Polio Eradication: Beginning of the End, or End of the Beginning?

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What is Polio?

- Polio is a disease caused by polio-virus, which cripples its victims for life. The virus is mainly transmitted through the fecal-oral route. The disease can be prevented by vaccine.
Poliomyelitis

- First described by Michael Underwood in 1789
- First outbreak described in U.S. in 1843
- More than 21,000 paralytic cases reported in the U.S. in 1952
- 1988 resolution to achieve global eradication within next decade
Poliovirus

- Enterovirus (RNA)
- Three serotypes: 1, 2, 3
- Minimal heterotypic immunity between serotypes
- Rapidly inactivated by heat, formaldehyde, chlorine, ultraviolet light
Poliomyelitis Pathogenesis

- Oral entry into the body
- Replication in pharynx, GI tract, local lymphatics
- Hematologic spread to lymphatics and central nervous system
- Viral spread along nerve fibers
- Destruction of motor neurons
Outcomes of poliovirus infection

- **Asymptomatic:** Up to 95% of infections are inapparent or asymptomatic. Ratio of inapparent to paralytic illness vary from 50:1 to 1,000:1 (usually 200:1). Infected persons without symptoms shed virus in the stool and are able to transmit the virus to others.

- **Minor non-CNS:** Approximate 4% (up to 8%) of polio infections consist of a minor, nonspecific illness without clinical or laboratory evidence of central nervous system invasion. This clinical presentation is characterized by complete recovery, usually in less than a week.

- **Paralytic:** <1% of infections result in AFP.

- **Death**
Poliovirus Epidemiology

• Reservoir: Human
• Transmission: Fecal-oral
• Communicability: 7-10 days before onset
• Virus present in stool 3 to 6 weeks
Polio Eradication - Can it be done?

What makes it possible?

• No animal reservoir
• Effective vaccine/strategies
• No chronic carrier state
• Short 1/2 life in environment
• Political commitment with adequate finance

What makes it difficult?

• Inapparent infections (1000:1 ratio)
• Differential diagnosis
• Surveillance challenge
• Emergence of cVDPVs
Two Excellent Vaccines

Dr Jonas Salk
IPV, 12 April 1955

Dr Albert Sabin
OPV, 1961 & 1962
Oral Polio Vaccine

- Highly effective in producing immunity to poliovirus
- Approximately 50% immune after 1 dose
- More than 95% immune after 3 doses
- Immunity probably lifelong
Inactivated Polio Vaccine

• Highly effective in producing immunity to poliovirus
• 90% or more immune after 2 doses
• At least 99% immune after 3 doses
• Duration of immunity not known with certainty
Vaccine-Associated Paralytic Polio

- Increased risk in persons 18 years and older
- Increased risk in persons with immunodeficiency
- No procedure available for identifying persons at risk of paralytic disease
- 5-10 cases per year in US with exclusive use of OPV
- Most cases in healthy children and their household contacts
# Some Key Differences

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<tr>
<th></th>
<th>IPV</th>
<th>OPV</th>
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<tr>
<td><strong>Immunity</strong></td>
<td>Humoral</td>
<td>Intestinal/humoral</td>
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<tr>
<td><strong>Cost</strong></td>
<td>US dollars</td>
<td>US cents</td>
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<td><strong>Delivery</strong></td>
<td>Injection</td>
<td>Oral</td>
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<tr>
<td><strong>Herd immunity</strong></td>
<td>Limited</td>
<td>Substantial</td>
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Strategies always rely on:

- Immunizing susceptible population
- Conducting effective surveillance
- Sustaining the gains
Poliomyelitis, Cuba, 1946-1980

Source: PAHO & MOH
Poliomyelitis, Costa Rica, 1950-1980

Source: PAHO & MOH
Polio Eradication - Brazil

- NIDs
  - Surveillance
  - 3rd Round in NE
Basic strategies for polio eradication

- Strong routine immunization program achieving high coverage
- National Immunization Days (NIDs)
- Surveillance of acute flaccid paralysis with laboratory support
- “Mopping-up” immunization - final stage
Political Will
Strategic plan - Guiding principles

- Provides vision for future work
- Operationalizes the scientific components
- Prioritizes targets
- Utilizes lessons learned
- Produces results and is product oriented
- Develops direction with accountability
- Promotes partnerships and collaboration
- Remains focused & promotes quality of work
- Expect the unexpected
- “Disease eradication fights inequities and creates social justice”
PAHO Polio Eradication – General Lessons

