus isolation.
Interpretation of results	If poliovirus is isolated, it must be characterized as being either a "wild" or "vaccine-derived" strain. Absence of virus does not rule out the possibility of poliomyelitis.	Isolation of poliovirus from central nervous system tissue confirms poliovirus infection.

Stool. The virus can usually be found in feces from 72 hours to six weeks after infection, with the highest probability during the first two weeks after onset of paralysis.

Cerebrospinal fluid (CSF). It is not likely to yield virus, and therefore its collection is not recommended.

Throat. It is not likely to yield virus, and therefore specimen collection from this site is not recommended.

Blood. It is not likely to yield virus, and current serologic tests cannot differentiate between wild and vaccine-derived virus strains. Experience has shown that for polio, interpretation of serologic data can often be misleading. Therefore, collection of blood specimens is not recommended.

If a probable case dies, a definite diagnosis of polio can be made or rejected by examining the spinal cord. It is important that a qualified and experienced pathologist do the examination and that a specimen be sent directly to a reference laboratory so that efforts can be made to culture for poliovirus.

Specimen collection

Probable case. **One** stool sample should be collected from probable cases within two weeks of the onset of paralysis.

Probable case, patient has died. Specimens should be collected from intestinal contents or nearly formed stools; tissue (medulla, spinal cord) and serum may also be collected as soon as possible after death. These specimens will be sent to the laboratory, where they should be cultured and undergo polymerase chain reaction (PCR) and histopathologic analysis. A section of nerve from the affected limb should also be obtained.

Contacts. When so indicated by the epidemiologist, stool specimens should be collected from five or more contacts who are under 5 years of age and who have not received oral polio vaccine within the last 30 days. The epidemiologist will usually give instructions to collect specimens from contacts when the probable case has clinical or epidemiological manifestations suggesting that it is a true case of poliomyelitis (high fever, asymmetrical acute flaccid paralysis, etc.), or when there is more than one probable case in the community.

If the probable case is seen later than 14 days after the onset of paralysis, and is clinically compatible with polio, special studies will be needed in addition to analysis of the stool specimen. Such studies may include community surveys to collect stool specimens from 50 to 100 of the patient's contacts and neighbors who are under the age of 5 and who have not been vaccinated within the previous 30 days.

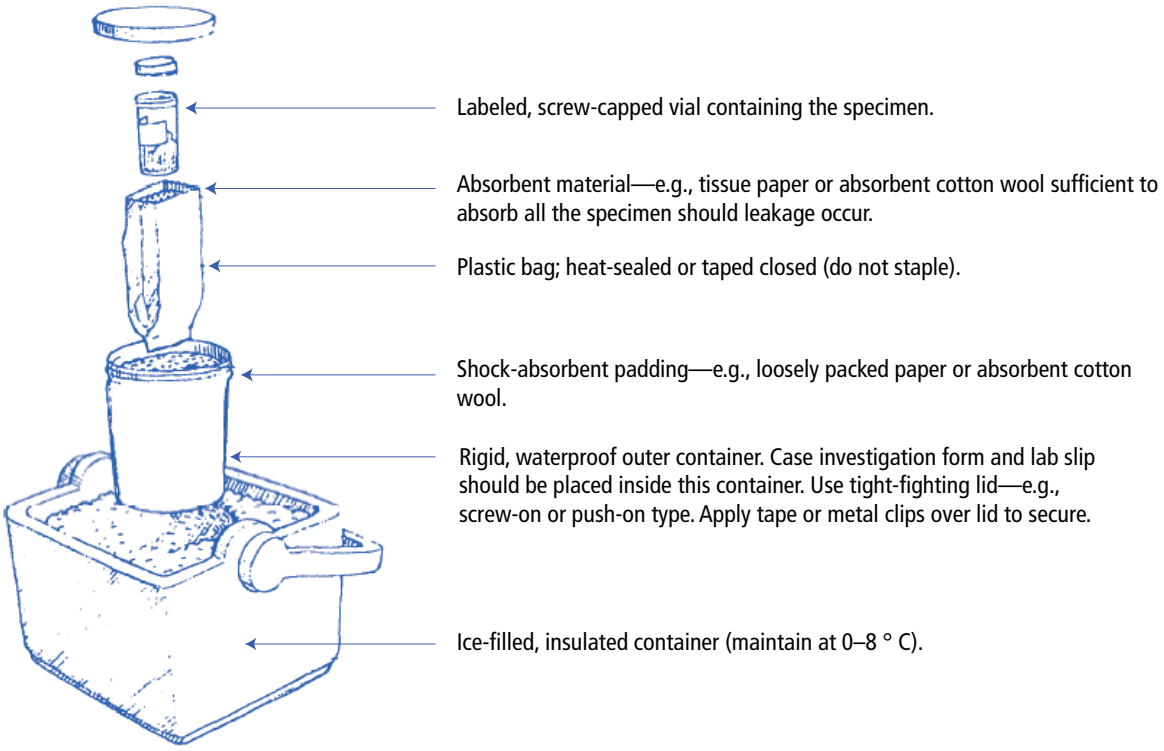
At least 8 g of specimen (about the size of two thumbs) should be collected directly in the container that will be sent to the laboratory. Rectal swabs are not recommended, although rectal tubes may be used in special circumstances.

Storage and shipment of specimens

Stool specimens should be kept cold if they are to remain in adequate condition for reliable testing when they arrive at the laboratory (see Figure 11). The best way to keep them cold is with dry ice; when dry ice is unavailable, ice packs are recommended. Dry ice requires special handling, so it should be ensured that any box containing dry ice is hermetically sealed.

The person responsible for shipping should make sure that there is sufficient quantity of the stool specimen and ice. In addition, the shipper should telephone and send a fax to the receiver, and should ensure that the appropriate forms are included with the shipment. Upon delivery, the receiver should inform the shipper of the date and time the specimens were received and their condition. If possible, this verification should take place within 48 hours, so that arrangements can be made to collect additional specimens if necessary.

Figure 11. Packaging for virological specimens



When specimens are sent by messenger service or hand-delivered, the carrier should be advised of the contents and special handling requirements of the package, as well as the importance of delivering the samples directly and immediately. The delivery service should inform the shipper when delivery has been successfully completed.

The following information should be provided for all specimens:

- Collection date,
- Case identification number,
- Health jurisdiction,
- Hospital/clinic,
- Key clinical information, and
- Vaccination history and date of last OPV dose.

Quality control of specimen collection

Ongoing evaluation of the quality of stool specimen collection, transportation, and storage is a crucial component of the program. Laboratories in the network should

be evaluated annually to ensure the quality of specimen processing. Specific forms should accompany each specimen to assist in the collection of critical monitoring information (see Annex 10). A detailed record of the condition in which each specimen is received should be kept by both the receiving laboratory and the central laboratory in each country, so that those responsible for sending the specimen will receive feedback about the quality of the shipment.

The laboratory should note:

- The adequacy of packaging for the specimen;
- The type of specimen;
- Whether the specimen was sufficient (8 g);
- Whether ice was still present when the specimen arrived;
- Whether the package was correctly identified.

Results of the laboratory analysis

It is important that the status and results of the tests on the samples be conveyed back to the individuals who requested them as soon as possible. Initial laboratory results should be reported within 28 days of receipt of the specimens.

Isolation of poliovirus

Failure to isolate poliovirus from a stool specimen does not rule out the diagnosis of poliomyelitis. Many factors can influence the results, including intermittent shedding of the virus in stool, insufficient material collected, collection of the specimen too late in the course of the illness, inadequate storage and shipping of specimens, and problems with laboratory technique. The proportion of specimens from which enteroviruses were isolated should be reported, since this figure is an indirect indicator of specimen quality. In tropical areas, at least 10% of the specimens can be expected to yield enteroviruses.

Characterization of poliovirus

All polioviruses isolated from the stools of patients with acute flaccid paralysis or from their contacts should be characterized. This characterization determines whether the virus is "wild" or "vaccine-like." The initial identifications are confirmed by polymerase chain reaction (PCR) analysis using primer sets specific to each vaccine strain and to the predominant wild polioviruses indigenous to the region. Wild viruses identified using this procedure should be further characterized by partial nucleotide sequencing of the virus genomes, which reveals the genetic relationships between virus isolates. Given that poliovirus genomes evolve rapidly during replication in humans, the proximity of epidemiological links between cases may be estimated by analyzing the nucleotide sequence relationships in the genomes of the iso-

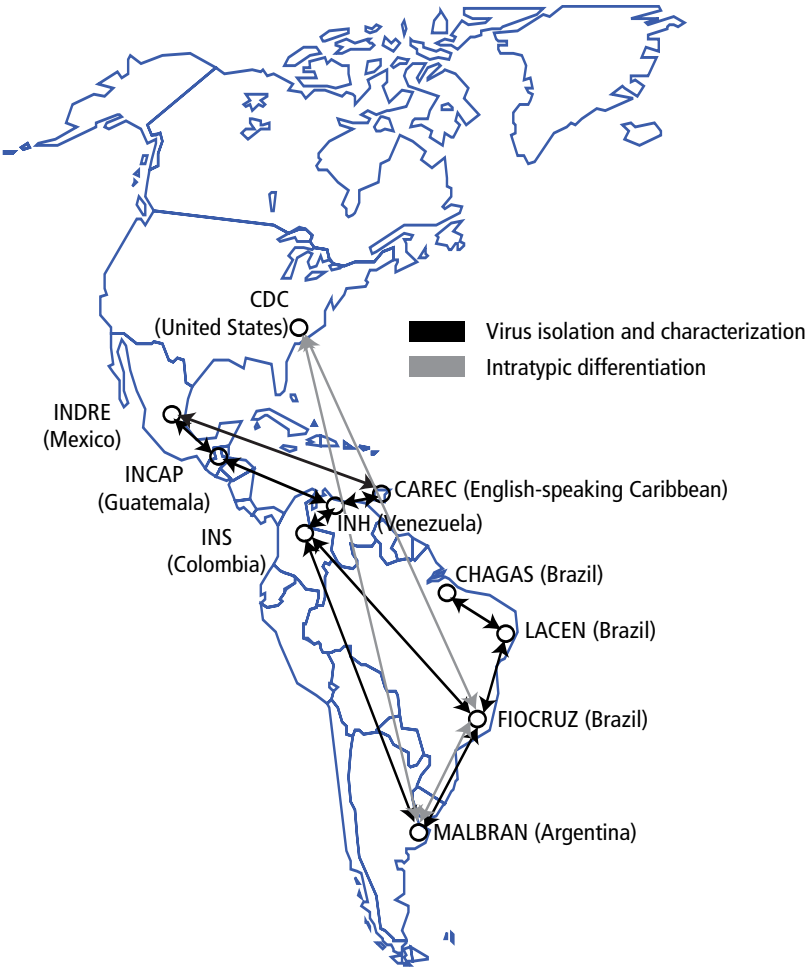
lated viruses. Sequence information is also used in the systematic design of nucleic acid probes and in the initiation of RNA segments for PCR. This further characterization also makes it possible to know if it is a vaccine virus or one derived from the Sabin vaccine.

Laboratory network

Poliomyelitis is not clinically distinctive and may be confused with other causes of flaccid paralysis. Surveillance systems, therefore, need laboratory support in order to confirm or rule out poliovirus as the cause of a case of acute flaccid paralysis. Techniques for analyzing stool specimens, isolating poliovirus, and differentiating between vaccine-derived virus and wild poliovirus must be standardized, and the quality of procedures must be monitored.

PAHO has sponsored the formation of a laboratory network (see Figure 12) to analyze stool specimens for poliovirus. Several of the more sophisticated (level 3) labs perform intratypic differentiation tests for poliovirus, and the results are published in the *Polio Weekly Bulletin* of the Pan American Health Organization (see Annex 11). It is important for the laboratories to provide regular updates of their findings so that the epidemiologic surveillance system can monitor the status of all stool specimens collected from AFP patients.

