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

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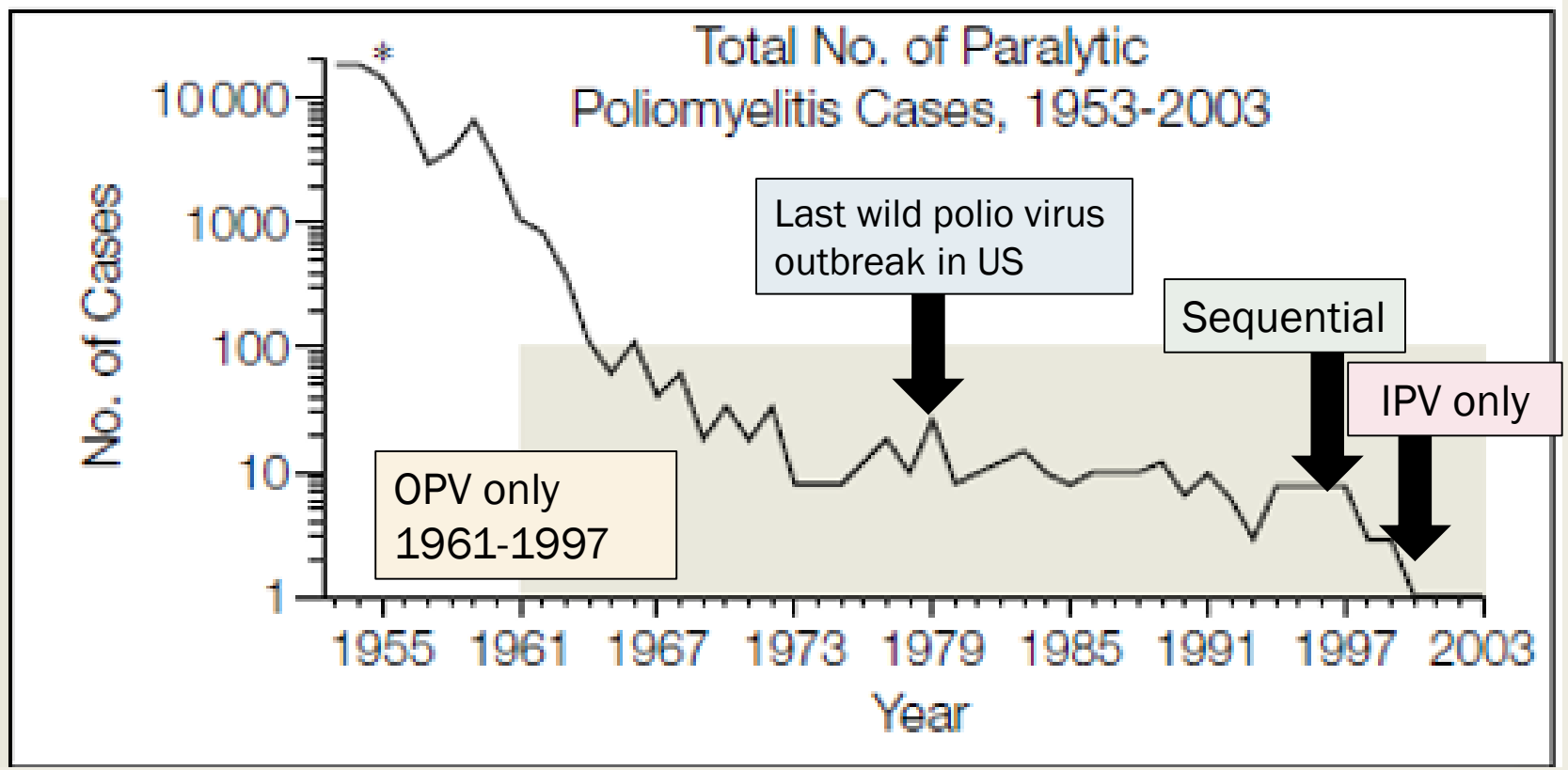
Outline

- Oral polio vaccine (OPV) era – 1961-1997
- Sequential schedule era – 1997-2000
- Inactivated polio vaccine (IPV) only era – 2000-present
- Take home messages

