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Inside: Continuing Education Examination

Poliomyelitis Prevention in the United States

Updated Recommendations of the Advisory Committee on Immunization Practices (ACIP)

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
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Poliomyelitis Prevention in the United States

Updated Recommendations of the Advisory Committee on Immunization Practices (ACIP)

Summary

These recommendations of the Advisory Committee on Immunization Practices (ACIP) for poliomyelitis prevention replace those issued in 1997. As of January 1, 2000, ACIP recommends exclusive use of inactivated poliovirus vaccine (IPV) for routine childhood polio vaccination in the United States. All children should receive four doses of IPV at ages 2, 4, and 6–18 months and 4–6 years. Oral poliovirus vaccine (OPV) should be used only in certain circumstances, which are detailed in these recommendations. Since 1979, the only indigenous cases of polio reported in the United States have been associated with the use of the live OPV. Until recently, the benefits of OPV use (i.e., intestinal immunity, secondary spread) outweighed the risk for vaccine-associated paralytic poliomyelitis (VAPP) (i.e., one case among 2.4 million vaccine doses distributed). In 1997, to decrease the risk for VAPP but maintain the benefits of OPV, ACIP recommended replacing the all-OPV schedule with a sequential schedule of IPV followed by OPV. Since 1997, the global polio eradication initiative has progressed rapidly, and the likelihood of poliovirus importation into the United States has decreased substantially. In addition, the sequential schedule has been well accepted. No declines in childhood immunization coverage were observed, despite the need for additional injections. On the basis of these data, ACIP recommended on June 17, 1999, an all-IPV schedule for routine childhood polio vaccination in the United States to eliminate the risk for VAPP. ACIP reaffirms its support for the global polio eradication initiative and the use of OPV as the only vaccine recommended to eradicate polio from the remaining countries where polio is endemic.

INTRODUCTION

As a result of the introduction of inactivated poliovirus vaccine (IPV) in the 1950s, followed by oral poliovirus vaccine (OPV) in the 1960s, poliomyelitis control has been achieved in numerous countries worldwide, including the entire Western Hemisphere (*1,2*). In the United States, the last indigenously acquired cases of polio caused by wild poliovirus were detected in 1979 (*3*). In 1985, the countries of the Americas* established a goal of regional elimination of wild poliovirus by 1990 (*4*). In 1988, the World

*Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Canada, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, United States of America, Uruguay, Venezuela, United Kingdom Virgin Islands, and United States Virgin Islands.

Health Assembly (WHA), which is the directing council of the World Health Organization (WHO), adopted the goal of global polio eradication by the end of 2000 (*5*). In the Americas, the last case of polio associated with isolation of wild poliovirus was detected in Peru in 1991 (*6*). The Western Hemisphere was certified as free from indigenous wild poliovirus in 1994, an accomplishment achieved by the exclusive use of OPV (*7*). The global polio eradication initiative has reduced the number of reported polio cases worldwide by >80% since the mid-1980s, and worldwide eradication of the disease by the end of 2000 or soon after appears feasible (*8*).

Summary of Recent Polio Vaccination Policy in the United States

Based on the continued occurrence of vaccine-associated paralytic poliomyelitis (VAPP) in the United States, the absence of indigenous disease, and the sharply decreased risk for wild poliovirus importation into the United States, the Advisory Committee on Immunization Practices (ACIP) recommended in June 1996 a change from an all-OPV schedule for routine childhood poliovirus vaccination to a sequential IPV-OPV vaccination schedule (i.e., two doses of IPV at ages 2 and 4 months, followed by two doses of OPV at ages 12–18 months and 4–6 years). These recommendations were officially accepted by CDC and published in January 1997 (*9*). The sequential schedule was intended to be a transition policy in place for 3–5 years until eventual adoption of an all-IPV schedule. At the same time that ACIP recommended a sequential schedule, the American Academy of Pediatrics (AAP) and the American Academy of Family Physicians (AAFP) recommended expanded use of IPV, with all-OPV, all-IPV, and sequential IPV-OPV as equally acceptable options (*10,11*).

After the successful implementation of expanded IPV use without any observed declines in childhood immunization coverage (*12,13*), AAP and AAFP joined ACIP in January 1999 in recommending that the first two doses of polio vaccine for routine vaccination be IPV in most circumstances (*14,15*). However, an all-IPV schedule was still needed to eliminate the risk for VAPP while maintaining population immunity. Thus, ACIP recommended in June 1999 that the all-IPV schedule begin January 1, 2000 (*16*). Although AAFP concurred with this recommendation, AAP recommended only that the all-IPV schedule begin during the first 6 months of 2000 (*17,18*).

The United States can remain free of polio only by maintaining high levels of population immunity and reducing or eliminating the risk for poliovirus importation. ACIP strongly reaffirms its support for the global polio eradication initiative, which relies on OPV in countries where the disease has recently been endemic. This report provides the scientific and programmatic background for transition to an all-IPV schedule, presents the current recommendations for polio prevention in the United States, and summarizes recommendations for OPV use if the U.S. vaccine stockpile is needed for outbreak control.

BACKGROUND

Characteristics of Poliomyelitis

Acute Poliomyelitis

Poliomyelitis is a highly contagious infectious disease caused by poliovirus, an enterovirus. Most poliovirus infections are asymptomatic. Symptomatic cases are typically characterized by two phases — the first, a nonspecific febrile illness, is followed (in a small percentage of cases) by aseptic meningitis or paralytic disease. The ratio of cases of inapparent infection to paralytic disease ranges from 100:1 to 1,000:1.

After a person is exposed to poliovirus, the virus replicates in the oropharynx and the intestinal tract. Viremia follows, which can result in infection of the central nervous system. Replication of poliovirus in motor neurons of the anterior horn and brain stem results in cell destruction and causes the typical clinical manifestations of paralytic polio. Depending on the sites of paralysis, polio can be classified as spinal, bulbar, or spino-bulbar disease. Progression to maximum paralysis is rapid (2–4 days), is usually associated with fever and muscle pain, and rarely continues after the patient's temperature has returned to normal. Spinal paralysis is typically asymmetric and more severe proximally than distally. Deep tendon reflexes are absent or diminished. Bulbar paralysis can compromise respiration and swallowing. Paralytic polio is fatal in 2%–10% of cases. After the acute episode, many patients recover at least some muscle function and prognosis for recovery can usually be established within 6 months after onset of paralytic manifestations.

Post-Polio Syndrome

After 30–40 years, 25%–40% of persons who contracted paralytic polio during childhood can experience muscle pain and exacerbation of existing weakness or develop new weakness or paralysis. This disease entity, called post-polio syndrome, has been reported only in persons infected during the era of wild poliovirus circulation. Risk factors for post-polio syndrome include a) the passage of more time since acute poliovirus infection, b) the presence of permanent residual impairment after recovery from the acute illness, and c) being female (*19*).