Figure 12. Polio reference laboratory network in the Americas



The network serves to enhance laboratory performance by developing new technologies and analytic approaches, by providing training, and by maintaining strong collaboration among laboratories. Network representatives should be encouraged to meet regularly to discuss the evaluation of testing methods, interpretation of findings, implementation of new technologies, network resource and training needs, and ways to improve network performance, particularly in the area of research. The laboratories need to communicate their requirements regarding timely collection, storage, and appropriate means of shipping clinical specimens.

Maintenance of a central database that summarizes laboratory information on each case and contact (Annex 12) is critical, as is dissemination of this information among the participants. Quality control of laboratories includes: annual accreditation; site visits to evaluate operations; testing of each laboratory with a panel of specimens known to the sender but not to the laboratory; and analysis of the time taken to report initial results of whether or not poliovirus was isolated, including the time taken to identify and report the type of virus isolated (vaccine-derived, wild, type 1, 2, or 3); among other requirements (see Annex 13).

6.5 Monitoring and Feedback

Information dissemination

At the country level, a bulletin should be distributed to all those involved in surveillance and eradication to provide results on reported and confirmed cases. In addition, the bulletin should indicate the number of units reporting each week (including negative reporting). Information should also be included about the current epidemiological status of polio and other EPI target diseases. Polio update bulletins should be distributed on a weekly or monthly basis to all health care workers, other health service providers, and members of the community at large.

6.6 Surveillance Indicators for Acute Flaccid Paralysis

The following indicators should be evaluated and reported on a routine basis:

Surveillance

1. *Percentages of reporting sites that submit reports every week:* At least 80% of the sites should submit weekly reports, even in the absence of cases.
2. *Sensitivity of surveillance:* It should be expected that in a given year at least 1 case of acute flaccid paralysis will be detected in every 100,000 children under 15 years of age. Each country's monitoring data should be reviewed to ascertain whether or not the territorial units (states, provinces, departments) are complying with their annual guidelines. This indicator is particularly helpful in detecting "silent" areas (i.e., those that have failed to follow the indicated guidelines), and it will be used to adopt the corrective measures called for by the review. The review should not be limited to verifying whether a jurisdiction has followed established reporting guidelines, since data attributed to that jurisdiction may be coming from a large referral hospital that is actually reporting cases from elsewhere. In such cases it will then have to be determined whether a consultation occurred in a patient's place of origin and whether the relevant health facility reported the case. Cases should be assigned to the jurisdiction in which the patient resided for the last 45 days prior to onset of paralysis. Table 3 gives an example of the type of line-listing

the country should prepare in order to determine the rate of AFP in its respective territorial jurisdictions.

3. *Interval between case onset and notification:* At least 80% of all cases should be detected and reported within 14 days of the onset of paralysis.

Investigation

1. *Interval between notification of a probable case and investigation:* 100% of the cases should have been investigated within 48 hours of notification.
2. *Stool specimen from probable cases:* For at least 80% of the AFP cases, a stool specimen should have been obtained within 14 days of the onset of paralysis.
3. *Interval between specimen collection and receipt in the laboratory:* 100% of the specimens should be received by the laboratory within 3 days.
4. *Case follow-up:* At least 80% of all probable cases should be followed up within 60 days of paralysis onset to determine whether or not there is residual paralysis.
5. *Case investigation form:* 100% of the cases should have a completed investigation form with demographic, clinical, and laboratory information.
6. *Critical clinical variables:* The medical records for 100% of the cases should contain the following variables: date of paralysis onset; time or period of progression of paralysis; presence of fever at onset of paralysis; residual paralysis 60 days after onset; atrophy at 60 days; location of paralysis (proximal or distal, symmetrical or asymmetrical); and final diagnosis.

Table 3. Rate of reported cases of acute flaccid paralysis per 100,000 population under 15 years of age, by department (fictitious data)

	YEAR			
DEPARTMENT	2000	2001	2002	2003
Akron	4.10	7.50	2.00	0.70
Antigua	0.30	1.50	1.00	1.50
Cárdenas	0.60	0.00	0.00	0.00
Chattanooga	0.40	0.40	0.40	0.00
Coronado	5.70	0.90	1.80	0.90
Evansville	1.90	1.90	0.70	0.60
Huila	2.30	0.00	1.10	1.10
Jacksonville	3.20	1.70	0.70	0.70
La Unión	0.00	0.60	1.21	0.60
Lowell	0.40	0.80	0.40	0.00
Mangas	4.10	2.10	2.10	1.00
Ogden	0.20	1.60	3.30	1.40
Providence	1.10	1.10	0.40	1.50
San Juan	4.70	2.20	2.20	0.70
San Marco	2.40	1.50	1.50	1.00
Savannah	0.30	0.30	0.60	0.00
Shreveport	10.90	0.00	0.00	0.00
Somerville	10.90	0.00	4.40	0.00
Spokane	1.60	1.60	0.00	0.00
Tampa	1.80	0.40	1.10	0.40
Toledo	0.70	0.50	0.70	0.50
Waterbury	1.10	0.00	1.60	0.00
Yonkers	1.80	1.80	0.00	0.00
Youngstown	0.00	0.00	2.00	2.00
AVERAGE	1.77	1.15	1.11	1.06

Laboratory

1. *Condition of specimens:* 100% of the specimens received should have proper epidemiological data, be correctly packaged, and be surrounded by ice.
2. *Interval between receipt of specimen and report of results:* 100% of the findings should be communicated to the sender within 28 days of receipt of the specimen.
3. *Recovery of virus:* Enterovirus should be recovered in at least 10% of the stools processed.

Control

1. Control measures must be instituted for 90% of all cases classified.

6.7 Response to Outbreaks

Outbreak management

When it is decided that outbreak control is necessary, certain information should be gathered and a plan of required actions adopted. The decision to adopt measures to combat an outbreak should be based on epidemiologic analysis (which at that point may, but need not, include laboratory results). Although it is difficult to list all the criteria that need to be met in order to start taking action against an outbreak, this decision may be made if one or more of the following conditions are present:

- A case of AFP in which the wild virus has been isolated;
- Cases of AFP that seem to be epidemiologically connected with no obvious external cause (for example, poisoning from organophosphorus compounds);
- Cases of AFP with the clinical characteristics of polio;
- Detection of wild poliovirus or vaccine-derived virus in neighboring areas or countries; and
- Low vaccination coverage.

The following factors, among others, need to be taken into account when managing an outbreak:

- *Population data:* Obtain the most recent data on population size and distribution.
- *What's been done:* List any measures already taken.
- *Case review:* List cases reported in the area in the last six months. Construct an epidemic curve.
- *Coverage rates:* Obtain existing coverage data, including official estimates.

- *Spot map:* On a map, use pins or a pen to mark the location of cases and areas targeted for vaccination.
- *Resources:* Determine what resources are available at all levels (transportation, vaccine, cold chain materials, etc.). Field personnel to assist in outbreak control should include teams from other programs, district staff, medical and nursing students, interpreters, and drivers. Arrange for transportation and payment of travel advances.
- *Coordination:* Inform appropriate health and community authorities when and where the team will be arriving and ask that specific health system staff and community representatives be present.
- *Supplies:* Organize necessary supplies to take to the outbreak area:
  - Adequate supply of OPV vaccine for estimated target population;
  - Cold chain materials: ice packs, portable refrigerators/cold boxes, vaccine shipping containers, vaccine control cards, thermometers. Determine whether refrigerators for the ice packs are locally available or need to be brought (e.g., a kerosene refrigerator);
  - Adequate supply of forms: line-listings for probable cases and laboratory information, AFP case investigation forms (Annex 7), summary of outbreak control measures (Annex 9), and mop-up work tally sheets (Annexes 14 and 15).
- *Outbreak monitoring:* Information on cases, immunization activities, and villages visited needs to be updated continuously and monitored during an outbreak. This information on control measures should be kept on a form that can be quickly summarized, such as the one shown in Annex 9. Outbreak containment will have been successful if no additional cases are reported one month after the second round of immunizations. At that time, special reviews and checks should be made to ensure that no new cases have occurred.

6.8 Information and Data Analysis Systems

An important component of a successful polio eradication program is a well-developed information system—one that provides program managers and health workers with the necessary information to take appropriate action. Information from the disease surveillance system is used to prepare regular summary reports. These reports should be distributed to the personnel responsible for acting on specific problems. All surveillance information should be standardized, that is, it should include the same type of data elements.

Data collection

The system, whether it is manual or computerized, consists of two main elements:

Case tracking and data collection

At the national and regional levels of a country, there should be a system that is capable of tracking reported AFP cases until they are either confirmed or discarded. Such a system should incorporate the following:

- A uniform case identification number;
- A standardized case investigation form;
- The basic demographic data on each case;
- The basic clinical data on each case;
- The recording and monitoring of laboratory specimens from the time they are obtained until the final results are received.

Reporting units

At the national and the regional levels of a country there should be a system to keep track of reporting units. These units may be a geographic jurisdiction (such as a county, district, or municipality), or a health facility such as a hospital or private clinic. The critical data to be monitored for each of these units are promptness of reporting (on-time or late) and frequency of reporting.

Computerization

In the Americas, a computer-based system known as the Polio Eradication Surveillance System (PESS) has been used to process the above-mentioned information for all countries in the Region. The database is menu-driven, which allows users who have limited computer ability to operate the program. This system has helped to create a standard set of variables that allows comparisons over time within countries and between countries. The standardization of surveillance data is fundamental. Work is under way on a new system that will handle this information more expeditiously and in real time.

Analysis

Initially, analysis should focus on data related to vaccination coverage and the degree of compliance with epidemiologic surveillance indicators. Once this part is done, more attention can be given to the time, place, and characteristics of AFP cases; the search for information pointing to the existence of cases that are clustered either geographically or in time periods; the presence of characteristics that might more closely meet the definition of clinical poliomyelitis; the predominance of AFP cases in immunized or unimmunized children; the ages of any such children;

the presence of sequelae in these cases; etc. Polio-compatible cases should also be studied.

The structure of the case investigation forms and line-listings should be analyzed in order to gain an overview of the cases and to determine whether the standards for reporting and investigation are being met (see Annexes 16, 17, and 18). The following information should be analyzed:

Stool samples. In order to confirm poliomyelitis, it is essential to collect a stool sample from the patient within 14 days after onset of paralysis, as well as at least five samples from contacts (if so instructed by the epidemiologist).

Clinical data. It is equally critical to determine the presence of clinical risk factors for poliomyelitis, such as fever at onset of paralysis, rapid progression of paralysis, and residual paralysis after 60 days.

Age. The age distribution of cases is useful for establishing which age groups to target in the vaccination campaign. In the Americas, the great majority of cases have been seen in children under 6 years of age.

Geographic location. Cases should be plotted on a map and this information should be compared with coverage data and surveillance reporting sites. These maps can be useful for coordinating activities (for example, locations for administering vaccinations).

Source of notification. This information will help determine whether improvements are needed in the notification process for surveillance. For example, if cases are being reported only from rehabilitation centers, then additional sources from clinics and hospitals may be required.

Rate of acute flaccid paralysis. The effectiveness of the surveillance program can be judged by the rate of AFP cases. The surveillance program should find at least 1 case in every 100,000 children under 15 years of age.

Vaccination history of cases. Accurate information on the vaccination history of persons with poliomyelitis is essential for evaluating vaccine efficacy and possible cold chain problems.

Virus typing. Ultimately, the results of genomic sequencing will be useful in determining whether an outbreak was caused by the circulation of indigenous poliovirus or by a vaccine-derived or imported strain. Urgent control measures should be taken in the area that is the source of the identified virus.

Annex 20 provides examples of how to organize and present this information on AFP surveillance and to facilitate the assessment of an immunization program.

7. CERTIFICATION OF POLIO ERADICATION IN THE AMERICAS

On 6 July 1990, delegates to the first meeting of the International Commission for the Certification of Poliomyelitis Eradication in the Americas (ICCPE) established preliminary criteria for certifying countries as free of poliomyelitis. National commissions in each country were formed that would be responsible for reviewing and supervising pre-certification activities, and it was decided that the countries should prepare national reports to present to the ICCPE. In these reports they would document: (1) the quality of surveillance for AFP; (2) surveillance for wild poliovirus; (3) active AFP case-finding in areas of poor surveillance (Annex 19); and (4) the implementation of mass vaccination campaigns in high-risk areas.