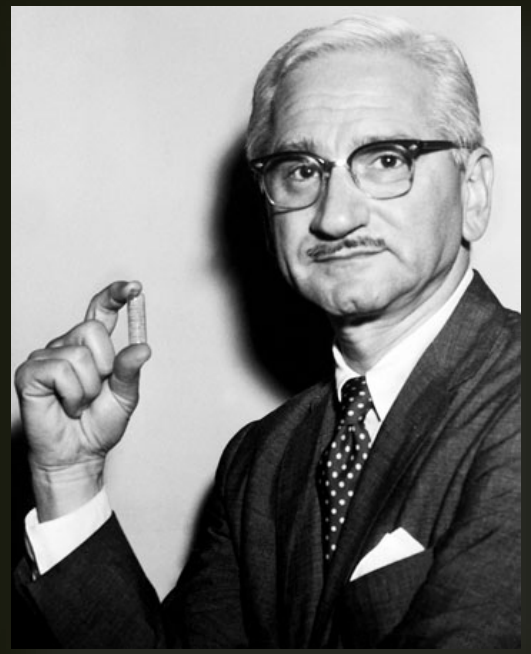
U.S. Polio Vaccine Policy

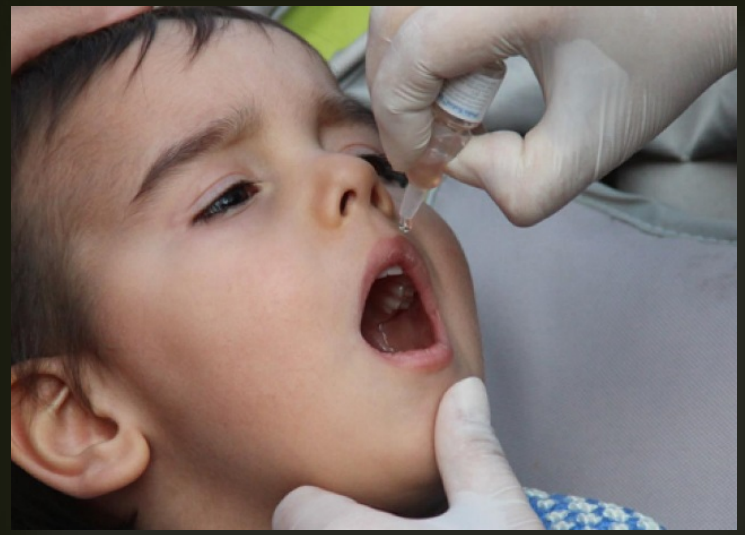
Year	Schedule
1961	4 OPV – 2 mo, 4 mo, 6-18 mo, 4-6 yr
1997	2 IPV - 2 mo, 4 mo 2 OPV - 12-18 mo, 4-6 yr
2000	4 IPV – 2 mo, 4 mo, 6-18 mo, 4-6 yr



https://www.cdc.gov/vaccines/schedules/past.html

Alexander L, Seward JF, Santibanez TA, et al. Vaccine policy changes and epidemiology of poliomyelitis in the United States. JAMA. 2004 Oct 13;292(14):1696–1701.





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

Study group	Proportion excreting	Mean duration of excretion (d)	Mean titer of virus excreted (log $TCID_{50}$)	Excretion index (million)*	Reduction in viral excretion (%)
Susceptible control subjects	0.80	20.4	5.15	2.305	Reference
IPV-vaccinated	0.74	12.3	4.11	0.1173	95
OPV-vaccinated	0.37	4.6	2.18	0.00022	99
Naturally immune	0.37	5.4	2.03	0.00022	99

IPV, inactivated poliovirus vaccine; OPV, oral poliovirus vaccine; $TCID_{50}$, 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.
Constructed from data in Fine and Carneiro,[206] Global Programme for Vaccines and Immunization,[614] and Ghendon and Sanakoyeva.[368]

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

	No. of pharyngeal isolations (%)		No. of stool isolations (%)	
Challenge dose	IPV	OPV	IPV	OPV
High (560,000-600,000 TCID50)	1/45 (2)	3/45 (7)	37/45 (82)	14/45 (31)
Low (500-800 TCID50)	0/48 (0)	0/34 (0)	22/48 (46)	6/34 (18)
Total	1/93 (1)	3/79 (4)	59/93 (63)	20/79 (25)

IPV, inactivated poliovirus vaccine; OPV, oral poliovirus vaccine; TCID50, median tissue culture infective dose.
From Onorato IM, Modlin JF, McBean AM, et al. J Infect Dis 163:1-6, 1991. With permission.