Epidemiology

Polio is caused by three serotypes of poliovirus — types 1, 2, and 3. In countries where poliovirus is still endemic, paralytic disease is most often caused by poliovirus type 1, less frequently by poliovirus type 3, and least frequently by poliovirus type 2. The virus is transmitted from person to person primarily by direct fecal-oral contact. However, the virus also can be transmitted by indirect contact with infectious saliva or feces, or by contaminated sewage or water.

The first paralytic manifestations of polio usually occur 7–21 days from the time of initial infection (range: 4–30 days). The period of communicability begins after the virus replicates and is excreted in the oral secretions and feces. This period ends with the termination of viral replication and excretion, usually 4–6 weeks after infection. After household exposure to wild poliovirus, >90% of susceptible contacts become infected. Poliovirus infection results in lifelong immunity specific to the infecting viral serotype.

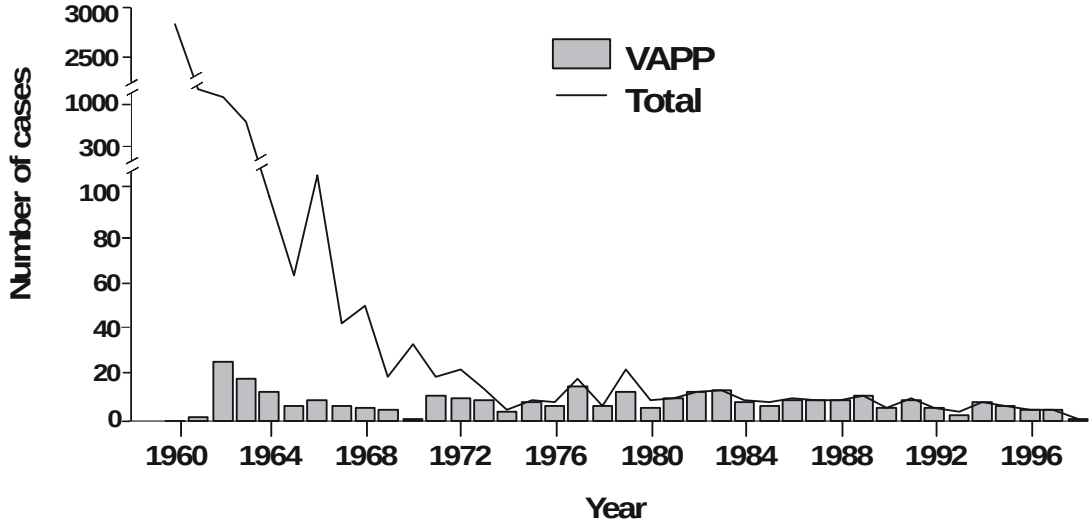
Humans are the only reservoir for poliovirus. Long-term carrier states (i.e., excretion of virus by asymptomatic persons >6 months after infection) are rare and have been reported only in immunodeficient persons (*20,21*). Risk factors for paralytic disease include larger inocula of poliovirus, increasing age, pregnancy, strenuous exercise, tonsillectomy, and intramuscular injections administered while the patient is infected with poliovirus (*22–24*).

Secular Trends in Disease and Vaccination Coverage in the United States

In the United States, poliovirus vaccines have eliminated polio caused by wild poliovirus. The annual number of reported cases of paralytic disease declined from >20,000 in 1952 to an average of 8–9 cases annually during 1980–1994 (Figure) (*3,25,26*). During 1980–1998, a total of 152 cases of paralytic polio were reported, including 144 cases of VAPP, six imported cases, and two indeterminate cases (*16*). Until worldwide polio eradication is achieved, epidemics caused by importation of wild virus to the United States remain a possibility unless population immunity is maintained by vaccinating children early in their first year of life. In the United States, outbreaks of polio occurred in 1970, 1972, and 1979 after wild poliovirus was introduced into susceptible populations that had low levels of vaccination coverage. Vaccination coverage among children in the United States is at the highest level in history because of ongoing immunization initiatives. Assessments of the vaccination status of children entering kindergarten and first grade indicated that 95% had completed primary vaccination against polio during the 1980–81 school year, and rates continue to be above that level.

Coverage levels among preschool-aged children are lower than the levels at school entry, but have increased substantially in recent years. Nationally, representative vaccination coverage rates among children aged 19–35 months are derived from the National Immunization Survey (NIS). Vaccination coverage with at least three doses of poliovirus vaccine among children in this age group increased from 88% in 1995 to 91% in 1996 and remained >90% in 1997 and 1998 (*13*).

FIGURE. Total number of reported paralytic poliomyelitis cases and total number of reported vaccine-associated paralytic polio (VAPP) cases — United States, 1960–1998*



*Updated June 16, 1999.

Serosurveys have identified high levels of population immunity consistent with these high coverage rates. Based on data from selected surveys, >90% of children, adolescents, and young adults had detectable antibodies to poliovirus types 1 and 2, and >85% had antibody to type 3 (*27,28*). Data from seroprevalence surveys conducted in two inner-city areas of the United States during 1990–1991 documented that >80% of all children aged 12–47 months had antibodies to all three poliovirus serotypes. Of the children who had received at least three doses of OPV, 90% had antibodies to all three serotypes (*29*). A serosurvey conducted during 1997–1998 among low-income children aged 19–35 months living in four U.S. cities reported that 96.8%, 99.8%, and 94.5% were seropositive to poliovirus types 1, 2, and 3, respectively (*30*).

Both laboratory surveillance for enteroviruses and surveillance for polio cases suggest that endemic circulation of indigenous wild polioviruses ceased in the United States in the 1960s. During the 1970s, genotypic testing (e.g., molecular sequencing or oligonucleotide fingerprinting) of poliovirus isolates obtained from indigenous cases (both sporadically occurring and outbreak-associated) in the United States indicated that these viruses were imported (*31*). During the 1980s, five cases of polio were classified as imported. The last imported case, reported in 1993, occurred in a child aged 2 years who was a resident of Nigeria; the child had been brought to New York for treatment of paralytic disease acquired in her home country. Laboratory investigations failed to isolate poliovirus among samples taken from this child after she arrived in the United States.

Recent experience in Canada illustrates the continuing potential for importation of wild poliovirus into the United States until global eradication is achieved. In 1993 and 1996, health officials in Canada isolated wild poliovirus in stool samples from residents of Alberta and Ontario. No cases of paralytic polio occurred as a result of these wild virus importations. The strain isolated in 1993 was linked epidemiologically and by genomic sequencing to a 1992 polio outbreak in the Netherlands (*32*). The isolate obtained in 1996 was from a child who had recently visited India (*33*).

Inapparent infection with wild poliovirus no longer contributes to either the establishment or maintenance of poliovirus immunity in the United States because these viruses no longer circulate in the population. Thus, universal vaccination of infants and children is the only way to establish and maintain population immunity against polio.

