

POLIO ENDGAME: INNOVATIONS IN SURVEILLANCE

BILL & MELINDA
GATES foundation

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OUTLINE

- **Polio Eradication: Background**
- **Polio Surveillance**
- **Innovations**



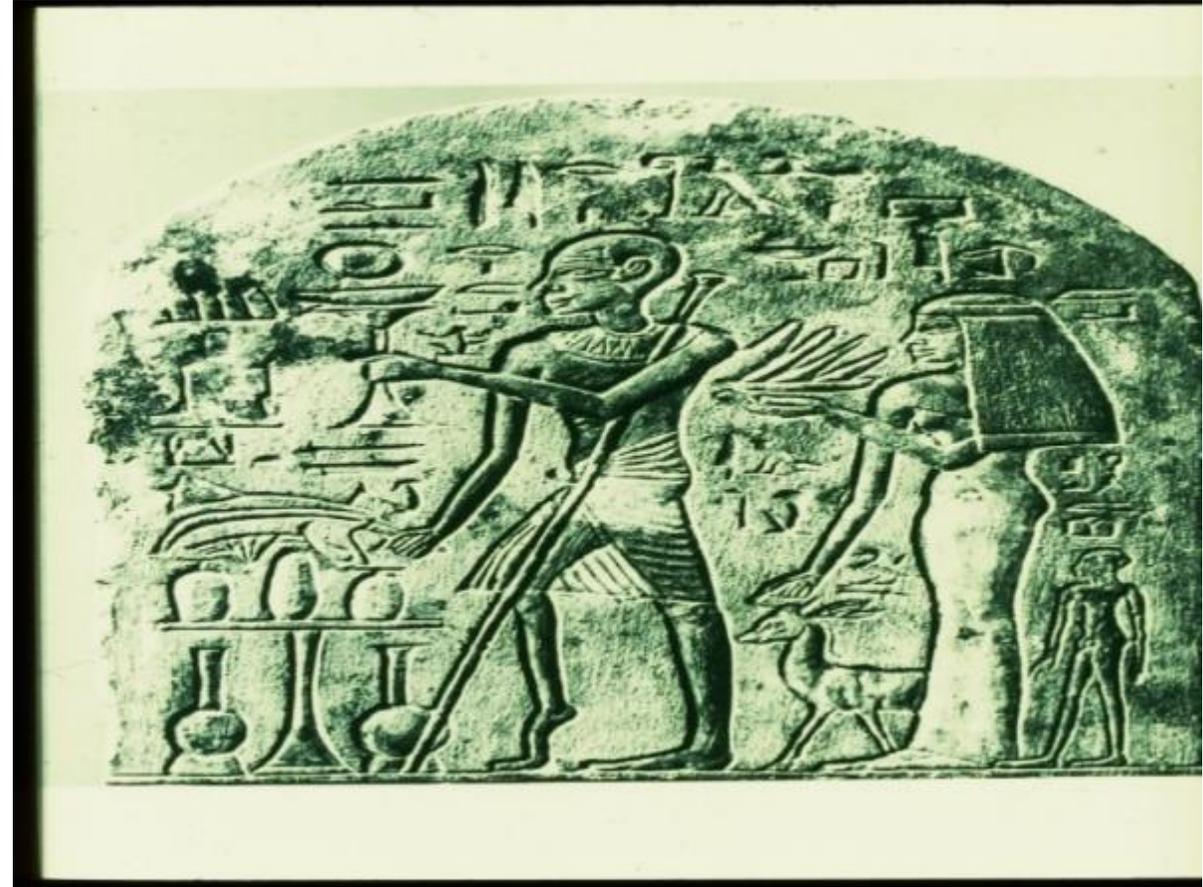
Credit: AFP/Pius Utomi Ekpe

DISEASE ERADICATION

- *“The worldwide absence of a specific disease agent in nature as a result of deliberate control efforts that may be discontinued where the agent is judged no longer to present a significant risk from extrinsic sources (e.g., smallpox)”*
- ***Permanent reduction to zero of the worldwide incidence of infection***

WHAT IS POLIO?

- **Viral disease** passed from person to person, primarily through contact with feces
- Mostly affects **children**
- **Paralysis** in 1 out of 200 infections
- Preventable through **immunization**



Polio: “Many diseases”?

Wild

- Type 1 (highest **case-infection** ratio)
- Type 2 (**eradicated**)
- Type 3 (**last** detected: **November 2012**)

OPV related

VAPP

- Overall risk in developing countries:
1 case per 4 – 5 million OPV doses.

VDPVs

- Most are circulating VDPVs (cVDPVs)
- **Type 2 cVDPVs account for ~90% of cVDPVs**



POLIO ERADICATION: PROGRESS TO DATE



Polio cases have declined by 99.9% over the last 30 years – from 350,000 cases across 125 countries in 1988 to 22 cases reported with just three endemic countries (Nigeria, Pakistan and Afghanistan) in 2017, the lowest ever recorded.