• Acute flaccid paralysis surveillance oversight
• Coordination of the polio lab network of the Americas
• Protocol for the certification of polio eradication
• Better understanding of risks

## Table 1: Risk of vaccine-associated paralytic poliomyelitis (VAPP), Latin America, 1989–91

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<tr>
<th>Type of case</th>
<th>Risk of: (^a)</th>
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<tr>
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<td>Recipient VAPP</td>
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<td><strong>Known neurological sequelae:</strong></td>
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<td>Overall risk</td>
<td>3.6 (85)(^b)</td>
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<td>First-dose risk</td>
<td>1.2 (24)</td>
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<td>Subsequent-dose risk</td>
<td>4.5 (61)</td>
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<tr>
<td><strong>Including unknown neurological sequelae and known final diagnosis:</strong></td>
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<tr>
<td>Overall risk</td>
<td>3.4 (89)</td>
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<tr>
<td>First-dose risk</td>
<td>1.1 (25)</td>
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<td>Subsequent-dose risk</td>
<td>4.3 (64)</td>
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<td><strong>Including unknown neurological sequelae and unknown final diagnosis:</strong></td>
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<td>Overall risk</td>
<td>2.7 (114)</td>
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<td>First-dose risk</td>
<td>1.1 (27)</td>
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<tr>
<td>Subsequent-dose risk</td>
<td>3.2 (87)</td>
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\(^a\) Shown is the ratio of one case to \(10^8\) doses. Corrected VAPP excludes cases with diagnoses unlikely to be true VAPP, i.e., trauma, tumour, transverse myelitis, and GBS.

\(^b\) Figures in parentheses are the number of cases.
Direct detection of wild poliovirus in sewage

Figure 1. Upper left, map of Colombia showing location of Cartagena on tropical Caribbean coast. Upper right, view of housing within study community and adjacent lagoon as seen near sampling site B1 on canal Barcelona. Bottom, Schematic map of study community (containing ~5300 children <5 years of age) showing locations of health clinics (+), day care centers (■), and sampling sites along sewage canals (B = Barcelona, A = Amador, SM = San Martin, L = Libano).
LAST CASE OF POLIO IN THE AMERICAS
PERU - 1991
Lessons Learned and Impact of Polio on Capacity Development

- General lessons learned – Political commitment, technical and operational excellence
- Partnerships
- Lessons for capacity development
  - Positive impact does not happen automatically, people have to look actively for linkages
  - Mistakes will happen, is there sufficient capacity to react to extraordinary circumstances?
- Report of the Taylor Commission
  - Culture of prevention
  - Increased community awareness
  - Multi-sectoral coordination
Using the PAHO experience for the global effort
Wild Poliovirus Cases in Orissa-India, 1998

Total cases 1934

Districts with wild poliovirus cases
Orissa, 1998
Number of cases = 49

Polio Eradication
Impact of Mopping-up operation in Orissa, 1999

Polio Eradication

Zero case 99/2000
Mopping-up Operation in Orissa, 1999

Mopping-up operation in 8 Districts immunizing over 1.7 million children

Polio Eradication
SEAR Polio Eradication, 1993-2000

- Successful resource mobilization to implement strategies
- Successful eradication of wild poliovirus transmission in Bangladesh, Nepal, Myanmar, Indonesia, Thailand*
- Creation of high quality surveillance in India and other key countries
- Lowest levels of transmission in India

Real Progress by the late 1990s:
3 of 6 WHO Regions Certified Polio-Free by 2002

1991: Luis Fermín Tenorio Cortez, last case in the *Americas* (Peru)
1997: Mum Chanty, last case in the *Western Pacific Region* (Cambodia)
1998: Melik Minas, last case in *Europe* (Turkey)

Images from CDC, Rotary
Global progress, as well as setbacks and challenges (2000-present)

Are we repeating the same mistakes? Will the pending ramp down of resources protect the gains?
Uttar Pradesh outbreak 1600 cases in 2002
International spread of wild polioviruses into previously polio-free areas, 2003-2009
Immunogenicity of Monovalent OPV1 vs. Trivalent OPV

Randomized Clinical Trials

Source: WHO
Global Polio Cases by Serotype, 2001-2009

Number of Cases

Source: WHO/Polio database
193 WHO Member States

mOPV: monovalent Oral Polio Vaccine
## Risks of Polio After 'Eradication'