Polio Eradication

After the widespread use of poliovirus vaccine in the mid-1950s, the incidence of polio declined rapidly in many industrialized countries. In the United States, the number of cases of paralytic polio reported each year declined from >20,000 cases in 1952 to <100 cases in the mid-1960s (*3*). In 1988, the WHA resolved to eradicate polio globally by 2000 (*5*). This global resolution followed the regional goal to eliminate polio by 1990, set in 1985 by the countries of the Western Hemisphere. The last case of polio associated with wild poliovirus isolation was reported from Peru in 1991, and the entire Western Hemisphere was certified as free from indigenous wild poliovirus by an International Certification Commission in 1994 (*7*). The following polio eradication strategies, which were developed for the Americas, were adopted for worldwide implementation in all polio-endemic countries (*34*):

- Achieve and maintain high vaccination coverage with at least three doses of OPV among infants aged <1 year.

- Develop sensitive systems of epidemiologic and laboratory surveillance, including acute flaccid paralysis (AFP) surveillance.
- Administer supplemental doses of OPV to all young children (usually those aged <5 years) during National Immunization Days (NIDs) to rapidly decrease widespread poliovirus circulation.
- Conduct mopping-up vaccination campaigns (i.e., localized campaigns that include home-to-home [or boat-to-boat] administration of OPV) in areas at high risk to eliminate the last remaining chains of poliovirus transmission.

In 1998, global coverage with at least three doses of OPV among infants aged <1 year was 80%. All WHO regions* reported coverage rates of >80%, except the African Region (AFR), where coverage improved from 32% in 1988 to 53% in 1998 (*8*). Also in 1998, a total of 90 countries conducted either NIDs (74 countries) or Sub-National Immunization Days (16 countries). These 90 countries provided supplemental doses of OPV to approximately 470 million children aged <5 years (i.e., approximately three quarters of the world's children aged <5 years) (*8*). In 1999, NIDs were conducted in all 50 polio-endemic countries. NIDs in the AFR targeted approximately 88 million children aged <5 years (*35*). Synchronized NIDs were conducted in 18 countries of the European Region (EUR) and Eastern Mediterranean Region (EMR), vaccinating 58 million children aged <5 years. Another 257 million children aged <5 years were vaccinated in December 1998 and January 1999 in countries of the EMR (Pakistan), South East Asia Region (SEAR) (Bangladesh, Bhutan, India, Myanmar, Nepal, and Thailand), and Western Pacific Region (WPR) (China and Vietnam) (*36–40*). NIDs in India reached 134 million children, representing the largest mass campaigns conducted to date. Each round of NIDs in India was conducted in only one day (*41*). Mopping-up campaigns have been conducted widely in the countries of the Americas (including Brazil, Colombia, Mexico, Peru, and several countries in Central America) and more recently in the Mekong delta area encompassing Cambodia, Laos, and Vietnam in 1997 and 1998, and in Turkey in 1998 (*37,38*).

These supplemental immunization activities have been successful in decreasing the number of reported polio cases globally from 35,251 in 1988 (when the polio eradication target was adopted) to 6,227 in 1998, a decrease of 82% (*8*). This decrease in incidence is even more remarkable considering the progress in implementing sensitive systems for AFP surveillance, which substantially increased the completeness of reporting of suspected or confirmed polio cases. To conduct virological surveillance, a global laboratory network has been established that processes stool specimens in WHO-accredited laboratories, with both quality and performance monitored closely (*42*).

Concurrent with the decline in polio incidence, the number of polio-endemic countries has decreased from >120 in 1988 to approximately 50 in 1998. Approximately 50% of the world's population resides in areas now considered polio-free, including the Western Hemisphere, WPR (which encompasses China), and EUR. Two large endemic areas of continued poliovirus transmission exist in South Asia and Sub-Saharan Africa. Priority countries targeted for accelerated implementation of polio eradication strategies include seven reservoir countries (Bangladesh, Democratic Republic of the Congo,

*African Region (AFR), Region of the Americas (AMR), Eastern Mediterranean Region (EMR), European Region (EUR), South East Asia Region (SEAR), and Western Pacific Region (WPR).

Ethiopia, India, Nepal, Nigeria, and Pakistan) and eight countries in conflict (Afghanistan, Angola, Democratic Republic of the Congo, Liberia, Sierra Leone, Somalia, Sudan, and Tajikistan) (8). Progress in these countries will be essential to achieve the goal of global polio eradication by the end of 2000.

Vaccine-Associated Paralytic Poliomyelitis (VAPP)

Cases of VAPP were observed almost immediately after the introduction of live, attenuated poliovirus vaccines (*43,44*). Before the sequential IPV-OPV schedule was introduced, 132 cases of VAPP were reported during 1980–1995 (Figure) (*26*; CDC, unpublished data, 2000). Fifty-two cases of paralysis occurred among otherwise healthy vaccine recipients, 41 cases occurred among healthy close contacts of vaccine recipients, and 7 cases occurred among persons classified as community contacts (i.e., persons from whom vaccine-related poliovirus was isolated but who had not been vaccinated recently or been in direct contact with vaccine recipients). An additional 32 cases occurred among persons with immune system abnormalities who received OPV or who had direct contact with an OPV recipient (Table).

TABLE. Ratio of the number and type of cases of vaccine-associated paralytic poliomyelitis (VAPP) to the number of doses of trivalent oral poliovirus vaccine (OPV)* distributed — United States, 1980–1995

	Ratio of VAPP cases to doses of OPV distributed† (and number of VAPP cases)		
Case category	**All doses**	**First doses**	**Subsequent doses**
Recipient	1: 6.1 (52)	1: 1.4 (43)	1: 28.9 (9)
Contact	1: 7.7 (41)	1: 2.3 (26)	1: 17.3 (15)
Community-acquired	1: 45.3 (7)	NA	NA
Immunologically abnormal§	1: 9.9 (32)	1: 5.1 (12)	1: 13.0 (20)
Total	**1: 2.4 (132)**	**1: 0.75 (81)**	**1: 5.1 (51)**

*Live, attenuated vaccine.

†In millions.

§Because the denominator is doses of OPV distributed, the calculated ratio is low. However, if the denominator is the number of immunodeficient infants born each year, the risk for VAPP among immunodeficient infants is 3,200-fold to 6,800-fold higher than among immunocompetent infants (Sutter RW, Prevots DR. Vaccine-associated paralytic poliomyelitis among immunodeficient persons. Infect Med 1994;11:426,429–30,435–8).

The overall risk for VAPP is approximately one case in 2.4 million doses of OPV vaccine distributed, with a first-dose risk of one case in 750,000 first doses distributed (Table). Among immunocompetent persons, 83% of cases among vaccine recipients and 63% of cases among contacts occurred after administration of the first dose (Table) (*3,25,36*). Among persons who are not immunodeficient, the risk for VAPP associated with the first dose of OPV is sevenfold to 21-fold higher than the risk associated with subsequent doses (*25*). Immunodeficient persons, particularly those who have B-lymphocyte disorders that inhibit synthesis of immune globulins (i.e., agammaglobulinemia and hypogammaglobulinemia), are at greatest risk for VAPP (i.e., 3,200-fold to 6,800-fold greater risk than immunocompetent OPV recipients) (*45*).

