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Vaccines

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Vaccines

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Course Objectives

- Prevention and Control of Vaccine Preventable diseases
- Global Impact of vaccines: Successes and challenges
- Vaccine fundamentals
  - Basic Immunology
  - Introduction to Vaccinology

Strategies for Prevention and Control

Eradication: Worldwide interruption of transmission.
No disease anywhere

Elimination: Interruption of transmission in a substantial geographic area. No endemic cases in the area, but still cases elsewhere

Control: Reduction of cases in the geographic area of interest

Ingredients for Eradication/Elimination Programs

- Easily recognizable disease
- No non-human reservoir
- Pathogen is genetically stable
- No subclinical infection
- Usually not highly communicable

Ingredients for Eradication/Elimination Programs

- An effective, safe (and cheap) intervention
- Bold vision and determination
- Resources, administrative skill, flexibility
  Cooperation of the affected populations

SMALLPOX (Eradication)
Ingredients for Control

- Very distinctive disease
- Humans only reservoir
- Stable virus
- No sub-clinical infection
- Transmitted slowly
- Vaccine was cheap, easy to administer
- Strong vision

SMALLPOX

Global mass vaccination campaign

Surveillance and containment

Smallpox spreads slowly

Ring vaccination

Administrative barriers

Effective surveillance

SMALLPOX

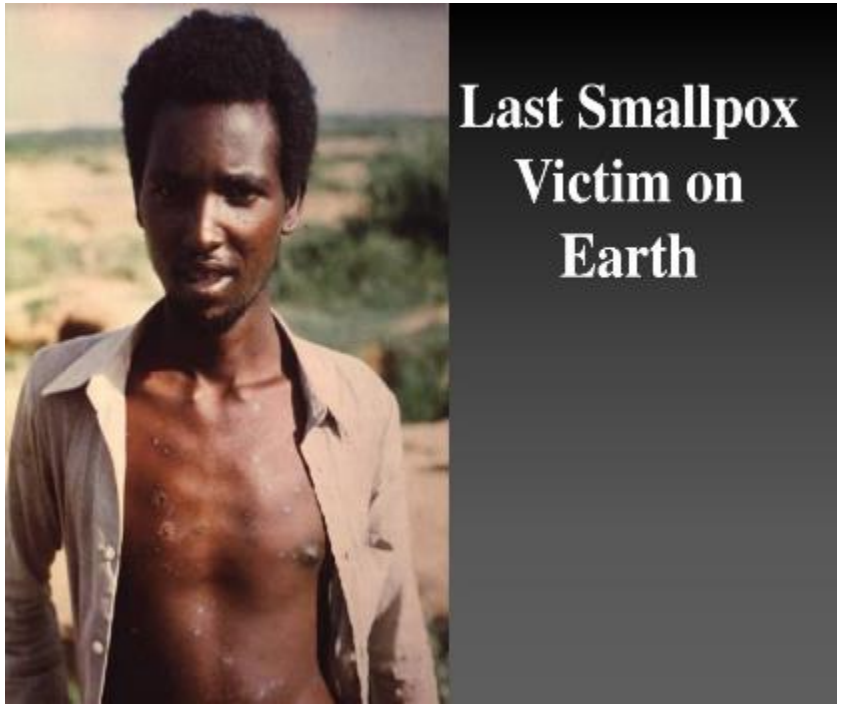
1977 Last naturally-occurring case
Ali Maow Maalin
Cook/ Healthcare Worker, Somalia

1978 Birmingham, UK
Research photographer died
Poor laboratory safety

1980 Declared eradicated by WHO

2014 Vials of smallpox virus found
NIH cold room being renovated

2019 Gas explosion and fire
State Research Center of Virology
Koltsovo, Siberia



2019 Continuing debate whether two stocks
of smallpox virus (US, Russia) should be destroyed

POLIO
Ingredients for Control

- Easily recognized disease
- No non-human reservoir
- 3 pathogens genetically stable
- **MUCH** sub-clinical infection
- Very transmissible
- Vaccine effective –
  - needs several doses
  - easy to administer (oral drops)
  - Cheap
  - but can revert to virulence
- International commitment

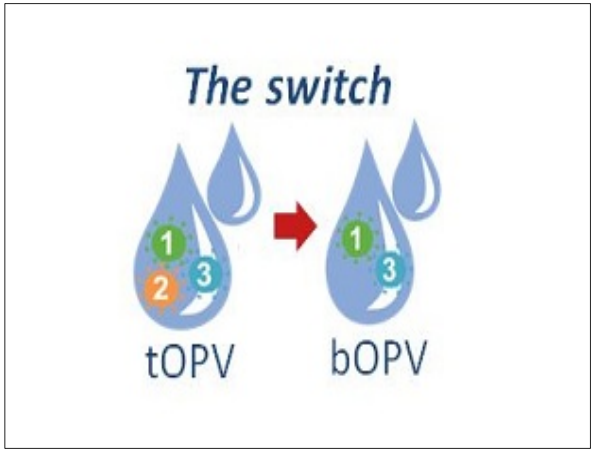
POLIO

- Three individual and immunologically-distinct wild polio virus strains (WP1, WP2, WP3)
- Symptomatically all the same, however genetic differences that require each one to be eradicated
- OPV is a weakened but live virus vaccine, meaning you are giving the recipient a polio virus. In very small number every year, reverts to full virulence and causes **Vaccine Derived Polio Virus (VDPV)**

POLIO ENDGAME

1988 Global Polio Eradication Initiative launched

2012 WPV3 last time seen, presumed eradicated
2015 WPV2 declared eradicated globally
2016 tOPV replaced with bOPV (serotypes 1 & 3)
2019 WPV3 declared eradicated



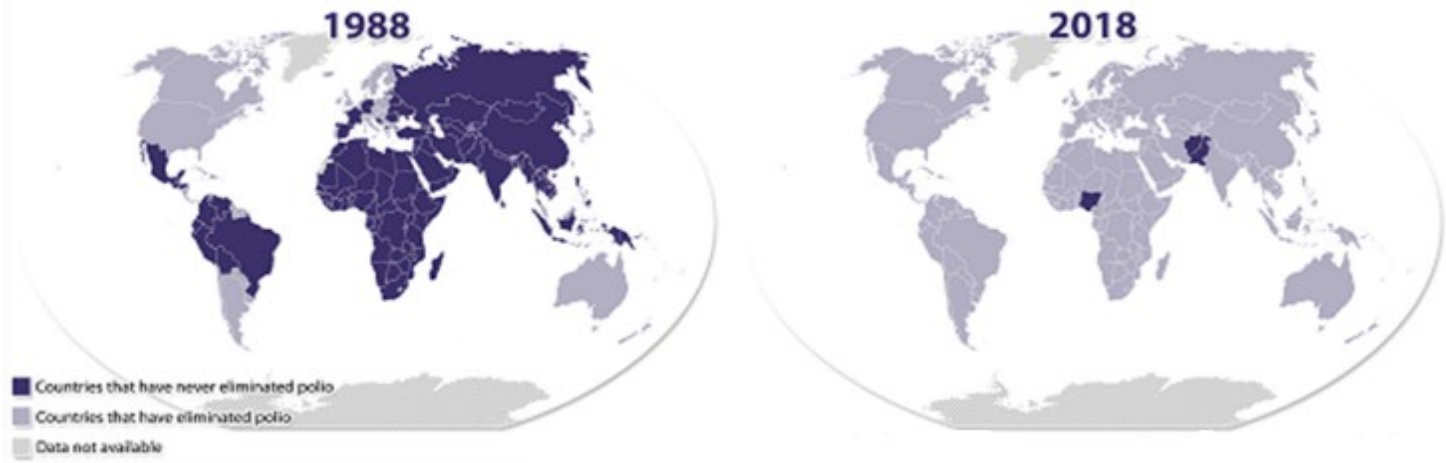
Wild poliovirus (WPV1) continues to circulate

OPV-derived viruses circulating in Africa, SE Asia, China

2016 IPV being introduced into vaccine programs globally

Global POLIO Eradication

- Political instability, wars
- Religious and political opposition
- Immunization fatigue



BBC NEWS

Africa declared free of wild polio in 'milestone'

By Naomi Scherbel-Ball
BBC News
Published
25 August

Wild polio eradicated in Africa

Countries with polio cases in the past 12 months

Vaccine-derived poliovirus

Wild poliovirus

*Afghanistan and Pakistan also have cases of vaccine-derived poliovirus

Source: WHO (data up to 19 August 2020)

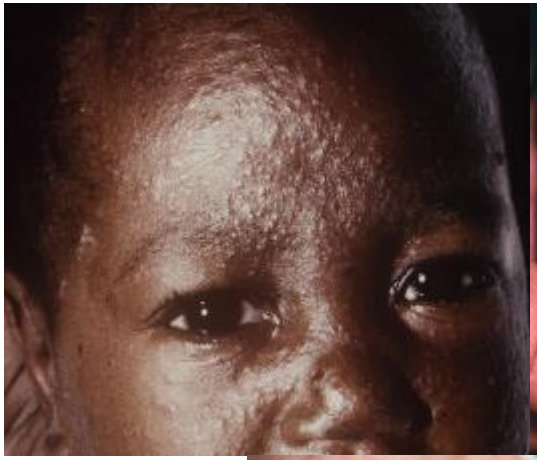
BBC

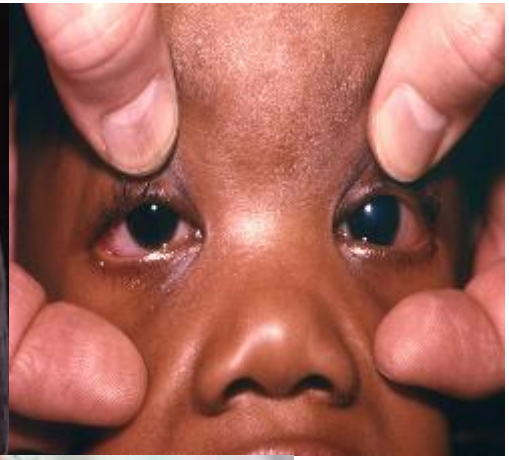
Role of Inactivated Polio Vaccine (IPV)

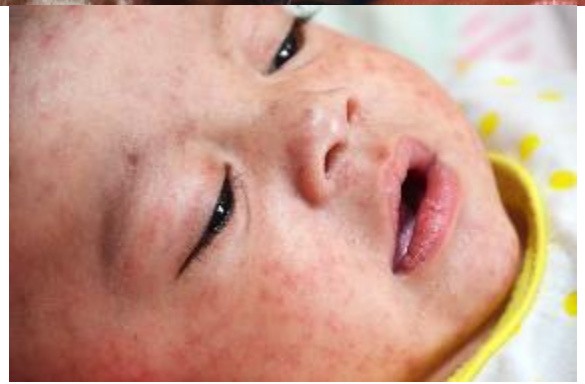
- Every country that has eliminated polio used OPV to do it; because it induces local immunity in the intestinal tract against polio.

- IPV induces only very low-level immunity and cannot interrupt wild type transmission in the environment

Three children with a rash







- Fever to 40°C
- Rhinorrhea
- Cough
- Rash (as pictured)
- Conjunctivitis (as pictured)

Which virus is MOST likely cause of symptoms?

- Rubella
- Varicella
- Lassa fever
- Measles
- Yellow Fever
- Ebola

Which virus is MOST likely cause of symptoms?

