Poliovirus

Despite marked progress in global efforts to eradicate polio, wild polioviruses still persist in a small number of Asian and African countries. Thus, it is essential to ensure high poliovirus immunity levels in US children to prevent outbreaks should poliovirus be imported into this country. In 2000, inactivated poliovirus vaccine (IPV) became the poliovirus vaccine of choice for routine immunization in the United States; it replaced oral poliovirus vaccine (OPV), which had been in use since the 1960s. The rationale behind the change to IPV was to prevent the rare occurrence of vaccine-associated paralytic polio caused by OPV. Since 2000, 3 combination vaccines containing IPV have been licensed. This brief policy statement provides guidance on the optimal use of such combinations. In addition, the appropriate intervals between doses, particularly for catch-up schedules, and the importance of the dose at 4 through 6 years of age for maintaining long-term immunity to polio are addressed.

BACKGROUND AND RATIONALE

Before the introduction of IPV in 1955, more than 15,000 cases of paralytic polio occurred annually in the United States. During the early 1960s, OPVs replaced IPV as the vaccine of choice because of their ease of use and because, at the time, it was believed that OPV would provide better community protection and produce long-lasting immunity. Use of OPV led to the elimination of indigenous polio in this country; the last reported outbreak was in 1979. Although the use of OPV was highly effective, there were rare but serious cases of vaccine-associated paralytic polio (~8 cases per year) in both healthy and immunocompro-
OPV is the vaccine used in most of the world. Rarely, circulation of oral vaccine viruses has been associated with acquisition of a wild virus phenotype (comparable neurovirulence and transmissibility to wild polioviruses) leading to outbreaks of polio. The medical care costs of even 1 case of polio are substantial. A recent study estimated that such costs were on the order of $520,000 per case (range: $250,000–$1,500,000). These costs are exclusive of the costs that would be incurred trying to contain an outbreak. Thus, the United States remains at risk of importation of pathogenic polioviruses, which indicates the need, into the foreseeable future, to maintain high levels of polio immunity in the population through widespread use of IPV. Individual protection is important, because even within the United States, there are pockets of underimmunized children who might sustain polio transmission if the virus is introduced.

**EVIDENCE TO SUPPORT POLICY/RECOMMENDATION**

Seroconversion rates and geometric mean titers (GMTs) after receipt of IPV are influenced by preexisting maternal antibody, the age at which doses are administered, and the intervals between doses. For example, a study from Puerto Rico reported seroconversion rates of 99.6%, 100%, and 99.1% against serotypes 1, 2, and 3, respectively, when administered at 2, 4, and 6 months of age, compared with 85.8%, 86.2%, and 96.9%, respectively, when administered at 6, 10, and 14 weeks of age. In each schedule, children with higher maternal antibodies tended to have lower GMTs and lower seroconversion rates; maternal antibodies decrease with increasing age. For example, infants vaccinated during the first 6 months of life using 1-month intervals at 2, 3, and 4 months or 3, 4, and 5 months of age tend to produce lower antibody levels than do infants vaccinated using 2-month intervals.

The duration of immunity after receipt of the IPV series is long-term, possibly lifelong. A study in Sweden revealed persistent levels of antibody for the 12-year duration of follow-up for children who received a 4-dose series beginning in the first year of life with a booster at 4 through 5 years of age. A review of IPV schedules in 36 countries that used IPV in 2009 revealed that 34 countries included a booster dose at 4 or more years of age. Thus, there is substantial experience showing that countries that provide such a booster dose at that age have been able to sustain polio elimination. On the other hand, the experience in countries that do not provide the booster has been limited.

Four preparations of IPV are available in the United States (Table 1), including a stand-alone preparation and 3 combination vaccines: DTaP-HepB-IPV (diphtheria and tetanus toxoids and acellular pertussis adsorbed, hepatitis B [recombinant], and IPV combined [Pediarix (GlaxoSmithKline Biologicals, Rixensart, Belgium)], licensed for the first 3 doses of the IPV series through 6 years of age; DTaP-IPV/Hib (diphtheria-tetanus-acellular pertussis [DTaP], IPV, and Haemophilus influenzae type b [Hib] conjugate [tetanus toxoid conjugate] vaccine [Pentacel (Sanofi Pasteur, Swiftwater, PA)], licensed for 4 doses of the IPV series through 4 years of age; and DTaP-IPV (Kinrix [GlaxoSmithKline Biologicals]), licensed for the booster dose at 4 through 6 years of age.