The ICCPE sought to accomplish the following:

- Verify the absence of virologically confirmed indigenous poliomyelitis cases in the Americas for a period of at least three years under adequate AFP surveillance conditions;
- Confirm the absence of detectable wild polioviruses in designated communities by testing stool samples of healthy children and, where appropriate, by testing wastewater from high-risk populations;
- Obtain an on-site evaluation by national certification commissions;
- Institute appropriate measures to deal with imported cases.

As already mentioned, in 1994 the ICCPE concluded that the Region of the Americas was free from indigenous circulation of wild poliovirus. However, the fact that polio eradication in the Americas has been certified does not mean that the children of this hemisphere are not at risk of contracting the disease. At the time this Guide was prepared, poliomyelitis continued to be endemic in many countries of the world, and imported cases constitute a threat for those that have already eliminated the disease. There is also the possibility that the vaccine-derived virus can be reintroduced in municipalities, departments, provinces, or countries with low vaccination coverage, as occurred in Haiti and the Dominican Republic in 2000 and 2001.

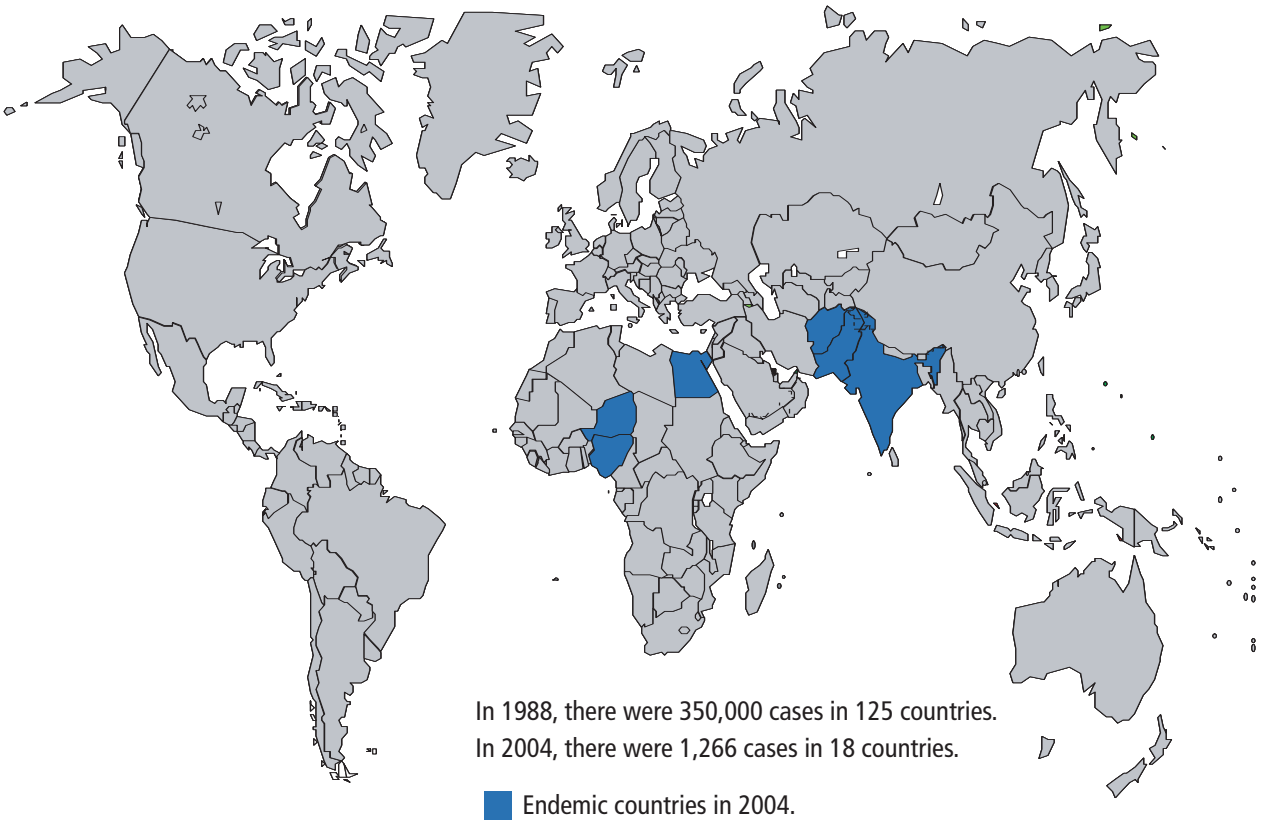
In order to detect an outbreak in a timely manner, and guarantee that the children of the Americas will remain protected, the countries of the Region should maintain vaccination coverage levels of 95% or higher in all their municipalities, and continue to comply with the surveillance indicators for acute flaccid paralysis.

8. THE FINAL PHASE OF GLOBAL ERADICATION OF POLIOMYELITIS

The enormous progress made by the worldwide initiative for poliomyelitis eradication is clearly illustrated in Figure 13, which shows that the annual number of cases decreased from nearly 350,000 in 1988 to 1,266 in 2004. This significant achievement also reveals some of the risks the world faces at this stage, considering that the only previous experience in this regard has been the global eradication of smallpox. The Region of the Americas was certified polio-free in 1994 (the last case associated with wild poliovirus was reported in Peru in 1991).

Once the indigenous circulation of the wild poliovirus has ended in a country, continent, or in the world, there is still the risk of the occurrence of polio cases from a virus derived from the oral vaccine that has mutated after circulating in the population (cVDPV), or from a chronic excretor of the virus (iVDPV), as well as cases caused by wild poliovirus that has been released accidentally or intentionally from a laboratory where it was stored. There is also the risk of cases of paralysis associated with

Figure 13. Progress of polio eradication, 1988 and 2004



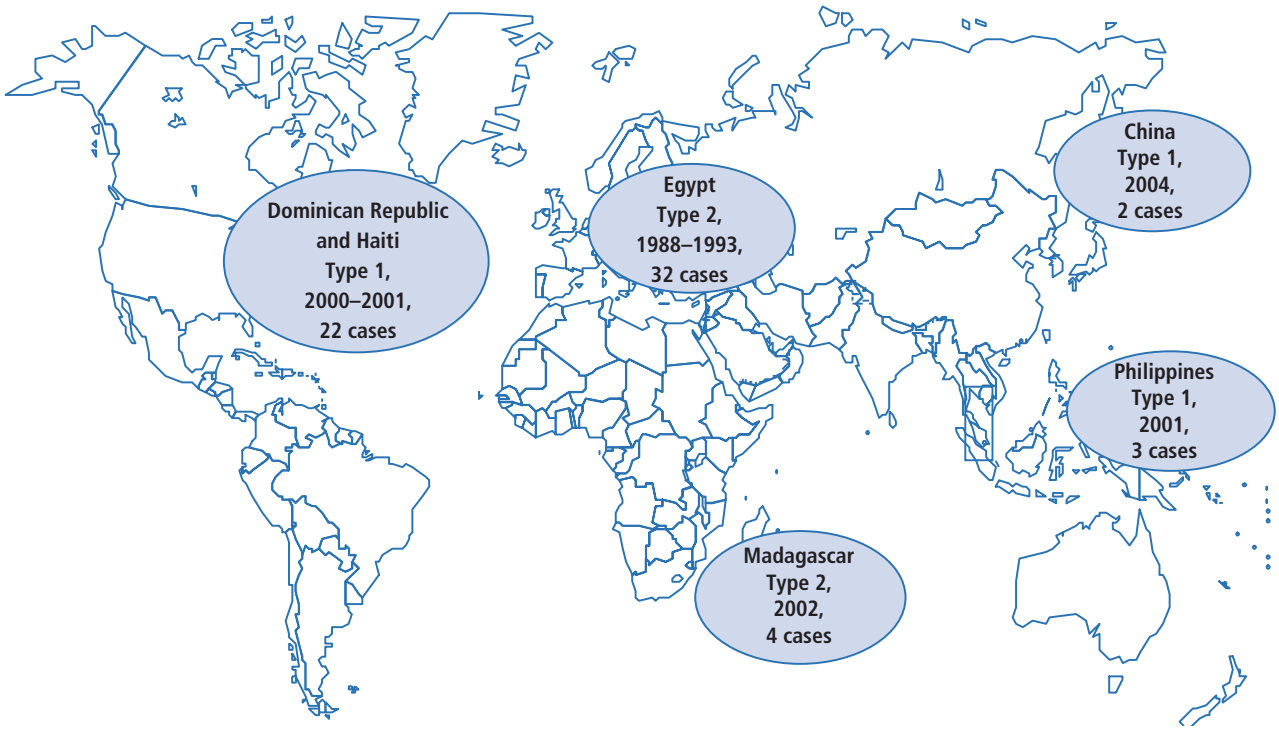
Source: World Health Organization.

vaccination using oral polio vaccine (OPV). Recent outbreaks in Egypt, Haiti, and Indonesia underscore the risk from the presence of the oral polio vaccine-derived virus in areas with low levels of immunity.

Before proposing scenarios for the world following the eradication of poliomyelitis, it is important to clarify that the risks outlined above are being carefully analyzed so that necessary measures can be taken to minimize or avoid them. At the time of writing this field guide, the following was known:

- Outbreaks of poliomyelitis caused by the virus derived from the oral polio vaccine have occurred in different parts of the world (see Figure 14). All of these outbreaks occurred in populations where OPV is used and where there is low vaccination coverage. Those viruses, known as cVDPV (circulating vaccine-derived poliovirus), have presented more than 1% genetic sequence difference from the vaccine-derived poliovirus, and have recovered the neurovirulence and transmissibility characteristics of the wild poliovirus. Among the most important outbreaks associated with Sabin vaccine strains of poliovirus are: that of Egypt, which occurred between 1988 and 1993 and produced 32 cases that were associated with a type 2 poliovirus; that of the Philippines in

Figure 14. Outbreaks caused by circulating vaccine-derived poliovirus (cVDPV)



Source: World Health Organization.

2001, with 3 cases, caused by a type 1 poliovirus; that of the Dominican Republic and Haiti in 2000 and 2001, with 22 cases, caused by type 1 poliovirus; that of Madagascar in 2002, with 4 cases, caused by type 2 poliovirus; and that of China in 2004, with 2 cases, caused by type 1 poliovirus.

- Poliovirus has been isolated from patients who are immunodeficient chronic excretors of vaccine-derived polioviruses (iVDPV). As of June 2005, 20 such cases of chronic excretion of poliovirus had been documented. Over the last 40 years, 8 of these cases occurred in Europe; 7 were in the United States; and 1 in each of the following countries: Argentina, Iran, Japan, Peru, and Taiwan. Seven of the isolated viruses were type 1, 12 were type 2, and 1 was type 3. It has not been verified whether these cases have given rise to polio outbreaks.
- There has been documentation of wild poliovirus contamination from viruses stored in laboratories. For this reason, the Global Commission for the Certification of the Eradication of Poliomyelitis requires that, in addition to interrupting poliovirus transmission in communities, every country have a national plan for the containment of wild poliovirus in laboratories. This plan includes the creation of national committees that will be responsible for developing a list of all national laboratories, conducting a survey in those laboratories, and preparing a national inventory of laboratories that retain wild poliovirus infectious material or potential wild poliovirus infectious material. This material would include specimens (feces, organs, cultures, etc.) that were collected at times and in places where wild poliovirus was known to be present, and could potentially contain poliovirus that has not yet been identified.
- There is documentation of cases of vaccine-associated paralytic poliomyelitis (VAPP) with the use of oral polio vaccine (OPV). In the United States, the occurrence is 1 case per 2.4 million doses of distributed vaccine. Frequency after the first dose (including of those vaccinated and contacts of those vaccinated) has been 1 case per 750,000 doses. It is more common to see cases of VAPP associated with serotype 3 of the vaccine than with serotypes 1 or 2.

