Global Viral Outbreaks: Emerging & Re-emerging

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Medical Director – UW Health Immunization Program
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University of Wisconsin SCHOOL OF MEDICINE AND PUBLIC HEALTH
UW Health American Family Children's Hospital

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Disclosure

I do not plan on referencing any un-licensed pharmaceutical products, nor off-license use of any such products.
In the last 24 months I have had the following relationships with commercial entities:

COMPANY	FINANCIAL RELATIONSHIP
Moderna vaccines	Scientific Advisor
Sanofi vaccines	Scientific Advisor
Merck vaccines	Scientific Advisor
Pfizer vaccines	Scientific Advisor
GSK vaccines	Scientific Advisor
Centers for Disease Control	Co-investigator, Research

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Objectives

- Discuss current global communicable disease surveillance & limitations
- Examine epidemiology of significance for resurgent vaccine-preventable diseases
  - Measles
  - Polio
- Consider the impacts of decreasing immunization rates globally

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Global Disease Surveillance – recent history

- ProMed 1993
  - First global infectious disease surveillance network, emerged from IOM 1992 Forum on Microbial Threats
- Global Public Health Information Network (GPHIN) 1997
  - Initiated by WHO, Health Canada & European Commission's Medical Intelligence System (MedISys)
- WHO Global Outbreak Alert & Response Network 2000
  - "Network of networks"
- Global Measles & Rubella Laboratory Network (GMRLN) 2001
  - 760 regional, national & sub-national labs (funding recently cut by US govt)
  - Had been proposed to expand surveillance into *all* vaccine preventable disease
- HealthMap 2006
  - freely accessible, automated, collects from multiple web-based sources

https://www.ncbi.nlm.nih.gov/books/NBK52873/

4

Abbott Pandemic Defense Coalition

Global Health Institute UNIVERSITY OF WISCONSIN-MADISON

22 sites monitoring infectious diseases on 5 continents

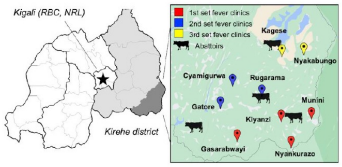
5

Establishing a Rwandan One Health genomic surveillance network for endemic and emerging viral hemorrhagic fevers

World Health Organization | HUB

WHO launches global network to detect and prevent infectious disease threats

Stellenbosch University | Rwanda Biomedical Centre



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Home Suites Boutique
Sierra Leone Police Hospital
Dia Dunning Children's Hospital
Sierra Leone River Estuary (SLRE...
Lumley Beach Freetown Sierra Leone
King Harman Road Satellite Hospital
Netlands Hospital
Government Hospital Macauley Street
Shell
China Medical Hospital
Treasure Health Hospital
Rokupa
Rokupa Government Hospital
Lumley Hospital
Choithram Memorial Hospital
Sierra Leone Freetown
Leicester
WELLINGTON
Mountainland Entertainment
Portersville Private Lodge
Goderich
Sugarland Beach
Adonkia Godrich
Regent
Tacugama Chimpanzee Sanctuary
Govt Hospital Kakua
Mambo Waterfalls
Transit
Click on stations for more information
Chicken Town (Juh)

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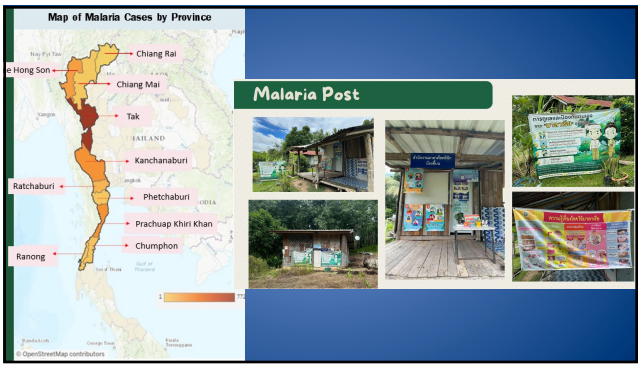
Map of Malaria Cases by Province
Chiang Rai
Chiang Mai
Tak
Kanchanaburi
Ratchaburi
Phetchaburi
Prachuap Khiri Khan
Chumphon
Ranong
Malaria Post
© OpenStreetMap contributors

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NATIONAL WASTEWATER SURVEILLANCE SYSTEM
Wastewater Surveillance
provides early detection of increasing cases
independent from medical systems
fast and efficient
national coverage
used to track emerging health threats
can be used to track changes in health threats
complementary to other public health surveillance data
www.thelancet.com/lancetgh Vol 11 June 2023
Number of Wastewater Sampling Sites Reporting to NWSS in the Last Two Months
1,376
Estimated U.S. Population Covered by NWSS
146,000,000
(43.0%)
Explore Wastewater Data
COVID-19
Influenza A
Avian Influenza A(H5)
RSV
Mpox
https://www.cdc.gov/nwss/about.html