400 million

Children vaccinated per
year



20 million

Polio volunteers
globally

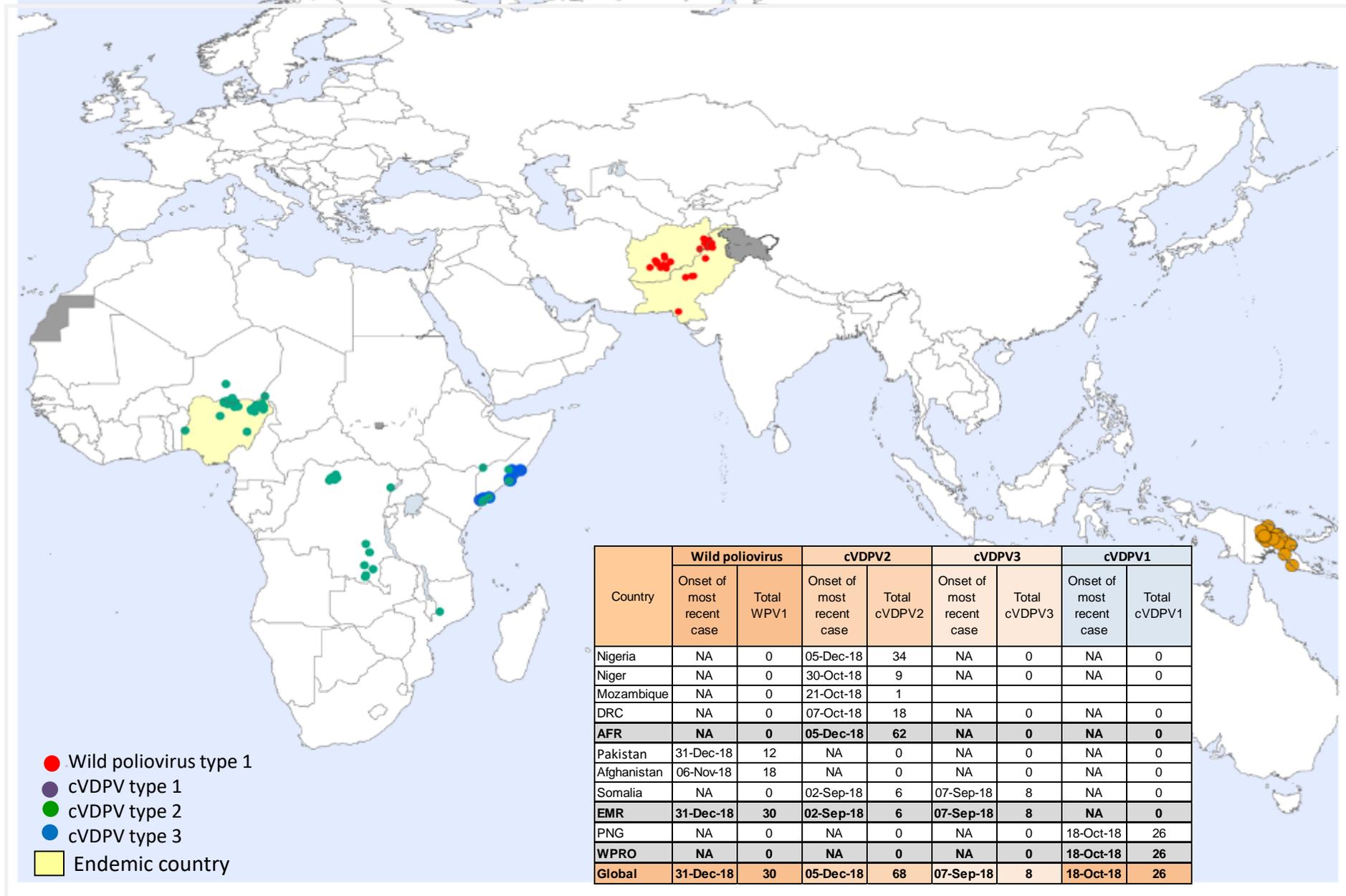


18 million

People walking who
would have been
paralyzed



Global Wild Poliovirus & cVDPV Cases¹, Previous 12 Months²



¹Excludes viruses detected from environmental surveillance

²Onset of paralysis 23 Jan. 2018 – 22 Jan. 2019

Political Instability in Key Areas



“..The level of destruction is massive, affecting the LGA secretariat, houses and health infrastructures...”

POLIO SURVEILLANCE



The polio program closely tracks the poliovirus in 70 countries by regularly collecting environmental samples and testing paralyzed children to 1) to detect virus transmission and 2) to generate evidence to support certification process of eradication



Credit: Imperial College, UK and CMC Vellore, India



Credit: © Bill & Melinda Gates Foundation/Prashant Panjjar

Polio surveillance systems

Acute Flaccid Paralysis (**AFP**) Surveillance

- **Global** case-based, syndromic surveillance.
 - Virologic confirmation as 'Wild' , 'vaccine-derived', 'Discarded', etc.
- Nearly 100% specific, but limited sensitivity (~1 polio case per 100 – 2000 infections)
- Targets, for countries using AFP surveillance:
 - 2 AFP cases per 100k children <15 per year in uncertified regions (AFRO, EMRO)
 - 1 AFP case per 100k children <15 in certified regions (PAHO, SEARO, WPRO, EURO)