Once global certification of polio eradication has been achieved, WHO recommends that use of OPV be discontinued. Countries unable to afford IPV will most likely choose not to introduce IPV, while countries with more resources, like the United States, may elect to use IPV in the post-certification era. The reason for this is to provide protection against the small risk of VAPP, bioterrorism, or escape of the virus from containment. The decision of countries to discontinue use of any polio vaccine during the post-certification era is justified by the fact that the risk of bioterrorism or containment failure is very small. WHO will maintain reserves of polio vaccine to address any emergency.

BIBLIOGRAPHY

Andrus JA, de Quadros CA, Olivé J-M, et al. Screening of cases of acute flaccid paralysis for poliomyelitis eradication; ways to improve specificity. *Bull World Health Organ* 1992;70(5):591–596.

Bernier RH. *Prevalence Survey Techniques for Paralytic Polio: An Update.* Geneva: World Health Organization; 1984; Document EPI/GENE/84/3.

Centers for Disease Control and Prevention (CDC). Poliomyelitis. In: Atkinson W, Hamborsky J, McIntyre L, Wolfe S, eds. *Epidemiology and Prevention of Vaccine-Preventable Diseases.* 8th ed. Washington, DC: Public Health Foundation; 2005:89–100.

Cherry JD. Enteroviruses and parechoviruses. In: Feigin RD, Cherry J, Demmler GJ, Kaplan S, eds. *Textbook of Pediatric Infectious Diseases.* 5th ed. Philadelphia: W. B. Saunders Company; 2004:1984–2041.

de Quadros CA, Andrus JA, Olivé J-M, et al. Eradication of poliomyelitis: progress in the Americas. *Pediatr Infect Dis J* 1991;10:222–229.

de Quadros CA, Andrus JA, Olivé J-M, Macedo CG de, Henderson DA. Polio eradication from the Western Hemisphere. *Annu Rev Public Health* 1992;12:239–252.

Gershon A, Hotez PJ, Katz S. *Krugman's Infectious Diseases of Children.* 11th ed. St. Louis: C. V. Mosby; 2004.

Halsey NA, de Quadros CA, eds. *Recent Advances in Immunization: A Bibliographic Review.* Scientific and Technical Publication No. 451. Washington, DC: Pan American Health Organization; 1983.

Heymann DL, ed. *Control of Communicable Diseases Manual.* 18th ed. Washington, DC: American Public Health Association; 2004:533–534.

Hinman AR, Koplan JP, Orenstein WA. Live or inactivated poliomyelitis vaccine: an analysis of benefits and risks. *Am J Public Health* 1988;78:291–295.

Orenstein WA, Bernier RH, Donder TJ, et al. Field evaluation of vaccine efficacy. *Bull World Health Organ* 1985;63(6):1055–1068.

Pan American Health Organization, Expanded Programme on Immunization. Strategies for the certification of the eradication of wild poliovirus transmission in the Americas. *Bull Panam Health Organ* 1993;27(3):287–296.

ANNEXES

ANNEX 1. Poliomyelitis outbreak caused by vaccine-derived virus in Haiti and the Dominican Republic[1]

Mauricio Landaverde,[2] Linda Venczel,[2] and Ciro A. de Quadros[2]

In October 2000, the Ministries of Health of the Dominican Republic and Haiti reported two cases of acute flaccid paralysis (AFP). These cases were detected through the national flaccid paralysis surveillance systems, which require notification of every case of AFP in which polio is suspected. The policy in such cases is to collect stool samples and submit them to a laboratory of the regional polio detection laboratory network to determine whether or not the paralysis is caused by wild poliovirus. The case reported by the Dominican Republic was found in a 9-month-old female from a rural village in the province of Monseñor Nouel; the Haitian case was in a 2-year-old girl from a town in the Northwest Department. The symptoms appeared on 18 July and 30 August 2000, respectively. Wild poliovirus has not circulated in the Western Hemisphere since 1991, when the last case was detected in Peru. The last case of polio in the Dominican Republic was reported in 1985, and the last one in Haiti was reported in 1989.

The stool samples collected from these cases were sent to the PAHO Poliovirus Detection Laboratory at the Caribbean Epidemiology Center (CAREC, located in Port of Spain, Trinidad and Tobago), where poliovirus type 1 was isolated in both instances. The isolates were then sent to the Poliovirus Laboratory at the Centers for Disease Control and Prevention (CDC, located in Atlanta, Georgia, United States of America) for identification. Genetic sequencing revealed that the virus associated with this outbreak was atypical: it was derived from the oral polio vaccine (OPV), but it diverged genetically by 3% from the parent vaccine strain of the OPV. Normally, vaccine-derived virus isolates diverge by less than 0.5% from the parent strain. In other words, the strain had recovered the neurovirulence and transmissibility of wild poliovirus type 1. In contrast, wild polioviruses normally have < 82% genetic similarity to OPV (1). The differences found in the nucleotide sequences of the strains responsible for the outbreak indicate that the virus had been circulating in an area of low vaccination coverage for about two years, during which time the virus had accumulated genetic changes that restored the essential properties of wild poliovirus (2).

[1]This article was originally published in Spanish in *Rev Panam Salud Publica/Pan Am J Public Health* 9(4), 2001.

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Prolonged circulation of vaccine-derived poliovirus in low-coverage areas with OPV (Sabin 2) have been documented elsewhere: a vaccine-derived type 2 virus circulated in Egypt for about 10 years (1983–1993) and was associated with more than 30 reported cases of AFP (3). Vaccination coverage was very low in the affected areas, and circulation of the vaccine-derived poliovirus was interrupted when coverage increased.

In response to the outbreak, the Ministries of Health of the Dominican Republic and Haiti, with support from PAHO and the CDC, initiated activities to discover the extent of virus circulation, control it, and eradicate it using door-to-door vaccination coupled with national immunization days and intensive public information and social mobilization campaigns.

Rigorous case-finding was undertaken to ascertain the magnitude and scope of the outbreak, identify case foci, and organize areas for vaccination activities. Two teams of national and foreign epidemiologists were created to search for AFP cases in both countries. In all, 16 epidemiologists were enlisted, and the search covered health centers, hospitals, emergency centers, physical therapy clinics, orphanages, and the community at large. Every suspected case was the subject of an exhaustive epidemiologic investigation, and stool samples were collected. Preventive activities included door-to-door vaccination in municipalities where probable cases were found, as well as mass vaccinations during national immunization days that were widely covered in the media. The laboratory testing was carried out by CAREC and the CDC.

Between July 2000 and mid-March 2001, a total of 99 AFP cases (probable cases of poliomyelitis) were found; 78 were in the Dominican Republic and 21 in Haiti. In the Dominican Republic, 14 of the probable cases have been confirmed as vaccine-derived poliovirus type 1; 24 cases have been discarded by laboratory tests; 2 have been classified as polio-compatible; and 38 are still awaiting laboratory results. In Haiti, 3 of the probable cases have been confirmed as vaccine-derived poliovirus type 1; 1 has been classified as polio-compatible; 13 were discarded by laboratory tests; and 4 are awaiting laboratory results.

The confirmed cases in the Dominican Republic are located in the provinces of La Vega (6 cases), Santiago (3 cases), Monseñor Nouel (1 case), and Espaillat (1 case); 3 cases were found in the capital of Santo Domingo. With respect to these 14 confirmed cases, 7 (54%) were unvaccinated and 6 were incompletely vaccinated. Their ages range from 9 months to 14 years, with a median age of 2 years. The AFP cases awaiting final diagnosis in the Dominican Republic are in the provinces of Santiago (5 cases), La Vega (8 cases), and Monseñor Nouel (3 cases), the city of Santo Domingo (8 cases), and the western part of the country (14 cases).

The epidemiologic investigations revealed poor environmental sanitation and low OPV coverage in the affected areas. In the municipality of Constanza (La Vega Province), where most of the outbreak-related cases were found, triple-dose OPV3 coverage was between 20% and 30% in children under 5 years of age. National OPV3 coverage of infants under 1 year old in the Dominican Republic has been close to 80% in the last five years, and 20% of the districts had coverage levels of 80% or higher; as a result, national immunization days were discontinued five years ago. Between 1983 and 1993, a total of 16.1 million doses were given to children under 3 years of age during the national immunization days.

Haiti's Northwest Department reported 40% OPV coverage in 1999. In Haiti, national OPV3 coverage of children under 1 year of age has fluctuated between 30% and 50% over the last 10 years, and national immunization days have not been held for five years.

In the Dominican Republic, the rate of AFP was less than 1 per 100,000 children under 15 years of age in 6 of the last 10 years; in Haiti this figure has been around 0.1 since 1995. The percentage of AFP cases with adequate stool samples in the Dominican Republic was approximately 80% in 1993–1998 and between 30% and 36% in 1999–2000; in Haiti this percentage has declined to zero in the last five years. In the Dominican Republic, the percentage of sites filing weekly reports has been over 80% in the last 10 years, except in 1999, when it was 50%. In Haiti, the percentage of sites reporting weekly has been less than 50% in the last 10 years, except in 1998, when it was 95%. The rate of enterovirus isolation has been over 15% in the Dominican Republic in the last 10 years, except in 1996 and 1999, when the figure was zero, and in 1997, when it was 9%.

Both AFP outbreaks are being investigated to determine their extent and evaluate the causes of the prolonged circulation of this vaccine-derived virus. A total of 60 environmental samples have been collected under this investigation, and the results are still pending.

The ministries of health of the Dominican Republic and Haiti have already conducted door-to-door vaccination and case-finding activities wherever cases have been detected. The Dominican Republic conducted a polio immunization campaign in December 2000 and vaccinated 1.2 million children under 5 years of age, representing nearly 100% coverage. A second mass immunization campaign was conducted in January 2001 with the same level of coverage, and a third one is planned for April 2001. Haiti has scheduled three national rounds: the first was held in January 2001, and the second will be held in early March 2001.

Since there is no indication that OPV-derived poliovirus circulates in high-coverage areas, the current outbreak has emphasized the need to maintain high vaccina-

tion coverage in disease-free areas until global eradication is achieved. At the same time, it is essential to maintain effective surveillance for AFP cases and the poliovirus.

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REFERENCES

1. Kew OM, Mulders MN, Lipskaya GY, da Silva ED, Pallansch MA. Molecular epidemiology of polioviruses. *Semin Virol* 1995;6:401–414.
2. U.S. Centers for Disease Control and Prevention. Public health dispatch: outbreak of poliomyelitis in the Dominican Republic and Haiti. *MMWR* 2000;49(48):1094–1103.
3. Naguib T, Yang SJ, Pallansch MA, Kew OM. Prolonged circulation of Sabin 2-derived polioviruses. In: *Program and Abstracts of Progress in Polio Eradication: Vaccination Strategies for the End Game.* Geneva: International Association for Biologicals; 2000.

ANNEX 2. Distribution of diagnoses for discarded cases of acute flaccid paralysis

JURISDICTION: _____						
YEAR	20___		20___		20___	
DIAGNOSIS	#	%	#	%	#	%
GUILLAIN-BARRÉ SYNDROME						
TRAUMATIC NEURITIS						
TRANSVERSE MYELITIS						
TUMOR						
(OTHER)						
WITHOUT DIAGNOSIS						
TOTALS						

ANNEX 3. Description of differential diagnoses of poliomyelitis

Guillain-Barré syndrome

Guillain-Barré syndrome (GBS) is the most common cause of AFP in childhood. There are important differences between GBS and polio. Generally, poliomyelitis occurs earlier in life than GBS. In one study, polio patients ranged from 9 months to 5 years of age, while the age for GBS ranged from 4 to 18 years (with exceptions in both cases). Approximately 50% of AFP cases are discarded because they are considered to be GBS.

1. Prodromes and Fever. Prodromes are present in both polio and GBS; they consist of an upper respiratory tract infection and gastrointestinal infection. However, in polio these conditions occur closer to the onset of AFP (within 4 to 10 days), whereas in GBS they present 7 to 15 days prior to the onset of AFP.

