

Immunizations (and Poliovirus)

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For World Polio Day

October 24, 2022

Vaccines—the beginning

Dr. Edward Jenner (English physician)--1796

- Milkmaids who contract Cowpox (*Vaccinia* virus) do not get Smallpox
- James Phipps, age 8, inoculated with pus from a Cowpox lesion
- 6 weeks later, Jenner exposed James to Smallpox, and he did not get sick
- Over 2 years, 23 additional patients either inoculated or infected with Cowpox were followed—none got Smallpox
- Paper published by Jenner concluded, “that the cowpox protects the human constitution from the infection of smallpox.”
- Multiple sources coined the term “vaccine” based on Jenner’s work

Vaccine-Preventable Diseases (Childhood)

- Hepatitis B
- DTP
 - Diphtheria
 - Tetanus
 - Pertussis
- Polio
- Haemophilus Influenza B
- Pneumococcus
- Rotavirus
- Influenza
- MMR
 - Measles
 - Mumps
 - Rubella
- Varicella
- Hepatitis A
- Human Papilloma Virus
- Meningococcus
- Covid-19

Success of Vaccines--Cases

Disease	Pre-Vaccine Era Estimated Annual Morbidity*	Most Recent Reports [†] or Estimates [‡] of U.S. Cases	Percent Decrease
Diphtheria	21,053	0 [†]	100%
<i>H. influenzae</i> (invasive, <5 years of age)	20,000	243 ^{†§}	99%
Hepatitis A	117,333	11,049 [‡]	91%
Hepatitis B (acute)	66,232	11,269 [‡]	83%
Measles	530,217	61 [†]	>99%
Mumps	162,344	982 [†]	99%
Pertussis	200,752	13,506 [†]	93%
Pneumococcal disease (invasive, <5 years of age)	16,069	4,167 [‡]	74%
Polio (paralytic)	16,316	0 [†]	100%
Rubella	47,745	4 [†]	>99%
Congenital Rubella Syndrome	152	1 [†]	99%
Smallpox	29,005	0 [†]	100%
Tetanus	580	14 [†]	98%
Varicella	4,085,120	449,363 [‡]	89%

*CDC. JAMA, November 14, 2007; 298(18):2155–63

[†]CDC. MMWR, January 8, 2010; 58(51,52):1458–68

[‡]2008 estimates, *S. pneumoniae* estimates from Active Bacterial Core Surveillance