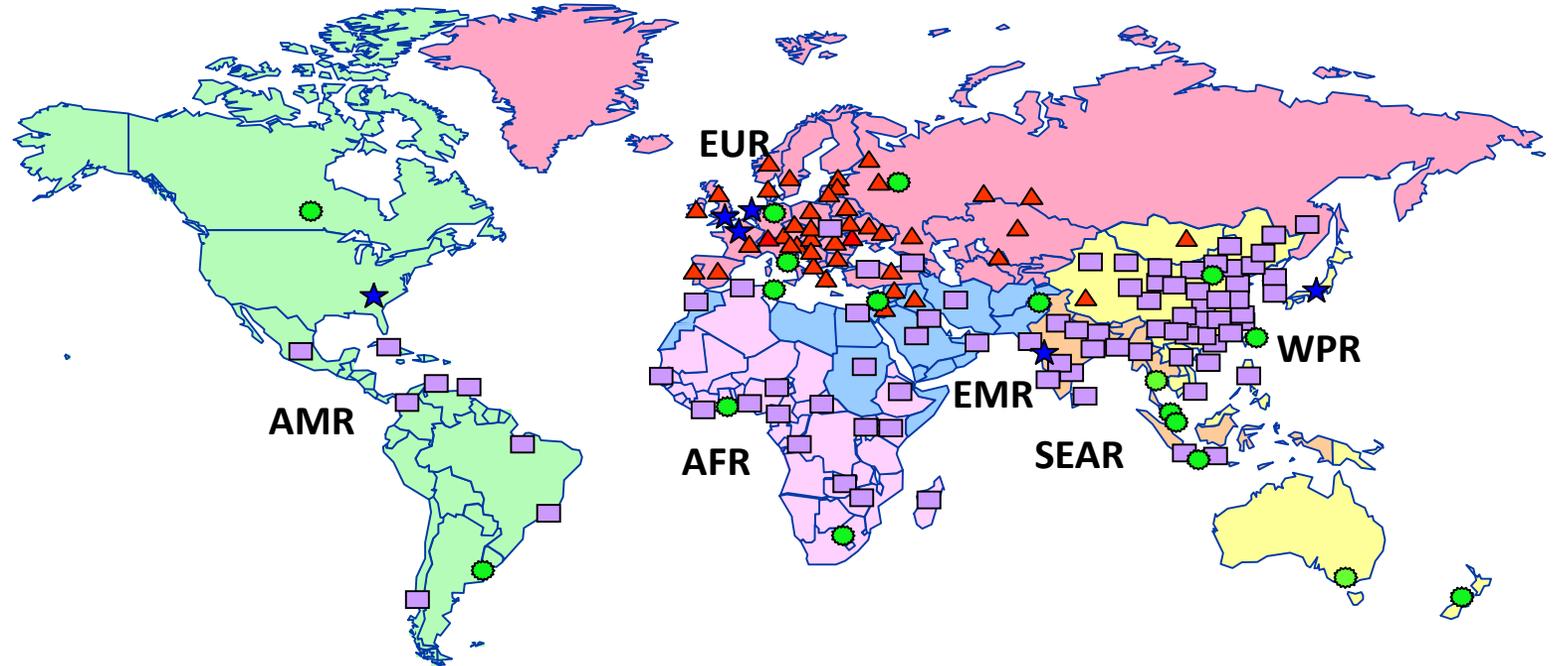
Environmental surveillance

- **Sewage** samples taken from fixed sites in select countries
- Can be highly sensitive, but depends on suitable conditions (catchment population, convergent sewage network, sewage contaminants)
- Site and network size indicators still under development



The Global Polio Laboratory Network

- 146 Laboratories Worldwide:
- ★ Global Specialized Laboratory (6)
 - Sequencing Laboratory (26)
 - VI and ITD Laboratory (79)
 - ▲ Virus Isolation Laboratory (41)