   A hallmark of paralytic polio is the presence of fever at onset of paralysis. The fever disappears the day after onset with remarkable uniformity. In GBS, fever may appear several days after onset and is often secondary to bacterial pneumonia, which is the most common complication in GBS patients.
2. Progression of Paralysis. Since AFP is synonymous with lower motor neuron syndrome, muscle strength, muscle tone, and deep tendon reflexes (DTR) have to be considered together. Onset of paralysis or lack of muscle strength is acute in polio and GBS; however, in polio it usually progresses to completion in 24 to 48 hours, while in GBS it may take up to two weeks to gradually progress to its maximum. The distribution of flaccid paralysis in polio is asymmetric and irregular, affecting each limb to different degrees, predominantly in the proximal muscular groups. In GBS, demyelination of peripheral nerves is symmetrical and a universal finding. In general, it occurs in ascending fashion, affecting lower limbs first, then the trunk, and then the upper limbs; it may even reach the cranial nerves (Miller-Fisher syndrome).
3. Muscle Pain. Children with polio suffer severe myalgia one or two days prior to the onset of AFP and up to one or two days afterward. Myalgia is more severe in the more extensively affected limbs. It can be spontaneous or initiated upon touch. Older children complain of back pain. The child with polio usually refuses to be seated, touched, or handled.
4. Sensation. Children with GBS often complain of hypoesthesia or anesthesia in a glove-boot distribution. Tingling and burning sensations in soles or palms

are also frequent, as are cramps in peroneal muscles. However, the child with GBS is not disturbed by handling or changes in position.

5. Cranial Nerve Involvement. Cranial nerve involvement is rare in polio. It is only present in the bulbar form, accompanied by severe respiratory insufficiency, often leading to death. GBS affects the lower cranial nerves much more often than was previously thought, possibly in up to 70% or 80% of cases.
6. Respiratory Insufficiency. In polio, respiratory insufficiency may present in the bulbar form or when thoracic involvement of the spinal cord is severe. In children with GBS, respiratory insufficiency occurs secondary to demyelination of the intercostal nerves.
7. Neurophysiological Studies. (a) Nerve conduction velocity (motor and sensory) study is preferably performed three weeks after onset of flaccid paralysis. For both GBS and polio the test should be abnormal at this time. (b) Electromyography is recommended after three weeks and is highly abnormal in polio, with signs of severe denervation and giant action potentials. However, a normal result does not rule out the possibility of polio. In GBS, the result is abnormal (because of demyelination) or minimally abnormal.
8. Cerebrospinal Fluid. In polio, the cerebrospinal fluid (CSF) is inflammatory and may be under pressure. It may be transparent or slightly turbid. Protein is moderately increased, to 40–65 mg. From 10 to 200 cells per mm^3 are present, with mononuclear predominance. CSF pressure in GBS is usually not elevated and the fluid is transparent. The most notable feature is a rise in protein, which can be as high as 200 mg, coupled with a cell count of usually 10 or fewer monocytes per mm^3 of CSF. A white cell count of 50 leukocytes or more is strong evidence against a diagnosis of GBS. If GBS is suspected and the CSF does not show an albuminocytologic dissociation in the first lumbar puncture, the procedure should be repeated one week later.
9. Sequelae. In children with polio, sequelae can be severe and permanent. Because anterior horn cells are destroyed, the motor units supplied by these nerves in the muscle are also destroyed. This is manifested in the patient as mild to severe atrophy of muscle groups with an asymmetrical, haphazard distribution. Weakness of some muscle groups allows functional predominance of others, resulting in skeletal deformities that may require orthoses or orthopedic surgery. Severely affected limbs remain flaccid, hypotonic, and reflexes are diminished or lost.

   In children with GBS, sequelae may be present three months after the onset of flaccid paralysis. Typically they consist of symmetrical atrophy of peroneal and anterior tibial muscles in the legs and atrophy of the thenar and

hypothenar eminence in the palms. The patients drop their feet when seated or walking, causing them to walk like a stork, in "steppage" fashion. When asked to extend their arms, their hands also hang in a dropped position. As the child recovers strength and muscle tone, deep tendon reflexes return to normal. Skeletal deformities do not generally occur, so orthoses and orthopedic surgery are not needed.

Traumatic Neuritis Secondary to Intramuscular Injections

In the case of traumatic neuritis caused by an injection, the onset of AFP in the affected lower limb occurs from one hour to five days after receiving an intramuscular injection. Fever may occur before, during, or after onset of paralysis if the injection was given for a preexisting illness or if it has caused an abscess. The sequence of symptoms is difficult to establish when several injections are applied in both gluteus muscles. In the majority of children suffering from traumatic neuritis, the substance injected is penicillin and it may be administered by the mother, a pharmacist, or a private physician. AFP from this cause is usually accompanied by pain in the gluteal region or along the affected leg. Atrophy may appear 40 to 60 days later, accompanied by hyporeflexia, but atrophy never advances to the degree observed in polio. Differences in leg circumference usually do not exceed 0.5 to 1 cm. Upper limbs and cranial nerves are unaffected. In rare cases, both lower limbs are affected because injections were given on both sides. Sequelae are sometimes severe, but children generally recover with physiotherapy within three to nine months.

Transverse Myelitis

In general, patients with transverse myelitis (TM) range from 4 to 18 years of age. Fever may be present before the onset of AFP, but rarely during onset. Paralysis is usually symmetrical in the lower limbs and is accompanied by profound anesthesia to all forms of sensation. The level of sensory deficit may vary and can be lumbar, thoracic, or cervical. Arms may also be partially paralyzed, but this occurrence is not frequent. Muscle strength, muscle tone, and deep tendon reflexes are usually absent in TM.

Dysfunction of the autonomic nervous system and the bladder occur frequently with this disease. Recovery is related to onset: when onset is fulminant or rapid (within hours), recovery usually begins several weeks to months later, and neurological deficits remain. In contrast, children whose paralysis took several days to develop usually begin to recover one to five days after symptoms peak, and most patients recover completely.

Other Differential Diagnoses

Peripheral Neuropathy. The peripheral neuropathy that is most relevant to the differential diagnosis of polio in the Americas occurs secondary to ingestion of the poisonous berries of *Karwinskia humboldtiana* or *K. calderoni,* shrubs of the buckthorn family that grow in parts of southwestern United States, Mexico, and Central America. Paralysis usually lasts three to four days; recovery is spontaneous and there are no sequelae. However, case fatality can be as high as 20% if proper respiratory support is not given. Other peripheral neuropathies are those caused by metabolic defects (diabetes), toxins (including lipid solvents and toxins present in certain fish), organophosphate pesticides, raw metals (lead), several pharmacological products, hereditary disease (Charcot-Marie-Tooth), diphtheria toxin, and tick bite.

Enteroviruses. A number of enteroviruses, besides the poliovirus, are known to cause AFP. Many of the Coxsackie A viruses, most of the Coxsackie B and ECHO viruses, enterovirus types 70 and 71, and the mumps virus have all been temporally associated with both mild and severe neurologic disease. Reports on sequelae are not clear, and most cases tend to show gradual improvement. However, because normal children excrete other non-polio enteroviruses, the isolation of such viruses from patients with AFP may not be causally related.

China Syndrome. It is not clear whether China syndrome is a form of GBS or some other neurologic condition. It appears to attack the motor neurons of the spinal cord, while GBS generally attacks the myelin sheath that surrounds peripheral nerve fibers, blocking nerve impulses that have already fired. Patients do not exhibit high fevers early in the course of the illness, as is common in polio. The paralysis is often less extensive than in polio. Despite frequently requiring respiratory support, children appear to have a better prognosis for eventually recovering most or all of their motor function. Unlike poliomyelitis, paralysis in China syndrome is symmetrical. In addition, cases are seasonal, are generally sporadic, and occur almost exclusively in rural areas.

Post-Polio Syndrome

Post-polio syndrome, also called post-polio sequelae or post-polio muscular atrophy, refers to a group of disorders experienced by many polio survivors, typically starting 25–35 years after initial onset. Symptoms include renewed, usually gradual progression of muscle weakness, increased fatigability, joint pain, muscle cramps, intolerance to cold, and sometimes increased difficulty in breathing (when respiratory muscles are involved). Post-polio syndrome appears to be more frequent and severe in persons who had a more severe initial polio illness. No single examination

procedure or laboratory test can definitely diagnose this condition. There is no evidence to suggest that these patients are reinfected or have chronic infection; rather, they may be experiencing the consequences of long-term overuse to compensate for the original destruction of nerve cells.

ANNEX 4. Refrigerator record form

Temperature in the refrigerator																																	
MONTH_____ DAY			1						7							14							21							28			31
ALL TYPES	Temperature (°C)	Morning																															
		Afternoon																															
	Is the ice solid?	Yes___ No___																															
	Refrigeration failure	No. of hours																															
		Temperature when found																															
		Mark days not in use																															
KEROSENE	Parts replaced	Clean and fill tank																															
		Fuel used per week (gallons)																															
		Wick trimmed																															
		Wicks																															
		Glass																															
		Burner																															
GAS	New bottle																																
	New hose																																
	Jet cleaned																																

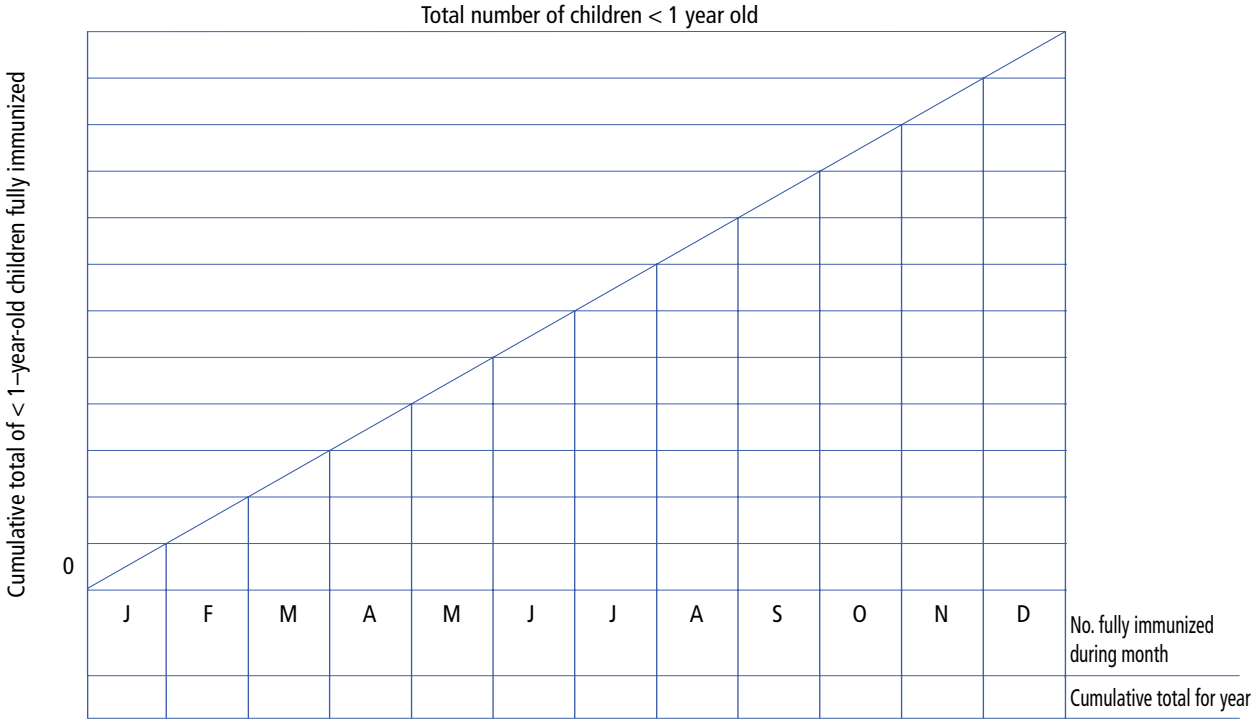
Source: WHO/EPI Training Course for Mid-Level Managers. "Manage the Cold Chain System," p. 48, WHO-Geneva, 1985.

ANNEX 5. Immunization coverage of < 1–year-old children

Area (district or municipality): _____ Year _____

VACCINE _____ FULL IMMUNIZATION _____ DOSES _____

Total no. of children < 1 year old_____



1. Enter for each month the total number of fully immunized children in the first row and cumulative total for the month in the second row.
2. Plot progress on the graph by marking "X" for the cumulative total at the end of each month and join with a solid line.