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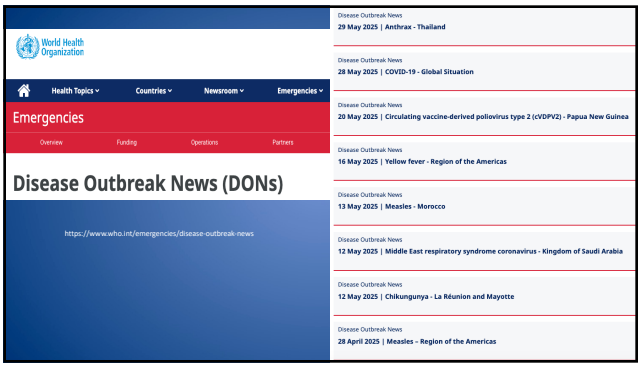
World Health Organization
Health Topics
Countries
Newsroom
Emergencies
Emergencies
Overview
Funding
Operations
Partners
Disease Outbreak News (DONs)
https://www.who.int/emergencies/disease-outbreak-news
Disease Outbreak News
29 May 2025 | Anthrax - Thailand
Disease Outbreak News
28 May 2025 | COVID-19 - Global Situation
Disease Outbreak News
20 May 2025 | Circulating vaccine-derived poliovirus type 2 (cVDPV2) - Papua New Guinea
Disease Outbreak News
16 May 2025 | Yellow fever - Region of the Americas
Disease Outbreak News
13 May 2025 | Measles - Morocco
Disease Outbreak News
12 May 2025 | Middle East respiratory syndrome coronavirus - Kingdom of Saudi Arabia
Disease Outbreak News
12 May 2025 | Chikungunya - La Réunion and Mayotte
Disease Outbreak News
28 April 2025 | Measles – Region of the Americas

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CDC Outbreaks
Also tracking:
Hemorrhagic fevers
Lassa, Marburg, Sudan, Ebola?
Avian influenza & H5N1
Various arboviruses
Zika, Oropouche, Dengue, yellow fever
New world screwworm
Diphtheria
Pertussis
International Outbreaks
JUN 2024 Oropouche
MAR 2024 Dengue
MAY 2022 Mpox Outbreaks
JAN 2020 Coronavirus Disease 2019 (COVID-19)
International Travel Health Notices
MAY 2025 Level 1 - Global Measles
MAY 2025 Level 1 - Global Dengue
MAY 2025 Level 2 - Chikungunya in the Region of the Indian Ocean
APR 2025 Level 2 - Global Polio
APR 2025 Level 2 - Yellow Fever in South America
APR 2025 Level 1 - Oropouche in the Americas

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CDC Outbreaks
CDC Travelers' Health
Travelers Health > Travel Notices > Global Measles
Travelers Health
Destinations
Travel Notices
Global Measles
Global Measles
Level 4 - Avoid All Travel
Level 3 - Reconsider Nonessential Travel
Level 2 - Practice Enhanced Precautions
Level 1 - Practice Usual Precautions

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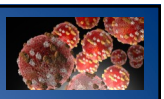
Measles Characteristics



- Classic symptoms
  - Typical incubation 10-12 days, but can be 7-21 days
  - Symptoms usually start around 14 days after infection
  - Fever (up to 105F) + generalized maculopapular rash + one of the "3 C's"
    - 3 C's: Cough, coryza (runny nose), conjunctivitis
  - Clues to measles:
    - Prodrome of fever and at least 1 of 3 C's often starts 2–4 days before rash
    - Rash starts on head or face and spreads downwards
    - Fever continues through onset of rash, often peaking when the rash starts
- Measles rare in vaccinated people, especially with 2 MMR doses
  - 1 dose generally provides 93% protection, and 2 doses provides 97% protection from measles infection

https://www.cdc.gov/measles/hcp/clinical-overview/

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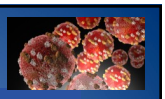
Measles



Complications

30% have one of more complications, even in well-resourced settings

- Diarrhea 8%
- Otitis media 7%
- Pneumonia 6%
- Viral or bacterial superinfection

https://www.cdc.gov/measles/hcp/clinical-overview/

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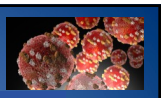
Measles



Rare complications

Encephalitis (1 in 1,000 children)

- Likely immune-mediated
- Supportive care
- Often mild/self-limited, but can have lasting sequelae

Subacute sclerosing pan-encephalitis (SSPE, 1 in 100,000)

- Mean time from infection to SSPE = 10 years
- Progressive deterioration in cognitive function, behavior à myoclonus à autonomic dysfunction à non-responsive state
- May have seizures, rate of progression variable, often fatal

https://www.cdc.gov/measles/hcp/clinical-overview/

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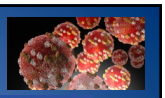
Measles



Recommendations for older children and adolescents

Older children and adolescents who do not have two documented doses of measles-containing vaccine are recommended to receive two doses of vaccine, spaced appropriately.