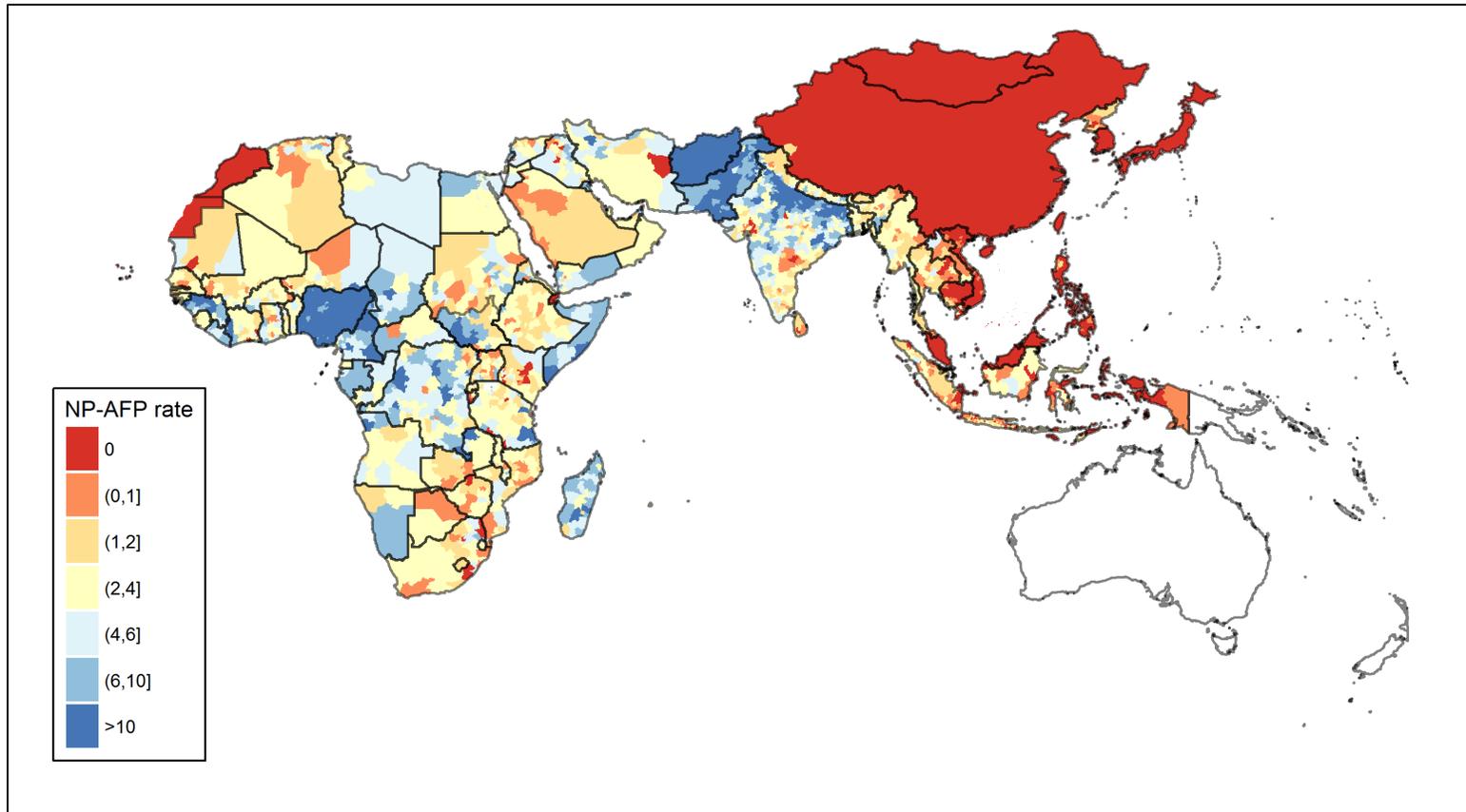


As of June 2017; Courtesy: WHO, HQ

Global AFP Surveillance

Non-Polio AFP Rate, 2017

Cases per 100,000 individuals under-15

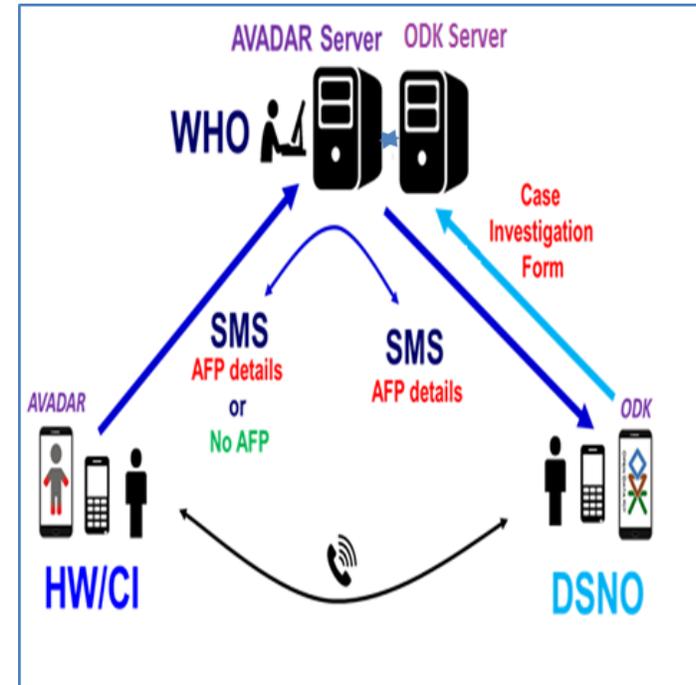
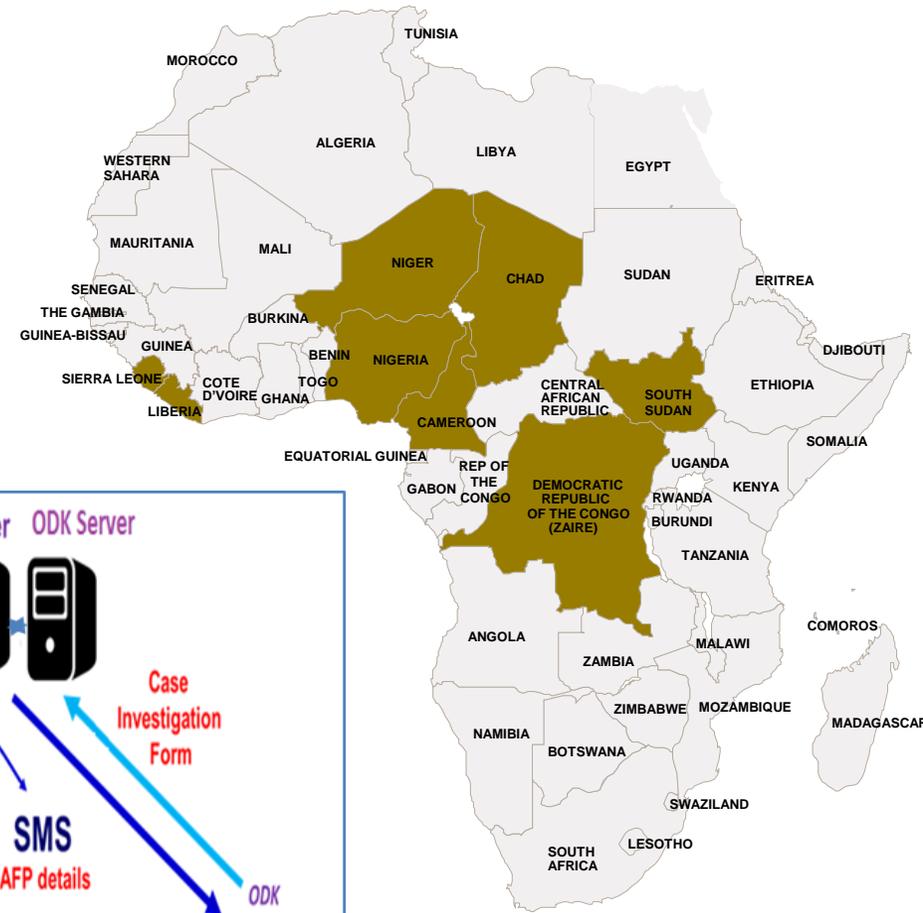


Annualized as of Sept 3 2017. Does not include data for N. Syria

- **Auto-Visual AFP Detection And Reporting (AVADAR)**
- **Electronic Surveillance**
 - **Integrated Supportive Supervision (ISS)**
 - eSurv
- **GIS Applications**
 - AFP Case Verification/Validation/Geo-coding AFP
 - Digital Elevation Models (DEM)
 - Blue Line Technology
- **Staff Accountability and Reward**

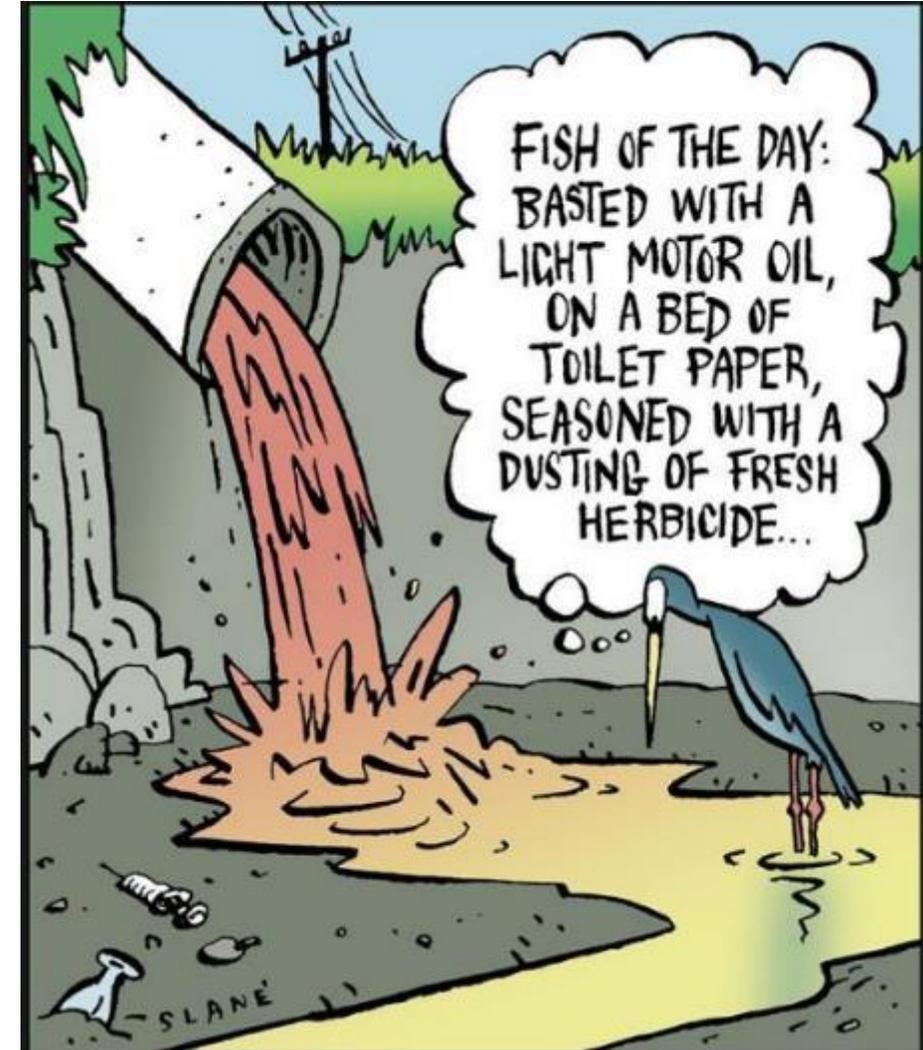
WHAT IS AVADAR?