ANNEX 6. Coverage of 1-year-old population with at least three doses of OPV

COUNTRY _____ YEAR _____

PROVINCE/STATE	TOTAL NUMBER OF LOCALITIES/MUNICIPALITIES (A)	NUMBER* WITH < 50% (B)	% (A/B)	NUMBER* WITH 50% to 94% (C)	% (C/A)	NUMBER* WITH 80% OR MORE (D)	% (D/A)	NUMBER* WITH ≥ 95% (E)	% (E/A)
TOTALS									

*In this column, indicate the number of localities or municipalities with coverage within the range indicated.

ANNEX 7. Acute flaccid paralysis case investigation form

(This form should be completed for all persons with acute flaccid paralysis for which no specific cause can be immediately identified.)

IDENTIFICATION

CASE ID: _____ YEAR _____
COUNTRY _____ PROV/STATE _____ MUNICIP. _____ LOCALE _____
Patient's Name _____ Mother's Name _____
Address _____ Type: ☐Urban ☐Periurban ☐Rural
Sex ☐Male ☐Female Date of Birth: ____/____/____ Age: yrs _____ month_____ No. OPV Doses _____ Date Last dose ____/____/____
Date Investigated ____/____/____ Date Reported: Local ____/____/____ National ____/____/____ First Reported by: _____
OBSERVATIONS:

CLINICAL DATA

PRODROME	PARALYSIS	SITE OF FLACCID PARALYSIS			REFLEXES	SENSITIVITY
Fever : ☐Yes ☐No ☐Unk. Respiratory: ☐Yes ☐No ☐Unk. Gastrointes-tinal: ☐Yes ☐No ☐Unk.	Date of Onset ____/____/____ Craneal Pairs: ☐Yes ☐No ☐Unk. Respiratory: ☐Yes ☐No ☐Unk.				1=Increased 2=Decreased 3=Absent 4=Normal 9=Unknown	
		RIGHT ARM	☐Yes ☐No ☐Unk.	☐Proximal ☐Distal		
		LEFT ARM	☐Yes ☐No ☐Unk.	☐Proximal ☐Distal		
		RIGHT LEG	☐Yes ☐No ☐Unk.	☐Proximal ☐Distal		
SIGNS	PROGRESSION	LEFT LEG	☐Yes ☐No ☐Unk.	☐Proximal ☐Distal		
Muscle Pain: ☐Yes ☐No ☐Unk. Meningeal: ☐Yes ☐No ☐Unk.	Number of days for paralysis to fully develop: _____ ☐Ascending ☐Descending ☐Mixed	Unk.=Unknown Pend.=Pending				
		If Hospitalized? Name:_____ Date: ____/____/____ Med. Rec #				

Death? ☐Yes ☐No ☐Unk. If Yes, Date ____/____/____ Cause:_____
OBSERVATIONS:

LABORATORY DATA

Sample #	Date Taken	Date Sent	National Laboratory			
			Lab. Name	Date Received	Result †	Date Result
01	____/____/____		_____	____/____/____	_____	____/____/____
02	____/____/____		_____	____/____/____	_____	____/____/____

(†) 0=Negative, 1= P1, 2=P2, 3=P3, 4= Non Polio Enterovirus, 5=Inadequate ,6=Other Virus,

CONTACTS*	Initials	Age (YY/MM)	No. OPV Doses	Date of Last Dose	Date Stool Taken	Date Received National Lab	Results	Date Result Received
Contact 1	_____	_____	_____	____/____/____	____/____/____	____/____/____	_____	____/____/____
Contact 2	_____	_____	_____	____/____/____	____/____/____	____/____/____	_____	____/____/____

* Contacts should be < 5 yrs of age and not vaccinated within 30 days. List add'l contacts on separate page.

OBSERVATIONS:

CONTROL

Date special control vaccination begun ____/____/____ Population <5 years _____ No. <5 years Vaccinated _____
Estimated number of households in target area _____ Number of house-holds visited _____
OBSERVATIONS:

ANNEX 7. Acute flaccid paralysis case investigation form (cont.)

FOLLOW-UP

Date Follow-up ____/____/____ Residual Paralysis at 60 days ☐Yes ☐No ☐Unknown Atrophy ☐Yes ☐No ☐=Unknown

FINAL CLASSIFICATION	CLASSIFICATION CRITERIA		IF DISCARDED	
Date Classified: ____/____/____ ☐Polio Wild ☐Polio Vacc. Derived ☐Polio Vacc. Associated ☐Polio Compatible ☐Discarded	☐Laboratory ☐EPI Link ☐Lost to Follow Up	☐Death ☐With Residual Paralysis ☐Without Residual Paralysis	☐Guillain-Barré ☐Traumatic Neuritis ☐Transverse Myelitis	☐Tumor ☐Unknown ☐ Other _____
OBSERVATIONS:				

INVESTIGATOR

Name of Investigator _____ Signature _____

Title _____ Office: _____ Date ____/____/____

OBSERVATIONS:

ANNEX 8. Line-listing of probable cases

LABORATORY _____

CASE ID No.	NAME OF CASE	SEX	AGE	ADDRESS	DATE REPORTED	DATE INVESTIGATED	VACCINATION STATUS (No. of Doses)	DATE OF PARALYSIS ONSET	FEVER AT ONSET? (Yes or No/ Degrees)	PROGRESSION IN DAYS/ ASCENDING OR DESCENDING	SITE OF PARALYSIS/ PROXIMAL OR DISTAL	DESCRIBE PARALYSIS

ANNEX 8. Line-listing of probable cases (cont.)

CASE ID No.	STOOL SAMPLES				CONTACTS		FOLLOW-UP		FINAL DIAGNOSIS		CONTROL	COMMENTS
	DATE TAKEN	DATE RECEIVED BY LABORATORY	DATE OF RESULTS	LAB RESULTS/ P1, P2, P3, OTHER	No. OF CONTACT STOOLS COLLECTED	LAB RESULTS	DATE	RESIDUAL PARALYSIS AT 60 DAYS	POLIO/POLIO-COMPATIBLE/ VACCINE-DERIVED/ DISCARDED (SPECIFY)	DATE CLASSIFIED	DATE CONTROL MEASURES STARTED/ NUMBER OF CHILDREN < 5 YEARS VACCINATED	

ANNEX 9. Polio outbreak control measures—summary form

Case name (index case): _____ Case No.: _____

Province/State: _____ Country: _____

Municipality/District: _____ Village/City: _____

List neighboring areas that also have polio outbreaks: _____

Date of paralysis onset, earliest case: _____/_____/_____

Date of paralysis onset, latest case: _____/_____/_____

NUMBER OF CASES BY AGE (IN YEARS)

	<1	1	2	3	4	5–9	10–14	≥15	TOTALS
Probable cases									
Confirmed cases									

IMMUNIZATION STATUS OF CASES

AGE (years)	CONFIRMED POLIO CASES					
	Not immunized	Number of doses of OPV*			Immunization status unknown	Total No.
		1	2	3		
<1						
1–2						
3–4						
5–9						
10–14						
≥15						
TOTALS						

COMMUNITY COVERAGE

AGE (years)	3 or more doses
<1	
1–2	
3–4	
5–9	
10–14	
≥15	
TOTALS	

* Do not count the OPV zero dose (given at birth)

IMMUNIZATIONS FOR OUTBREAK CONTROL

	<1 yr.	1–4 yrs.	>5 yrs.	TOTAL
Date of 1st round ___/___/___ No. of vaccinations given:				
Date of 2nd round ___/___/___ No. of vaccinations given:				
TOTALS				

LIST VILLAGES/CITIES VISITED IN THE COURSE OF THE INVESTIGATION

Name	Date	No. immunized	Comments (Cases found?)
_____	___/___/___	_____	_____
_____	___/___/___	_____	_____
_____	___/___/___	_____	_____
_____	___/___/___	_____	_____

Describe control activities: _____

_____

_____

Describe follow-up activities: _____

_____

_____

Name of the investigator:_____ Place: _____ Date: ___/___/___

ANNEX 10. Specimen tracking form

Name of patient: _____

Case: _____ or contact _____

Case ID No.: _____

District/state/country: _____

Date of paralysis onset (case): ____/____/____

Date specimen collected: ____/____/____

Number of OPV doses (patient): _____

Date of last dose (patient): ____/____/____

Date mop-up campaign initiated: ____/____/____

Date specimens sent to laboratory: _____/_____/_____

Comments: _____

_____

TO BE FILLED OUT AT LABORATORY

Date specimens received: ____/____/____

Condition of specimens: Good _____ Fair _____ Poor _____

Results of virus isolation: _____

Date of notification: _____/_____/_____

Specimens sent to reference laboratory: Yes ___ No ___

Date shipped to reference laboratory: ____/____/____

Comments: _____

_____

TO BE FILLED OUT AT REFERENCE LABORATORY

Date specimens received: ____/____/____

Condition of specimens: Good _____ Fair _____ Poor _____

Results of virus identification: _____

Date of notification: _____/_____/_____

Comments: _____

_____

ANNEX 11. *Polio Weekly Bulletin*

Pan American Health Organization
Regional Office of the World Health Organization

Immunization Unit
Family and Community Health Area
Polio Weekly Bulletin

Vol. 20, No. 45 ***Week ending 12 November 2005***

Poliovirus Surveillance in the Americas

Table No. 1
Status of Case Stool Sample Analysis
Last 52 Weeks (2004/46- 2005/45)

Lab.	Country	Total*	WITHOUT RESULTS			ENTEROVIRUS ISOLATION					
			Not yet in lab.	<28 days	>28 days	% Isolation	Negative	Other Enterovirus	Poliovirus Pending	Poliovirus Vaccine	Poliovirus Wild
CAR	BAH	1	0	0	0	0.0	1	0	0	0	0
	BLZ	1	0	0	0	100.0	0	1	0	0	0
	DOR	11	2	0	0	11.1	8	1	0	0	0
	GUY	8	1	0	0	14.3	6	1	0	0	0
	HAI	7	2	0	0	0.0	5	0	0	0	0
	HON	68	12	0	5	33.3	34	16	0	1	0
	JAM	8	0	0	0	12.5	7	1	0	0	0
	SUR	3	0	0	0	0.0	3	0	0	0	0
	TRT	2	0	0	0	50.0	1	1	0	0	0
CDC	DOR	1	0	0	0	100.0	0	0	0	1	0
FIO	BRA	363	124	0	11	12.7	199	25	0	4	0
	PER	64	13	0	0	9.8	46	5	0	0	0
IEC	BRA	51	20	0	1	0.0	30	0	0	0	0
INC	ELS	50	1	0	0	30.6	34	15	0	0	0
	GUT	95	0	4	16	13.3	65	10	0	0	0
	HON	1	0	0	0	0.0	1	0	0	0	0
	NIC	24	0	0	0	33.3	16	8	0	0	0
	PAN	5	0	0	0	40.0	3	2	0	0	0
INDRE	MEX	345	0	0	48	12.5	260	33	0	4	0
INH	VEN	100	0	0	2	10.2	88	9	0	1	0
INS	COL	118	0	4	3	10.8	99	12	0	0	0
	ECU	27	3	0	0	8.3	22	2	0	0	0
ISP	CHI	92	0	1	1	4.4	86	3	0	1	0
MAL	ARG	123	0	2	0	13.2	105	5	0	11	0
	BOL	46	3	0	0	16.3	36	4	0	3	0
	CHI	4	0	0	0	100.0	0	3	0	1	0
	PAR	13	1	0	0	16.7	10	1	0	1	0
	URU	9	1	0	0	0.0	8	0	0	0	0
TOTAL		1640	183	11	87	13.7	1173	158	0	28	0

* Each sample relates to an individual — Case samples only

Table No. 2
Status of Poliovirus Pending Intratypic Differentiation
Last 52 Weeks (2004/46- 2005/45)