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<th>Risk</th>
<th>Frequency to date</th>
<th>Annual burden</th>
<th>Evolution over time</th>
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<td>VAPP</td>
<td>2-4/million birth cohort</td>
<td>250-500</td>
<td>stable</td>
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<tr>
<td>iVDPV</td>
<td>19 identified (since 1963)</td>
<td>&lt;1</td>
<td>decreases</td>
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<tr>
<td>cVDPV</td>
<td>1* per year</td>
<td>20</td>
<td>increases</td>
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<tr>
<td>IPV sites</td>
<td>1 accident (1990s)</td>
<td>&lt;1</td>
<td>decreases</td>
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<tr>
<td>Lab accident</td>
<td>1 investigation</td>
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<tr>
<td>Deliberate</td>
<td>0</td>
<td>NK</td>
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*Based on current understanding. Source: WHO*
Areas with Confirmed Polio Cases
Hispaniola, 2000 - 2001

= areas confirmed polio cases
Distribution of iVDPVs* by income level & duration of excretion, 2004

*Individuals with severe primary immunodeficiencies who are known to have excreted a vaccine-derived poliovirus (VDPV) for >12 months.
Polio-Paralyzed Children, 2013

International Spread of Polio, 2013

- Egypt, Israel
- Palestine sewage
- Syria re-infected
- Horn of Africa re-infected
- Cameroon importation
- 2014: EQ Guinea & Iraq
Circulating vaccine-derived poliovirus (cVDPV) is associated with 2 or more AFP cases. Niger 2006, Niger 2009, Niger 2010, Chad 2010 cVDPVs are linked to the Nigeria outbreak. Kenya 2012 cVDPVs are linked to the Somalia outbreak. VDPV type 2 cases with greater than or equal to 6 nt difference from sabin in VP1; VDPV types 1 and 3 cases with greater than or equal to 10 nt difference from sabin in VP1 are reported here.


Figures include multiple emergences and transmission chains. 1 cVDPV2 awaiting country assignment is not represented in the slide. On 22 May a case, with a date of onset of paralysis of 4 May, was reported in Niger from a Nigerian child.

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Data in WHO HQ as of 04 November 2014

1. Circulating vaccine-derived poliovirus (cVDPV) is associated with 2 or more AFP cases. Niger 2006, Niger 2009, Niger 2010, Chad 2010 cVDPVs are linked to the Nigeria outbreak. Kenya 2012 cVDPVs are linked to the Somalia outbreak. VDPV type 2 cases with greater than or equal to 6nt difference from sabin in VP1; VDPV types 1 and 3 cases with greater than or equal to 10nt difference from sabin in VP1 are reported here. Figures exclude VDPV from non-AFP sources. Nigeria figures include the following cases with WPV1/cVDPV2 mixture: 2005 - 2, 2006 - 1, 2007 - 1, 2008 - 3, 2009 - 1, 2011 - 1; WPV3/cVDPV2 mixture 2007 - 2.

2. Figures include multiple emergences and transmission chains. 1 cVDPV2 awaiting country assignment is not represented in the slide. On 22 May a case, with a date of onset of paralysis of 4 May, was reported in Niger from a Nigerian child.
Current situation
Pakistan and Afghanistan
WPV Trend in Pakistan

Number of WPV from any source, Pakistan, 2013-2017

- Number of WPV cases has significantly declined in 2017
- However, environmental surveillance detection of WPV1 persists

Source: WHO
Pakistan: Decreasing transmission in the core reservoirs, outbreaks in tier-4 districts

**Tier-1**
- 11 districts, 4M target
- Karachi
- Peshawar
- Quetta Block
- Kila Abdullah

**Tier-2**
- 33 districts, 6.4M target

**Tier-3**
- 24 districts, 8.7M target

**Tier-4**
- 87 districts, 17.8M target

*Data as of 30 May 2017*

Source: WHO
Afghanistan: Recent cases linked to cross-border transmission

Source: WHO
Africa
• 4 wild poliovirus type 1 (WPV1) cases confirmed in July 2016 from insecure areas of Borno State in Nigeria

• Ministers of Health from Lake Chad Basin countries declared the outbreak a sub-regional public health emergency