Since implementation of the sequential IPV-OPV schedule in 1997, five cases of VAPP with onset in 1997 and two cases with onset in 1998 were confirmed. Three of these cases were associated with administration of the first or second dose of OPV to children

who had not previously received IPV, and one of the 1998 cases was associated with administration of the third dose. Although these data suggest a decline in VAPP after introduction of the sequential schedule, continued monitoring with additional observation time is required to confirm these preliminary findings because of potential delays in reporting (*25,46*).

Transition to an All-IPV Schedule

Adopting an all-IPV schedule for routine childhood polio vaccination in the United States is intended to eliminate the risk for VAPP. However, this schedule requires two additional injections at ages 6–18 months and 4–6 years because no combination vaccine that includes IPV as a component is licensed in the United States. Because of concerns regarding potential declines in childhood immunization coverage after introduction of the sequential IPV-OPV schedule (which required two additional injections at ages 2 and 4 months), several evaluations were conducted during this transition period. No evidence exists that childhood vaccination coverage declined because of these additional injections. In two West Coast health maintenance organizations (HMOs) with automated recording and tracking systems for vaccination, researchers assessed the up-to-date vaccination status of infants at age 12 months (i.e., two doses of poliovirus vaccine, three doses of diphtheria and tetanus toxoids and acellular pertussis vaccine [DTaP], two doses of Haemophilus influenzae type b vaccine [Hib], and two doses of hepatitis B vaccine [HepB]). The proportion of children who started the routine vaccination schedule with IPV ranged from 36%–98% across the HMOs by the third quarter of 1997. Infants starting with IPV were as likely to be up-to-date as were infants starting with OPV (*12*).

Available data from other public-sector clinics showed similar results. In one inner-city clinic in Philadelphia, 152 children due for their first dose of polio vaccine received IPV. Of the 145 children who returned to the clinic, 144 received a second dose of IPV. More than 99% of children due for their third and fourth injections (including IPV) during a single visit received them as indicated (*47*). An evaluation conducted at six public health clinics in one Georgia county also concluded that, of 567 infants who received their first dose of polio vaccine by age 3 months, 534 (94%) received IPV. Among these infants, 99.6% were also up-to-date for their first doses of diphtheria and tetanus toxoids vaccine (DTP), DTaP, Hib, and HepB (*48*). More detailed data on compliance with the recommended vaccination schedules is available from state immunization registries.

Another study reviewed immunization data from children born in Oklahoma during January 1, 1996–June 30, 1997 (i.e., 36,391 children seen at one of 290 facilities). The percentage of children who received IPV as their first dose of polio vaccine increased from <2% of children born in 1996 to 15% of children born in the first quarter of 1997 and to 30% of children born in the second quarter of 1997. However, receipt of IPV did not impact overall vaccination coverage; 80% of children receiving IPV for their first dose were up-to-date, as were 80% of children receiving OPV (*49*).

In 1995, a total of 448,030 doses of IPV were distributed (i.e., approximately 2% of total poliovirus vaccine doses) in the United States. IPV use increased from 6% of all polio doses distributed in 1996 to 29% in 1997 and 34% in 1998. Through August 31, 1999, a total of 69% of doses purchased were IPV, indicating increased acceptance of IPV (*18*).

INVESTIGATION AND REPORTING OF SUSPECTED POLIOMYELITIS CASES

Case Investigation

Each suspected case of polio should prompt an immediate epidemiologic investigation with collection of laboratory specimens as appropriate (see Laboratory Methods). If evidence suggests the transmission of wild poliovirus, an active search for other cases that could have been misdiagnosed initially (e.g., as Guillain-Barré syndrome [GBS], polyneuritis, or transverse myelitis) should be conducted. Control measures (including an OPV vaccination campaign to contain further transmission) should be instituted immediately. If evidence suggests vaccine-related poliovirus, no vaccination plan should be developed because no outbreaks associated with live, attenuated vaccine-related poliovirus strains have been documented.

The two most recent outbreaks of polio reported in the United States affected members of religious groups who object to vaccination (i.e., outbreaks occurred in 1972 among Christian Scientists and in 1979 among members of an Amish community). Polio should be suspected in any case of acute flaccid paralysis that affects an unvaccinated member of such a religious group. All such cases should be investigated promptly (see Surveillance).

Surveillance

CDC conducts national surveillance for polio in collaboration with state and local health departments. Suspected cases of polio must be reported immediately to local or state health departments. CDC compiles and summarizes clinical, epidemiologic, and laboratory data concerning suspected cases. Three independent experts review the data and determine whether a suspected case meets the clinical case definition of paralytic polio (i.e., a paralytic illness clinically and epidemiologically compatible with polio in which a neurologic deficit is present 60 days after onset of symptoms [unless death has occurred or follow-up status is unknown]). CDC classifies confirmed cases of paralytic polio as a) associated with either vaccine administration or wild virus exposure, based on epidemiologic and laboratory criteria, and b) occurring in either a vaccine recipient or the contact of a recipient, based on OPV exposure data (*25*). For the recommended control measures to be undertaken quickly, a preliminary assessment must ascertain as soon as possible whether a suspected case is likely vaccine-associated or caused by wild virus (see Case Investigation and Laboratory Methods).

Laboratory Methods

Specimens for virus isolation (e.g, stool, throat swab, and cerebrospinal fluid [CSF]) and serologic testing must be obtained in a timely manner. The greatest yield for poliovirus is from stool culture, and timely collection of stool specimens increases the likelihood of case confirmation. At least two stool specimens and two throat swab specimens should be obtained from patients who are suspected to have polio. Specimens should be obtained at least 24 hours apart as early in the course of illness as possible, ideally within 14 days of onset. Stool specimens collected $\geq$2 months after the onset of

paralytic manifestations are unlikely to yield poliovirus. Throat swabs are less often positive than stool samples, and virus is rarely detected in CSF. In addition, an acute-phase serologic specimen should be obtained as early in the course of illness as possible, and a convalescent-phase specimen should be obtained at least 3 weeks later.

The following tests should be performed on appropriate specimens collected from persons who have suspected cases of polio: a) isolation of poliovirus in tissue culture; b) serotyping of a poliovirus isolate as serotype 1, 2, or 3; and c) intratypic differentiation using DNA/RNA probe hybridization or polymerase chain reaction to determine whether a poliovirus isolate is associated with a vaccine or wild virus.

Acute-phase and convalescent-phase serum specimens should be tested for neutralizing antibody to each of the three poliovirus serotypes. A fourfold rise in antibody titer between appropriately timed acute-phase and convalescent-phase serum specimens is diagnostic for poliovirus infection. The recently revised standard protocol for poliovirus serology should be used (*50*). Commercial laboratories usually perform complement fixation and other tests. However, assays other than neutralization are difficult to interpret because of inadequate standardization and relative insensitivity. The CDC Enterovirus Laboratory is available for consultation and will test specimens from patients who have suspected polio (i.e., patients with acute paralytic manifestations). The telephone number for this lab is (404) 639-2749.