- Rubella
- Varicella
- Lassa fever
- **Measles**
- Yellow Fever
- Ebola

Measles
Ingredients for Control

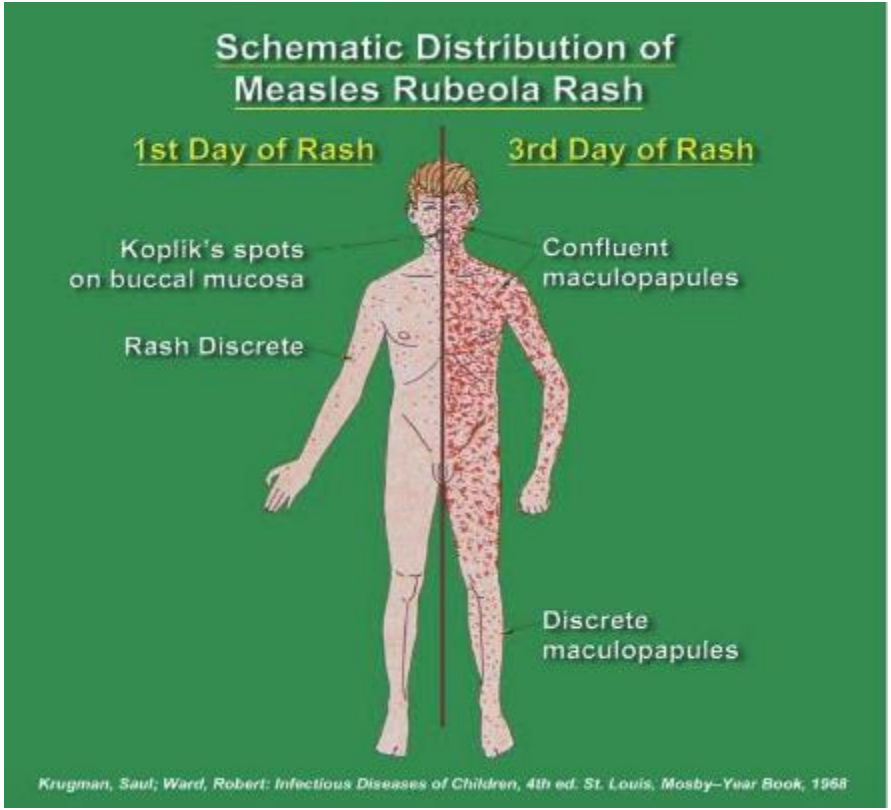
- Distinctive disease
- No non-human reservoir
- Virus is genetically stable
- No subclinical infection

- *Right conditions for elimination or eradication programs*

Measles

- One of the most contagious viral infections. Infecting 90% of susceptible contacts
- Spread during asymptomatic phase
- Can live 2 hours or longer in the air after an infected person coughs or sneezes
- Much more easily spread than COVID-19

Measles



Complications of measles

- Otitis media ~1 in 10
- Pneumonia ~1 in 10
- Diarrhea ~1 in 10
- Acute encephalitis ~1-1000
- Death ~2 per 1000

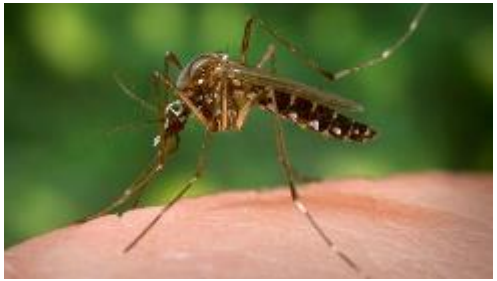
Measles

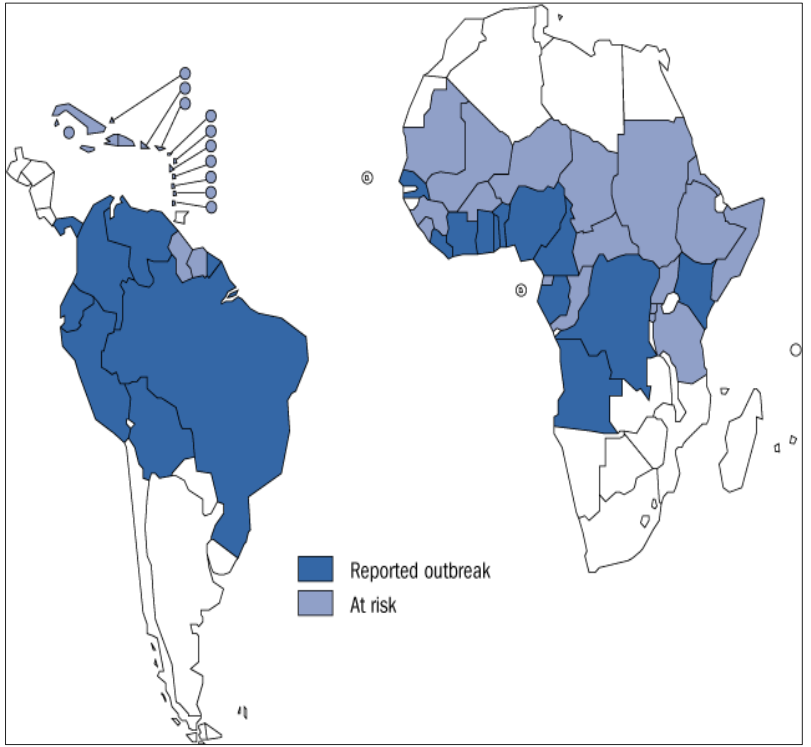
Prevention

- Education of health care personnel and community
- Vaccination
- Nutrition (Vitamin A supplementation)
- Treatment of underlying disease (eg. HIV)

Yellow Fever

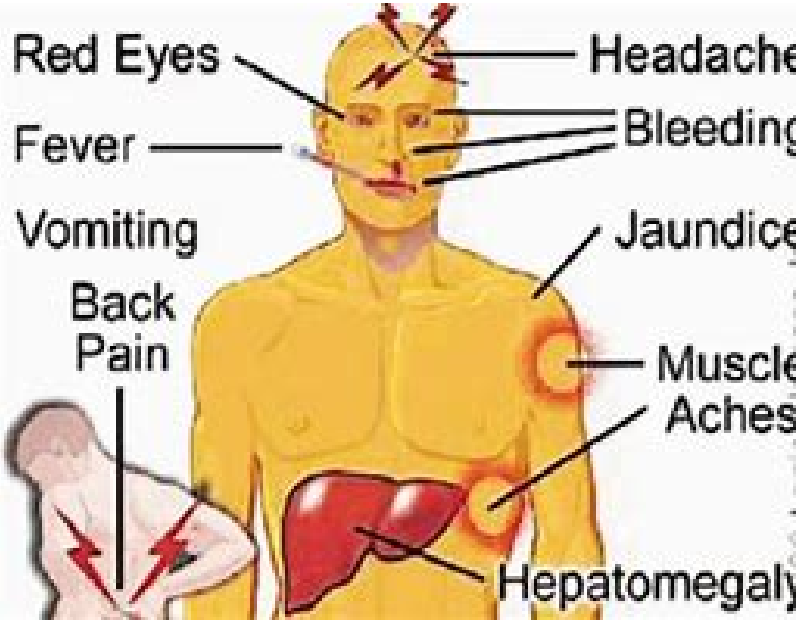
- An acute viral hemorrhagic fever
- Originated in Central Africa
- Spread by *aedes aegypti* mosquito
- Monkeys can also be infected





Yellow Fever

- Incubation period is 3-6 days
- Sudden onset fever, chills
- Yellow eyes
- Headache
- Backache
- Vomiting
- Bleeding
- Death can occur on days 7-12 of illness



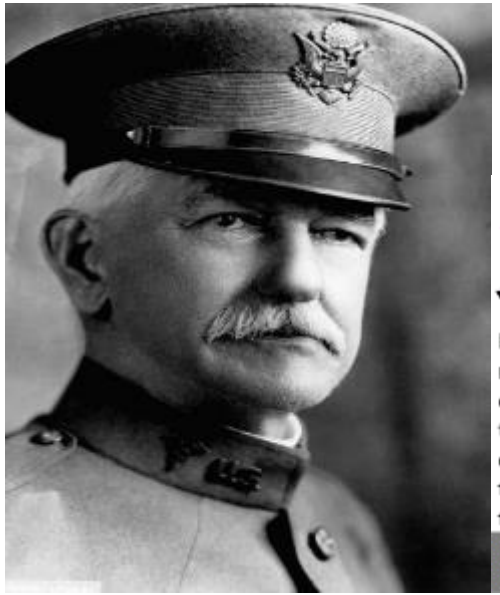
Yellow Fever
Ingredients for Control

1851 First International Sanitary Conference (international cooperation regarding quarantine to prevent cholera and other problems)

1905 Yellow Fever and Malaria control Panama (William Crawford Gorgas)

- Non-distinctive febril illness at beginning
- Non-human reservoirs
  - Monkeys
  - Mosquitos
- Highly effective vaccine

- ***Could be compatible for elimination or control strategies***



Approximately 25,000 workers died during the building of the Panama Canal and approximately 20,000 of them contracted malaria and yellow fever

Yellow Fever and Malaria

Diseases such as yellow fever, malaria, pneumonia, diarrhea and other, aided by poor nutrition caused thousands of deaths. By the late 19th century, the French were victims of these diseases that killed 22 thousand of its workers.