- Highly-structured form of **community-based surveillance** that uses a mobile application with GIS capabilities to report and investigate potential AFP cases
- Designed to **strengthen AFP surveillance** at the subnational level in priority communities in Africa
- Implemented by **WHO AFRO** with upstream technology support from **Novel-T** and downstream logistical support from **eHealth Africa**
- **2016:** 2 LGAs, 1 country
- **2017:** 31 districts/LGAs, 7 countries
- **2018:** 63 districts/LGAs, 8 countries



POLIO ENDGAME AND ENVIRONMENTAL SURVEILLANCE

- **Sabin 2 withdrawal**
 - *Dis-/re-appearance monitoring*
- **Outbreak response with mOPV2**
 - *Risk of new/continued vaccine-derived transmission*
- **IPV use**
 - *Risk of “silent transmission”*
- **Long-term implementation/expansion of ES**
 - *Reduced lab complexity*
 - *Integration with other surveillance systems*



Environmental Surveillance

Large expansion of ES in recent years

Country deployments vary widely

- Endemic areas with dozens of sites
- Ad-hoc /temporary sites in some areas with recent outbreaks

Countries with environmental surveillance in SEAR, WPR, AFR, EMR

Pre-2017



Current status

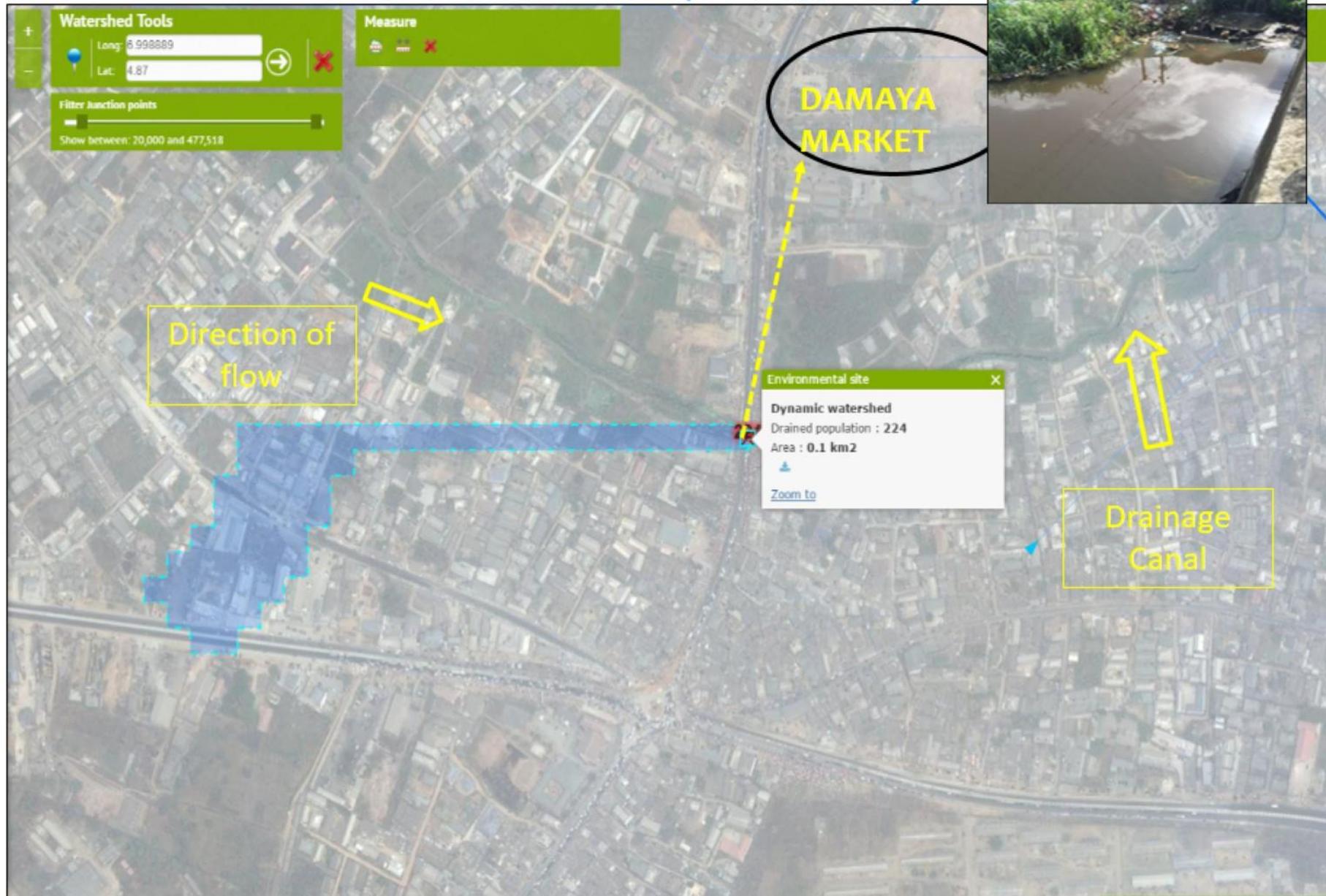


POLIO ES RESEARCH / APPLICATION: EXAMPLES

- **Expansion**
 - Coordinated and monitored by GPEI, with focused support groups: Near 60% increase in # of countries with ES in the past one year.
- **New Tool/s:** Bag Mediated Filtration System (BMFS)
- **Data, Analytics:**
 - Site characterization, validation and accuracy assessment of catchment area/population dynamics, risk assessment (etc.)
 - Digital tools: DEM, GIS capacity building, standardized reporting tools.
 - Transmission study data: Bangladesh, Mexico; virus survival studies in a variety of environmental conditions.
- **Integration of ES with other surveillance systems for long-term deployment**
 - Vellore (Typhoid surveillance)
 - Dhaka (AMR gene surveillance)
- **Methodologies for iVDPV surveillance**

Digital Elevation Models & ES site selection

Rivers state (4.87, 6.998889)



POLIO SURVEILLANCE: THE FUTURE?

