POLIO AND POLIO POLICY
U.S. - THE OPV TO IPV SWITCH

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Outline

- Oral polio vaccine (OPV) era – 1961-1997
- Sequential schedule era – 1997-2000
- Inactivated polio vaccine (IPV) only era – 2000-present
- Take home messages
U.S. Polio Vaccine Policy

<table>
<thead>
<tr>
<th>Year</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>4 OPV – 2 mo, 4 mo, 6-18 mo, 4-6 yr</td>
</tr>
<tr>
<td>1997</td>
<td>2 IPV - 2 mo, 4 mo</td>
</tr>
<tr>
<td></td>
<td>2 OPV - 12-18 mo, 4-6 yr</td>
</tr>
<tr>
<td>2000</td>
<td>4 IPV – 2 mo, 4 mo, 6-18 mo, 4-6 yr</td>
</tr>
</tbody>
</table>

Last wild polio virus outbreak in US
Sequential
OPV only 1961-1997
IPV only

https://www.cdc.gov/vaccines/schedules/past.html
OPV ERA
1961-1997
Advantages of Oral Polio Vaccine (OPV) over Inactivated Polio Vaccine (IPV)

- Less expensive
- Easier to administer
- Induced better intestinal immunity
- Spread to unvaccinated contacts
Intestinal Immunity and Shedding

**Table 28-12** Intestinal Immunity in Vaccinated (OPV or IPV) and Naturally Immune and Susceptible Children

<table>
<thead>
<tr>
<th>Study group</th>
<th>Proportion excreting</th>
<th>Mean duration of excretion (d)</th>
<th>Mean titer of virus excreted (log TCID&lt;sub&gt;50&lt;/sub&gt;)</th>
<th>Excretion index (million)&lt;sup&gt;*&lt;/sup&gt;</th>
<th>Reduction in viral excretion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susceptible control subjects</td>
<td>0.80</td>
<td>20.4</td>
<td>5.15</td>
<td>2.305</td>
<td>Reference</td>
</tr>
<tr>
<td>IPV-vaccinated</td>
<td>0.74</td>
<td>12.3</td>
<td>4.11</td>
<td>0.1173</td>
<td>95</td>
</tr>
<tr>
<td>OPV-vaccinated</td>
<td>0.37</td>
<td>4.6</td>
<td>2.18</td>
<td>0.00022</td>
<td>99</td>
</tr>
<tr>
<td>Naturally immune</td>
<td>0.37</td>
<td>5.4</td>
<td>2.03</td>
<td>0.00022</td>
<td>99</td>
</tr>
</tbody>
</table>

*IPV, inactivated poliovirus vaccine; OPV, oral poliovirus vaccine; TCID<sub>50</sub>, median tissue culture infective dose.
*Excretion index is the proportion of children excreting challenge type 1 virus times the mean duration of excretion days times the titer of virus excreted.

**Table 27-11** Isolation of Poliovirus From Stool or Pharynx of Prior Recipients of IPV or OPV After Challenge with Type 1 OPV

<table>
<thead>
<tr>
<th>Challenge dose</th>
<th>No. of pharyngeal isolations (%)</th>
<th>No. of stool isolations (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IPV</td>
<td>OPV</td>
</tr>
<tr>
<td>High (560,000-600,000 TCID&lt;sub&gt;50&lt;/sub&gt;)</td>
<td>1/45 (2)</td>
<td>3/45 (7)</td>
</tr>
<tr>
<td>Low (500-800 TCID&lt;sub&gt;50&lt;/sub&gt;)</td>
<td>0/48 (0)</td>
<td>0/34 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>1/93 (1)</td>
<td>3/79 (4)</td>
</tr>
</tbody>
</table>

*IPV, inactivated poliovirus vaccine; OPV, oral poliovirus vaccine; TCID<sub>50</sub>, median tissue culture infective dose.

From Sutter et al. Poliovirus vaccine-live, Vaccines 6th ed
Poliovirus antibody seroprevalence among unvaccinated inner-city preschool children, by age groups, Detroit and Houston, 1990 to 1991. P1, poliovirus type 1; P2, poliovirus type 2; P3, poliovirus type 3; 12-23 m, 12 to 23 months of age; 24-35 m, 24 to 35 months of age.