NATIONAL IMMUNIZATION SCHEDULE

Liberia

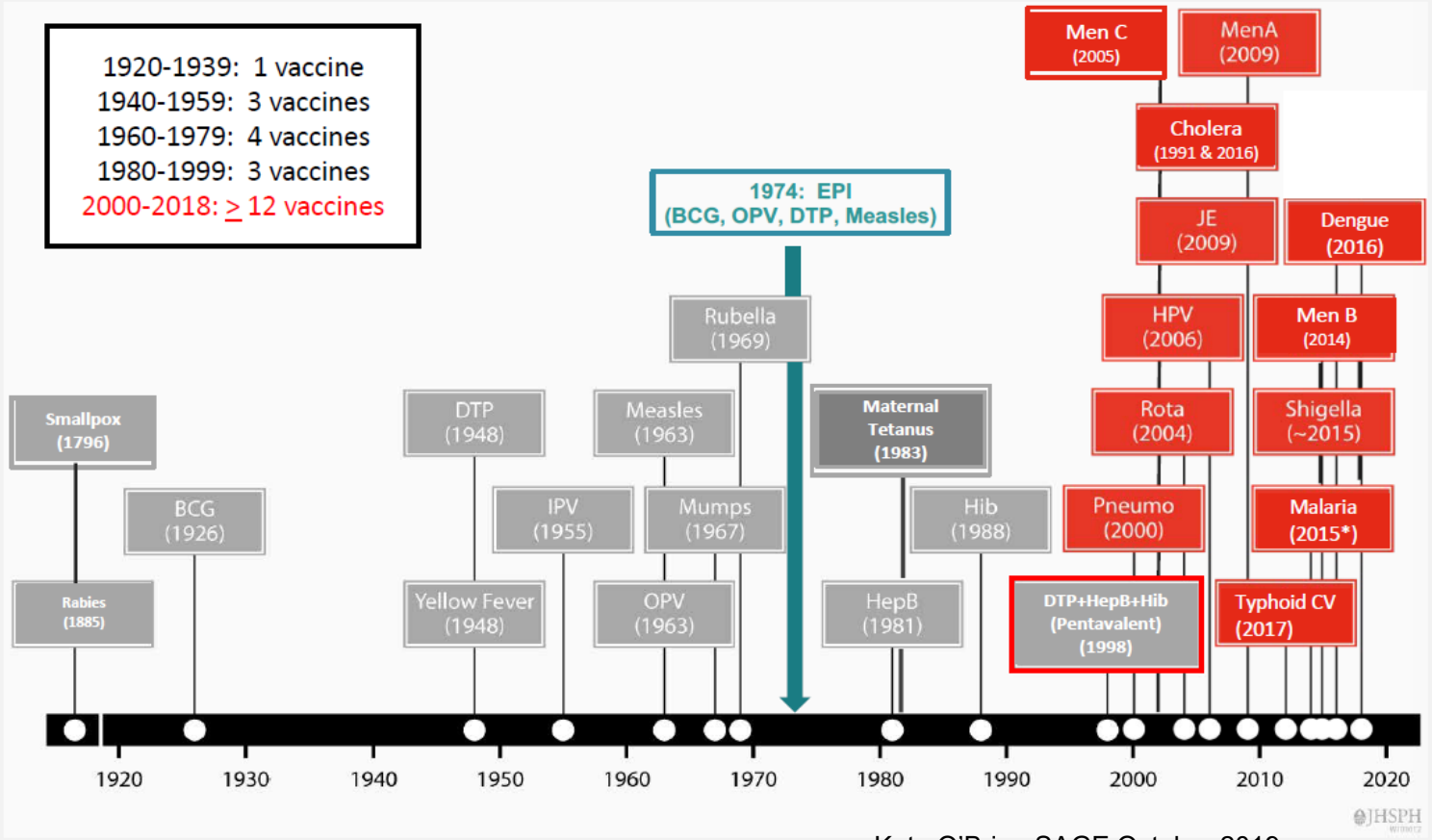
Recommended routine immunization

Vaccine	Description	Schedule	Comments
Primary Infant Vaccination Schedule			
BCG	Bacille Calmette-Guérin vaccine	Birth	
OPV	Oral polio vaccine	Birth; 6, 10, 14 weeks	
DTwPHibHepB	Diphtheria and Tetanus and Pertussis and Haemophilus influenzae and Hepatitis B vaccine	6, 10, 14 weeks	
Pneumo_conj	Pneumococcal conjugate vaccine	6, 10, 14 weeks	
Rotavirus	Rotavirus vaccine	6, 10, 14 weeks	
IPV	Inactivated polio vaccine	14 weeks	From January 2018
Measles	Measles vaccine	9 months	
YF	Yellow fever vaccine	9 months	
Adolescents and Adult Vaccination Schedule			
HPV	Human Papillomavirus vaccine	10 years (2 doses)	Not available in all parts of the country
TT	Tetanus toxoid vaccine	14 years; +4 weeks; +6, +12 months	And pregnant women

Reference: Modified from World Health Organization (WHO)
Date accessed: 29 March 2018

Global Impact of Vaccines: Successes and Challenges

Substantial Advancement in Vaccine Innovation in last 15 years…and more to come



Kate O'Brien SAGE October 2019

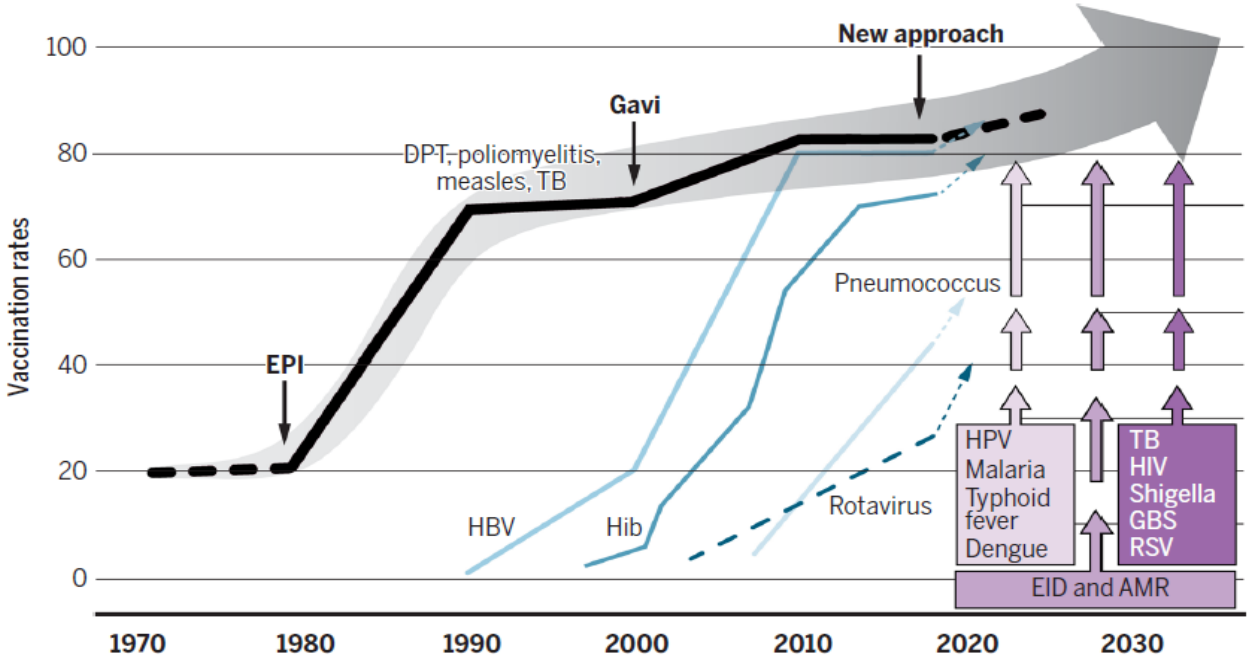


Fig. 1. Historical and projected vaccination coverage rates. The graph shows expansion of global vaccination rates over the past 50 years for vaccines against DPT, poliomyelitis, and measles and the BCG (Bacillus Calmette-Guérin) vaccine for TB, all of which were recommended in 1984 by the WHO EPI. In 2000, the establishment of Gavi allowed the acceleration and global expansion of vaccination efforts against hepatitis B virus (HBV), *Haemophilus influenzae* type b (Hib), pneumococcus, and rotavirus. Licensed vaccines exist for protection against human papillomavirus (HPV), malaria, typhoid fever, and dengue, but large-scale vaccination against these diseases in low-income countries has not yet been implemented. Vaccines against TB, HIV, shigella, group B streptococcus (GBS), respiratory syncytial virus (RSV), antimicrobial-resistant pathogens (AMR), and emerging infectious diseases (EIDs) are likely to reach the late stages of development during the next 3 to 10 years. EIDs refer to about 30 different pathogens that have the possibility to cause outbreaks and pandemics and for which we do not yet have vaccines (*31*).

Progress and Challenges with Achieving Universal Immunization Coverage

2018 WHO/UNICEF Estimates of National Immunization Coverage

(Data as of July 2019)

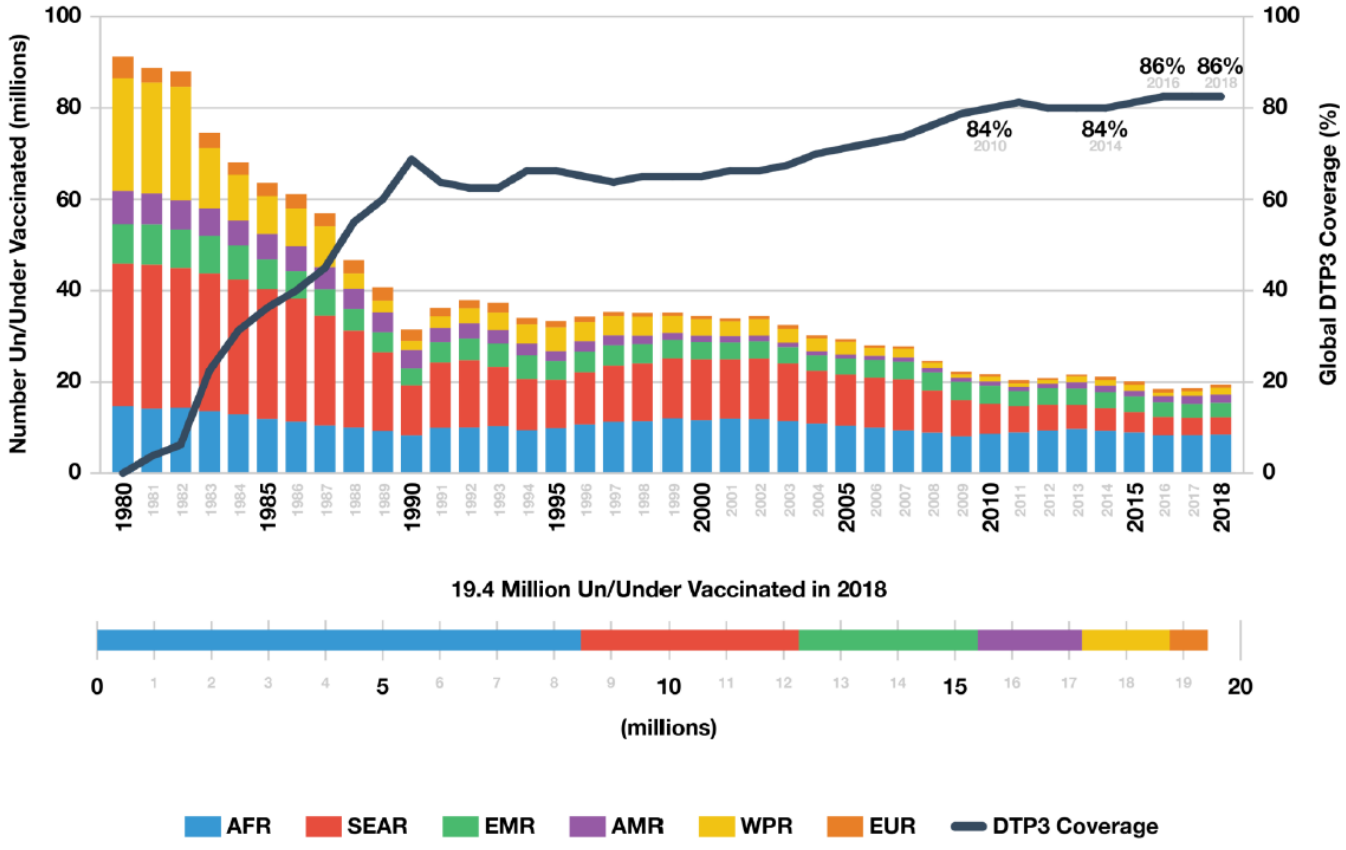
Sources:

- Member states reports to WHO and UNICEF.
- The 2019 World Bank Development Indicators Online
- United Nations, Population Division, 2019 revision

unicef

World Health Organization

Almost 9 out of 10 children reached in 2018, almost 20 million children un or under vaccinated



Coverage of a third dose of vaccine protecting against diphtheria, tetanus, and pertussis (DTPcv-3) remains at 86% in 2018, leaving 19.4 million children vulnerable to vaccine preventable diseases