[§]25 type b and 218 unknown

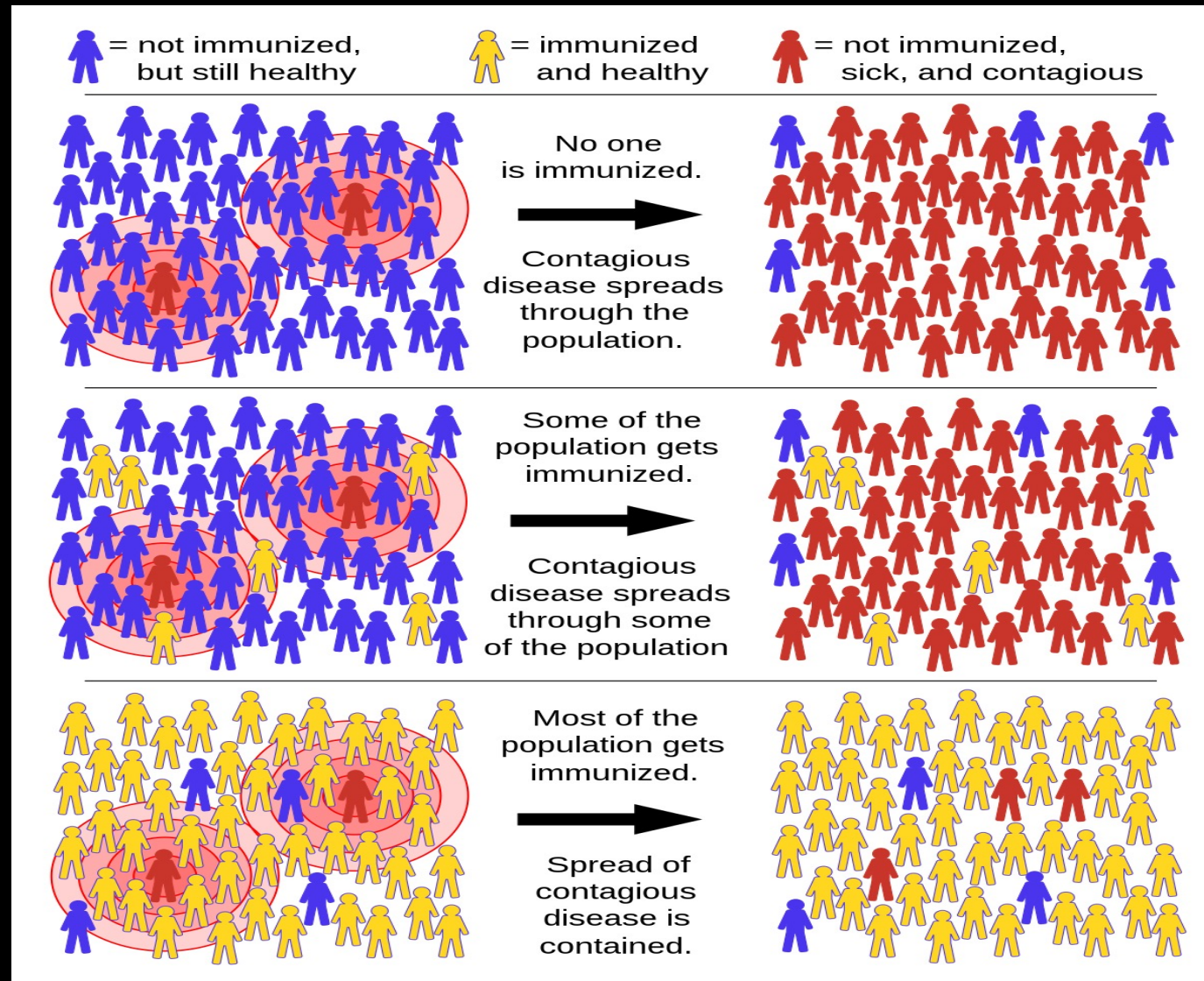
Vaccine success--Deaths

Table 1. Historical Comparison of Morbidity and Mortality for Vaccine-Preventable Diseases With Vaccines Licensed or Recommended Before 1980: Diphtheria, Measles, Mumps, Pertussis, Poliomyelitis, Rubella, Smallpox, Tetanus^a

Vaccine-Preventable Disease	Prevaccine No. (y)				Vaccine Date(s), y ^f	Most Recent Postvaccine Reported No.		Prevaccine Estimated Annual No. vs Most Recent Reported No. (% Reduction)	
	Estimated Annual Average		Peak			Cases, 2006 ^g	Deaths, 2004 ^h	Cases	Deaths
	Cases ^b	Deaths ^c	Cases ^d	Deaths ^e					
Diphtheria	21 053 (1936-1945)	1822 (1936-1945)	30 508 (1938)	3065 (1936)	1928-1943	0	0	21 053 (100)	1822 (100)
Measles	530 217 (1953-1962)	440 (1953-1962)	763 094 (1958)	552 (1958)	1963, 1967, 1968	55	0	530 162 (99.9)	440 (100)
Mumps	162 344 (1963-1968)	39 (1963-1968)	212 932 (1964)	50 (1964)	1940s, 1967	6584	0	155 760 (95.9)	39 (100)
Pertussis	200 752 (1934-1943)	4034 (1934-1943)	265 269 (1934)	7518 (1934)	1914-1941	15 632	27	185 120 (92.2)	4007 (99.3)
Poliomyelitis, acute	19 794 (1941-1950)	1393 (1941-1950)	42 033 (1949)	2720 (1949)	1955, 1961-1963, 1987	0	0	19 794 (100)	1393 (100)
Poliomyelitis, paralytic	16 316 (1951-1954)	1879 (1951-1954)	21 269 (1952)	3145 (1952)	1955, 1961-1963, 1987	0	0	16 316 (100)	1879 (100)
Rubella	47 745 (1966-1968)	17 (1966-1968)	488 796 (1964)	24 (1968)	1969	11	0	47 734 (99.9)	17 (100)
Congenital rubella syndrome	152 (1966-1969)	Not available	20 000 (1964-1965)	2160 (1964-1965)	1969	1	0	151 (99.3)	Not available
Smallpox	29 005 (1900-1949)	337 (1900-1949)	110 672 (1920)	2510 (1902)	1798	0	0	29 005 (100)	337 (100)
Tetanus	580 (1947-1949)	472 (1947-1949)	601 (1948)	511 (1947)	1933-1949	41	4	539 (92.9)	468 (99.2)

^aFootnote letters correspond to Box 1.