- The minimum interval between MMR doses is 28 days.
- The minimum interval between MMRV doses is 3 months.

https://www.cdc.gov/vaccines/vpd/mmr/hcp/recommendations.html

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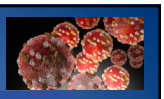
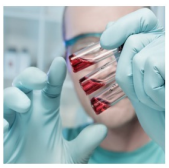
Measles



Diagnostic testing

- PCR testing (preferred)
  - Throat or NP swab
  - Consider urine in addition to respiratory samples (helpful later in course of illness)
  - Ideally collected within three days of rash onset, but can be collected for up to 10 days
- Serology testing
  - IgM tests for acute disease
  - IgG determines immunity



https://www.cdc.gov/measles/hcp/clinical-overview/#cdc_clinical_overview_test_dia-diagnosis-and-laboratory-testing

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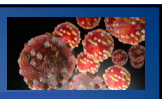
Measles



Measles post-exposure prophylaxis (PEP)

- Measles post-exposure prophylaxis (PEP) can prevent or modify disease after exposure.
  - Recommended for unvaccinated contacts exposed to a measles case
- MMR vaccine
  - Give within 72 hours
  - Preferred PEP
- Immune globulin (IG)
  - Give within six days post exposure
  - Contacts with high risk of complication

https://www.cdc.gov/measles/hcp/clinical-overview/

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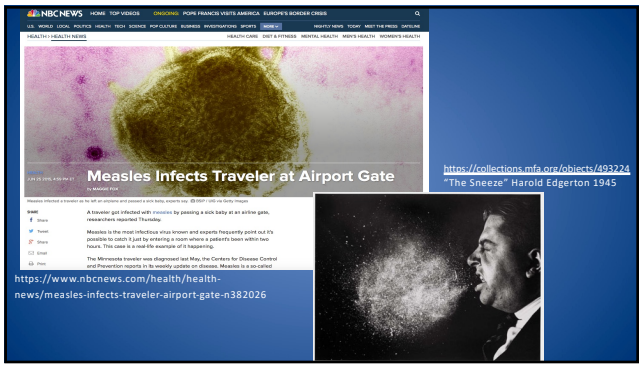

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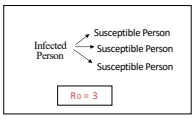
Basic Reproductive Number (R_0)

- Average number of secondary infections caused by introducing a single infected person (infectious individual) into an entirely susceptible population
- A value that shows how an infectious disease will spread in a population

I = Infected individual
S = Susceptible individual (not-immune)
→ = Transmission



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Rates Needed for Herd Immunity

> 80% → no large disease outbreaks
> 90% → eradication

Table 6 Estimated herd immunity thresholds and critical vaccination coverage using generally accepted reproductive numbers for common vaccine-preventable diseases

Vaccine-Preventable Disease	R_0*[59,60]	Herd Immunity Threshold (%)[31]	Critical Vaccination Coverage** (%)[31]
Diphtheria	4 to 5	75–80	79–84
Measles	11 to 18	91–94	96–99
Mumps	7 to 14	86–93	90 to 98
Rubella	6 to 14	83–94	87 to 99

*R_0 values indicate the number of individuals that can be directly infected by one infectious case. Herd immunity thresholds are a function of this value.
**Herd immunity thresholds are adjusted to account for vaccine effectiveness.

Int Arch Otorhinolaryngol. 2018 Jul; 22(3): 317–329.

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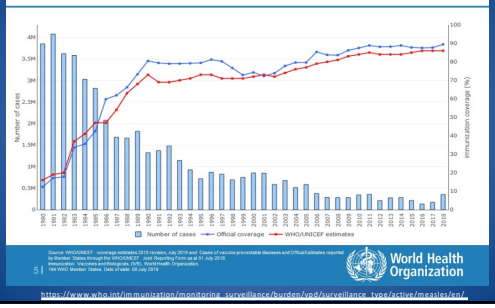
Measles Global annual reported cases and MCV1 coverage 1980-2018



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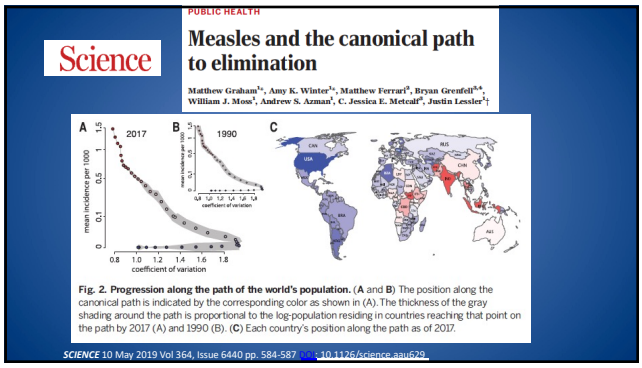