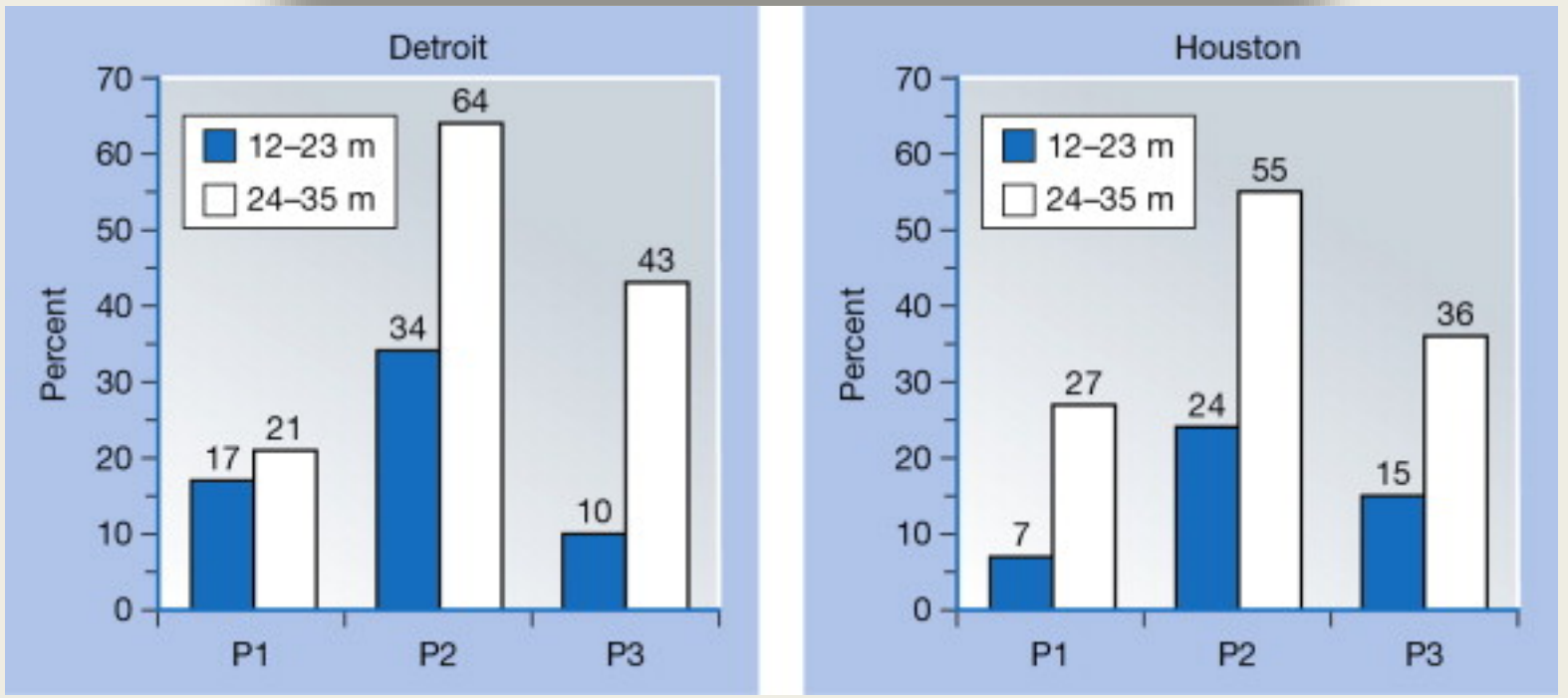
From Sutter et al. Poliovirus vaccine-live, Vaccines 6th ed

Seroprevalence of Antibody Against Poliovirus in Inner-city Preschool Children

Implications for Vaccination Policy in the United States

Robert T. Chen, MD; Sheryl Hausinger, MD; Adnan S. Dajani, MD; Marcus Hanfling, MD; Andrew L. Baughman, MPH; Mark A. Pallansch, PhD; Peter A. Patriarca, MD