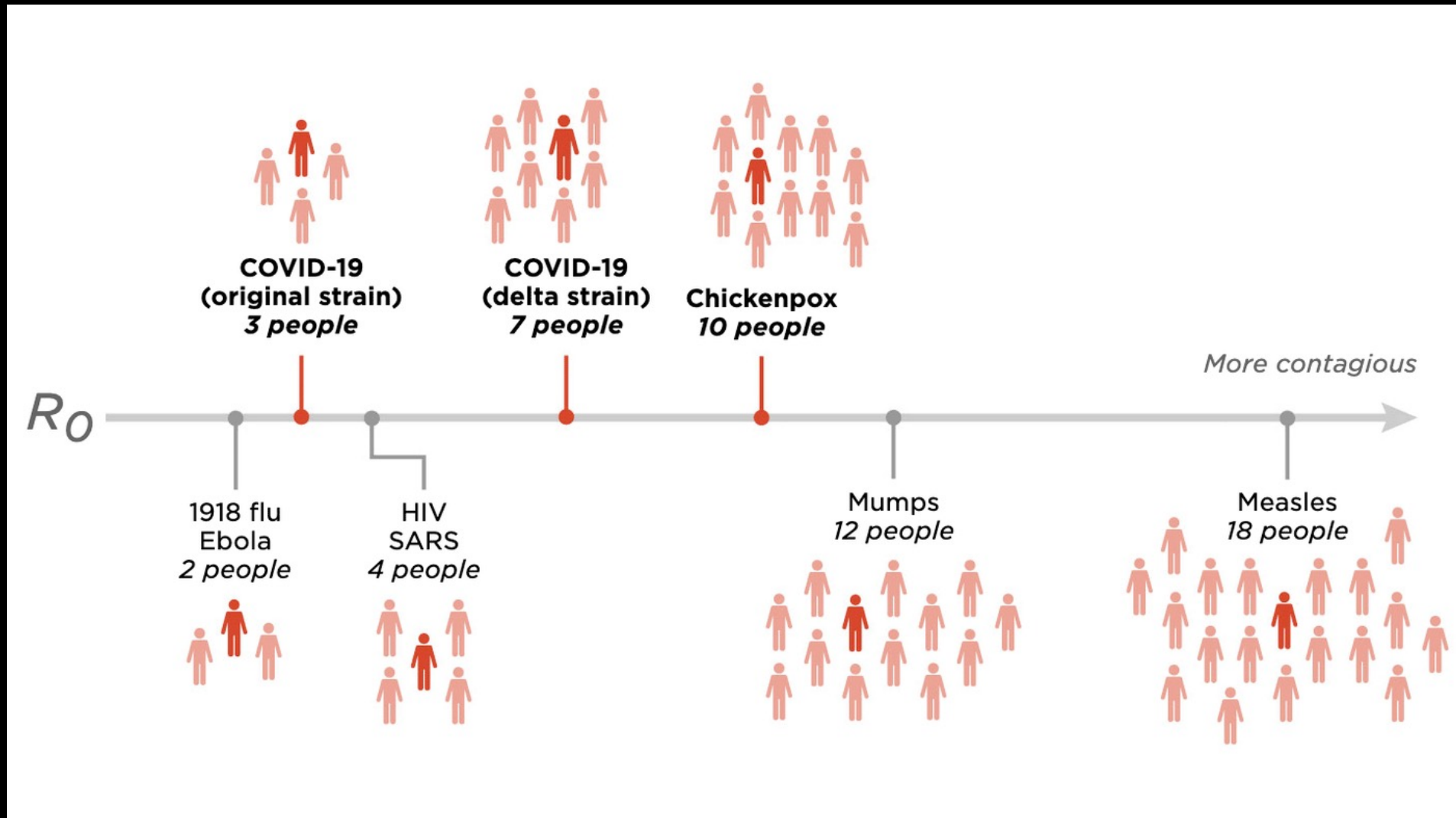
Herd Immunity



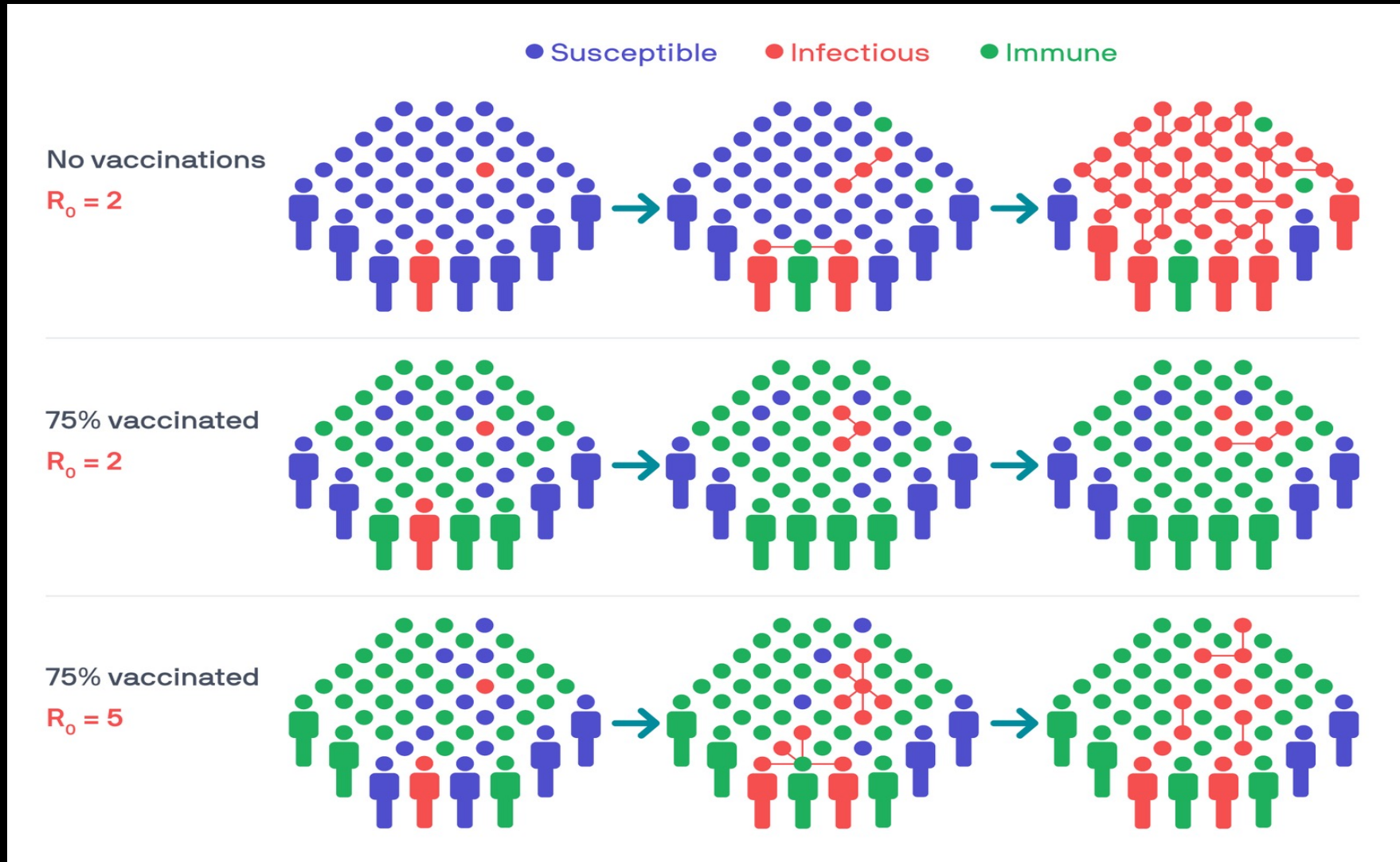
The Concept of R_0

Disease	R0	Threshold (%)
Mumps	4-7	75–86
Polio	5-7	80–86
Smallpox	5-7	80–85
Diphtheria	6-7	85
Rubella	6-7	83–85
Pertussis	12-17	92–94
Measles	12-18	83–94

R_0 Illustrated



R_0 in a Population



R_0 and Herd Immunity

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Outbreaks

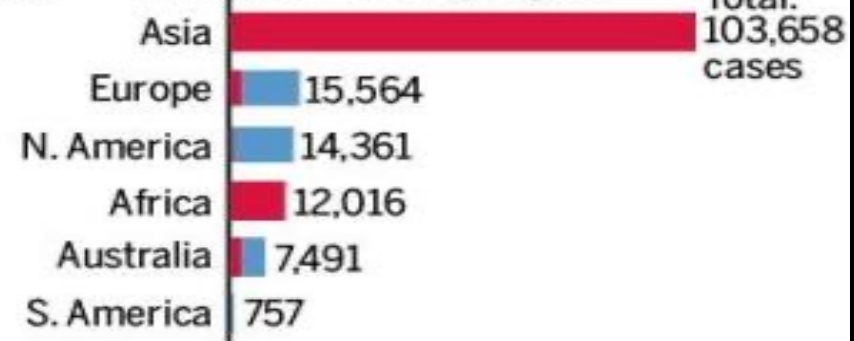
Vaccine-preventable outbreaks

Cases of whooping cough and measles around the globe in 2014. California is now battling a whooping cough epidemic and a measles outbreak.