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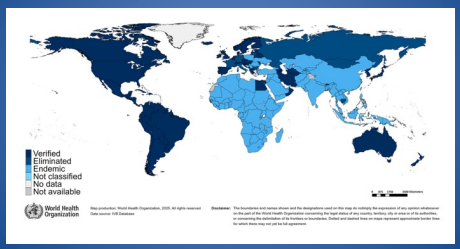
Measles verification of 'elimination'



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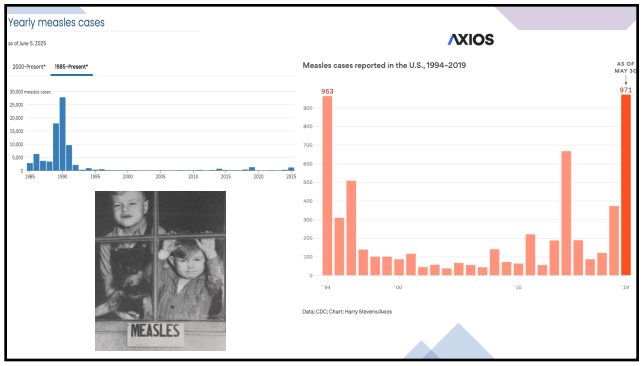

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Measles in the US - 2025

- 1168 cases cases
  - 89% of cases linked to outbreaks
  - Children 5-18yo most affected = 38%
  - Adults >19yo = 33%
  - 95% unimmunized
- >150 hospitalizations (12% of known cases)
- 3 deaths (2 children 1 adult)
- 34 states with cases (latest South Dakota)
  - 17 defined outbreaks (defined as 3 or more related cases)

https://www.cdc.gov/measles/data-research/index.html

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Top 10 countries with measles outbreaks

Country	Number of Cases
Yemen	10,487
Pakistan	8,895
India	8,397
Afghanistan	6,255
Ethiopia	6,188
Kyrgyzstan	5,849
Romania	5,583
Thailand	3,675
Indonesia	3,322
Nigeria	2,482

Source: World Health Organization

This table is based on provisional monthly surveillance data reported to the World Health Organization (Geneva) as of May 2025. The data reflected covers October 2024 – April 2025.

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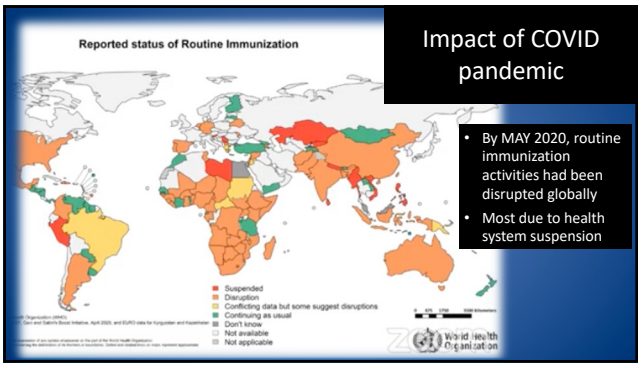

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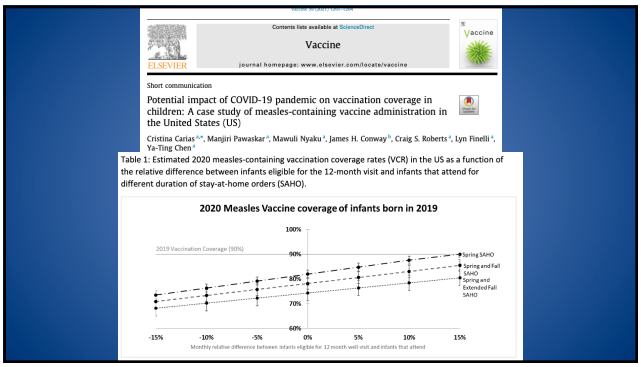

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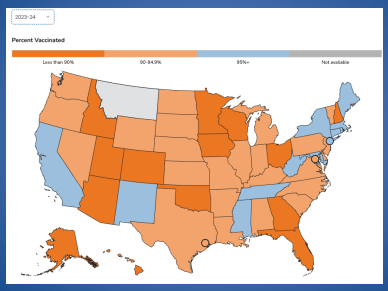
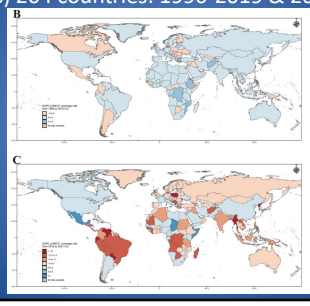
Measles Immunization Coverage (kindergarten)



https://www.cdc.gov/measles/data-research/index.html

31

Global trends Measles dose #1 coverage rates in children (0-5 yrs) 204 countries: 1990-2019 & 2019-2021