Poliovirus vaccine–live
Sutter, Roland W., Vaccines, 28, 598-645
Total number of reported paralytic poliomyelitis cases and total number of reported vaccine-associated paralytic polio (VAPP) cases—United States, 1960-1998

National Vaccine Injury Compensation Program (VICP)


- VICP may provide financial compensation to individuals who file a petition and are found to have been injured by a VICP-covered vaccine.

- Even in cases in which such a finding is not made, petitioners may receive compensation through a settlement.

- The VICP covered both recipient and contact cases of vaccine-associated paralytic polio (VAPP) caused by oral polio vaccine (OPV).
*ACIP recommends a sequential schedule of two doses of IPV followed by two doses of OPV for routine childhood vaccination.
An average of 8-10 cases of vaccine-derived polio per year were caused by the OPV (about 1 case per 2.4 million doses distributed).

Among OPV recipients, the risk was higher with first doses (1 per 750,000 doses), compared with subsequent doses (1 per 5.1 million doses).

In the absence of wild-type disease, the public and authorities began to deem the risk from the vaccine unacceptable.

**TABLE 1. Ratio of number of cases of vaccine-associated paralytic poliomyelitis (VAPP) to number of doses of trivalent OPV* distributed—United States, 1980–1994**

<table>
<thead>
<tr>
<th>Case category</th>
<th>Ratio of number of cases to millions of doses of OPV* distributed and number of cases reported (N) 1980–1994</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All doses</td>
</tr>
<tr>
<td>Recipient</td>
<td>1:6.2 (49)</td>
</tr>
<tr>
<td>Contact</td>
<td>1:7.6 (40)</td>
</tr>
<tr>
<td>Community-acquired</td>
<td>1:50.5 (6)</td>
</tr>
<tr>
<td>Immunologically abnormal</td>
<td>1:10.1 (30)</td>
</tr>
<tr>
<td>Total</td>
<td>1:2.4 (125)</td>
</tr>
</tbody>
</table>

*Live, oral poliovirus vaccine (attenuated).

†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 in immunodeficient infants is 3,200-fold to 6,800-fold greater than in immunocompetent infants [31].

MMWR Recomm Rep, 1997 Jan 24; 46 (RR-3):1-25
5 reasons for adopting a sequential schedule

1. A sequential schedule was expected to reduce recipient VAPP by more than 90%
2. A sequential schedule may reduce contact VAPP
3. Continued use of OPV induces high levels of intestinal immunity
4. Maintaining OPV in the schedule results in fewer injections than going to an all-IPV schedule
5. Stocking of both vaccines facilitates choice for providers
ACIP recommends a transition policy that will increase use of IPV and decrease use of OPV during the next 3–5 years.”

- “...The risk-benefit ratio associated with the exclusive use of OPV for routine immunization has changed because of rapid progress in global polio eradication efforts.”

- “The relative benefits of OPV to the U.S. population have diminished because of the elimination of wild-virus–associated poliomyelitis in the Western Hemisphere and the reduced threat of poliovirus importation into the United States.”

- “The risk for vaccine-associated poliomyelitis caused by OPV is now judged less acceptable because of the diminished risk for wild-virus–associated disease (indigenous or imported).”
Advantages and Disadvantages of Three Poliovirus Vaccination Options

<table>
<thead>
<tr>
<th>Attribute</th>
<th>OPV*</th>
<th>IPV†</th>
<th>IPV-OPV§</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurrence of VAPP†</td>
<td>8–9 cases/year</td>
<td>None</td>
<td>2–5 cases/year**</td>
</tr>
<tr>
<td>Other serious adverse events</td>
<td>None known</td>
<td>None known</td>
<td>None known</td>
</tr>
<tr>
<td>Systemic immunity</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Immunity of GI mucosa</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Secondary transmission of vaccine virus</td>
<td>Yes</td>
<td>No</td>
<td>Some</td>
</tr>
<tr>
<td>Extra injections or visits needed</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Compliance with immunization schedule</td>
<td>High</td>
<td>Possibly reduced</td>
<td>Possibly reduced</td>
</tr>
<tr>
<td>Future combination vaccines</td>
<td>Unlikely</td>
<td>Likely</td>
<td>Likely (IPV)</td>
</tr>
<tr>
<td>Current cost</td>
<td>Low</td>
<td>Higher</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

*Oral poliovirus vaccine.
†Inactivated poliovirus vaccine.
§Sequential vaccination with IPV and OPV.
¶Vaccine-associated paralytic poliomyelitis.
**Estimated.