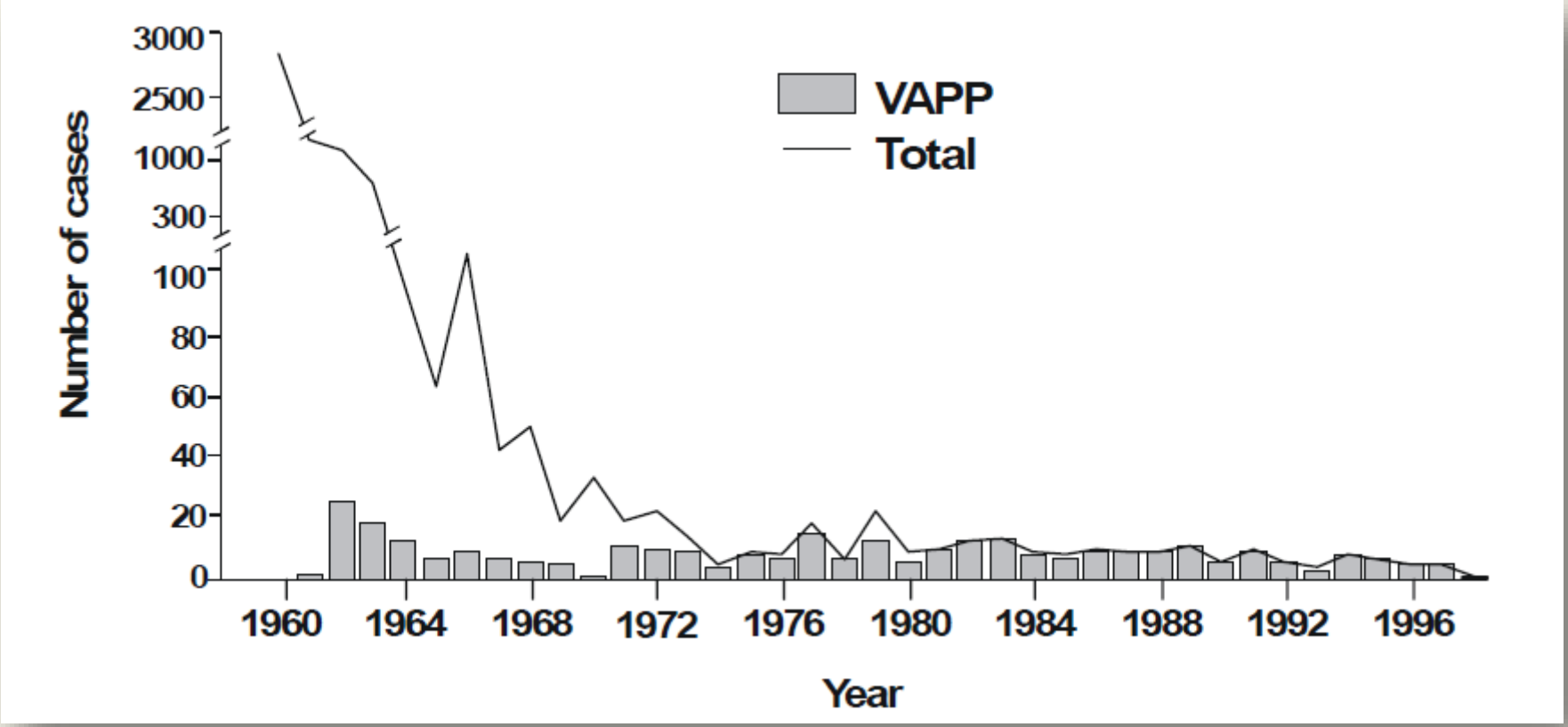
JAMA, June 5, 1996—Vol 275, No. 21



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



JAMA. 2004; 292(14):1696–1701.

National Vaccine Injury Compensation Program (VICP)

- The National Childhood Vaccine Injury Act of 1986 (Public Law 99-660) created the VICP, which began on October 1, 1988
- 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)