Number of cases by disease



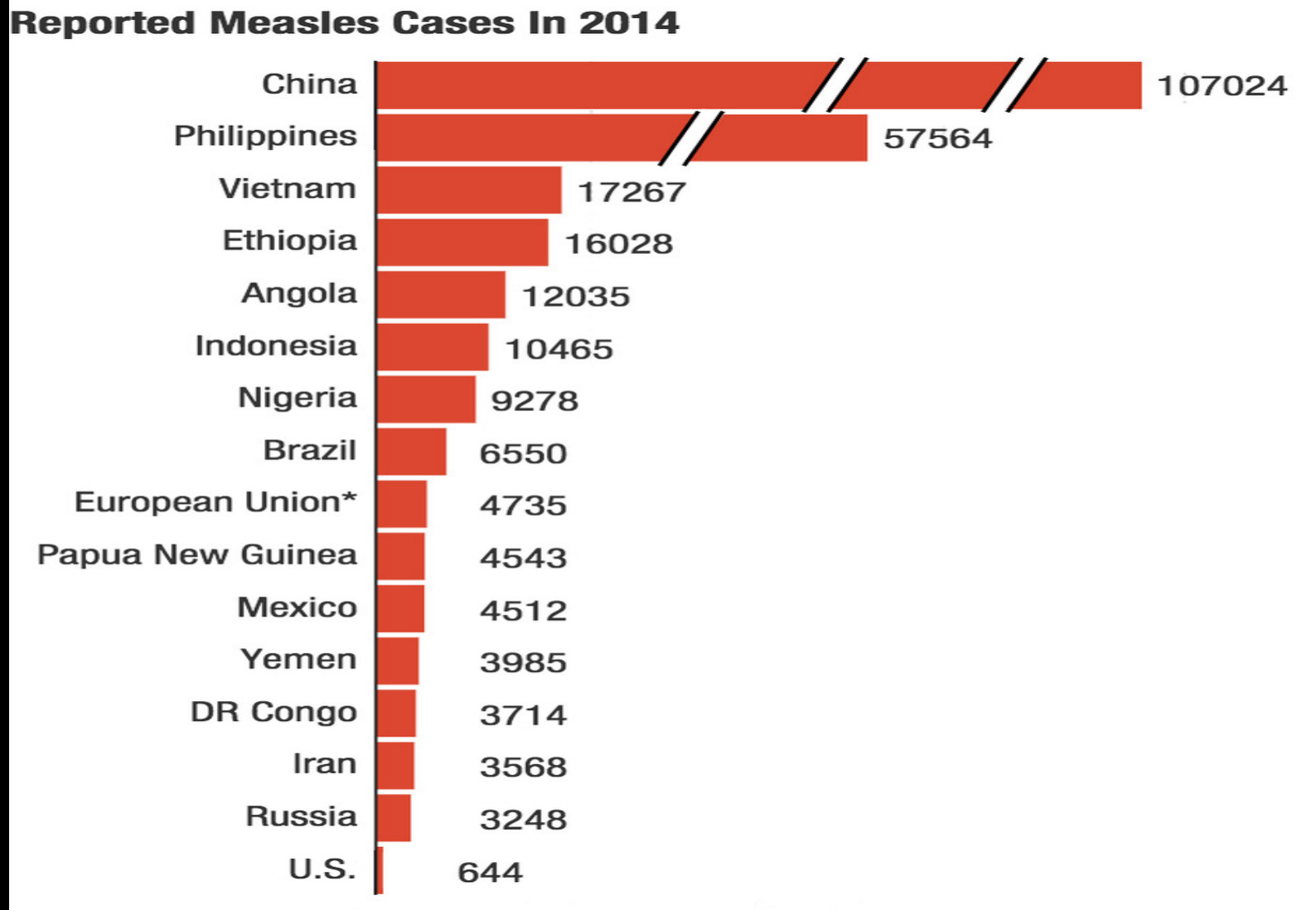
Number of cases by region



Source: Council on Foreign Relations

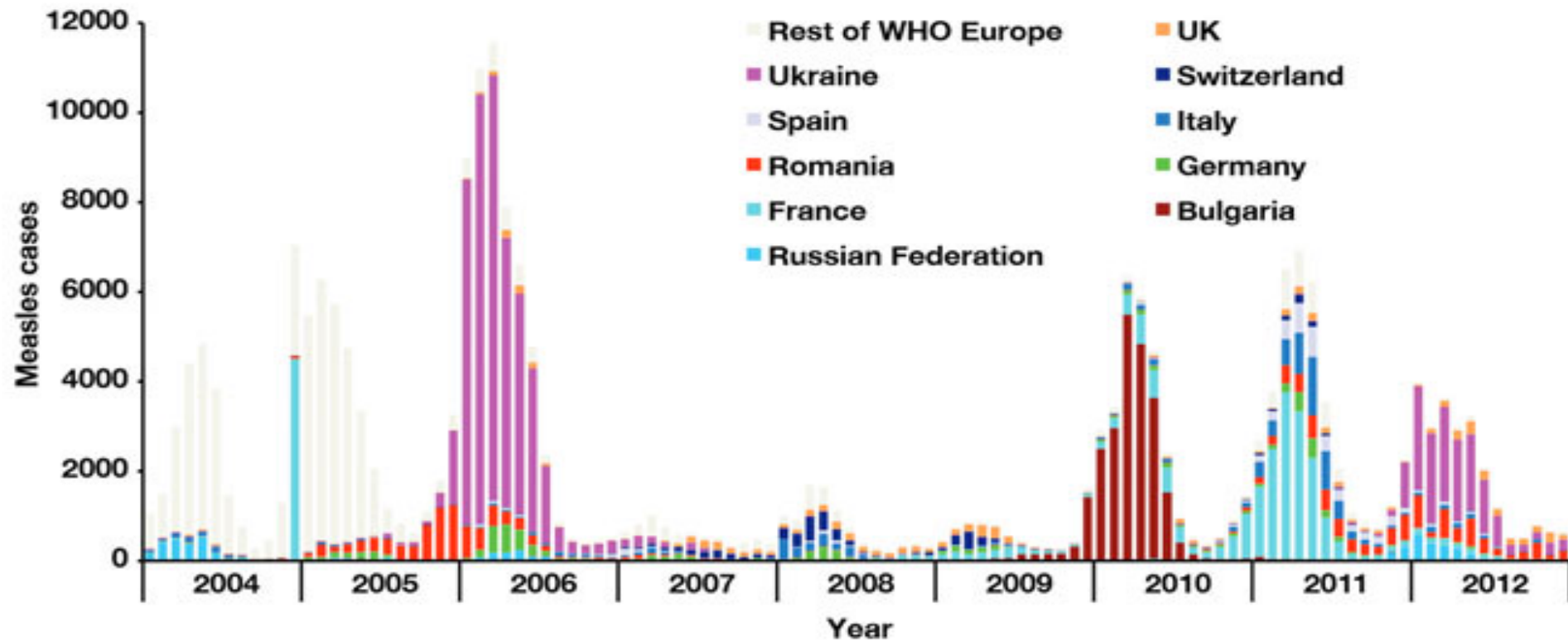
JEFF DURHAM/BAY AREA NEWS GROUP

Measles Outbreaks Worldwide



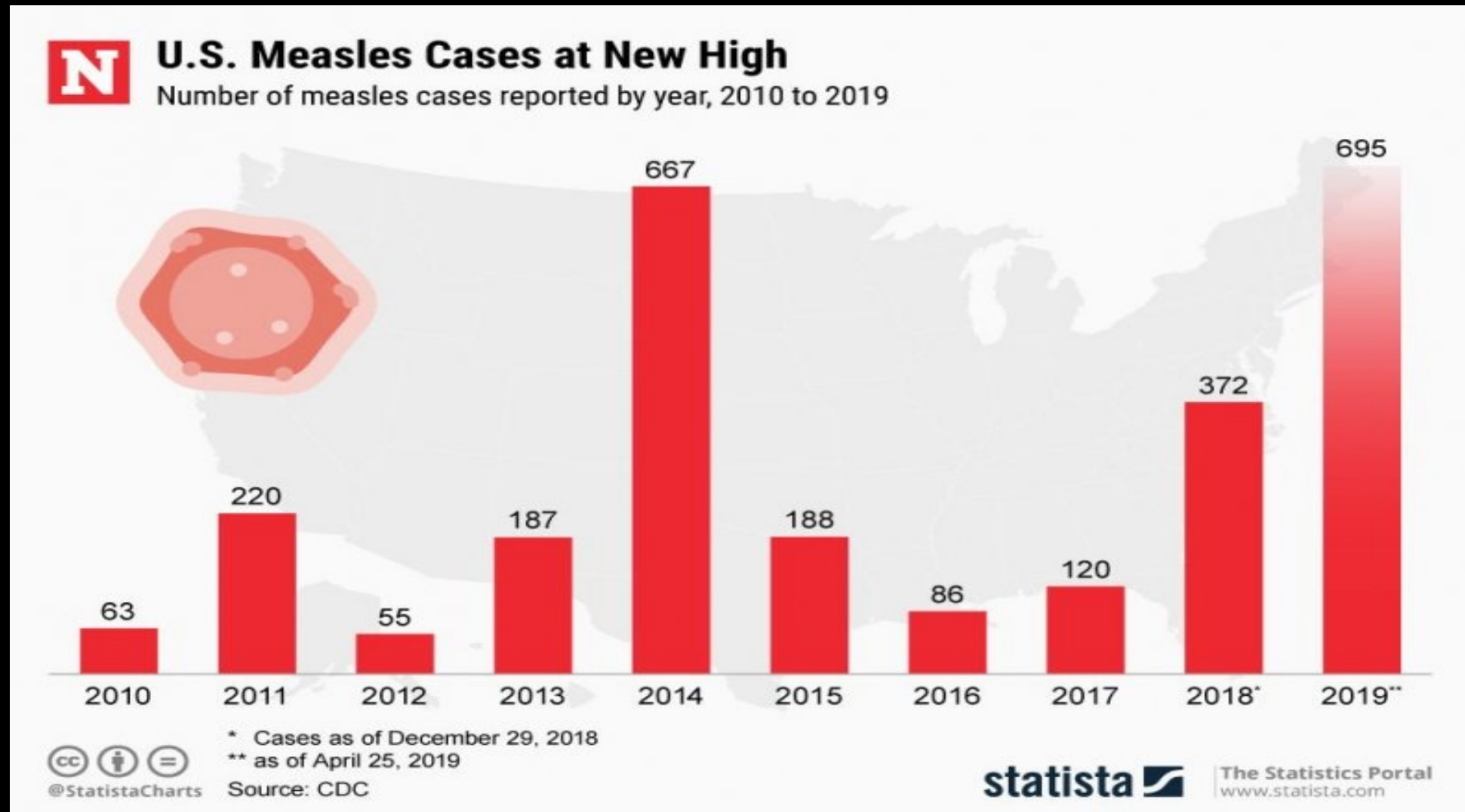
Measles Outbreaks--Europe

Measles outbreaks in central Europe, 2004-2012



"Immunization Highlights, 2011-2012," World Health Organization

Measles Outbreaks in the USA



Poliovirus

- RNA virus
- Three serotypes (type 1, type 2, type 3)
- Transmission
 - Incubation period 3-6 days
 - Fecal-oral or oral-oral spread
 - Can shed virus for 6 weeks in the stool
- Symptoms
 - 75% asymptomatic
 - ~25% Flu-like symptoms
 - 1% Paralytic Polio