International Journal of Infectious Diseases, 2025-07-01, Volume 156, Article 107908

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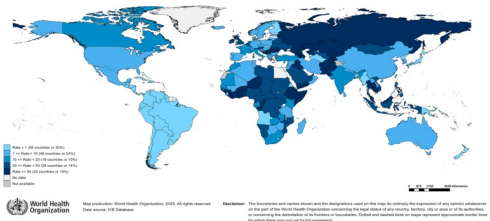
Measles Incidence Rate per Million (12M period)



Highest incidence rates

Country	Cases	Rate
Kyrgyzstan	11080	1,541.89
Romania	21197	1,114.75
Yemen	21918	540.08
Kazakhstan	7654	371.69
Afghanistan	11186	262.29
Bosnia and Herzegovina	674	213.00
Liberia	1149	204.71
Iraq	9168	199.12
Azerbaijan	1520	147.05
Serbia	969	143.85

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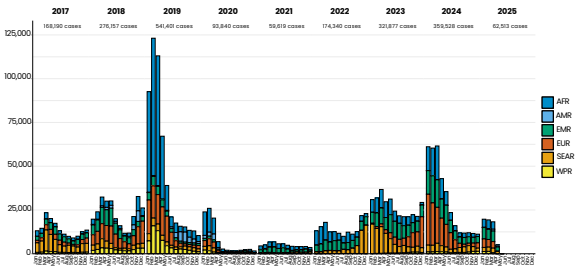
Measles case distribution by month and WHO Region (2017-2025)



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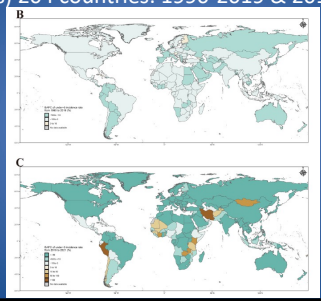
Global Trends: Measles *mortality rates* in children (0-5 yrs) 204 countries: 1990-2019 & 2019-2021



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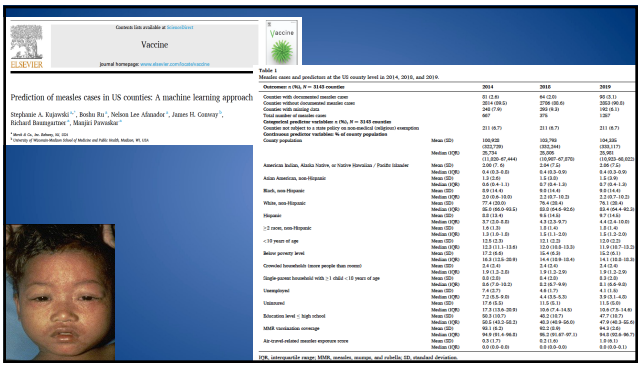

Prediction of measles cases in US counties: A machine learning approach

Vaccine

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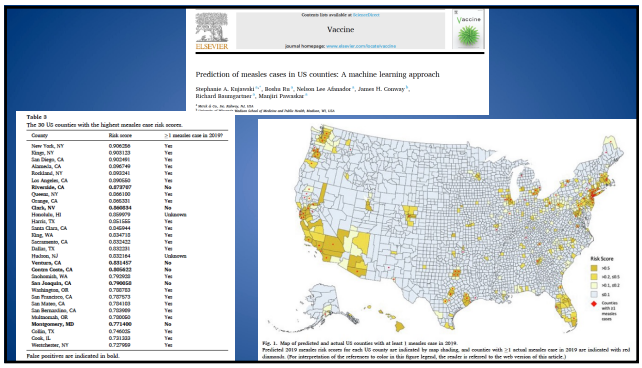

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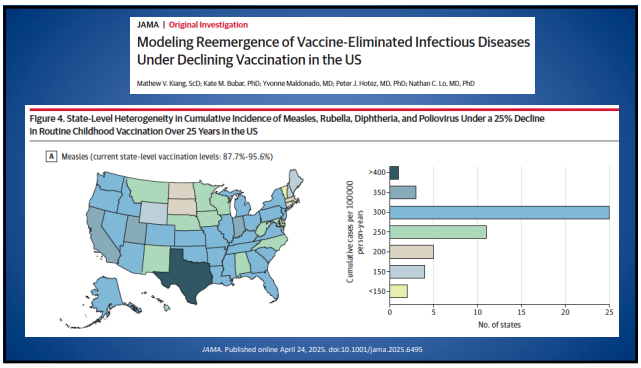