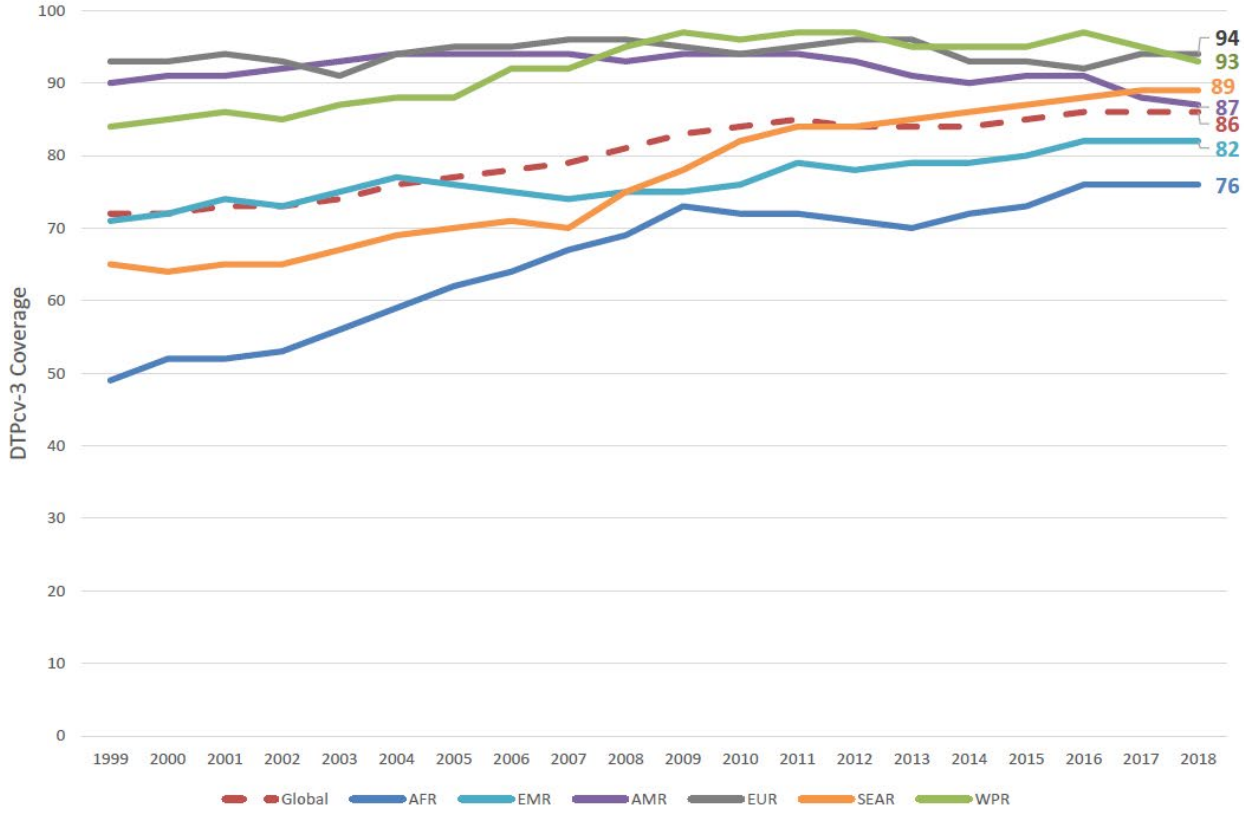
The key goal of the Immunization Agenda 2030 is to make vaccination available to everyone, everywhere, by 2030.

While immunization is probably the most successful public health intervention, reaching 86% of infants is not enough. The upward trend in coverage has increased by only 5% in the past decade and has plateaued.

unicef World Health Organization

WUENIC 2019

Coverage levels vary substantially across regions



The gap between the best performer, the European Region, and the lowest performer, the African Region, is 18 percentage points

The Western Pacific Region and especially the Region of the Americas experience drops in coverage.

The biggest gains have been made by the African Region (over a 20 year period), and the South East Asian Region (over a ten year period).

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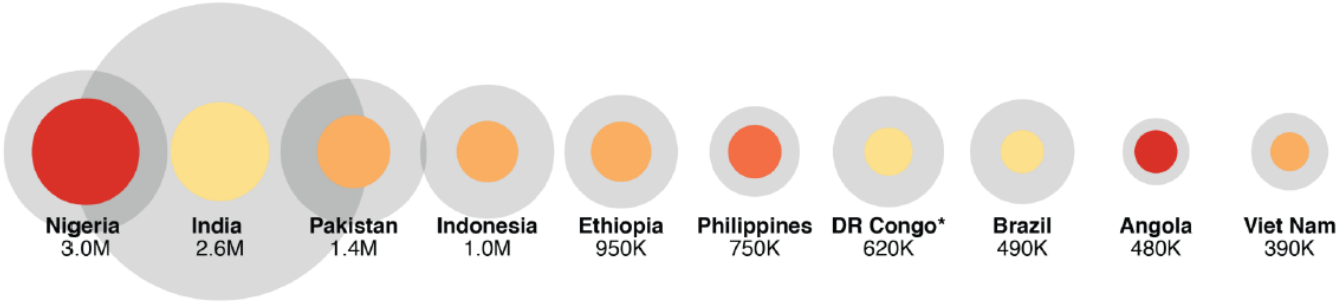
WUENIC 2019

Just 10 countries account for 60% of unprotected children



* Preliminary survey suggests lower coverage and higher number of unvaccinated

Countries with most unprotected children

10 countries account for 11.7 of the 19.4 million under and un vaccinated children in the world (60%). This list includes some countries with moderate coverage and very large birth cohorts, and other countries with substantially lower coverage.

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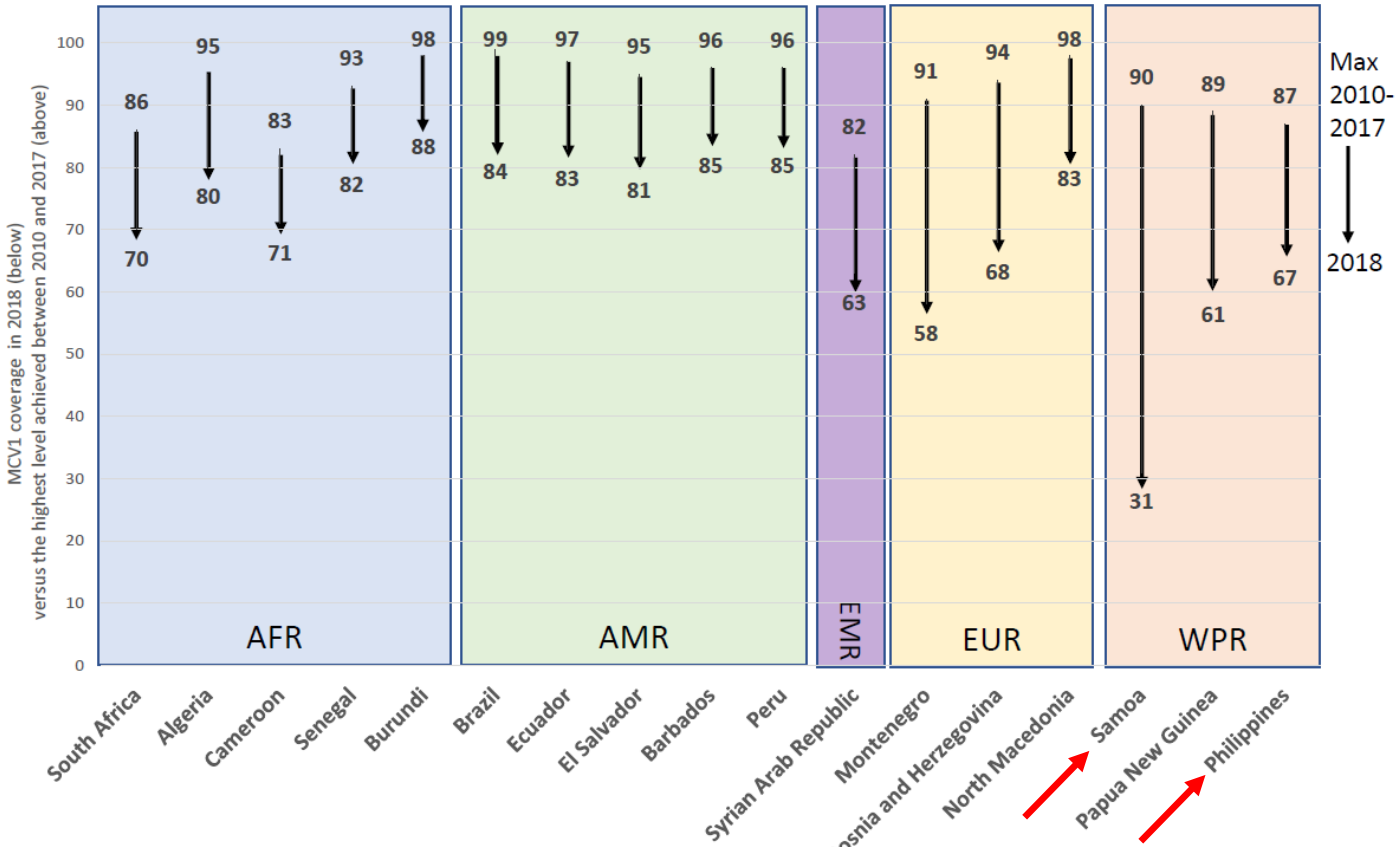
World Health Organization

WUENIC 2019

However, many countries that previously had attained high coverage levels backslided in the last few years



Many countries that had previously reached at least 90% coverage with a first dose of measles containing vaccine, dropped back in the last few years. The chart shows 19 selected countries with significant drops in coverage (10 percentage points or more).

Reasons for backsliding include complacency, lack of investment in public health, conflict, and in some places lack of trust in vaccines.

Measles elimination requires sustained very high coverage in all age and population groups.

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WUENIC 2019

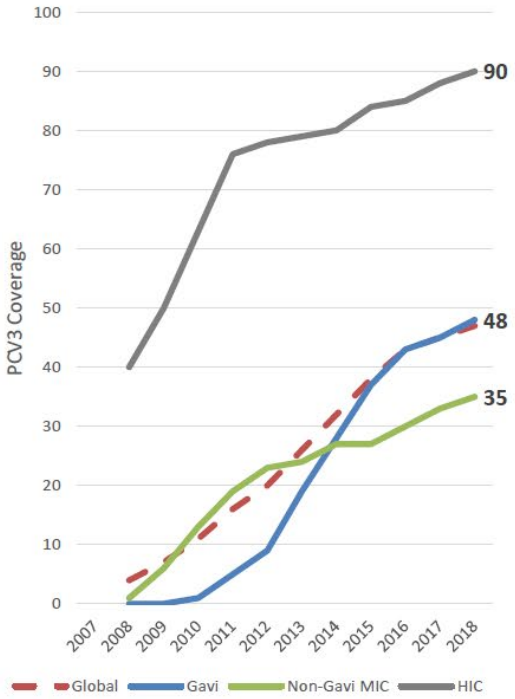
GAVI'S IMPACT

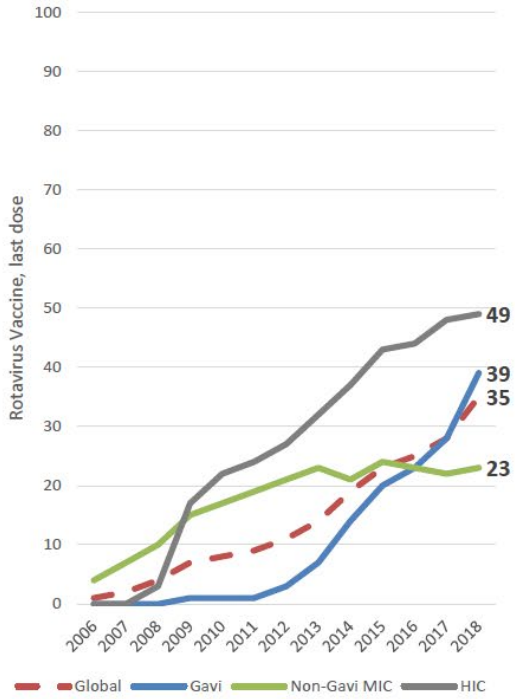
- ***Increased childhood survival***
  - Halved childhood mortality by preventing approximately 13 million deaths
  - Marked decline in incidence of deadly and debilitating infectious diseases.

- ***National Development thrives.***
  - For every US$ 1 invested in vaccines in Gavi-supported countries, there is a US$ 54 return in savings from averted illness and broader societal benefits.

- ***Global health security improves.***
  - In the face of global challenges, such as climate change, urbanization, human migration, fragility and conflict, Gavi has helped countries broaden vaccine coverage and improve health systems.

Coverage for newer vaccines in Gavi countries is now better than average





Progress for newer vaccine uptake

The trajectories for Pneumococcal Conjugate and Rotavirus Vaccines are especially noteworthy, as lower income countries have been able to achieve higher coverage than the global average thanks to support from the Gavi Alliance. Non-Gavi Middle Income countries are falling behind.