Polio surveillance: Current status

Surveillance types:

- Primary: Acute Flaccid Paralysis (AFP) surveillance
- Secondary: Environmental Surveillance (ES)

Designed sensitivity:

- Detect each instance of polio in humans or the environment

Strengths:

- Sensitive surveillance system¹ to detect each instance of polio for certification efforts
- Widespread polio surveillance resources can be used to aid other disease programs

Weaknesses:

- Resource intensive

Open questions

Surveillance scale

- How long do we need to maintain polio surveillance after certification?
- How widespread does surveillance need to be in a post-certification world?

Surveillance types

- How quickly can Environmental Surveillance (ES) be reliably scaled up to become the primary surveillance method?
- What methodologies are needed to enhance passive AFP surveillance?

Surveillance integration

- Does combining surveillance systems actually provide synergies?

Polio surveillance: The Future (?)

Surveillance types:

- Primary: Likely Environmental Surveillance
- Secondary: Passive AFP (e.g. Event-based)

Designed sensitivity:

- Detect outbreaks

Strengths:

- Risk-based approach focuses efforts in areas most likely to experience outbreaks²
- Less resource intensive than active AFP surveillance

Weaknesses:

- Not widespread enough to detect every polio infection
- Difficult to identify the individual source of environmental isolate positives

1 Current sensitivity guidelines are nonpolio AFP rates of ≥ 2 per 100,000 persons aged < 15 years per year and $\geq 80\%$ of AFP cases with adequate stool specimens in areas where virus may be circulating; 2 Long term sensitivity guidelines are nonpolio AFP rates of ≥ 2 per 100,000 persons aged < 15 years for countries with poor immunization rates and either OPV use or detected cVDPV within the past 5 years, and ≥ 1 per 100,000 persons aged < 15 years for all other areas. $\geq 80\%$ of AFP cases with adequate stool specimens is advised for all areas

Searching for the Virus: In the *Real-World*



VACCINATION: “OLYMPIC” SPORT?

REACHING EVERY CHILD: A HEROIC FEAT

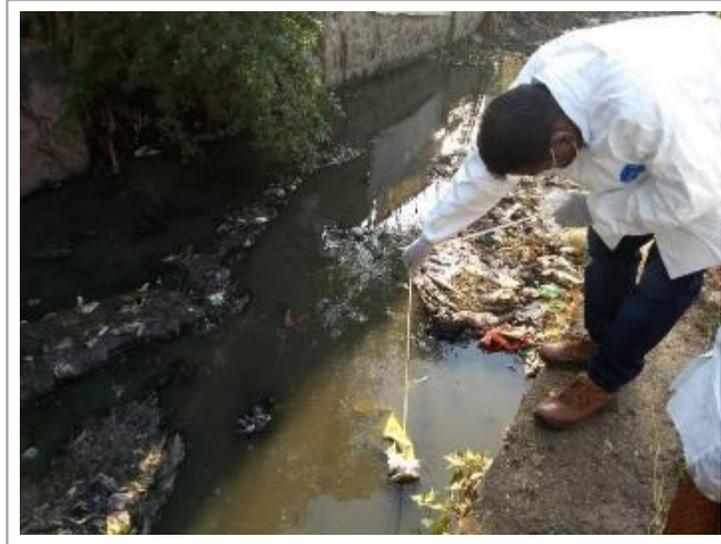


Credit: Ananda Bandyopadhyay, Bill & Melinda Gates Foundation

SUMMARY ..

- Polio is tantalizingly **close** to be the second human disease ever **eradicated**
- Sustained, good quality **vaccination** efforts and sensitive **surveillance** systems are cornerstones of eradication
- A **global** network of laboratories, medical officers and field staff constitute a highly **coordinated** surveillance system for polio
- **Newer methodologies** for **AFP** surveillance based on local need and **expanded** and **enhanced environmental** surveillance will be key for the “**endgame**” of polio and beyond
- **Long-term** strategies for **maintenance** and possible **integration** will be key for successful transition of polio expertise and investments

Thank You .. !



Appendix

Global Wild Poliovirus 2013 - 2018

Country or territory ³	Wild virus confirmed cases									Wild virus reported from other sources ²							
	Full year total					01 Jan - 31 Dec ¹		Onset of most recent type 1	Onset of most recent type 3	Full year total						Date of most recent virus	
	2013	2014	2015	2016	2017	2017	2018			2013	2014	2015	2016	2017	2018		2019
Pakistan	93	306	54	20	8	8	12	31-Dec-18	18-Apr-12	66	127	84	62	110	140	3	07-Jan-19
Afghanistan	14	28	20	13	14	14	21	06-Nov-18	11-Apr-10		17	20	2	42	83		26-Dec-18
Nigeria	53	6	0	4	0	0	0	21-Aug-16	10-Nov-12	3	1		1 ⁶				27-Sep-16
Somalia	194	5	0	0	0	0	0	11-Aug-14	NA								
Cameroon	4	5	0	0	0	0	0	09-Jul-14	15-Oct-09								
Equatorial Guinea	0	5	0	0	0	0	0	03-May-14	NA								
Iraq	0	2	0	0	0	0	0	07-Apr-14	NA								
Israel⁴	0	0	0	0	0	0	0	NA	NA	136	14						30-Mar-14
Syrian Arab Republic	35	1	0	0	0	0	0	21-Jan-14	NA								
West Bank and Gaza	0	0	0	0	0	0	0	NA	NA	7	1						05-Jan-14
Ethiopia	9	1	0	0	0	0	0	05-Jan-14	NA								
Kenya	14	0	0	0	0	0	0	14-Jul-13	NA	1							12-Oct-13
Total	416	359	74	37	22	22	33			213	160	104	65	152	223		
Total wild virus type 1	416	359	74	37	22	22	33										
Total wild virus type 3	0	0	0	0	0	0	0										
Tot. in endemic countries	160	340	74	37	22	22	33										
Tot. in non-end countries	256	19	0	0	0	0	0										
No. of countries (infected)	8	9	2	3	2	2	2										
No. of countries (endemic)	3	3	2 ⁵	2 ⁵	3	3	3										

Countries in yellow are endemic. ¹Data reported to WHO HQ on 23 Jan 2018 for 2017 data and 22 Jan for 2019 data.