SEQUENTIAL SCHEDULE ERA

1997-2000

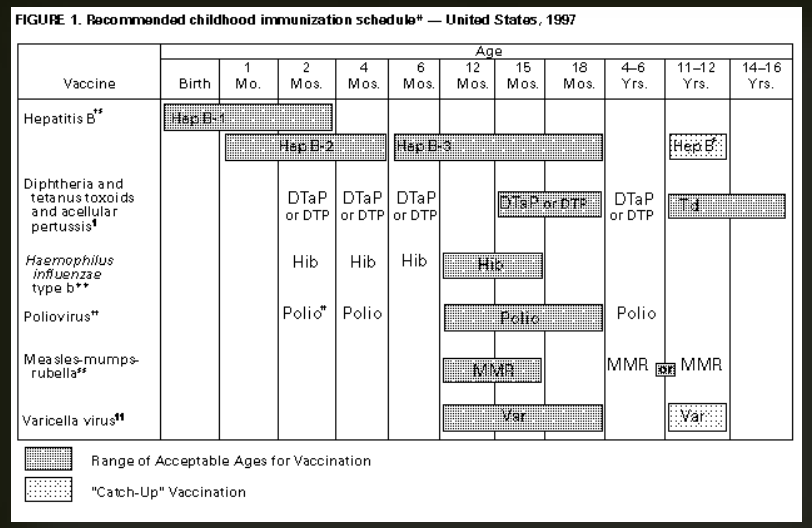


FIGURE 1. Recommended childhood immunization schedule* — United States, 1997

Vaccine	Age: Birth	1 Mo.	2 Mos.	4 Mos.	6 Mos.	12 Mos.	15 Mos.	18 Mos.	4–6 Yrs.	11–12 Yrs.	14–16 Yrs.
Hepatitis B†	Hep B-1	Hep B-2			Hep B-3					Hep B	
Diphtheria and tetanus toxoids and acellular pertussis§			DTaP or DTP	DTaP or DTP	DTaP or DTP		DTaP or DTP		DTaP or DTP	Td	
Haemophilus influenzae type b††			Hib	Hib	Hib	Hib					
Poliovirus¶			Polio¶	Polio		Polio			Polio		
Measles-mumps-rubella**						MMR			MMR	or MMR	
Varicella virus††						Var				Var	

Range of Acceptable Ages for Vaccination

"Catch-Up" Vaccination

*ACIP recommends a sequential schedule of two doses of IPV followed by two doses of OPV for routine childhood vaccination

ACIP Meeting June 19-20, 1996

- 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

Case category	Ratio of number of cases to millions of doses of OPV* distributed and number of cases reported (N) 1980–1994		
	All doses	First doses	Subsequent doses
Recipient	1:6.2 (49)	1:1.4 (40)	1:27.2 (9)
Contact	1:7.6 (40)	1:2.2 (26)	1:17.5 (14)
Community-acquired	1:50.5 (6)	NA	NA
Immunologically abnormal†	1:10.1 (30)	1:5.8 (11)	1:12.9 (19)
Total	**1:2.4 (125)**	**1:0.75 (77)**	**1:5.1 (42)**

*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

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

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

Poliomyelitis prevention in the United States: introduction of a sequential vaccination schedule of inactivated poliovirus vaccine followed by oral poliovirus vaccine. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recommendations and reports : Morbidity and mortality weekly report Recommendations and reports / Centers for Disease Control. 1997 Jan 24;46(RR-3):1–25.

Cost-effectiveness of Incorporating Inactivated Poliovirus Vaccine Into the Routine Childhood Immunization Schedule

Mark A. Miller, MD; Roland W. Sutter, MD, MPH&TM; Peter M. Strebel, MBChB, MPH; Stephen C. Hadler, MD

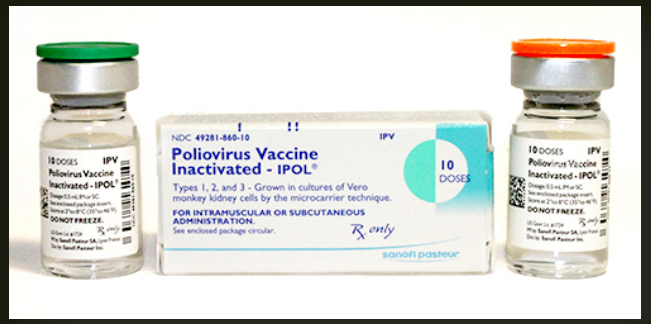
JAMA, September 25, 1996—Vol 276, No. 12

- 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 2.—Model Results Including the Annual Program Costs, Incremental Costs Relative to the OPV Schedule, VAPP Prevented, and Cost Benefit and Cost-effectiveness of Each New Program*