**RECOMMENDATIONS**

1. The standard schedule for IPV should be 4 doses administered at 2 months, 4 months, 6 through 18 months, and 4 through 6 years of age.
2. If there is risk of imminent exposure to circulating polioviruses, such as travel to a country in which
TABLE 1  Currently Licensed Vaccines Containing Inactivated Poliovirus Vaccine (IPV)—United States, 2011*

<table>
<thead>
<tr>
<th>Vaccine Composition</th>
<th>Trade Name</th>
<th>Manufacturer</th>
<th>Approved Use in ACIP Routine Schedule†</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPV</td>
<td>Ipol (Poliovax§)</td>
<td>Sanofi Pasteur</td>
<td>2, 4, 6–18 months, and 4–6 years</td>
<td>Approved for use in infants, children, and adults††</td>
</tr>
<tr>
<td>DTaP-HepB-IPV**</td>
<td>Pediarix</td>
<td>GlaxoSmithKline</td>
<td>2, 4, and 6 months</td>
<td>Approved for first 3 doses of IPV through 6 years old†††</td>
</tr>
<tr>
<td>DTaP-IPV/Hib§§</td>
<td>Pentacel</td>
<td>Sanofi Pasteur</td>
<td>2, 4, 6, and 15–18 months</td>
<td>Approved for 4 doses of IPV through 4 years old¶¶</td>
</tr>
<tr>
<td>DTaP-IPV***</td>
<td>Kinrix</td>
<td>GlaxoSmithKline</td>
<td>4–6 years</td>
<td>Approved for booster dose at age 4–6 years¶¶¶</td>
</tr>
</tbody>
</table>

* As of August 30, 2011.
† Advisory Committee on Immunization Practices. Full schedule available at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5751a5.htm.
‡ Not currently distributed in the United States.
§§ Diphtheria and tetanus toxoids and acellular pertussis adsorbed, inactivated poliovirus, and Haemophilus influenzae type b conjugate (tetanus toxoid conjugate) vaccine.
††† Diphtheria and tetanus toxoids and acellular pertussis adsorbed, inactivated poliovirus vaccine combined.

For this reason, the standard schedule in recommendation 1, which calls for vaccine administration during periods when maternal antibodies are likely to have waned substantially, should be implemented unless there is imminent exposure risk. Although not ideal, the great majority of infants vaccinated at the minimum age with minimal intervals are protected from polio, and with imminent risk of exposure, the benefits of using the abbreviated schedule far outweigh any risks of failure to induce a protective immune response.

- The minimum interval from doses 3 to 4 should be 6 months.
- The minimum interval from doses 1 to 2 and from doses 2 to 3 should be 4 weeks.
- The minimum age for dose 1 is 6 weeks.

3. The final dose of IPV should be administered at 4 through 6 years of age regardless of the number of doses administered before 4 years of age. The final dose should be given at least 6 months after the preceding dose.

4. When DTaP-IPV/Hib is used for the first 4 doses, a fifth dose of an IPV-containing preparation (IPV alone or DTaP-IPV) should be administered on or after the fourth birthday. The minimal interval between doses 4 and 5 of IPV in this case should be 6 months.

5. IPV should be administered to immunocompromised and immunodeficient children using the same schedule as that for children with normal immune systems. Because the vaccine is inactivated, it is safe in children with abnormal immune systems. IPV might not be as effective in such children, depending on the disorder and degree of immunocompromise, compared with protection rates in children with normal immune systems.

6. Adults who are at an increased risk of exposure to wild-type poliovirus and who previously completed primary immunization with OPV or IPV can receive a single dose of IPV.

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Pediatrics 2011;128;805; originally published online September 26, 2011;
DOI: 10.1542/peds.2011-1751

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