INACTIVATED POLIOVIRUS VACCINE (IPV)

Background

IPV was introduced in the United States in 1955 and was used widely until OPV became available in the early 1960s. Thereafter, the use of IPV rapidly declined to <2% of all poliovirus vaccine distributed annually in the United States. A method of producing a more potent IPV with greater antigenic content was developed in 1978 and is the only type of IPV in use today (*51*). The first of these more immunogenic vaccines was licensed in the United States in 1987. Results of studies from several countries have indicated that the enhanced-potency IPV is more immunogenic for both children and adults than previous formulations of IPV (*52*).

Vaccine Composition

Two IPV vaccine products are licensed in the United States,* although only one (IPOL®) is both licensed and distributed in the United States. These products and their descriptions are as follows:

- IPOL®. One dose (0.5 mL administered subcutaneously) consists of the sterile suspension of three types of poliovirus: type 1 (Mahoney), type 2 (MEF-1), and type 3 (Saukett). The viruses are grown on Vero cells, a continuous line of monkey kidney cells, by the microcarrier method. After concentration, purification, and formaldehyde inactivation, each dose of vaccine contains 40 D

*Official names: IPOL® (enhanced-inactivated poliomyelitis vaccine), manufactured and distributed by Aventis-Pasteur, Swiftwater, Pennsylvania; and POLIOVAX,® manufactured by Aventis-Pasteur, Ontario, Canada (licensed but not distributed in the United States).

antigen units of type 1 poliovirus, 8 D antigen units of type 2, and 32 D antigen units of type 3. Each dose also contains 0.5% of 2-phenoxyethanol and up to 200 ppm of formaldehyde as preservatives, as well as trace amounts of neomycin, streptomycin, and polymyxin B used in vaccine production. This vaccine does not contain thimerosal.

- POLIOVAX®. One dose (0.5 mL administered subcutaneously) consists of the sterile suspension of three types of poliovirus: type 1 (Mahoney), type 2 (MEF-1), and type 3 (Saukett). The viruses are grown on human diploid (MRC-5) cell cultures, concentrated, purified, and formaldehyde inactivated. Each dose of vaccine contains 40 D antigen units of type 1 poliovirus, 8 D antigen units of type 2, and 32 D antigen units of type 3, as well as 27 ppm formaldehyde, 0.5% of 2-phenoxyethanol, 0.5% of albumin (human), 20 ppm of Tween 80™, and <1 ppm of bovine serum. Trace amounts of neomycin and streptomycin can be present as a result of the production process. This vaccine does not contain thimerosal.

Immunogenicity

A clinical trial of two preparations of enhanced-potency IPV was completed in the United States in 1984 (*53*). Among children who received three doses of one of the enhanced-potency IPVs at ages 2, 4, and 18 months, 99%–100% had developed serum antibodies to all three poliovirus types at age 6 months, which was 2 months after administration of the second dose. The percentage of children who had antibodies to all three poliovirus serotypes did not increase or decrease during the 14-month period after the second dose, confirming that seroconversion had occurred in most of the children. Furthermore, geometric mean antibody titers increased fivefold to tenfold after both the second and third doses.

Data from subsequent studies have confirmed that 90%–100% of children develop protective antibodies to all three types of poliovirus after administration of two doses of the currently available IPV, and 99%–100% develop protective antibodies after three doses (*53–55*). Results of studies showing long-term antibody persistence after three doses of enhanced-potency IPV are not yet available in the United States. However, data from one study indicated that antibody persisted throughout a 4-year follow-up period (*56*). In Sweden, studies of persons who received four doses of an IPV with lower antigen content than the IPVs licensed in the United States indicated that >90% of vaccinated persons had serum antibodies to poliovirus 25 years after the fourth dose (*57*). One dose of IPV administered to persons during an outbreak of poliovirus type 1 in Senegal during 1986–1987 was 36% effective; the effectiveness of two doses was 89% (*58*).

Several European countries (e.g., Finland, Netherlands, Sweden, and Iceland) have relied exclusively on enhanced-potency IPV for routine poliovirus vaccination to eliminate the disease. More recently, all Canadian provinces have adopted vaccination schedules relying exclusively on IPV (i.e., five doses at ages 2, 4, 6, and 18 months and 4–6 years), and Ontario has used an all-IPV schedule since 1988 (*59*). In addition, France has used only IPV since 1983 (*60*).

Safety

In countries relying on all-IPV schedules, no increased risk for serious adverse events has been observed. An extensive review by the Institute of Medicine (IOM) of adverse events associated with vaccination suggested that no serious adverse events have been associated with the use of IPV in these countries (*61*). Since expanded use of IPV in the United States in 1996, no serious adverse events have been linked to use of IPV (CDC, unpublished data, 1999).

RECOMMENDATIONS FOR IPV VACCINATION

Recommendations for IPV Vaccination of Children

Routine Vaccination

All children should receive four doses of IPV at ages 2, 4, and 6–18 months and 4–6 years. The first and second doses of IPV are necessary to induce a primary immune response, and the third and fourth doses ensure "boosting" of antibody titers to high levels. If accelerated protection is needed, the minimum interval between doses is 4 weeks, although the preferred interval between the second and third doses is 2 months (see Recommendations for IPV Vaccination of Adults). All children who have received three doses of IPV before age 4 years should receive a fourth dose before or at school entry. The fourth dose is not needed if the third dose is administered on or after the fourth birthday.

Incompletely Vaccinated Children

The poliovirus vaccination status of children should be evaluated periodically. Those who are inadequately protected should complete the recommended vaccination series. No additional doses are needed if more time than recommended elapses between doses (e.g., more than 4–8 weeks between the first two doses or more than 2–14 months between the second and third doses).

Scheduling IPV Administration

Until appropriate combination vaccines are available, the administration of IPV will require additional injections at ages 2 and 4 months. When scheduling IPV administration, the following options should be considered to decrease the number of injections at the 2- and 4-month patient visits:

- Administer HepB at birth and ages 1 and 6 months.
- Schedule additional visits if there is reasonable certainty that the child will be brought back for subsequent vaccination at the recommended ages.
- Use available combination vaccines.

Interchangeability of Vaccines

Children who have initiated the poliovirus vaccination series with one or more doses of OPV should receive IPV to complete the series. If the vaccines are administered ac-

cording to their licensed indications for minimum ages and intervals between doses, four doses of OPV or IPV in any combination by age 4–6 years is considered a complete series, regardless of age at the time of the third dose. A minimum interval of 4 weeks should elapse if IPV is administered after OPV. Available evidence indicates that persons primed with OPV exhibit a strong mucosal immunogloblulin A response after boosting with IPV (*62*).

Administration with Other Vaccines

IPV can be administered simultaneously with other routinely recommended childhood vaccines. These include DTP, DTaP, Hib, HepB, varicella (chickenpox) vaccine, and measles-mumps-rubella vaccine.