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

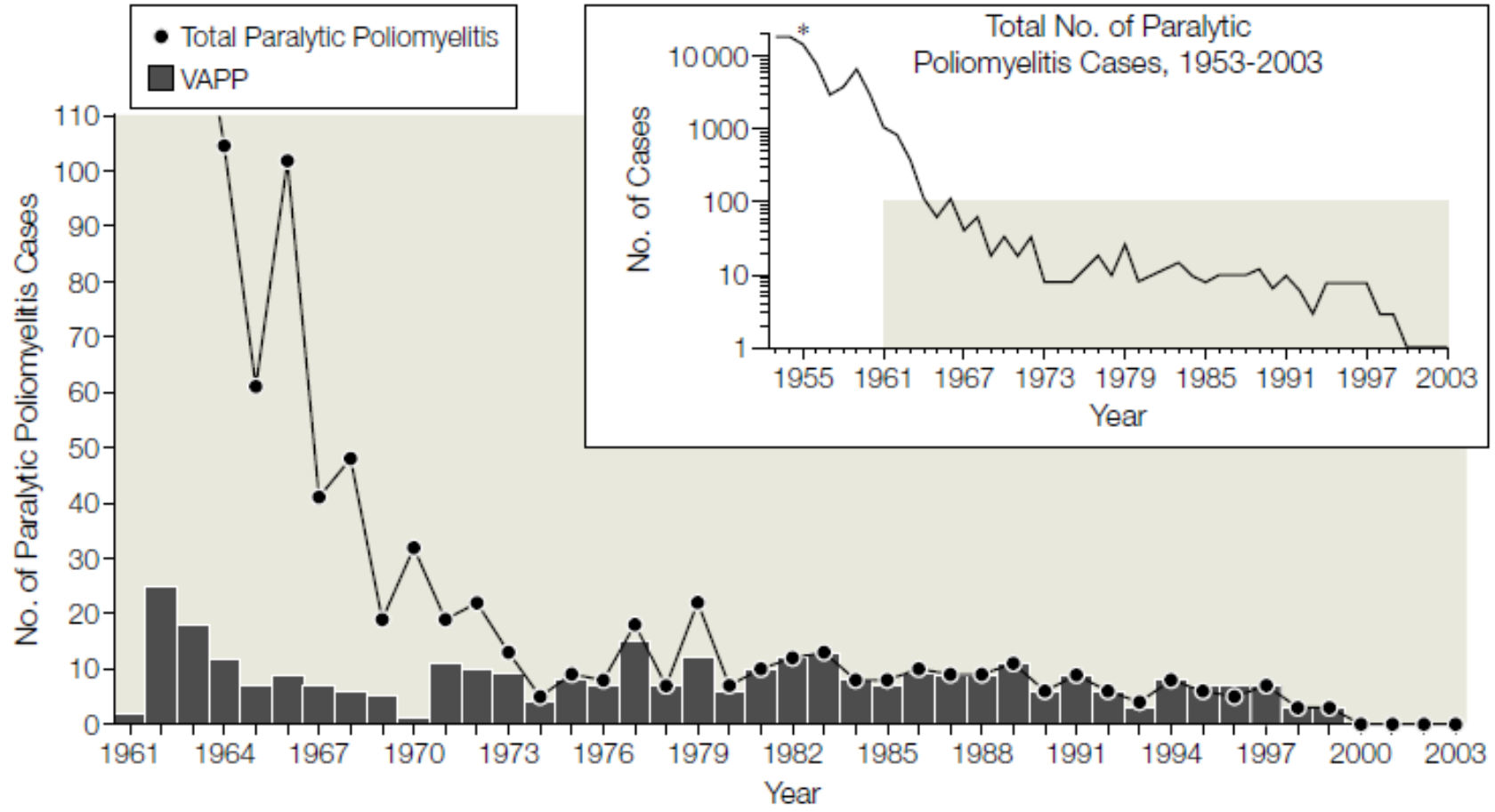
*OPV indicates live attenuated oral poliovirus vaccine; VAPP, vaccine-associated paralytic poliomyelitis; IPV, inactivated poliovirus vaccine.



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.

Alexander L, Seward JF, Santibanez TA, et al. Vaccine policy changes and epidemiology of poliomyelitis in the united states. JAMA. 2004 Oct 13;292(14):1696–701.