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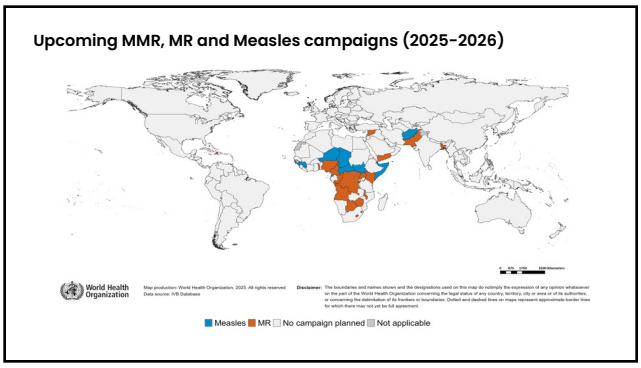

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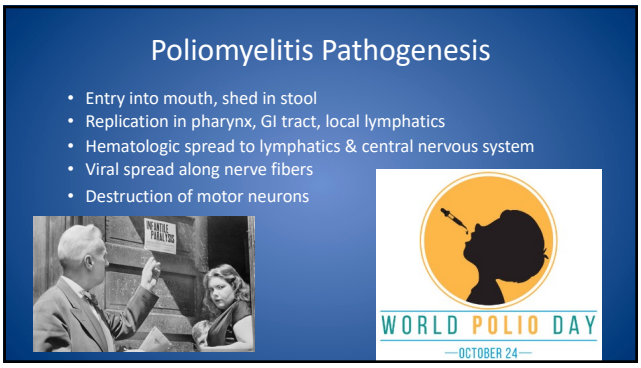

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Available polio vaccines

- Inactivated polio vaccine (IPV)
  - Only polio vaccine used in the United States since 2000
  - It is given by shot in the leg or arm, depending on the patient's age.
- Oral polio vaccine (OPV)
  - **No longer licensed or available** in the United States
  - Still used in many parts of the world.
- Anyone not fully vaccinated (or unsure) should have 1-2 doses prior to travel outside the US

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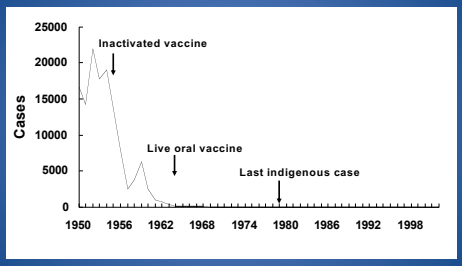
Poliomyelitis—United States, 1950-2002



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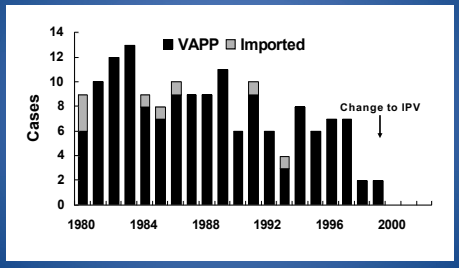
Poliomyelitis—United States, 1980-2002



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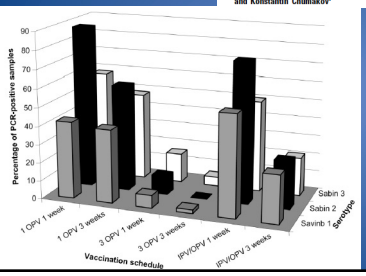
Effect of Different Vaccination Schedules on Excretion of Oral Poliovirus Vaccine Strains

Majid Laassri,[1] Kathleen Lottenbach,[4] Robert Belshe,[4] Mark Wolff,[2] Margaret Rennels,[3] Stanley Plotkin,[5] and Konstantin Chumakov[1]



JID 2005:192 (15 December)

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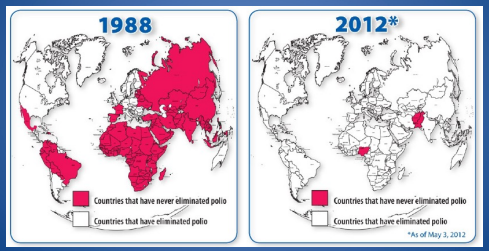
Global *Wild-type* Polio Elimination



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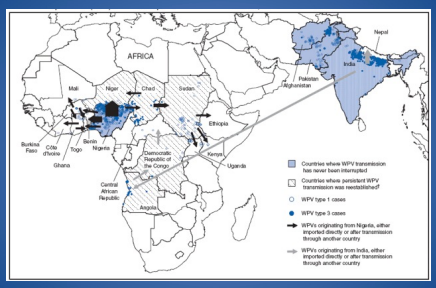

MMWR April 17, 2009 / 58(14);357-362

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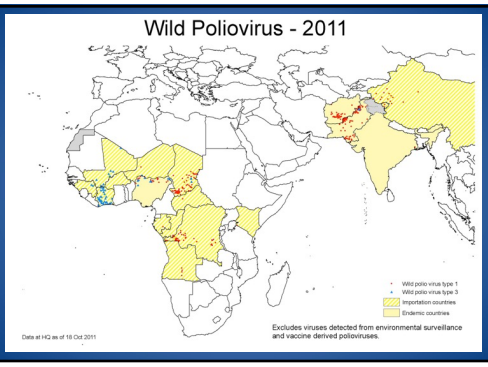