Recommendations for IPV Vaccination of Adults

Routine poliovirus vaccination of adults (i.e., persons aged ≥18 years) residing in the United States is not necessary. Most adults have a minimal risk for exposure to polioviruses in the United States and most are immune as a result of vaccination during childhood. Vaccination is recommended for certain adults who are at greater risk for exposure to polioviruses than the general population, including the following persons:

- Travelers to areas or countries where polio is epidemic or endemic.
- Members of communities or specific population groups with disease caused by wild polioviruses.
- Laboratory workers who handle specimens that might contain polioviruses.
- Health-care workers who have close contact with patients who might be excreting wild polioviruses.
- Unvaccinated adults whose children will be receiving oral poliovirus vaccine.

Unvaccinated adults who are at increased risk should receive a primary vaccination series with IPV. Adults without documentation of vaccination status should be considered unvaccinated. Two doses of IPV should be administered at intervals of 4–8 weeks; a third dose should be administered 6–12 months after the second. If three doses of IPV cannot be administered within the recommended intervals before protection is needed, the following alternatives are recommended:

- If more than 8 weeks are available before protection is needed, three doses of IPV should be administered at least 4 weeks apart.
- If fewer than 8 weeks but more than 4 weeks are available before protection is needed, two doses of IPV should be administered at least 4 weeks apart.
- If fewer than 4 weeks are available before protection is needed, a single dose of IPV is recommended.

The remaining doses of vaccine should be administered later, at the recommended intervals, if the person remains at increased risk for exposure to poliovirus. Adults who have had a primary series of OPV or IPV and who are at increased risk can receive another dose of IPV. Available data do not indicate the need for more than a single lifetime booster dose with IPV for adults.

Precautions and Contraindications

Hypersensitivity or Anaphylactic Reactions to IPV or Antibiotics Contained in IPV

IPV should not be administered to persons who have experienced a severe allergic (anaphylactic) reaction after a previous dose of IPV or to streptomycin, polymyxin B, or neomycin. Because IPV contains trace amounts of streptomycin, polymyxin B, and neomycin, hypersensitivity reactions can occur among persons sensitive to these antibiotics. No serious adverse events related to use of enhanced-potency IPV have been documented.

Pregnancy

Although no adverse effects of IPV have been documented among pregnant women or their fetuses, vaccination of pregnant women should be avoided on theoretical grounds. However, if a pregnant woman is at increased risk for infection and requires immediate protection against polio, IPV can be administered in accordance with the recommended schedules for adults (see Recommendations for IPV Vaccination of Adults).

Immunodeficiency

IPV is the only vaccine recommended for vaccination of immunodeficient persons and their household contacts. Many immunodeficient persons are immune to polioviruses as a result of previous vaccination or exposure to wild virus when they were immunocompetent. Administration of IPV to immunodeficient persons is safe. Although a protective immune response in these persons cannot be ensured, IPV might confer some protection.

False Contraindications

Breastfeeding does not interfere with successful immunization against polio. A dose of IPV can be administered to a child who has diarrhea. Minor upper respiratory illnesses with or without fever, mild to moderate local reactions to a previous dose of vaccine, current antimicrobial therapy, and the convalescent phase of an acute illness are not contraindications for vaccination (*63*).

ORAL POLIOVIRUS VACCINE (OPV)

Background

Routine production of OPV in the United States has been discontinued. However, an emergency stockpile of OPV for polio outbreak control is maintained. Because OPV is the only vaccine recommended to control outbreaks of polio, this section describes OPV and indications for its use.

Vaccine Composition

Trivalent OPV contains live attenuated strains of all three poliovirus serotypes. The viruses are propagated in monkey kidney cell culture. Until introduction of the sequential IPV-OPV schedule in 1997, OPV was the nation's primary poliovirus vaccine, after its licensing in the United States in 1963. One dose of OPV (0.5 mL administered orally from a single dose dispenser) is required to contain a minimum of 10^6 $TCID_{50}$ (tissue culture infectious dose) Sabin strain of poliovirus type 1 (LSc 2ab), $10^{5.1}$ $TCID_{50}$ Sabin strain of poliovirus type 2 (P712 Ch 2ab), and $10^{5.8}$ $TCID_{50}$ Sabin strain of poliovirus type 3 (Leon $12a_1b$), balanced in a formulation of 10:1:3, respectively. The OPV formerly manufactured in the United States* contained approximately threefold to tenfold the minimum dose of virus necessary to meet these requirements consistently (*64*). Each dose of 0.5 mL also contained <25 µG each of streptomycin and neomycin.

Immunogenicity

After complete primary vaccination with three doses of OPV, ≥95% of recipients develop long-lasting (probably lifelong) immunity to all three poliovirus types. Approximately 50% of vaccine recipients develop antibodies to all three serotypes after a single dose of OPV (*53*). OPV consistently induces immunity of the gastrointestinal tract that provides a substantial degree of resistance to reinfection with poliovirus. OPV interferes with subsequent infection by wild poliovirus, a property that is important in vaccination campaigns to control polio epidemics. Both IPV and OPV induce immunity of the mucosa of the gastrointestinal tract, but the mucosal immunity induced by OPV is superior (*65,66*). Both IPV and OPV are effective in reducing pharyngeal replication and subsequent transmission of poliovirus by the oral-oral route.

RECOMMENDATIONS FOR OPV VACCINATION

Recommendations for OPV Vaccination for Outbreak Control

Rationale

As affirmed by ACIP, OPV remains the vaccine of choice for mass vaccination to control polio outbreaks (*16*). Data from clinical trials and empirical evidence support the effectiveness of OPV for outbreak control. The preference for OPV in an outbreak setting is supported by a) higher seroconversion rates after a single dose of OPV compared with a single dose of IPV; b) a greater degree of intestinal immunity, which limits community spread of wild poliovirus; and c) beneficial secondary spread (intestinal shedding) of vaccine virus, which improves overall protection in the community.

As a live attenuated virus, OPV replicates in the intestinal tract and induces antibodies in more recipients after a single dose. Thus, OPV can protect more persons who are susceptible in a population, making it the preferred vaccine for rapid intervention during an outbreak (*53,67*). Among persons previously vaccinated with three doses of IPV

*Official name: Orimune® (poliovirus vaccine, live, oral, trivalent types 1,2,3 [Sabin]), manufactured by Lederle Laboratories, Division of American Cyanamid Company, Pearl River, New York.

or OPV, excretion of poliovirus from the pharynx and the intestine appears most closely correlated with titers of homologous humoral antibody (*68*). Three doses of either IPV or OPV induce protective antibody levels (neutralizing antibody titers >1:8) to all three serotypes of poliovirus in >95% of infant recipients (*9*). Therefore, boosting of immunity with a single dose of OPV or IPV is likely to reduce both pharyngeal and intestinal excretion of poliovirus, effectively stopping epidemic transmission of wild poliovirus.

Use of OPV for Outbreak Control

OPV has been the vaccine of choice for polio outbreak control. During a polio outbreak in Albania in 1996, the number of cases decreased 90% within 2 weeks after administration of a single dose of OPV to >80% of the population aged 0–50 years. Two weeks after a second round of vaccination with OPV, no additional cases were observed (*69*). Rapidly implemented mass vaccination campaigns resulting in high coverage appears to have been similarly effective in interrupting wild poliovirus outbreaks in other countries (*70*).