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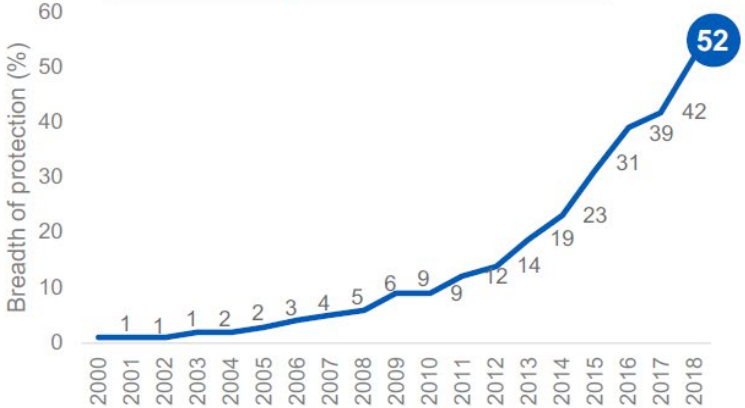
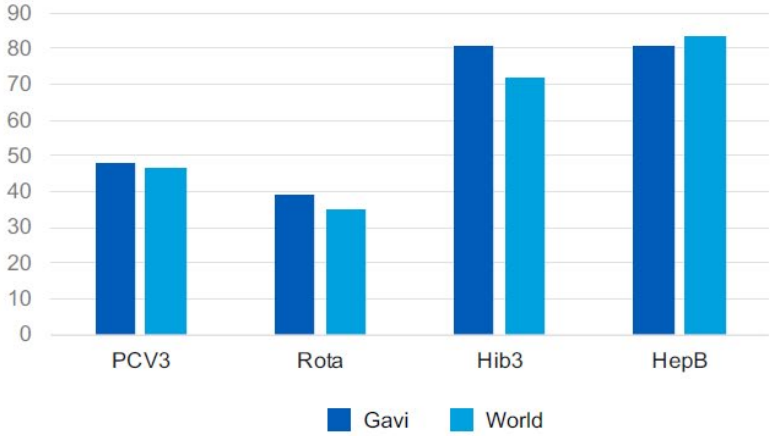
Success in scaling up new vaccines and increasing coverage in Gavi countries

Breadth of protection Gavi 68



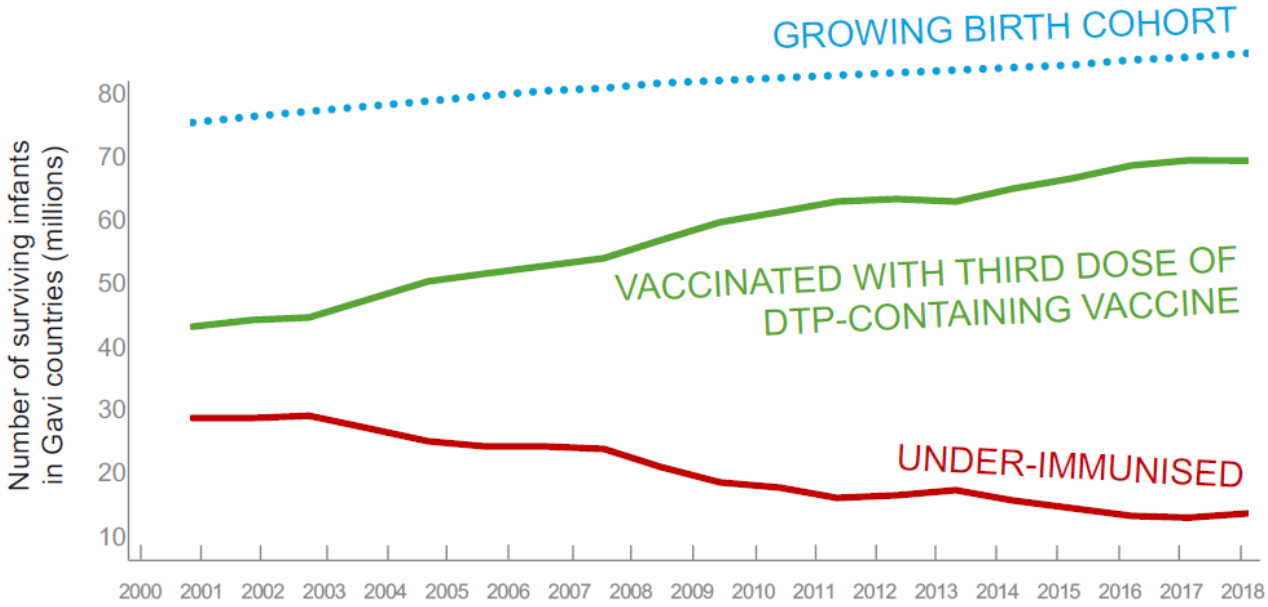
Rapid scale up of new vaccines in Gavi supported countries

Coverage in 2018



Coverage of select antigens now higher in Gavi supported countries vs. global

Significant coverage gains since Gavi's inception yet children being missed



Source: WUENIC 2019 update

- In last ~20 years, succeeded in vaccinating 4 in 5 children in Gavi supported countries
- Keeping pace with population growth will increasingly be a challenge
- Reaching 5 in 5 children will require new thinking and new approaches

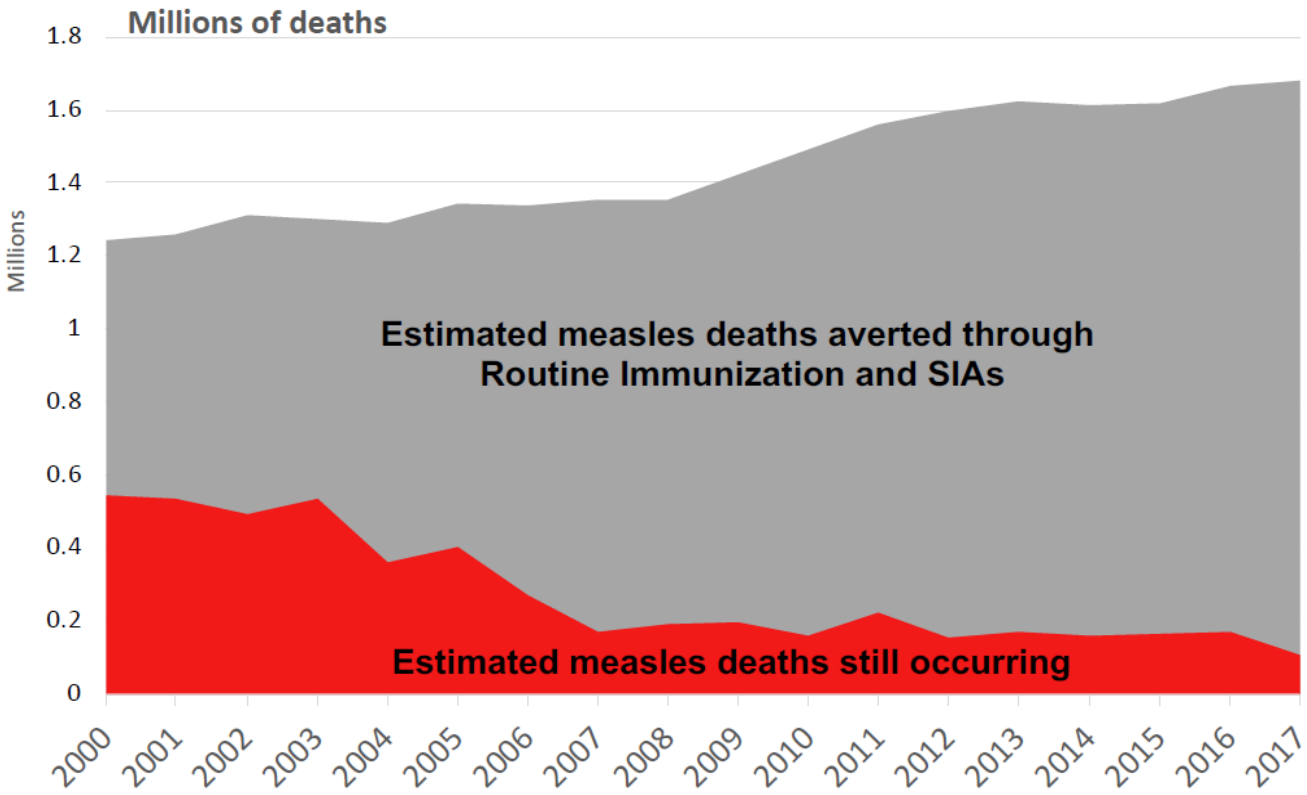
Gavi The Vaccine Alliance

Major Challenges to GVAP

- Accelerating urbanization
- Migration and displacement
- Conflict and political instability
- Vaccine unaffordability in middle-income countries
- Unexpected vaccine supply shortages both locally and globally
- Rising vaccine hesitancy

Measles Highlights Challenges in Vaccine Delivery

Measles program has prevented tens of millions of deaths in less than 2 decades, 2000 - 2017

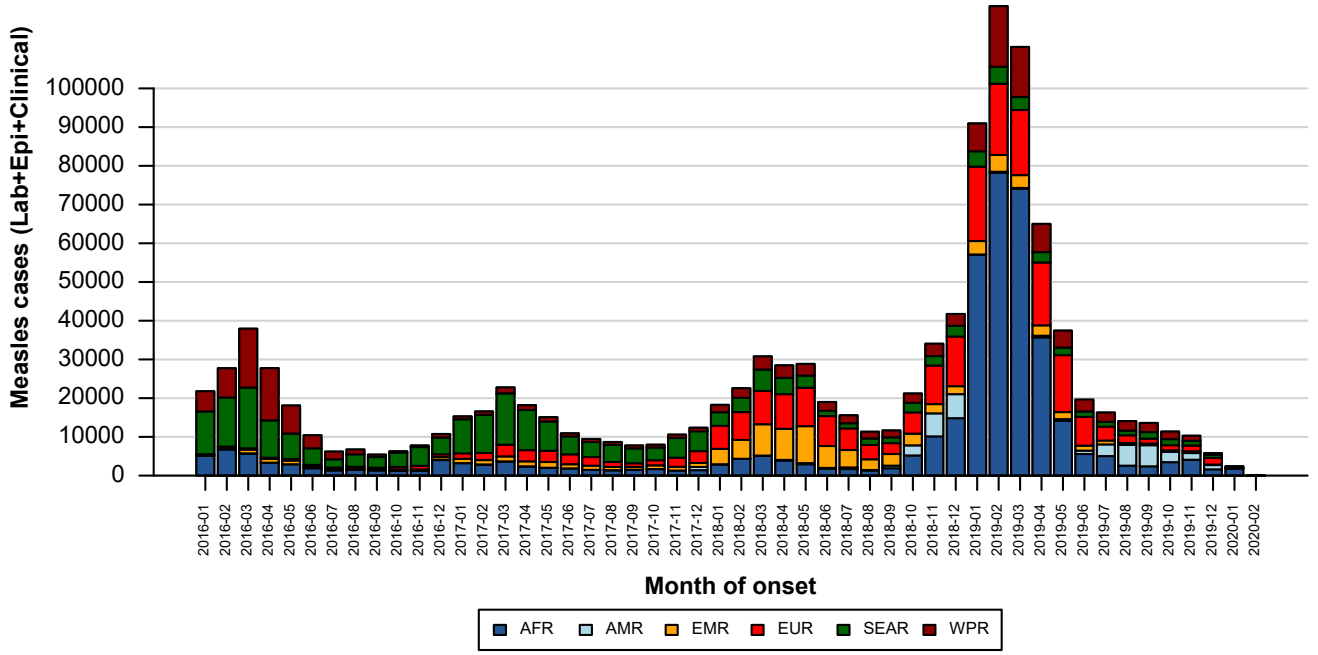


Measles vaccination has averted **21.1 million** estimated deaths 2000-2017

Measles contribution to U5 mortality has dropped from 6% to 2%

110K (estimated)

Source: Weekly epidemiological record, No 48, 2018, 93, 649–660 http://www.who.int/wer