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POLIO GLOBAL ERADICATION INITIATIVE

- Type 2 wild poliovirus declared eradicated in September 2015
  - last virus detected in India in 1999.
- Type 3 wild poliovirus was declared eradicated in October 2019
  - last detected in November 2012.
- Only type 1 wild poliovirus remains
- **Circulating Vaccine-Derived Polioviruses**
  - cVDPV type 2 (cVDPV2) are the most prevalent
  - cVDPV only form of the poliovirus that affects African Region

https://polioeradication.org/

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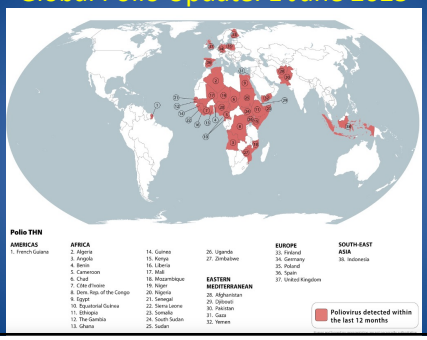
Global Polio Update: 1 June 2025



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Wastewater surveillance

- Wastewater testing can be used to:
  - Define the geographic size and extent of the outbreak
  - Determine where public health interventions should be focused
  - Describe the frequency of poliovirus importations & circulation of poliovirus
- Detection of poliovirus in wastewater **can:**
  - Indicate importation and when persistently detected, person-to-person transmission of poliovirus

https://www.cdc.gov/polio/php/laboratories/wastewater-testing.html

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- September-December 2024 polio detected in wastewater:
  - Spain, Poland, Germany, UK, Finland
  - July 2024 detected in Gaza
- Vaccine-derived poliovirus type-2 (VDPV2)
  - Based on the expected rate of nucleotide changes, had been circulating for >1 year
- No known cases or asymptomatic infections detected
- Communities responded with IPV catch-up campaigns

Update: Wastewater poliovirus detections in the EU: a call for continued surveillance and maintaining high vaccination coverage rates

European Centre for Disease Prevention and Control
An agency of the European Union

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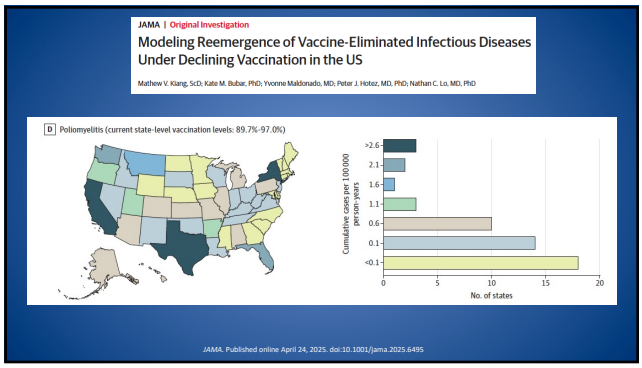

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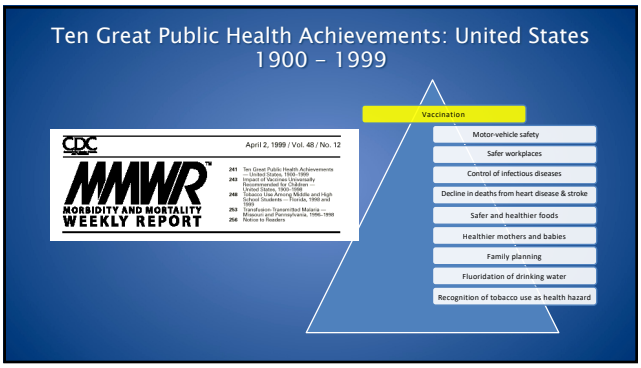

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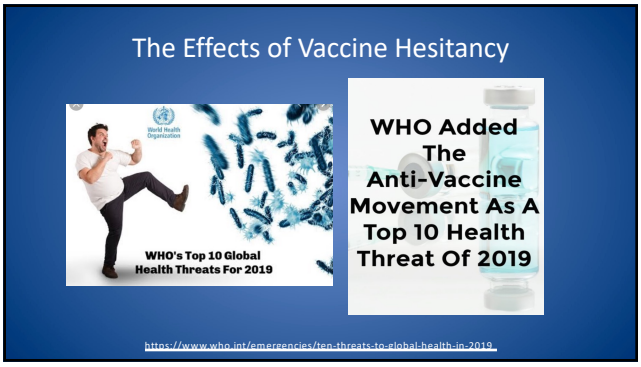

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The Challenge of Maintaining 'acceptance' of vaccines?

- High immunization rates lead to low disease incidence
- Low disease incidence leads to complacency about need to vaccinate
- Concerns about real (or perceived) adverse events associated with vaccines lead to *vaccine hesitancy*
- Diseases re-emerge as pathogens continue to circulate.