• 5 synchronized outbreak response rounds conducted in 2016 and 2 rounds in 2017

• Last WPV1 case with onset on 21 August 2017, in Borno State, Nigeria

Source: WHO
Inaccessibility affecting surveillance and vaccination activities, Borno State, Nigeria

Inaccessible settlements 6,145 (48%)

Inaccessible settlements 5,216 (37%)

- Though 9 months have passed, without WPV cases uncertainty that transmission has been stopped
- Using satellite imagery to determine if settlements are inhabited or destroyed
- Using military for innovations such as reaching every settlement and reaching inaccessible children

Source: WHO
Environmental Surveillance, 2016

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.
Polio, type 3 cases

Nigeria & Pakistan had type 3 last in 2012
Poliovirus: Decreasing Diversity

We’re zeroing in on polio, one viral strain at a time.

Type 2
Last seen 24 Oct 1999
Declared eradicated 20 Sept 2015

Type 3
Last seen 10 Nov 2012

Type 1
It’s next

#endpolio
Status of Polio Eradication

- Last case in United States in 1979
- Western Hemisphere last case 1991, certified polio free in 1994
- SEAR certified polio free 2015
- Last isolate of type 2 poliovirus in India in Oct 1999
- No wild type 3 isolated since 2012
- The entire African region had not had a WPV case since Aug 2014, so the recent cases in Nigeria in 2016 are a major set back
- 4 of 6 regions certified polio free
- Three countries remain endemic for polio – Nigeria, Afghanistan and Pakistan
Polio Eradication

- Nigeria latest WPV1 case - 20 August 2016 in Borno State, Nigeria (n=4); last cVDPV2 case 27 Oct 2016
- Pakistan latest WPV1 10 June 2017 (n=3)
- Afghanistan latest WPV1 9 July 2017 (n=6)
- 9 cVDPV2 cases in DR Congo with latest onset recently in 2017
- 47 cVDPV2 cases Syria with latest onset August 2017
- GPEI-funded human resource ramp-down commenced in 2017
- Polio transition planning is underway in priority countries
- The major priorities for the PEI are to quickly stop current cVDPV outbreaks and to strengthen surveillance to avoid missing any poliovirus circulation
Risks Going Forward
Financial Risk

1 billion dollars per year
OPV withdrawal in 3 stages

**Introduction**
- at least one dose of IPV into **routine immunization**

**Switch**
- tOPV to bOPV

**Withdrawal**
- of bOPV & routine OPV use

Ongoing STRENGTHENING of routine immunization services

Source: WHO
IPV supply remains tight throughout 2017

Source: WHO
Conflict-related access limitations

Potential risk
- Medium risk/partially accessible
- High risk/inaccessible
Polio Transition
Polio Transition Planning

- Helps protect a polio-free world
- Ensures that investments made to end polio continue protecting and improving health after eradication
- Every country with polio eradication resources and infrastructure should prepare for the transition
- Should be led by the national government and involve a broad range of stakeholders
GPEI presence in over 70 countries, but 95% of personnel footprint in 16 countries

Note: Philippines, Haiti also have between 1-10 polio funded personnel but are not displayed; no headquarters staff displayed

Source: GPEI partner HR databases, 2014

Includes social mobilizers. Does not include national government staff, vaccinators or regional/headquarters personnel.

Note: Philippines, Haiti also have between 1-10 polio funded personnel but are not displayed; no headquarters staff displayed

Source: GPEI partner HR databases, 2014
Characteristics of the 16 Priority “Polio Transition” Countries

• Most of the world’s unvaccinated and under-vaccinated children
  ➢ (53% of 20.8 million infants who did not receive measles vaccine in 2015 are in the Big 6 priority measles countries)

• Most of the world’s measles cases and deaths (88% of deaths)

• Most of the world’s rubella and congenital rubella syndrome
  ➢ (100,000 CRS cases)

Consequences of losing polio assets – risk that EPI progress in these countries and globally will be reversed!!
Polio-Funded Surveillance Officer Responsibilities

Other VPDs:
- Measles/Rubella
- Yellow Fever
- Neonatal tetanus
- Meningitis
- Acute encephalitis syndrome
- Diphtheria
- Cholera
- Pertussis
...and so on

Other Communicable Diseases:
- Bloody diarrhea
- Neglected tropical diseases
- Dengue
- Viral hemorrhagic fevers
- Rabies
- Malaria
...and so on
Thank you!
Poliomyelitis, Chile, 1946-1980

Source: PAHO & MOH