European countries that rely solely on IPV for routine poliovirus vaccination (e.g., the Netherlands and Finland) have also used OPV for primary control of outbreaks. During the 1992–93 polio outbreak in the Netherlands, OPV was offered to members of a religious community affected by the outbreak (who were largely unvaccinated before the outbreak) and other persons living in areas affected by the outbreak. IPV was given to immunized persons outside the outbreak areas to ensure protection in this population (*71*). During a 1984–85 polio outbreak in Finland, 1.5 million doses of IPV initially were administered to children <18 years for immediate boosting of protection (*72*). Later, approximately 4.8 million doses of OPV were administered to 95% of the population. In contrast, mass vaccination with IPV exclusively has had little impact on outbreaks and has rarely been used since OPV became available (*70,73*).

Recommendations for Other Uses of OPV

For the remaining nonemergency supplies of OPV, only the following indications are acceptable for OPV administration:

- Unvaccinated children who will be traveling in fewer than 4 weeks to areas where polio is endemic. If OPV is not available, IPV should be administered.
- Children of parents who do not accept the recommended number of vaccine injections. These children can receive OPV only for the third or fourth dose or both. In this situation, health-care providers should administer OPV only after discussing the risk for VAPP with parents or caregivers.

Precautions and Contraindications

Hypersensitivity or Anaphylactic Reactions to OPV

OPV should not be administered to persons who have experienced an anaphylactic reaction to a previous dose of OPV. Because OPV also contains trace amounts of neomycin and streptomycin, hypersensitivity reactions can occur in persons sensitive to these antibiotics.

Pregnancy

Although no adverse effects of OPV have been documented among pregnant women or their fetuses, vaccination of pregnant women should be avoided. However, if a pregnant woman requires immediate protection against polio, she can receive OPV in accordance with the recommended schedules for adults (see Use of OPV for Outbreak Control).

Immunodeficiency

OPV should not be administered to persons who have immunodeficiency disorders (e.g., severe combined immunodeficiency syndrome, agammaglobulinemia, or hypogammaglobulinemia) (*74–76*) because these persons are at substantially increased risk for VAPP. Similarly, OPV should not be administered to persons with altered immune systems resulting from malignant disease (e.g., leukemia, lymphoma, or generalized malignancy) or to persons whose immune systems have been compromised (e.g., by therapy with corticosteroids, alkylating drugs, antimetabolites, or radiation or by infection with human immunodeficiency virus [HIV]). OPV should not be used to vaccinate household contacts of immunodeficient patients; IPV is recommended. Many immunodeficient persons are immune to polioviruses as a result of previous vaccination or exposure to wild virus when they were immunocompetent. Although their risk for paralytic disease could be lower than for persons with congenital or acquired immunodeficiency disorders, these persons should not receive OPV.

Inadvertent Administration of OPV to Household Contacts of Immunodeficient Persons

If OPV is inadvertently administered to a household contact of an immunodeficient person, the OPV recipient should avoid close contact with the immunodeficient person for approximately 4–6 weeks after vaccination. If this is not feasible, rigorous hygiene and hand washing after contact with feces (e.g., after diaper changing) and avoidance of contact with saliva (e.g., sharing food or utensils) can be an acceptable but probably less effective alternative. Maximum excretion of vaccine virus occurs within 4 weeks after oral vaccination.

False Contraindications

Breastfeeding does not interfere with successful immunization against polio. A dose of OPV can be administered to a child who has mild diarrhea. Minor upper respiratory illnesses with or without fever, mild to moderate local reactions to a previous dose of vaccine, current antimicrobial therapy, and the convalescent phase of an acute illness are not contraindications for vaccination (*63*).

Adverse Reactions

Vaccine-Associated Paralytic Poliomyelitis (VAPP)

In rare instances, administration of OPV has been associated with paralysis in healthy recipients and their contacts. No procedures are available for identifying persons (other than those with immunodeficiency) who are at risk for such adverse reactions. Although

the risk for VAPP is minimal, vaccinees (or their parents) and their susceptible, close, personal contacts should be informed of this risk (Table). Administration of OPV can cause VAPP that results in death, although this is rare (*3,45*).

Guillain-Barré Syndrome (GBS)

Available evidence indicates that administration of OPV does not measurably increase the risk for GBS, a type of ascending inflammatory polyneuritis. Preliminary findings from two studies in Finland led to a contrary conclusion in a review conducted by IOM in 1993 (*77,78*). Investigators in Finland reported an apparent increase in GBS incidence that was temporally associated with a mass vaccination campaign during which OPV was administered to children and adults who had previously been vaccinated with IPV. However, after the IOM review, these data were reanalyzed, and an observational study was completed in the United States. Neither the reanalysis nor the new study provided evidence of a causal relationship between OPV administration and GBS (*79*).

REPORTING OF ADVERSE EVENTS AFTER VACCINATION

The National Childhood Vaccine Injury Act of 1986 requires health-care providers to report serious adverse events after poliovirus vaccination (*80*). Events that must be reported are detailed in the Reportable Events Table of this act and include paralytic polio and any acute complications or sequelae of paralytic polio. Adverse events should be reported to the Vaccine Adverse Events Reporting System (VAERS). VAERS reporting forms and information are available 24 hours a day by calling (800) 822-7967.

Vaccine Injury Compensation Program

The National Vaccine Injury Compensation Program, established by the National Childhood Vaccine Injury Act of 1986, provides a mechanism through which compensation can be paid on behalf of a person who died or was injured as a result of receiving vaccine. A Vaccine Injury Table lists the vaccines covered by this program and the injuries, disabilities, illnesses, and conditions (including death) for which compensation can be paid (*81*). This program provides potential compensation after development or onset of VAPP in a) an OPV recipient (within 30 days), b) a person in contact with an OPV vaccinee (no time frame specified), or c) an immunodeficient person (within 6 months). Additional information is available from the National Vaccine Injury Compensation Program ([800] 338-2382) or CDC's National Immunization Program Internet site at the following address: <http://www.cdc.gov/nip/vaers.htm>.

CONCLUSION

In 1997, ACIP recommended using a sequential schedule of IPV followed by OPV for routine childhood polio vaccination in the United States, replacing the previous all-OPV vaccination schedule. This change was intended to reduce the risk for VAPP. Since 1997, the global polio eradication initiative has progressed rapidly, and the likelihood of poliovirus importation into the United States has decreased substantially. The sequential schedule has been well accepted, and no declines in childhood immunization coverage have been observed. On the basis of these data, ACIP recommended on June 17, 1999,

an all-IPV schedule for routine childhood polio vaccination in the United States to eliminate the risk for VAPP. ACIP also reaffirms its support for the global polio eradication initiative and the use of OPV as the only vaccine recommended to eradicate polio from the remaining countries where polio is endemic.