Changing to an IPV-only or a sequential schedule would cost $28.1 million and $14.7 million, respectively.

The costs per case of VAPP prevented were estimated as $3.0 million and $3.1 million for each option, respectively.

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Total Program Cost, $ Millions</th>
<th>Cases of VAPP Prevented</th>
<th>Total Benefits, $ Millions</th>
<th>Net Incremental Cost (Cost-Benefit Analysis), $ Millions</th>
<th>Cost per Case of VAPP Prevented (Cost-effectiveness Analysis), $ Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 OPV</td>
<td>375.0</td>
<td>0</td>
<td>0</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>4 IPV</td>
<td>414.5</td>
<td>9.50</td>
<td>11.4</td>
<td>28.1</td>
<td>3.0</td>
</tr>
<tr>
<td>2 IPV and 2 OPV</td>
<td>395.4</td>
<td>4.75</td>
<td>5.7</td>
<td>14.7</td>
<td>3.1</td>
</tr>
</tbody>
</table>

*OPV indicates live attenuated oral poliovirus vaccine; VAPP, vaccine-associated paralytic poliomyelitis; IPV, inactivated poliovirus vaccine.
IPV ERA
2000-present
Figure 1. Reported Cases of Paralytic Poliomyelitis, United States, 1953-2003

Shaded region in the inset is represented in the larger graph, which shows both total number of cases of paralytic poliomyelitis and number of cases of vaccine-associated paralytic poliomyelitis (VAPP) from 1961 (first reported VAPP case) through 2003. Asterisk in the inset graph indicates data for 1955 do not include VAPP cases associated with inactivated poliovirus vaccine.
VAPP after 1997

- During 1997-1999, 13 VAPP cases occurred, 7 in 1997 and 3 each in 1998 and 1999
  - None of these cases occurred in persons who had followed the sequential IPV-OPV or all-IPV schedules.
  - Nine cases occurred in OPV recipients (6 of which were associated with a first OPV dose), 2 among contacts of OPV recipients (who had not followed the sequential schedule), and 2 among immunologically abnormal OPV recipients (both associated with a second dose).

<table>
<thead>
<tr>
<th>Table 2. VAPP Cases by Implicated OPV Dose and Epidemiologic Classification, United States, 1990-2003</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Epidemiologic Classification</strong></td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Sporadic OPV recipient</td>
</tr>
<tr>
<td>OPV contact</td>
</tr>
<tr>
<td>Community-acquired</td>
</tr>
<tr>
<td>Immunodeficient OPV recipient</td>
</tr>
<tr>
<td>OPV contact</td>
</tr>
<tr>
<td>Community-acquired</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Abbreviations: OPV, oral poliovirus vaccine; VAPP, vaccine-associated paralytic poliomyelitis. *NA indicates not applicable; implicated doses were assumed to be subsequent doses if unknown.

Key Issues

1. Continued VAPP cases were seen
2. No declines in childhood immunization coverage were seen after adoption of the sequential schedule
3. No indigenous wild polio virus (WPV) has been seen in the U.S.
4. Further progress was made by the Global Polio Eradication Initiative (GPEI) toward eradication (i.e., decreased risk of importation)

Note - ACIP still supported use of OPV for global eradication
No declines in immunization coverage were observed, despite the need for additional injections

- CDC investigated the impact of the change to a sequential IPV-OPV vaccination schedule at two large West coast health maintenance organizations (HMOs)¹
  - *Children receiving IPV as their first polio vaccination were as likely to be up-to-date at age 12 months as children receiving OPV*

- CDC's National Immunization Survey (NIS) provides ongoing estimates of vaccination coverage in the United States²
  - *National vaccination coverage achieved was greater than or equal to 90% each for three doses of poliovirus vaccine*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>≥3 doses</td>
<td>87.9%</td>
<td>91.1%</td>
<td>90.8%</td>
<td>90.8%</td>
</tr>
</tbody>
</table>

“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.”

- “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.”
THANK YOU