LAB	COUNTRY	POLIOVIRUS												TOTAL
		NOT YET IN LAB				IN LAB < 4 Weeks				IN LAB > 4 Weeks				
		P1	P2	P3	MIX	P1	P2	P3	MIX	P1	P2	P3	MIX	
TOTAL		0	0	0	0	0	0	0	0	0	0	0	0	0

Case samples only

POLIO HAS BEEN ERADICATED FROM THE AMERICAS
The last wild poliovirus was detected on September 5, 1991, in Peru

All issues of Polio Weekly Surveillance Bulletin can be accessed at:
http://www.paho.org/english/ad/fch/im/poliomyelitis.htm

Acute Flaccid Paralysis Surveillance

Vol. 20, No. 45

Table No. 1
CASES OF ACUTE FLACCID PARALYSIS UNDER INVESTIGATION BY WEEK OF REPORT

SITE	TOTAL	CUM.	Week														
	2004	2005	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41	42	43	44	45
ARG	0	17	0	0	0	0	0	0	0	1	2	4	4	1	2	3	0
BOL	0	3	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0
BRA	0	131	4	1	2	7	10	18	35	31	21	2	0	0	0	0	0
CAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	0	16	2	1	0	0	2	2	3	2	2	2	0	0	0	0	0
CHI	0	43	0	0	1	0	1	1	8	11	7	6	4	2	1	0	1
COL	0	10	0	0	0	2	1	0	0	0	0	3	1	2	1	0	0
COR	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CUB	0	28	1	2	5	4	3	2	7	1	1	2	0	0	0	0	0
DOR	0	3	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0
ECU	0	6	0	0	0	0	0	0	0	0	2	2	0	0	2	0	0
ELS	0	34	0	0	0	0	0	0	10	22	2	0	0	0	0	0	0
GUT	0	5	0	0	0	0	1	0	0	0	0	0	1	1	2	0	0
HAI	0	2	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
HON	0	17	0	0	0	0	2	4	0	4	6	1	0	0	0	0	0
MEX	0	138	3	2	6	4	5	3	10	47	35	23	0	0	0	0	0
NIC	0	5	0	0	0	0	0	0	0	2	2	0	0	0	0	1	0
PAN	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
PAR	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
PER	0	13	0	0	0	0	0	0	2	2	5	4	0	0	0	0	0
URU	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
USA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	476	11	6	14	17	25	30	76	123	85	54	10	8	11	4	2

Table No. 2
CASES OF AFP REPORTED, RATE PER 100,000 <15 yrs., % INVESTIGATED WITHIN 48 hrs., % WITH 1 ADEQUATE SAMPLE AND % OF SITES REPORTING WEEKLY

SITE	Total 2004		Last 52 weeks (2004/46- 2005/45)				
	CASES	RATE	CASES	RATE	% INV. <48 hrs.	%1 Sam-ple+	% Sites Report-ing
ARG	130	1.27	133	1.30	86	62	67
BOL	80	2.26	46	1.28	96	83	73
BRA	641	1.24	470	0.91	98	75	94
CAN	NR	NR	NR	NR	NR	NR	NR
CAR	28	1.31	30	1.40	90	50	100
CHI	84	1.95	105	2.44	79	83	98
COL	197	1.41	124	0.88	54	79	93
COR	8	0.65	1	0.08	100	0	72
CUB	18	0.79	30	1.38	100	97	100
DOR	26	0.86	16	0.52	100	56	72
ECU	22	0.51	30	0.70	97	67	78
ELS	103	4.43	89	3.81	98	88	83
GUT	108	2.37	98	2.15	89	85	44
HAI	17	0.53	8	0.20	63	25	0
HON	65	2.32	69	2.39	97	97	91
MEX	465	1.43	373	1.14	97	76	94
NIC	30	1.29	29	1.36	100	100	100
PAN	13	1.34	6	0.61	100	83	93
PAR	35	1.67	13	0.62	85	77	91
PER	92	1.02	64	0.71	88	84	0
URU	4	0.49	10	1.22	100	80	77
USA	NR	NR	NR	NR	NR	NR	NR
VEN	132	1.59	102	1.23	91	80	85
Total§	2298	1.39	1846	1.11	91	78	91

+ Taken within 14 days of onset of paralysis
§ Excluding Canada and USA

NR - No reporting

Table No. 3
CONFIRMED POLIO CASES BY WEEK OF ONSET

AS OF WEEK 45

SITE	TOTAL 2004	Cumulative	
		2004	2005
ARG	0	0	0
BOL	0	0	0
BRA	0	0	0
CAN	0	0	0
CAR	0	0	0
CHI	0	0	0
COL	0	0	0
COR	0	0	0
CUB	0	0	0
DOR	0	0	0
ECU	0	0	0
ELS	0	0	0
GUT	0	0	0
HAI	0	0	0
HON	0	0	0
MEX	0	0	0
NIC	0	0	0
PAN	0	0	0
PAR	0	0	0
PER	0	0	0
URU	0	0	0
USA	0	0	0
VEN	0	0	0
Total	0	0	0

CAR includes reports from all CAREC member countries

Table No. 4
POLIO COMPATIBLE CASES BY WEEK OF ONSET

AS OF WEEK 45

SITE	TOTAL 2004	Cumulative	
		2004	2005
ARG	0	0	0
BOL	0	0	0
BRA	3	2	0
CAN	0	0	0
CAR	0	0	0
CHI	0	0	0
COL	0	0	0
COR	0	0	0
CUB	0	0	0
DOR	0	0	0
ECU	0	0	0
ELS	0	0	0
GUT	2	2	1
HAI	11	11	0
HON	0	0	0
MEX	0	0	0
NIC	0	0	0
PAN	0	0	0
PAR	0	0	0
PER	0	0	0
URU	0	0	0
USA	0	0	0
VEN	0	0	0
Total	16	15	1

CAR includes reports from all CAREC member countries

ANNEX 12. Laboratory line-listing

LABORATORY _____

COUNTRY	CASE ID	LABORATORY ID	DATE OF POLIO VACCINATION	DATE OF PARALYSIS ONSET	DATE STOOL COLLECTED	DATE RECEIVED	CONDITION OF SAMPLE*	SPECIMEN QUANTITY SUFFICIENT**?	DATE OF RESULTS	RESULTS	OBSERVATIONS

* Adequate or inadequate

** Yes or no

ANNEX 13. Guidelines for laboratories within a network

1. Laboratories in a network should be supplied with the reagents and materials needed to carry out diagnosis of poliomyelitis. They should also have the human resources necessary to perform this task.
2. Laboratory staff should be aware of clinical and epidemiological criteria that will aid in setting priorities for processing the samples received by the regional laboratories.
3. Serologic diagnosis of poliomyelitis should be eliminated, since it is not possible to determine whether antibody is due to the vaccine or wild poliovirus.
4. Laboratory should report the results of stool sample analyses within 28 days.
5. All poliovirus strains isolated from probable cases and their contacts should be typed immediately.
6. Reisolation should be attempted with all wild poliovirus strains isolated from confirmed cases.
7. With any negative samples from clinically confirmed cases, an attempt should be made to isolate the virus using concentration techniques—i.e., ultracentrifuge at 150,000 G (gravity acceleration) for two hours. Epidemiologists should be requested to collect a sufficient amount of sample so that the laboratory can perform reisolation if necessary.
8. Quality control measures should be applied to poliovirus isolation and identification (i.e., coded samples) to ensure a reliability level of over 90% correct results.
9. All laboratories should take proper steps to prevent viral contamination.
10. All laboratory personnel must be fully immunized against polio and hepatitis B.
11. Laboratories should be accredited at least once a year.

ANNEX 14. Mop-up worksheet

VILLAGE/CITY _____ MUNICIPALITY/DISTRICT_____

Province/State: _____ COUNTRY_____

DATES OF MOP-UP _____/_____/_____ TO _____/_____/_____

PERSON RESPONSIBLE FOR SUPERVISION _____

PERSON RESPONSIBLE FOR VACCINE SUPPLY _____

PERSON RESPONSIBLE FOR EQUIPMENT _____

Keep a tally of persons vaccinated during mop-up. Vaccine should be given to all children under 5 years of age, regardless of their immunization status.

AGE	TALLY OF CHILDREN VACCINATED	TOTALS
< 1 yr.		
1 to 4 yr.		
5 to 14 yr.		

Keep a record of all houses visited in the area, whether or not children live in the house or were vaccinated there. "Open" means someone was at home. "Closed" means that people live in the house but were not at home at the time of the visit.

VISITED	NUMBER OF HOUSEHOLDS VISITED	TOTALS
Open		
Closed		

During the visits to households for vaccination, an active search should be conducted. Enter the name of any person who has or had acute flaccid paralysis.

NAME OF CASE	ADDRESS AND DIRECTIONS

ANNEX 15. Mop-up vaccination form

COUNTRY _____ YEAR _____ ROUND _____

STATE/ PROVINCE	DISTRICT/ MUNICIPALITY	DATE OF ROUND	TOTAL POPULATION < 5 YRS. (A)	NUMBER OF CHILDREN < 5 YRS. VACCINATED (B)	% (B/A)	NUMBER OF HOUSEHOLDS (C)	NUMBER OF HOUSEHOLDS VISITED (D)	% (D/C)
TOTALS								

ANNEX 16. Weekly reporting monitor form

INSTRUCTIONS

1) Mark box with a check each week a report is received on time; put an X when the report is received late.
2) Calculate the percentage of sites reporting on time by dividing the number reporting on time by the total number of sites.

REPORTING UNITS	WEEK No.																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
TOTAL UNITS PRESENTING REPORTS																										
% OF UNITS PRESENTING REPORTS ON TIME																										

ANNEX 16. Weekly reporting monitor form (cont.)

INSTRUCTIONS

1) Mark box with a check each week a report is received on time; put an X when the report is received late.
2) Calculate the percentage of sites reporting on time by dividing the number reporting on time by the total number of sites.

REPORTING UNITS	WEEK No.																										
	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
TOTAL UNITS PRESENTING REPORTS																										
% OF UNITS PRESENTING REPORTS ON TIME																										

ANNEX 17. Summary of weekly reports

COUNTRY _____ YEAR _____							
WEEK No.	NUMBER OF SITES IN SYSTEM	NUMBER OF SITES REPORTING	% REPORTING	WEEK No.	NUMBER OF SITES IN SYSTEM	NUMBER OF SITES REPORTING	% REPORTING
1				27			
2				28			
3				29			
4				30			
5				31			
6				32			
7				33			
8				34			
9				35			
10				36			
11				37			
12				38			
13				39			
14				40			
15				41			
16				42			
17				43			
18				44			
19				45			
20				46			
21				47			
22				48			
23				49			
24				50			
25				51			
26				52			

ANNEX 18. Key surveillance indicators

COUNTRY _____

CRITERION	YEAR		
	20___	20___	20___
Percentage of surveillance units reporting weekly			
Percentage of reported AFP cases per 100,000 population under 15 yrs. of age			
Percentage of AFP cases with less than 15 days between paralysis onset and notification			
Percentage of AFP cases for which control activities have been carried out			
Percentage of AFP cases with less than 72 hrs. between notification and start of mop-up			
Percentage of AFP cases in which ONE stool specimen was collected within 15 days of paralysis onset			
Percentage of laboratory results received within 28 days			
Percentage of AFP cases in which enterovirus was isolated			
Percentage of AFP cases that received follow-up visit within 60 days of paralysis onset			
Percentage of AFP cases with key clinical data recorded, including: date of paralysis onset, days of paralysis progression, fever at paralysis onset, residual paralysis at 60 days, location of paralysis (proximal or distal), and final diagnosis			

ANNEX 19. Active search for cases of paralysis

A: HEALTH FACILITY CASE INVESTIGATION FORM

Health center:	
Town:	Date:
Health district:	Investigator:

PROCEDURE:
Check the box that applies:

DIRECTOR OF CENTER SIGNATURE SEAL

☐ Review of _____ (number) diagnoses on daily outpatient records.

☐ Review of _____ (number) compatible diagnoses on discharge records, out of a total of _____ (number) of discharges during the period.

The diagnoses were made in:

☐ Children < 15 years of age.

☐ All age groups.