Measles cases (Lab+Epi+Clinical)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
2016-01
2016-02
2016-03
2016-04
2016-05
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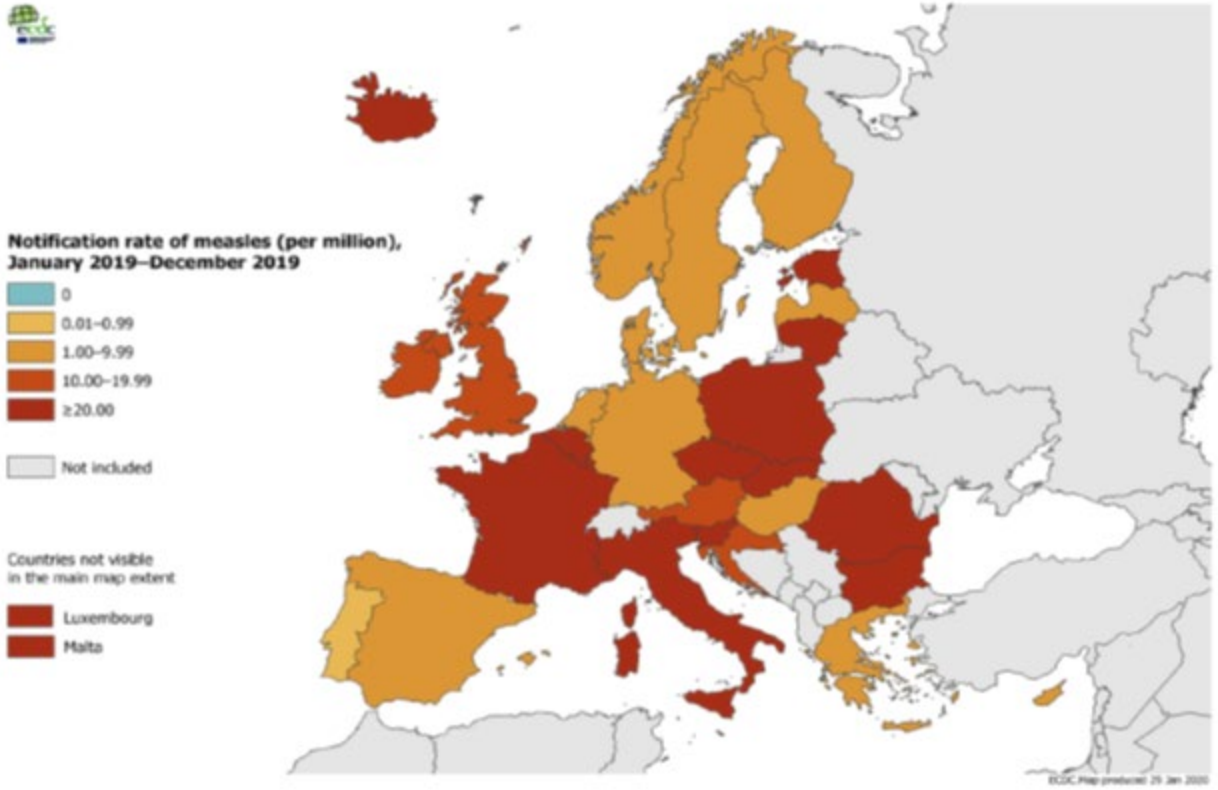
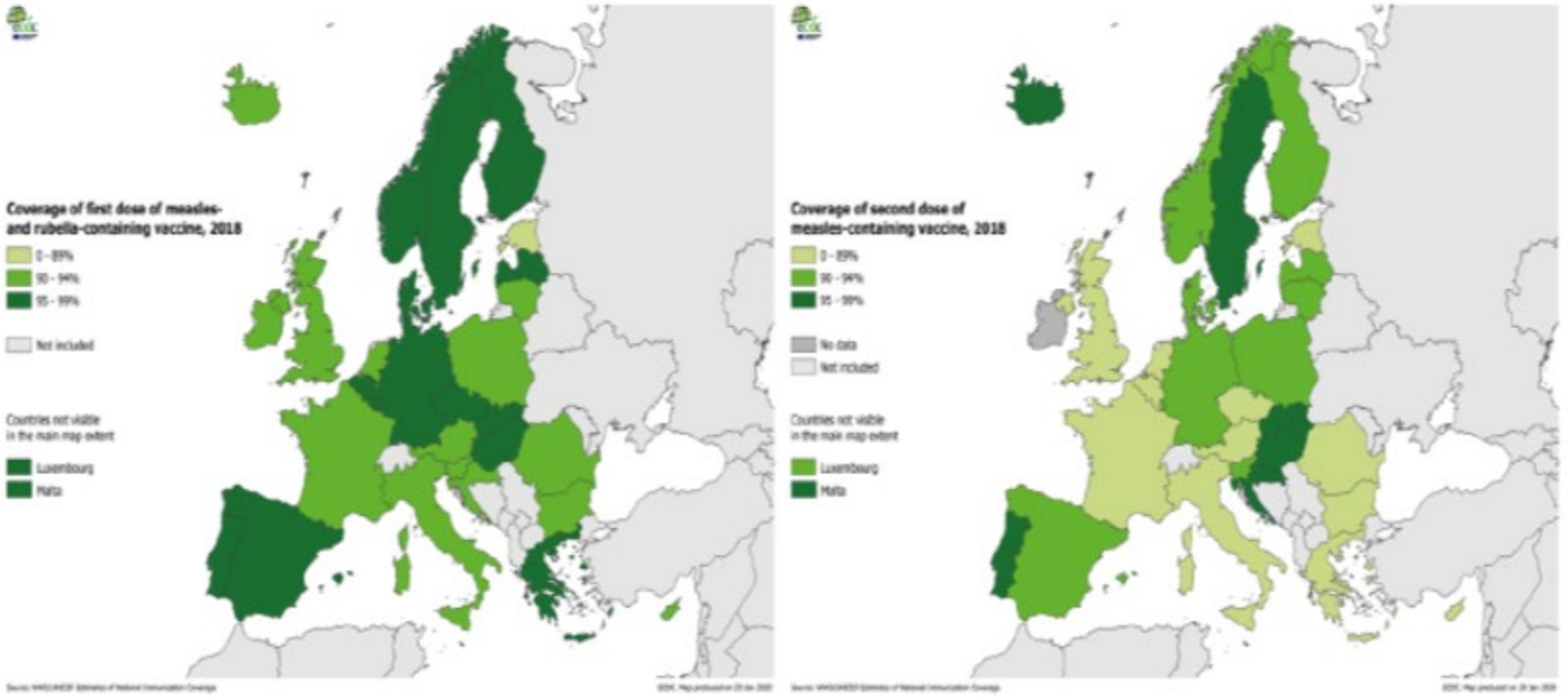
2019-11
2019-12
2020-01
2020-02
Month of onset
AFR
AMR
EMR
EUR
SEAR
WPR

Figure 2. Measles notification rate per million population by country, EU/EEA, 1 January 2019–31 December 2019



Ten deaths (case-fatality rate (CFR): 0.09%) attributable to measles were reported to TESSy during the 12-month period in Romania (5), France (2), Hungary (1), Italy (1) and United Kingdom (1) (see Figure 3). Over the 12 month period, the case fatality rates by age group ranged between 0 and 0.09% (Table 2).

Figure 4. **Vaccination coverage for first (left) dose of a measles- and rubella-containing vaccine and second (right) dose of a measles-containing vaccine, EU/EEA, 2018**



thebmj

BMJ 2019;364:l739 doi: 10.1136/bmj.l739 (Published 14 February 2019)

NEWS

Philippines measles outbreak is deadliest yet as vaccine scepticism spurs disease comeback

The sharp drop came in the wake of a political battle over Sanofi's dengue vaccine Dengvaxia, which was discontinued in the Philippines last year over safety concerns despite the company's protests, as politicians traded blame.[3]

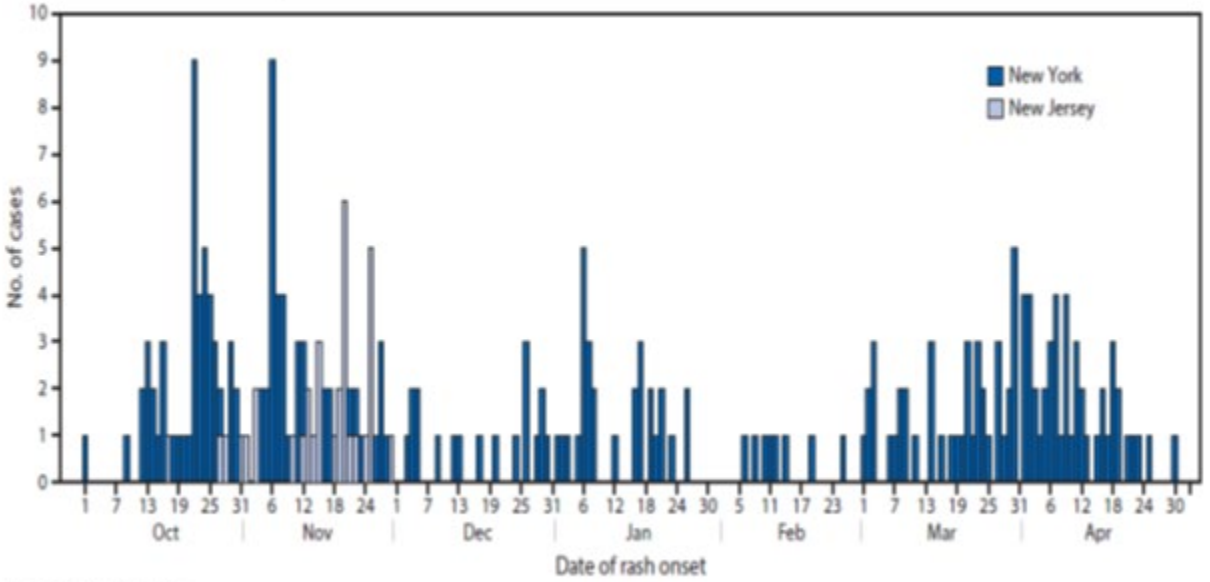
US measles outbreak concentrated among unvaccinated children

As 2019 begins, a measles outbreak has been reported in Washington state, and the number of cases has been steadily increasing. As of Feb 11, there have been 54 confirmed cases, according to the Washington State Department of Health (DOH) and all but one have occurred in Clark County, which borders on the state of Oregon. There are an additional 11 unconfirmed cases plus four confirmed related cases in Oregon.

As of Feb 7, four other outbreaks been reported in the USA in 2019: three in New York, and one in Texas.

Measles Outbreaks from Imported Cases in Orthodox Jewish Communities — New York and New Jersey, 2018–2019

FIGURE. Number of measles cases, by date of rash onset — New York (n = 242)* October 1, 2018–April 30, 2019, and New Jersey (n = 33) October 17, 2018–November 30, 2018



* Excludes New York City.

Vaccine hesitancy

Definition of WHO Sage

A behaviour, influenced by a number of factors including issues of **confidence** [do not trust vaccine or provider], **complacency** [do not perceive a need for a vaccine, do not value the vaccine], and **convenience** [access]. Vaccine-hesitant individuals are a heterogeneous group who hold varying degrees of indecision about specific vaccines or vaccination in general. Vaccine-hesitant individuals *may accept* all vaccines *but remain concerned* about vaccines, some may refuse or delay some vaccines, but accept others; some individuals may refuse all vaccines.