Poliovirus

- Symptoms (1st week)
 - Fever
 - Back pain
 - Muscle aches
 - Abdominal pain
- Paralytic polio (2nd and 3rd weeks)—destroys motor neurons
 - Muscle weakness
 - Difficulty breathing

The Iron Lung



Polio Vaccines

Salk Vaccine

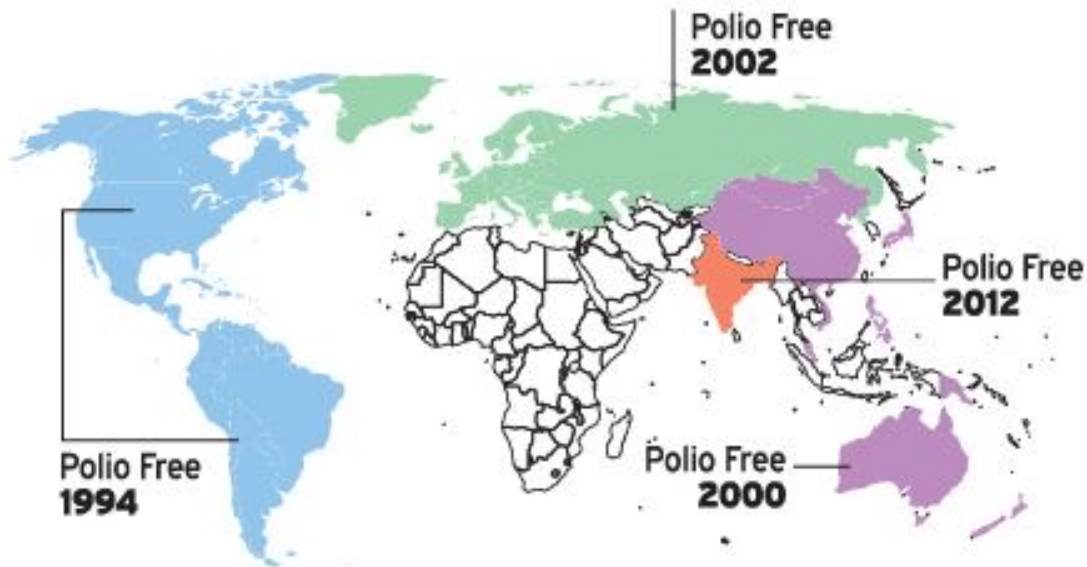
- Developed by Jonas Salk; released in 1955
- Inactivated vaccine (killed)
- Provides blood but not gut immunity
- Given by intramuscular injection
- Only vaccine given in US since 2000
- Cannot spread from person-to-person
- 90% protective after 2 doses
- 99% protective after 3 doses

Sabin Vaccine

- Developed by Albert Sabin; released in 1961
- Live, attenuated vaccine (weakened)
- Provides both blood and gut immunity
- Given orally
- Cheap, easy to administer, used for mass vaccination campaigns
- Can spread from person-to-person
- Can revert to non-weakened strain in underimmunized populations (Vaccine-Derived Poliovirus)

Polio Eradication

POLIO ERADICATION - TIMELINE



1988 : World Health Assembly sets goal of global polio eradication. Polio endemic in more than 125

countries, with over 350,000 cases of the disease annually.

1994 : WHO Region of the

Americas certified as polio-free

1999 : Of the three types of naturally-occurring wild poliovirus (type 1, type 2 and type 3), transmission of type 2 was successfully stopped.

2000 : WHO Western Pacific Region certified as polio-free

2002 : WHO European Region certified as polio-free

2011 : INDIA: Rukhsar becomes the last child to be crippled by a wild poliovirus in India

2012 : Goal of stopping wild

polio transmission globally by end-2012 missed. Some 222 wild polio cases reported from five countries.