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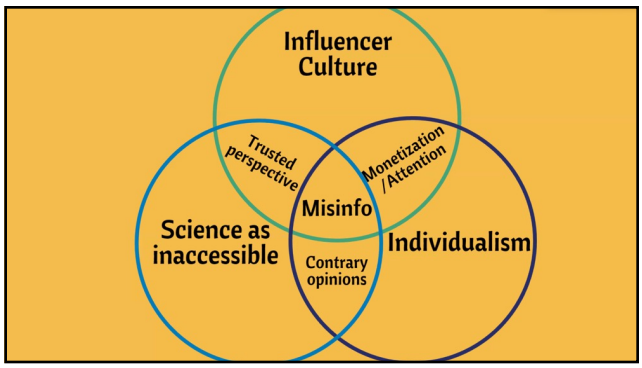
Influencer Culture
Trusted perspective
Monetization /Attention
Misinfo
Science as inaccessible
Individualism
Contrary opinions

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Our ultimate PUBLIC HEALTH goals:
Protect every individual & their community
https://icon-library.com
Inconvenience
Confusion
Myths
Complacency
https://www.allthescience.org/what-is-a-weight-scale.htm
Access
Acceptance
Facts
Importance
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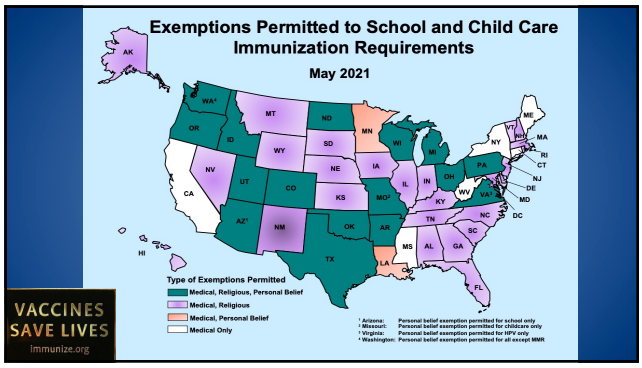
Exemptions Permitted to School and Child Care Immunization Requirements
May 2021
Type of Exemptions Permitted
Medical, Religious, Personal Belief
Medical, Religious
Medical, Personal Belief
Medical Only
VACCINES SAVE LIVES
Immunize.org

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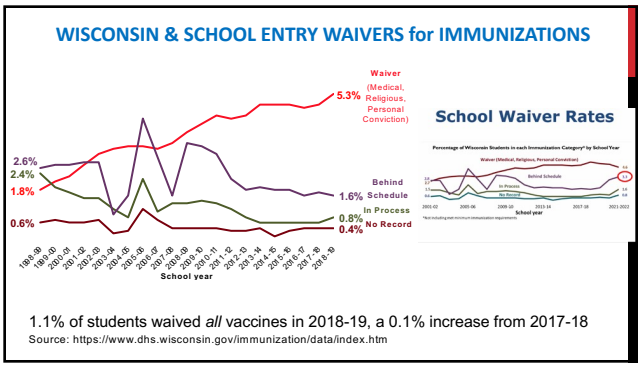
WISCONSIN & SCHOOL ENTRY WAIVERS for IMMUNIZATIONS
Waiver (Medical, Religious, Personal Conviction)
5.3%
2.6%
2.4%
1.8%
Behind Schedule
1.6%
In Process
0.8%
No Record
0.4%
0.6%
School year
School Waiver Rates
1.1% of students waived all vaccines in 2018-19, a 0.1% increase from 2017-18
Source: https://www.dhs.wisconsin.gov/immunization/data/index.htm

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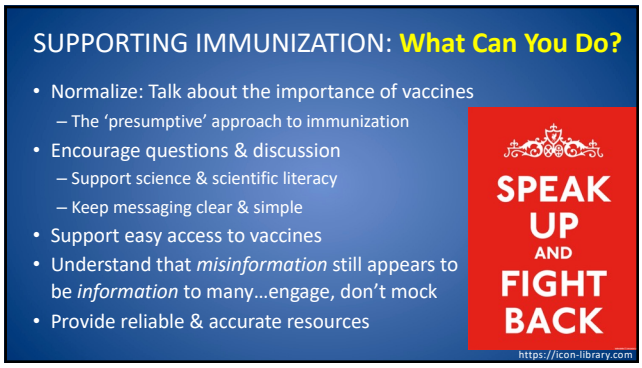
SUPPORTING IMMUNIZATION: What Can You Do?
• Normalize: Talk about the importance of vaccines
– The 'presumptive' approach to immunization
• Encourage questions & discussion
– Support science & scientific literacy
– Keep messaging clear & simple
• Support easy access to vaccines
• Understand that misinformation still appears to be information to many…engage, don't mock
• Provide reliable & accurate resources
SPEAK UP AND FIGHT BACK
https://icon-library.com

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