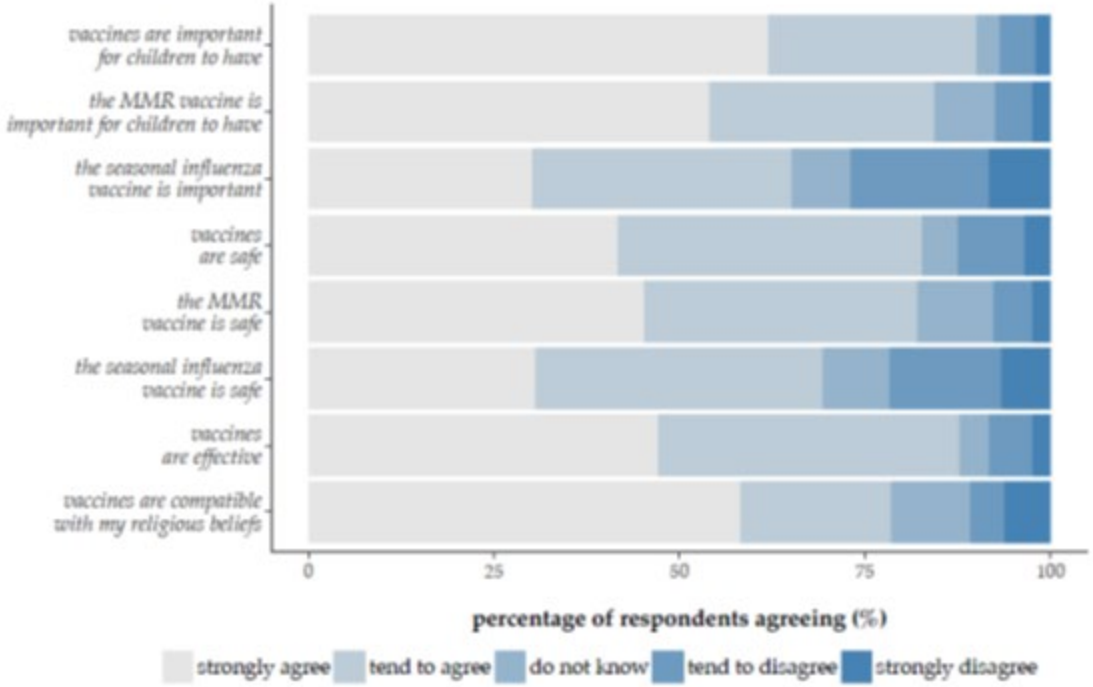


Figure 3: **The majority of the EU public agree that vaccines are important, safe, and effective**. Most of the EU public either strongly or tend to agree that vaccines – including the MMR and seasonal influenza vaccines – are important, safe, and effective. However, the seasonal influenza vaccine is viewed as both less important and less safe than the MMR vaccine and vaccines generally.

Vaccine Fundamentals

Immune system overview

- **Immunity**- the ability of an organism to resist an infection or toxin. The human body must be able to differentiate “self” from “non-self” (eg: bacteria, viruses, pollens)

- **Antigen**- anything that triggers an immune response
  - entire pathogen (bacteria,virus);
  - toxin expressed by pathogen;
  - piece of a pathogen (capsular polysaccharide)

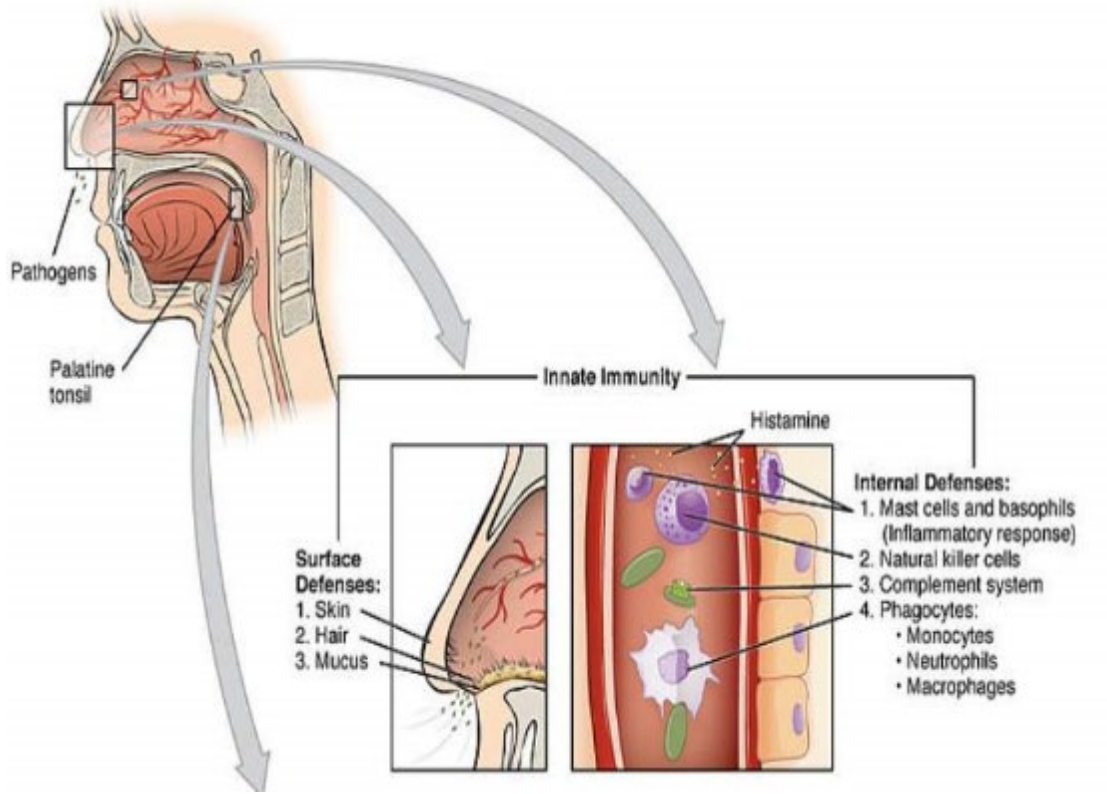
- Immune system has two overlapping subsystems:
  - **Innate** immune system
  - **Adaptive** immune system

Innate Immune System

- Also called “non-specific” or “inborn” immune system
- Functions as the first line of defense against infection
- Response is non-specific

Components of the Innate Immune System

- Non-specific barriers
  - Skin, saliva, mucous
- Soluble factors
  - Complement proteins,
  - Cytokines (responsible for inflammation)
- Cellular components
  - Neutrophils, basophils
  - Macrophages
  - Dendritic cells

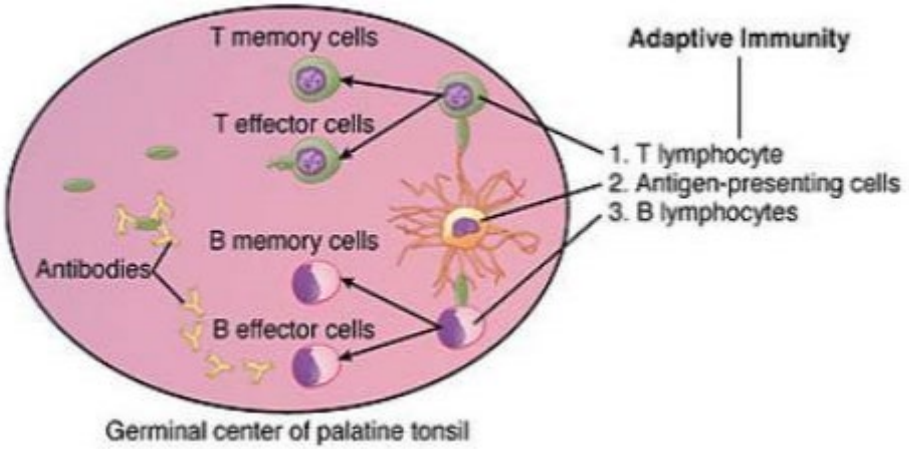


Adaptive Immune System

- Constantly evolves as we encounter new antigens
- Creates targeted response (antigenic specificity) to antigens
- Takes longer to develop than innate immunity because it is antigen-specific
- Said to have **“memory”** because it learns by experience and responds to previously seen antigens

Components of the Adaptive Immune System

- B-Cells
  - Secrete antibodies
  - Become memory cells
- T-Cells
  - Cell mediated immunity
  - Various roles
    - Hunt and destroy abnormal cells (cytotoxic t-cells)
    - Help activate B-cells (helper T-Cells)
- Antigen-presenting cells



What is a Vaccine?

- A substance used to stimulate production of antibodies and provide immunity against one or several diseases
- Prepared from the causative agent, its products, or a synthetic substitute
- Treated to act as an antigen without inducing disease

- Vaccines stimulate B and T-Cells (adaptive immunity) to produce long-lasting immunity

Inactivated vs. Live- attenuated Vaccines

Inactivated:

- Vaccine that is not live
- May be composed of toxoids, killed virues, or recombinent proteins
- Not infectious, but still antigenic

Live-Attenuated:

- Weakened microbes
- Mimic natural infection without causing the disease

Inactivated vs. Live- attenuated Vaccines

Inactivated:

- Vaccine that is not live
- May be composed of toxoids, killed virues, or recombinent proteins
- Not infectious, but still antigenic

- Examples
  - Pneumococcal conjugate
  - DTwPHibHepB
  - Inactivated polio (IPV)
  - HPV

Live-Attenuated:

- Weakened microbes
- Mimic natural infection without causing the disease

- Examples
  - BCG
  - Rotavirus
  - Measles
  - Oral Polio
  - Yellow Fever

Inactivated Vaccines

Advantages:

- Cannot replicate, so cannot cause infection
- Safe even in immunocompromised persons

Disadvantages:

- Produce weaker immune response than a live vaccine
- Induce mostly humoral response (Abs) with little cellular immunity
- Require multiple doses (a priming dose and additional doses to induce adequate immunity)
- Immunity may wane over time, requiring booster doses

Live- Attenuated Vaccines

Advantages:

- Induce strong, long-lasting immune cellular and humoral response
- Schedules often have repeat dosing to ensure a large percent of population is truly immunized (measles needs 95% for ehrd immunity)
  - People may miss dose or some people may not respond well to first dose

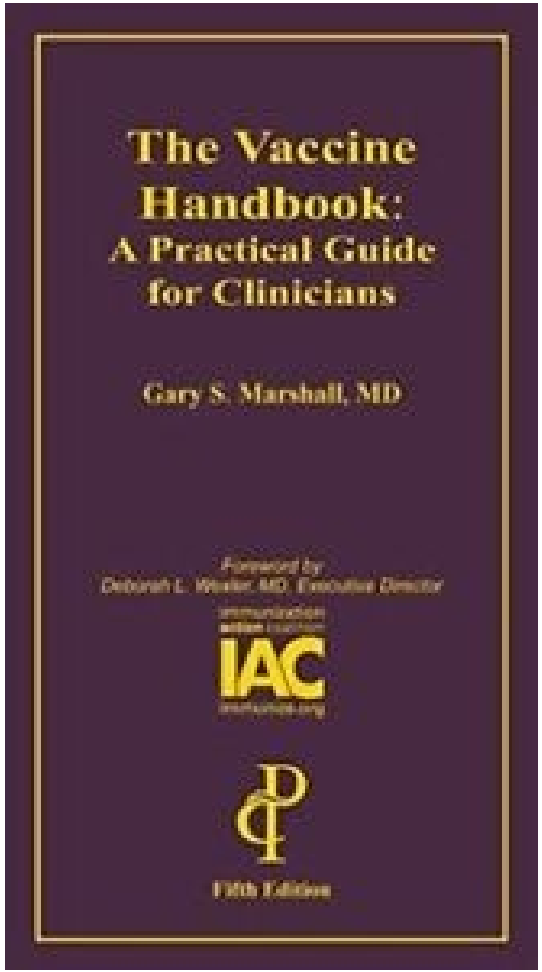
Disadvantages:

- Generally need caution when giving to immunocompromised patients
- May cause mild versions of te disease you are trying to prevent (eg: varicella vaccine may cause a rash 10 days after vaccination)
- Oral polio vaccine can rarely revert to a virulent form and cause disease