The review period covered _____(number of) year(s), from ____/____/____ to ____/____/____.

FINDINGS:
The following cases of flaccid paralysis were found in children < 15 years of age:

Case ID No.	Name of patient	Onset of paralysis		Address	Urban? Rural?	Parent(s) name(s)	Visit Yes/No	Final diagnosis	Discharged/ deceased
		Age	Date						

ANNEX 19. Active search for cases of paralysis (cont.)

B: CASE INVESTIGATION FORM FOR SCHOOLS, NURSERIES, AND OTHER INSTITUTIONS

Institution:	
Town:	Date:
Health district:	Investigator:

DIRECTOR OF CENTER SIGNATURE SEAL

1. POPULATION STUDIED

Ages	No. of children	Cases with paralysis	Cases examined
0 to 4 years			
5 to 14 years			
TOTALS			

2. CASES FOUND

No. of cases	Age (in years)	Date of onset	Address	Diagnosis

3. TEACHERS OR OTHER RESPONSIBLE ADULTS INTERVIEWED:

ANNEX 19. Active search for cases of paralysis (cont.)

C: CASE INVESTIGATION FORM FOR THE COMMUNITY

Health center:	
Town:	Date:
Health district:	Investigator:

1. PERSONS INTERVIEWED

Case ID No.	Name	Address	Does he/she know of a case of paralysis? Yes	No
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

2. CASES FOUND

*	First and last name	Address	Mother/ father	Diagnosis	Visit (Yes/No)	Date

** In this column, enter the case ID number (above) of the person interviewed.*

ANNEX 19. Active search for cases of paralysis (cont.)

D: INFORMATION SHEET

Town:	Date:
Health district:	Investigator:

Active search carried out from ____/____/_____ to ____/____/_____

A. HEALTH FACILITIES

No. of hospitals visited _____
No. of other health facilities _____
Total number of diagnoses reviewed _____
Total number of AFP cases found _____
Number of cases already known to surveillance system _____
Total number of cases visited _____
Total number of polio cases found _____
Date of onset of the most recent case of polio ____/____/_____

B. SCHOOLS, NURSERIES, AND OTHER INSTITUTIONS

No. of institutions visited:
- Schools _____
- Nurseries _____
- Other _____
- Total _____

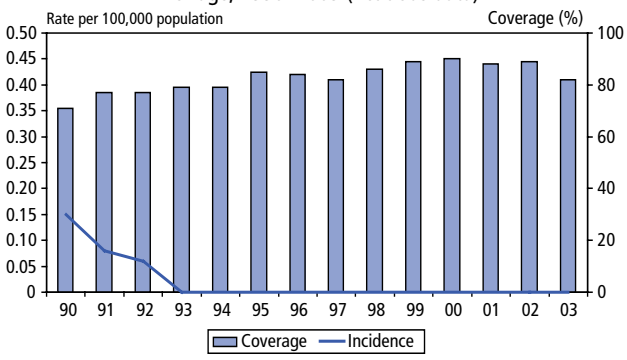
Total number of children included in the investigation _____
Number of cases of paralysis detected _____
Cases already known to the surveillance system _____
Cases visited _____
Cases of polio found _____
Date of onset of the most recent case of polio ____/____/_____

C. COMMUNITY

Number of communities visited _____
Number of houses visited _____
Number of persons interviewed _____
Cases of AFP detected _____
Cases already known to the surveillance system _____
Number of cases visited _____
Cases of poliomyelitis _____
Date of last polio case ____/____/_____

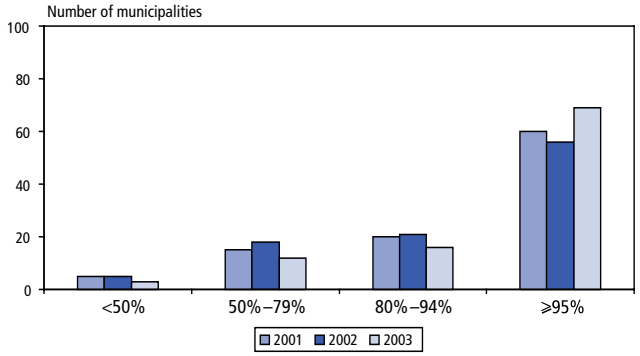
ANNEX 20. Sample presentation on surveillance of acute flaccid paralysis

Incidence of poliomyelitis and OPV3 vaccination coverage in children < 1 year of age, 1990–2003 (fictitious data)



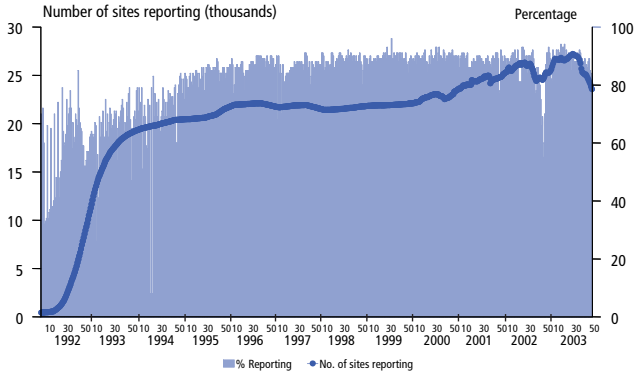
Source: Country data (fictitious).

Distribution of municipalities by OPV3 coverage in children < 1 year of age, 2001–2003 (fictitious data)



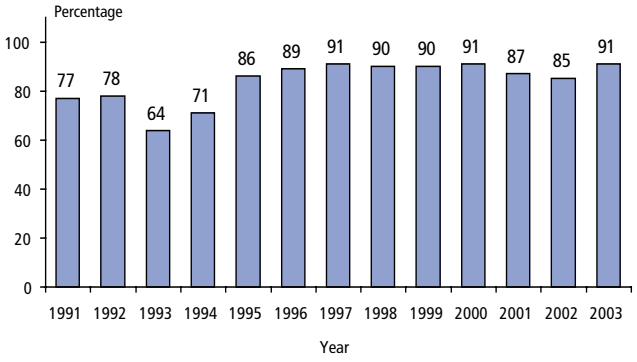
Source: Country data (fictitious).

Number of reporting sites and percentage of negative weekly reports of acute flaccid paralysis, 1992–2003 (fictitious data)



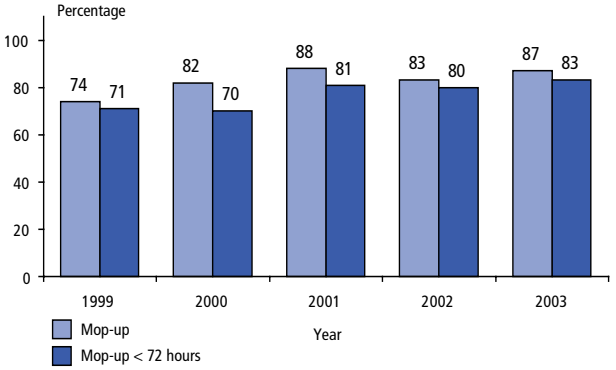
Source: Country data (fictitious).

Percentage of AFP cases investigated within 48 hours of report, 1991–2003 (fictitious data)



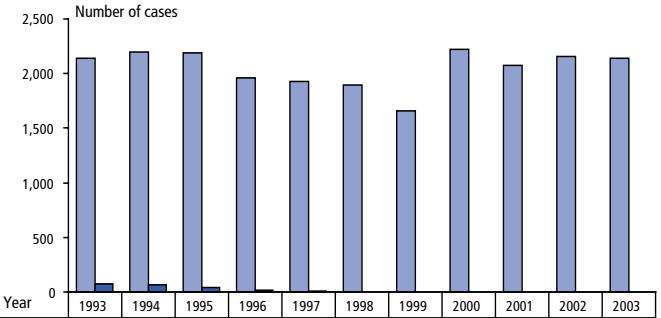
Source: Country data (fictitious).

Percentage of AFP with mop-up (control measures) and with mop-up within 72 hours of report, 1999–2003 (fictitious data)



Source: Country data (fictitious).

Polio: reported and confirmed cases, 1993–2003 (fictitious data)

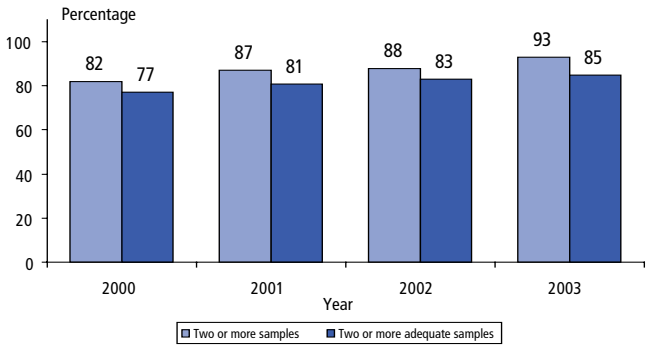


Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Reported	2,138	2,199	2,191	1,958	1,927	1,893	1,660	2,223	2,074	2,155	2,140
Confirmed	74	66	38	14	9	2	0	0	0	0	0

Source: Country data (fictitious).

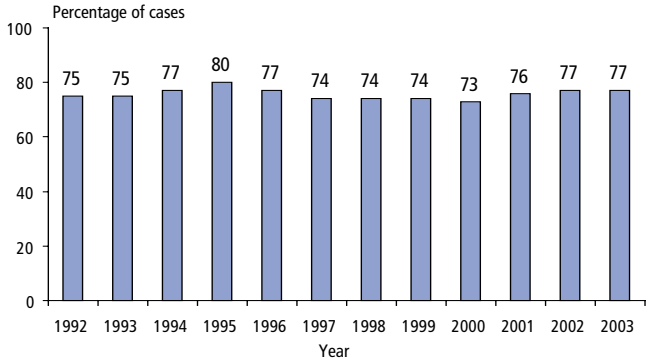
ANNEX 20. Sample presentation on surveillance of acute flaccid paralysis (cont.)

Percentage of AFP cases with stool samples collected, by number of samples, 2000–2003 (fictitious data)



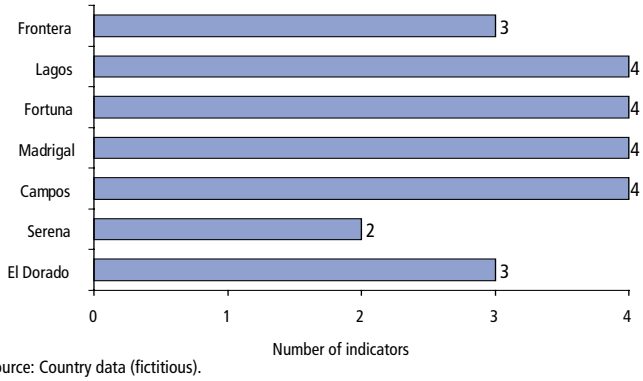
Note: Adequate samples are samples collected within 14 days of onset of paralysis and transported with adequate refrigeration.
Source: Country data (fictitious).

Percentage of AFP cases with follow-up within 70 days of paralysis onset, 1992–2003 (fictitious data)



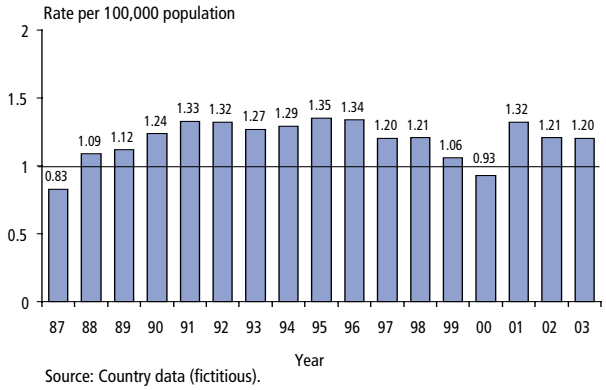
Source: Country data (fictitious).

Number of surveillance indicators for AFP that meet criteria for polio-eradication certification, 2003 (fictitious data)



Source: Country data (fictitious).

Rate of AFP per 100,000 population < 15 years of age, 1987–2003 (fictitious data)



Source: Country data (fictitious).

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