INDIA: Remained polio-free and was removed from the list of endemic countries

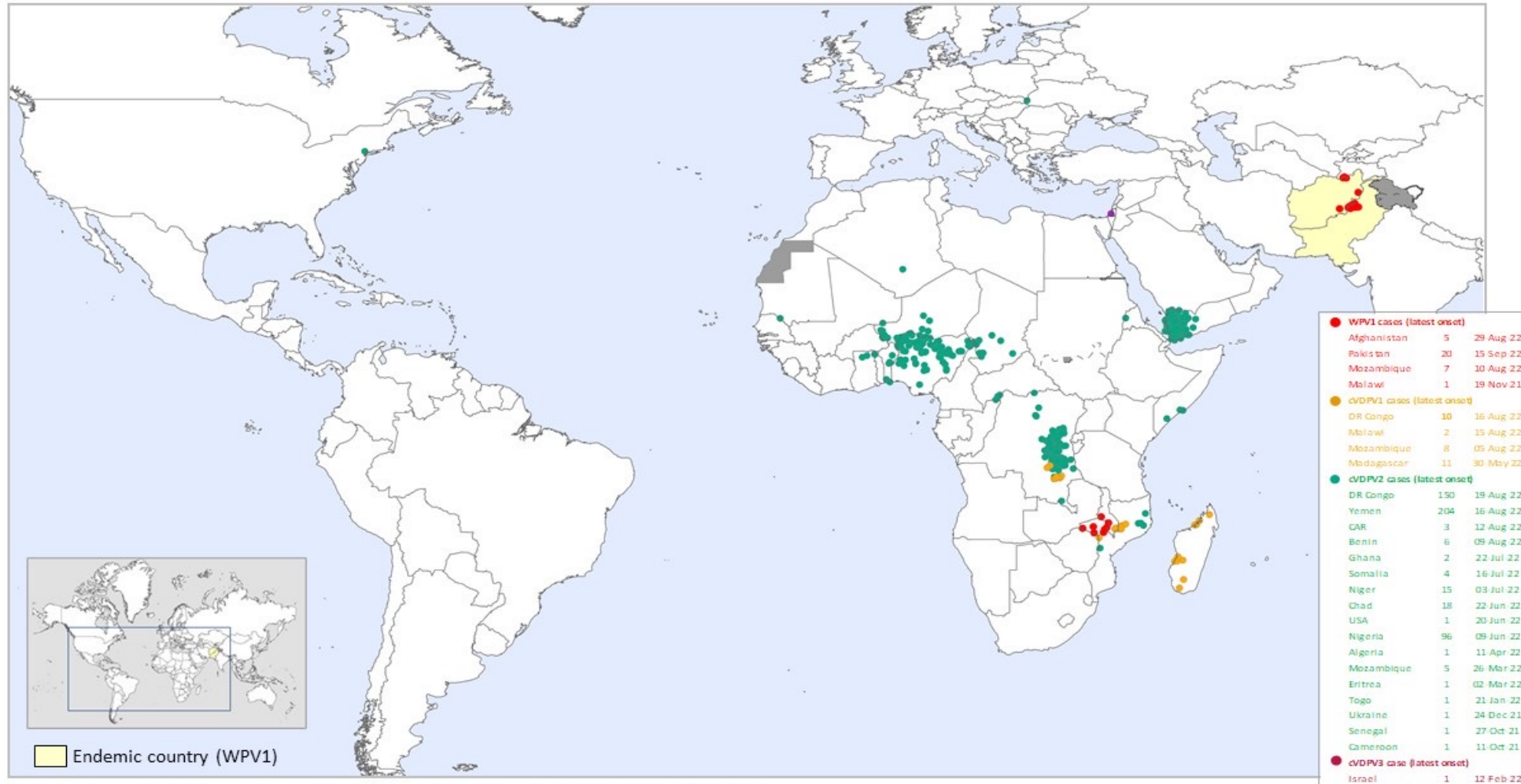
2014 : If India remains free of polio, the WHO South-East Asian Region can be certified as polio-free.

Last wild polio case in the world (Global Polio Eradication Initiative's draft "Polio Eradication and Endgame Strategic Plan, 2013-2018")?

End 2018 : Global certification of wild poliovirus eradication?

Polio Eradication—Where Are We Now?

Global WPV1 & cVDPV Cases¹, Previous 12 Months²



¹Excludes viruses detected from environmental surveillance; ²Onset of paralysis 05 Oct. 2021 to 04 Oct. 2022

Polio in New York

July 21, 2022

- Rockland County New York
- Unimmunized young adult developed fever, stiff neck, abdominal pain and muscle aches
- 3 days later developed leg weakness—presented to the ED—weakness worsened
- No history of recent travel
- Confirmed to be positive for Type 2 VDPV
- Discharged to a rehabilitation facility
- Wastewater surveillance in Rockland and surrounding counties identified 70 samples positive for Poliovirus, 63 of which were genetically linked to the case

Don't Forget to Get Your Flu Shot

2017-2018 Flu Season: Flu Burden and Flu Burden Averted by Vaccination

During the 2017-2018 flu season, CDC estimates flu caused:

49 million
flu illnesses

960,000
flu hospitalizations

79,000
flu deaths

This severe season could have been worse without flu vaccines.

Approximately 40% of the U.S. population chose to get a flu vaccine during the 2017-2018 flu season, and this prevented an estimated:

7 million
flu illnesses,



about the population of
New York City.

109,000
flu hospitalizations,



about the number of vehicles
crossing the Golden Gate Bridge
each day.

8,000
flu deaths,



twice the number of hospitals in
the United States.

**Imagine the impact if more Americans chose to get a flu vaccine.
Many more flu illnesses, flu hospitalizations and flu deaths could be prevented.**

<https://www.cdc.gov/flu/about/disease/burden-averted-vaccination.htm>



get vaccinated
www.cdc.gov/flu