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MMWR
MORBIDITY AND MORTALITY
WEEKLY REPORT

May 19, 2000 / Vol. 49 / No. RR-5

Recommendations and Reports

Continuing Education Activity Sponsored by CDC

Poliomyelitis Prevention in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP)

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Continuing Nursing Education (CNE). This activity for 1.2 contact hours is provided by CDC, which is accredited as a provider of continuing education in nursing by the American Nurses Credentialing Center's Commission on Accreditation.

GOALS and OBJECTIVES

This *MMWR* provides recommendations regarding the prevention of poliomyelitis in the United States. These recommendations were developed by the Advisory Committee on Immunization Practices (ACIP). The goal of this report is to provide guidance on the use of poliovirus vaccine in the United States. Upon completion of this educational activity, the reader should be able to a) describe the epidemiology of polio in the United States, b) describe the current recommendations for routine poliovirus vaccination in the United States, c) recognize contraindications and precautions to the use of inactivated poliovirus vaccine, and d) list the major components of the global polio eradication program.

To receive continuing education credit, please answer all of the following questions.

1. Which of the following statements is not true concerning the clinical features of acute polio?

A. Most poliovirus infections are asymptomatic.

B. Paralytic polio results from viral replication in the cortex of the brain.

C. Spinal paralysis from poliovirus is usually asymmetric.

D. Many patients recover some muscle function after the acute episode.

E. Paralytic polio is fatal in 2%–10% of cases.

2. Which of the following statements best describes the current epidemiology of poliovirus infection in the United States?

A. Outbreaks of polio occur approximately every 10 years.

B. Transmission of poliovirus occurs only among unvaccinated preschool-aged children.

C. Outbreaks of polio occur because of importation of poliovirus from outside the United States.

D. All paralytic polio reported in the United States since 1993 has been the result of live attenuated oral poliovirus vaccine.

E. No paralytic polio has been reported in the United States since 1985.

3. Which of the following statements is true regarding inactivated poliovirus vaccine (IPV)?

A. IPV contains three serotypes of poliovirus.

B. Approximately 90% of recipients develop antibodies to all vaccine serotypes after two doses of IPV.

C. IPV should be administered subcutaneously.

D. IPV can contain trace amounts of streptomycin and neomycin.

E. All of the above statements concerning IPV are true.

4. Which of the following statements is true regarding vaccine-associated paralytic poliomyelitis (VAPP) in the United States?

A. The overall risk for VAPP is approximately 1 case per 100,000 doses distributed.

B. VAPP occurs only among recipients of oral poliovirus vaccine (OPV).

C. The risk for VAPP is >7 times greater after the first dose of OPV than after any subsequent dose.

D. Persons with T-cell immunodeficiency are at the highest risk for VAPP.

E. VAPP has been reported after receipt of both OPV and IPV.

5. Which of the following is a component of the global polio eradication strategy?

A. Maintaining high vaccination coverage among children aged <1 year.
B. Sensitive surveillance for acute flaccid paralysis.
C. Supplemental poliovirus vaccination of children during National Immunization Days.
D. Localized vaccination campaigns in areas at high risk for outbreaks.
E. All of the above are components of the global polio eradication strategy.

6. What poliovirus vaccination schedule is recommended for children in the United States?

A. Two doses of IPV followed by two doses of OPV.
B. Two doses of OPV followed by two doses of IPV.
C. Four doses of IPV.
D. Four doses of OPV.
E. Poliovirus vaccination is no longer routinely recommended for children in the United States.

7. Which of the following conditions is a valid contraindication or precaution to using IPV?

A. Severe allergic reaction to a previous dose of IPV or to a vaccine component.
B. Breastfeeding.
C. Significant immunodeficiency from any cause.
D. Current administration of antibiotics.
E. All of the above are valid contraindications or precautions to the use of IPV.

8. What is the most common serious adverse event after administration of IPV?

A. Fever.
B. VAPP.
C. Allergic reactions (e.g., angioedema).
D. Guillain-Barré syndrome.
E. No serious adverse events have been associated with IPV use.

9. For which of the following groups of adults is polio vaccination recommended?

A. All unvaccinated adults born during or since 1957.
B. All health-care workers.
C. Adults with occupational exposure to sewage.
D. Travelers to areas where poliovirus infection is epidemic or endemic.
E. All of the above groups of adults.

10. Indicate your work setting.

A. State/local health department.
B. Other public health setting.
C. Hospital clinic/private practice.
D. Managed care organization.
E. Academic institution.
F. Other.

11. Which best describes your professional activities?

A. Patient care — emergency/urgent care department.
B. Patient care — inpatient.
C. Patient care — primary-care clinic or office.
D. Laboratory/pharmacy.
E. Public health.
F. Other.

12. I plan to use these recommendations as the basis for . . . *(Indicate all that apply.)*

A. health education materials.
B. insurance reimbursement policies.
C. local practice guidelines.
D. public policy.
E. other.

13. Each month, to approximately how many patients do you administer poliovirus vaccine?

A. None.
B. 1–5.
C. 6–20.
D. 21–50.
E. 51–100.
F. >100.

14. How much time did you spend reading this report and completing the exam?

A. 1–1.5 hours.
B. More than 1.5 hours but fewer than 2 hours.
C. 2–2.5 hours.
D. More than 2.5 hours.

15. After reading this report, I am confident I can describe the epidemiology of poliomyelitis in the United States.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

16. After reading this report, I am confident I can describe the current recommendations for routine poliovirus vaccination in the United States.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

17. After reading this report, I am confident I can recognize contraindications and precautions to the use of inactivated poliovirus vaccine.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

18. After reading this report, I am confident I can list the major components of the global polio eradication program.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

19. The objectives are relevant to the goal of this report.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

20. The table and figure are useful.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

21. Overall, the presentation of the report enhanced my ability to understand the material.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

22. These recommendations will affect my practice.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

Correct answers for questions 1–9.

1. B; 2. D; 3. E; 4. C; 5. E; 6. C; 7. A; 8. E; 9. D.

MMWR Response Form for Continuing Education Credit May 19, 2000/Vol. 49/No. RR-5

Poliomyelitis Prevention in the United States: Updated Recommendations of the Advisory Committee on Immunization Practices (ACIP)

To receive continuing education credit, you must
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Failure to complete these items can result in a delay or rejection of your application for continuing education credit.

<u>Check One</u>
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Fill in the appropriate blocks to indicate your answers. Remember, you must answer <u>all</u> of the questions to receive continuing education credit!

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3. [ ] A [ ] B [ ] C [ ] D [ ] E
4. [ ] A [ ] B [ ] C [ ] D [ ] E
5. [ ] A [ ] B [ ] C [ ] D [ ] E
6. [ ] A [ ] B [ ] C [ ] D [ ] E
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10. [ ] A [ ] B [ ] C [ ] D [ ] E [ ] F
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20. [ ] A [ ] B [ ] C [ ] D [ ] E
21. [ ] A [ ] B [ ] C [ ] D [ ] E
22. [ ] A [ ] B [ ] C [ ] D [ ] E

Signature ***Date I Completed Exam***

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