²Wild viruses from environmental samples, selected contacts, healthy children and other sources. ³In March 2014, a serotype 1 wild poliovirus was detected in an environment specimen from Brazil, further investigation indicates this is an isolated event without evidence of circulation. ⁴Results are based on L20B positive culture. Prior to reporting week 16, 2014, results were based on a combination of direct qRT-PCR on RNA from concentrated sewage and L20B positive culture. ⁵Between 27 Sep 2015 and 27 Sep 2016, Nigeria was not classified as endemic. NA - Most recent case had onset prior to 1999. ⁶Exceptionally reporting case-contact of a positive index case given the date of collection is later than the onset date of the most recent WPV.

Global Circulating Vaccine-derived Poliovirus^{1,2,3}

Country	AFP cases (Paralysis onset between 2000-2019)																				Other sources (Human) ⁵ (collection between 2015-2019)					Other sources (Environment) (collection between 2015-2019)								
	cVDPV type 1																																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Onset of most recent case	2015	2016	2017	2018	2019	most recent collection date	2015	2016	2017	2018	2019	most recent collection date	
PNG																					26				7		20-Sep-18				7		06-Nov-18	
Laos															8	3					11-Jan-16	6	5				09-Feb-16							
Madagascar														1	10						22-Aug-15	1					01-Aug-15							
Ukraine															2						07-Jul-15													
Mozambique											2										02-Jun-11													
Myanmar							1	4													06-Dec-07													
Indonesia					46																26-Oct-05													
China				2																	11-Nov-04													
Philippines		3																			26-Jul-01													
DOR/Haiti	12	9																			12-Jul-01													
Total type 1	12	12	0	0	2	46	1	4	0	0	0	2	0	0	1	20	3	0	26	0		7	5	0	7	0		0	0	0	7	0		
cVDPV type 2																																		
Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Onset of most recent case	2015	2016	2017	2018	2019	most recent collection date	2015	2016	2017	2018	2019	most recent collection date	
Nigeria						3	22	71	68	155	27	34	8	4	30	1	1		34		05-Dec-18		2 ²		53		29-Nov-18	2	1		43		11-Dec-18	
Niger							2			2	1	1		1						9	30-Oct-18				4		25-Sep-18							
Mozambique																			1		21-Oct-18				1		10-Dec-18							
DR Congo									13	5	18	11	17						22	20	07-Oct-18			19	15		08-Nov-18							
Somalia								1	6	1	9	1	1							6 ⁶	02-Sep-18				3		14-May-18			2	19		11-Oct-18	
Syria																				74	21-Sep-17		1 ⁴	66			12-Sep-17							
Pakistan												16	48	22	2	1					17-Dec-16							7	4				28-Dec-16	
Guinea														1	7						14-Dec-15													
Myanmar															2						05-Oct-15													
South Sudan														2							12-Sep-14													
Cameroon													4								12-Aug-13													
Chad									1		12	4									12-May-13													
Afghanistan									5	1	9	3									13-Mar-13													
Kenya												3									29-Aug-12										1		21-Mar-18	
China												2									06-Feb-12													
Yemen											9										05-Oct-11													
India									15	2											18-Jan-10													
Ethiopia								3	1												16-Feb-09													
Madagascar		1	4			3															13-Jul-05													
Total type 2	0	1	4	0	0	6	24	71	85	184	55	65	68	65	55	12	2	96	70	0		0	3	85	76	0		9	4	2	63	0		
cVDPV type 3																																		
Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Onset of most recent case	2015	2016	2017	2018	2019	most recent collection date	2015	2016	2017	2018	2019	most recent collection date	
Somalia																					7 ⁶	07-Sep-18				2		29-Jun-18						23-Aug-18
Yemen													3	1								12-Jul-13												
Ethiopia									1	5												17-May-10												
Cambodia						1	1															15-Jan-06												
Total type 3	0	0	0	0	0	1	1	0	0	1	5	0	3	1	0	0	0	0	0	7	0		0	0	0	2	0		0	0	0	11	0	

Environmental surveillance for poliovirus in selected sewage sites established and working

#NAME?

¹For cVDPV definition see http://polioeradication.org/wp-content/uploads/2016/09/Reporting-and-Classification-of-VDPVs_Aug2016_EN.pdf . Niger 2006, Niger 2009, Niger 2010, Chad 2010 cVDPVs are linked to the Nigeria outbreak. Kenya 2012 cVDPVs are linked to the Somalia outbreak. Nigeria figures include cases with WPV1/cVDPV2 mixture: 2005 - 2, 2006 - 1, 2007 - 1, 2008 - 3, 2009 - 1, 2011 - 1; WPV3/cVDPV2 mixture: 2007 - 2. ² include a cVDPV2 from a contact of a WPV1 case in Nigeria. ³Figures include multiple emergences. ⁴ stool collected in Sep - 2016 but the final result was reported in 2017. ⁵ Include contact, healthy and community samples . Positive contact of a negative index AFP case double counted in both AFP cases and other sources count . ⁶ 1 cVDPV2 and cVDPV3 isolated from one child .