VAPP after 1997

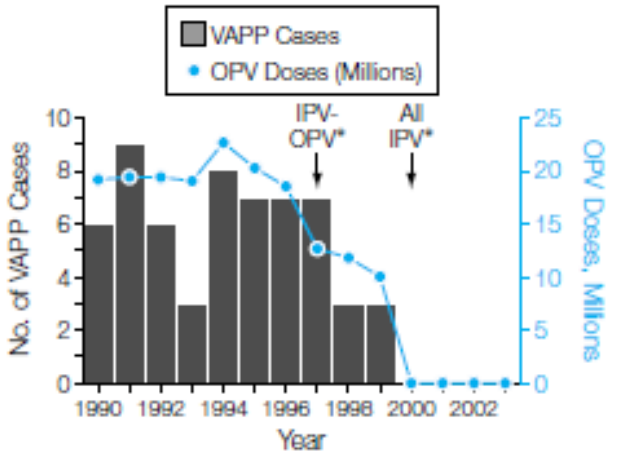
- During 1997-1999, 13 VAPP cases occurred, 7 in 1997 and 3 each in 1998 and 1999
  - None of these cases occurred in persons who had followed the sequential IPV-OPV or all-IPV schedules.
  - Nine cases occurred in OPV recipients (6 of which were associated with a first OPV dose), 2 among contacts of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

Table 2. VAPP Cases by Implicated OPV Dose and Epidemiologic Classification, United States, 1990-2003

Epidemiologic Classification	First OPV Dose, No. (%)	Subsequent OPV Dose, No. (%)	Total No.
Sporadic			
OPV recipient	23 (85)	4 (15)	27
OPV contact	7 (54)	6 (46)	13
Community-acquired	NA*	3 (100)	3
Immunodeficient			
OPV recipient	4 (29)	10 (71)	14
OPV contact	1 (50)	1 (50)	2
Community-acquired	NA	NA	0
Total	**35** (59)	**24** (41)	**59**

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

Figure 2. Number of VAPP Cases and OPV Doses Distributed, United States, 1990-2003



Asterisk indicates revised polio immunization schedule; IPV, inactivated poliovirus vaccine; OPV, oral poliovirus vaccine; and VAPP, vaccine-associated paralytic poliomyelitis.

Alexander L, Seward JF, Santibanez TA, et al. Vaccine policy changes and epidemiology of poliomyelitis in the United States. JAMA. 2004 Oct 13;292(14):1696–701.

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)

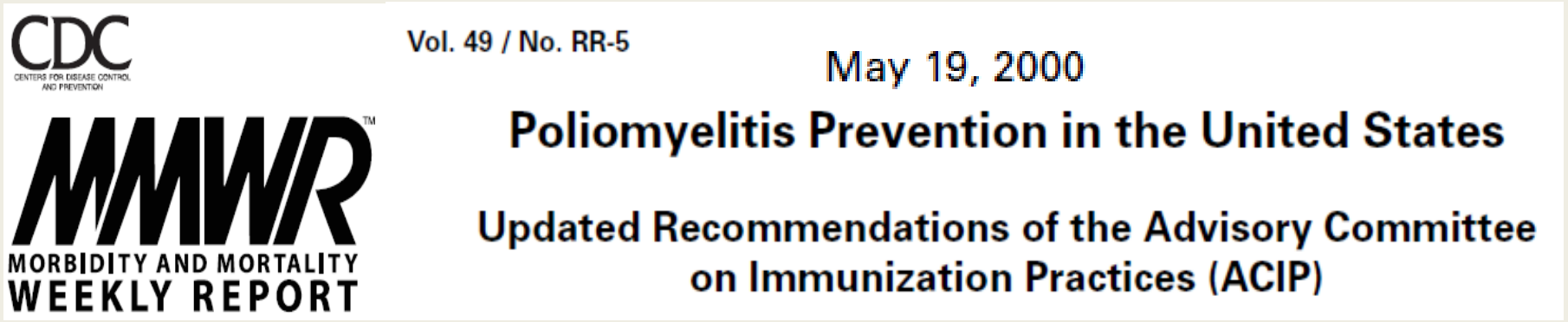
Note - ACIP still supported use of OPV for global eradication

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 States[2]
  - *National vaccination coverage achieved was greater than or equal to 90% each for three doses of poliovirus vaccine*

	1995	1996	1997	1998
≥3 doses	87.9%	91.1%	90.8%	90.8%

1. Impact of the Sequential IPV/OPV Schedule on Vaccination Coverage Levels -- United States, 1997 [Internet]. [cited 2017 Jan 4]. Available from: https://www.cdc.gov/mmwr/preview/mmwrhtml/00055785.htm
2. Centers for Disease Control and Prevention (CDC). National vaccination coverage levels among children aged 19-35 months--United States, 1998. MMWR Morb Mortal Wkly Rep. 1999 Sep 24;48(37):829–30.



"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