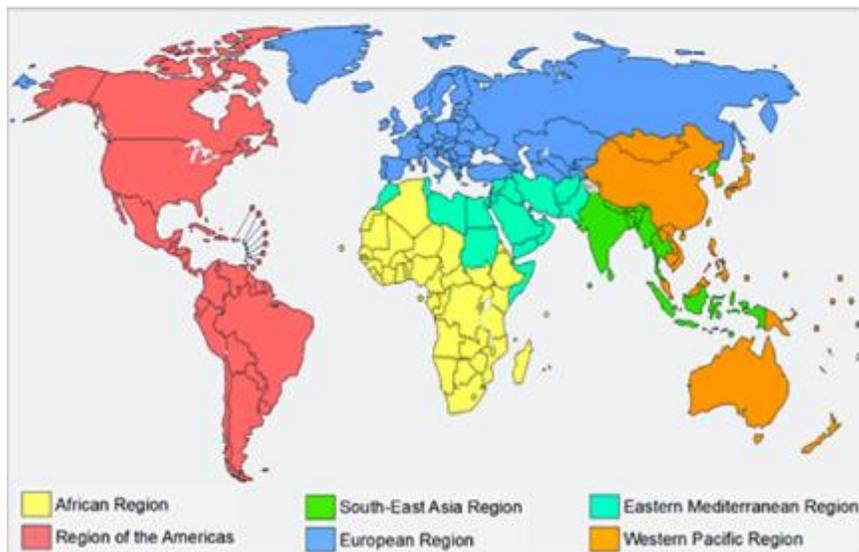
Global Surveillance Indicators: Year to Date Comparison

2018 & 2019: 01 January to 22 January 2019*

WHO region	AFP cases		Wild poliovirus cases		cVDPV ¹ cases		Polio compatibles		Pending final classification		
									Total		>90 days
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018
African	0	138	0	0	0	0	0	0	0	134	686
Central	0	15	0	0	0	0	0	0	0	15	66
South/East	0	20	0	0	0	0	0	0	0	20	372
West	0	103	0	0	0	0	0	0	0	99	248
American	1	18	0	0	0	0	0	0	1	2	185
Eastern Mediterranean	202	567	1	0	0	0	1	0	201	560	723
European	112	32	0	0	0	0	0	0	104	30	91
South East Asian	526	462	0	0	0	0	0	0	517	459	1,726
Western Pacific	5	0	0	0	0	0	0	0	5	0	878
Global	846	1,217	1	0	0	0	1	0	828	1,185	4,289

¹cVDPV includes all three serotypes 1, 2 and 3. Please refer to slide 5 for the distribution of cases by serotypes.

WHO Regions



For data at country, regional and global levels from 2000 onwards, see the WHO website at <https://extranet.who.int/polio/public/CaseCount.aspx>

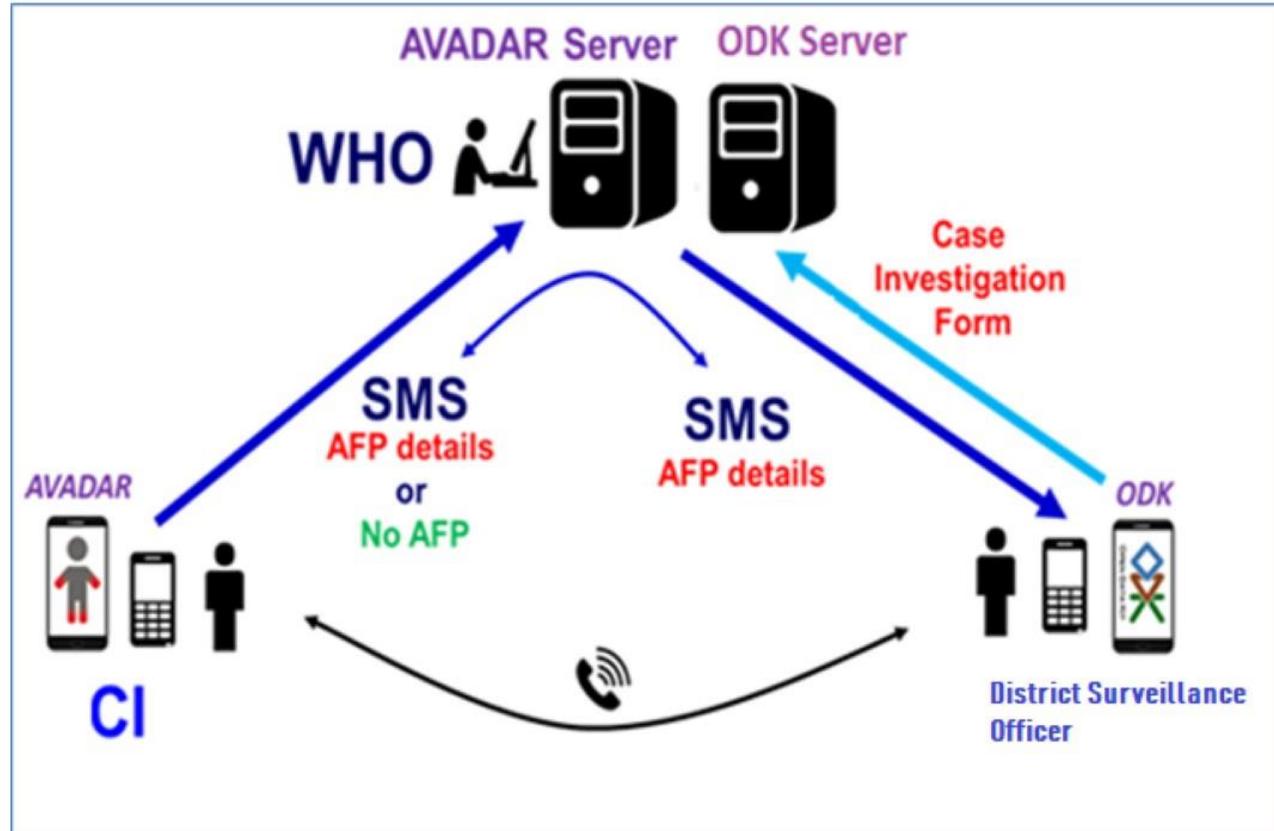
*Data for 2018 as of 23 January 2018 and for 2019 as of 22 January 2019

What is AVADAR?

Auto-Visual AFP Detection And Reporting

- *An app based mobile phone assisted (combining Visual, audio and SMS) reporting solution for Acute Flaccid Paralysis (AFP) surveillance.*
- *Designed to improve the sensitivity of AFP surveillance through improved Community participation:*
 - *AFP case detection and reporting (large number of informants)*
 - *Timeliness of reporting*
 - *'Zero' reporting of AFP cases*
 - *Real-time information on cases*
 - *Increased community participation & ownership.*

Auto-Visual AFP Detection And Reporting



Engagement of > 120 CI per district, > 6500 AFRO & >600 HW

Increase in Detecting AFP at the Community level