TABLE 1.2 — Generalizations About Vaccines by Type

Characteristic	Live Vaccines	Not Live (Inactivated) Vaccines
Immune response	Humoral and cell-mediated	Mostly humoral[a]
Dosing	One or 2 doses usually sufficient[b]	Multiple-dose series usually necessary[c]
Adjuvant	Not necessary	May be necessary[d]
Route of administration	Intranasal, oral, subcutaneous	Intramuscular, subcutaneous, intradermal[e]
Duration of immunity	Potentially lifelong	Booster doses may be necessary[f]
Person-to-person transmission	Possible[g]	Not possible
Effect of passively acquired antibodies	Inactivation possible	Interference possible
Use in immunocompromised hosts	May cause disease	May be less immunogenic
Use in pregnancy	Fetal damage theoretically possible[h]	Fetal damage theoretically unlikely
Rationale for storage requirements	Maintain viability	Maintain stability
Administration on the same day	Acceptable[i]	Acceptable[j]
Interval between doses of the *same* vaccine given in sequence	Minimum intervals apply[k]	Minimum intervals apply[l]
Interval between doses of *different* vaccines given in sequence	Minimum intervals apply[k]	No minimum intervals

[a] Inactivated vaccines may stimulate limited cell-mediated immune responses through cross-presentation.
[b] RV5 and typhoid Ty21a are given orally in multiple-dose series; cholera vaccine is given as a single oral dose. Although 1 dose of MMR or VAR may be sufficient to induce long-lasting immunity, second doses are given before school entry to ensure that children who did not seroconvert to the first dose have another chance to do so. Since immunity to varicella zoster virus can wane after immunization, the second dose of VAR may also serve as a booster.
[c] Older adults may respond well to a single dose of an inactivated vaccine because they have been previously primed by natural exposure. This might apply, for example, to PPSV23—adults who receive this vaccine have probably had prior exposures to *S pneumoniae*.
[d] Hib-T, IIV, MenACWY-D, MenACWY-CRM, PPSV23, IPV, and RAB do not contain adjuvants.
[e] Fluzone Intradermal (idIIV) was discontinued in 2017.
[f] Long-term protection has been demonstrated for some inactivated vaccines, such as HepA and HepB, in the absence of booster doses.
[g] This is relevant for OPV, where horizontal transmission contributes to immunity at the population level, but also on rare occasion leads to disease in contacts. Transmission of vaccinia represents a real risk to susceptible close contacts. Transmission of cholera vaccine, LAIV, RV, and VAR has been documented, but is rare. Transmission of MMR, Ty21a, and YFV has not been documented.
[h] The possibility of fetal infection leads to the general recommendation that live vaccines not be given during pregnancy (see *Chapter 6: Vaccination in Special Circumstances—Pregnancy, Postpartum, and Breast-Feeding*).
[i] Separate sites are always used for simultaneous administration. The only example of two live vaccines that cannot be given at the same time are VAR and smallpox (the concern is increased complications from smallpox vaccine).
[j] Separate sites are always used for simultaneous administration. Examples of two inactivated vaccines that cannot be given at the same time are MenACWY-D and PCV13 in anatomically or functionally asplenic children (the concern is reduced response to pneumococcal antigens) and PCV13 and PPSV23 (the concern is interference).
[k] Replication of the first live vaccine can interfere with replication of a second live vaccine that is given within 4 weeks.
[l] Proper spacing between the doses is necessary to maximize the immune response.



Get The App!

You can download **The Vaccine Handbook mobile app** for **FREE** from the app store (iphone users only)!

The app is fully searchable, allows for bookmarking, highlighting and annotation, and contains hyperlinks to valuable content from nonprofit and governmental sources.

The Vaccine Handbook, print edition, is also available for purchase. The 9th edition will be released May 2020.

Inactivated Polysaccharide vs. Inactivated Conjugate vaccines

- **Polysaccharide vaccines** are made using a sugar molecules from the outer coating of a bacterium (part of its capsule)

- Stimulates antibody response to capsule of the bacterium, which aids the immune system removing the bacteria

Limitations

- Not immunogenic in children <2 years
- Do not induce long-lasting immunity
- Repeated doses may not provide boost
  - Repeated doses (>3 in a lifetime) or too close together (<5 years) may actually reduce the immune response

- Pneumococcal-23
  - Reserved for children >2yrs with asplenia
  - Or persons >65 years of age

Inactivated Polysaccharide vs. Inactivated Conjugate vaccines

- **Conjugate vaccines** are made by combining a protein (antigen or toxoid) from a pathogen with the polysaccharide
- Conjugation helps promote a more robust immune response
- No worries giving to immunocompromised patients

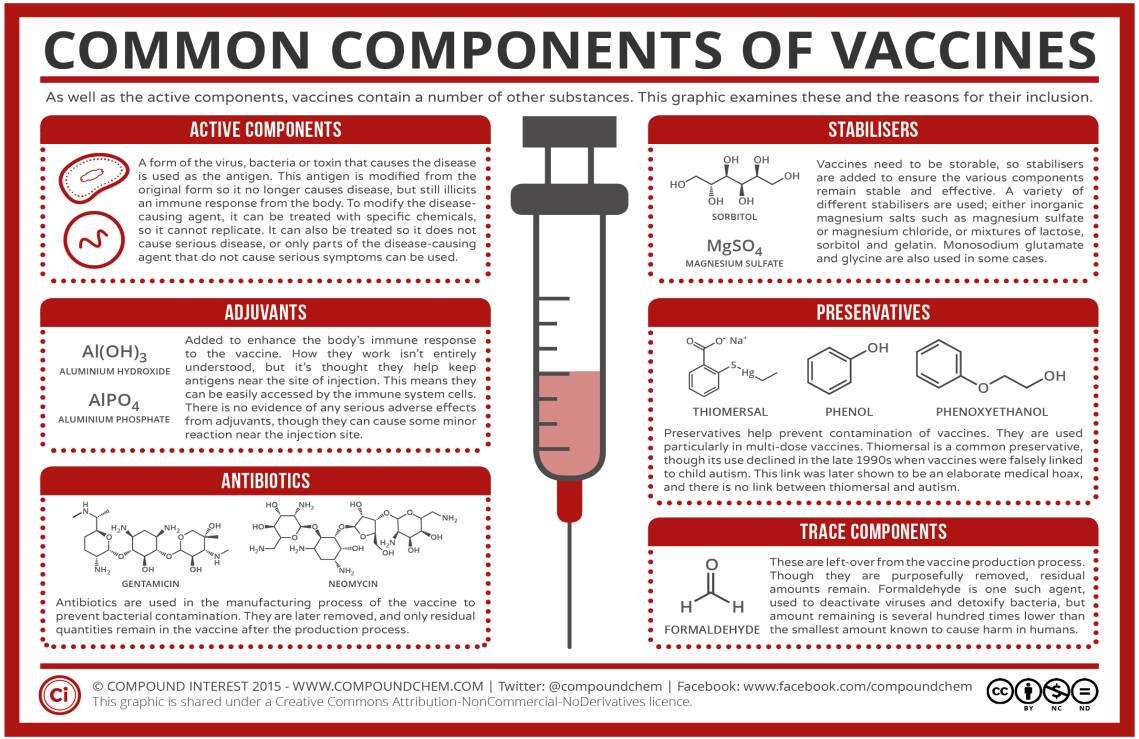
Advantages

- Immunogenic in kids <2 years and good in adults >65 years
- Do induce long-term immune memory
- Repeated doses “boost” the immune resposne

Eg: Pneumococcal conj; Diptheria, Tetanos, HIB,

Vaccine Components

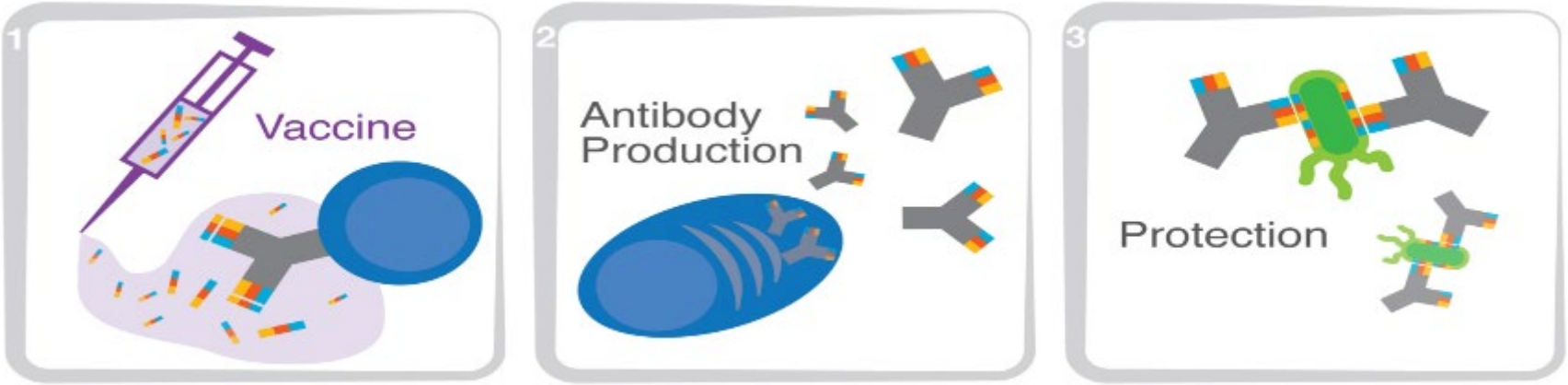
- Antigens (active components)
- Additives
  - Adjuvants
  - Antibiotics
  - Stabilizers
  - Preservatives
- Residuals (Trace components)



Antigens (aka immunogens)

Antigens are the components of a vaccine that induce immunity.

- Portion of disease-causing organism
- Modified toxin from the organism
- Live but weakened virus



Additives

Adjuvent: help generate a stronger immune response. By using adjuvent you can use less antigen or give fewer vaccine doses for the same effect.

- *Aluminum salts and oil-in-water emulsions most common*

Stabilizers: maintain vaccine potency during storage. Protect against extreme cold or heat. Provide a bulking matrix so the small amount of antigen does not stick to the vial wall.

- *Sugars (sucrose), amino acids (glycine), and proteins (gelatin-bovine) are most common*

Additives

Preservatives: Keep vaccines safe for injection. Includes antimicrobial agents added to inactivated vaccines to prevent growth of bacteria or fungi, especially in a multi-dose vial of vaccine.

- *Thimerosol is common preservative. Causes concern due to mercury content. However, made from ethylmercury and not methylmercury (the mercury found in fish and toxic at high levels)*

Residuals

Leftover products from the manufacturing process that may be present in final vaccine.

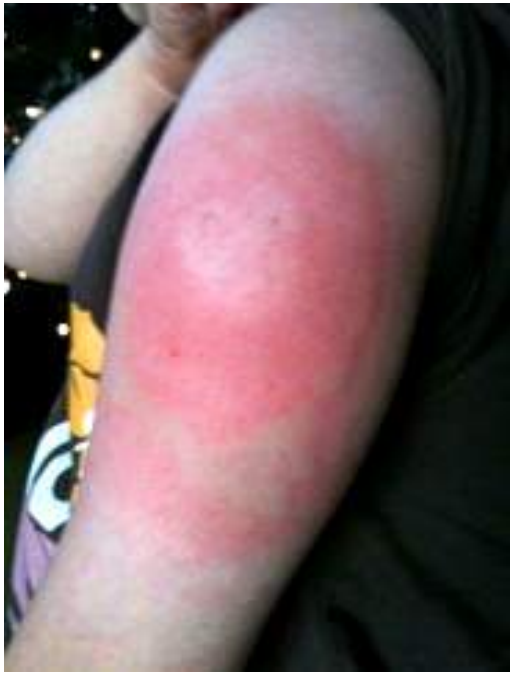
Examples include formaldehyde or antibiotics, such as streptomycin.

Vaccine Adverse Events (AE)

- Some individuals have a bad reaction to a vaccine, just as some people have reactions to medicines or foods

- Common AE
  - Fever
  - Soreness at injection site
  - Prolonged crying

- Serious AE's can be found in insert for vaccine

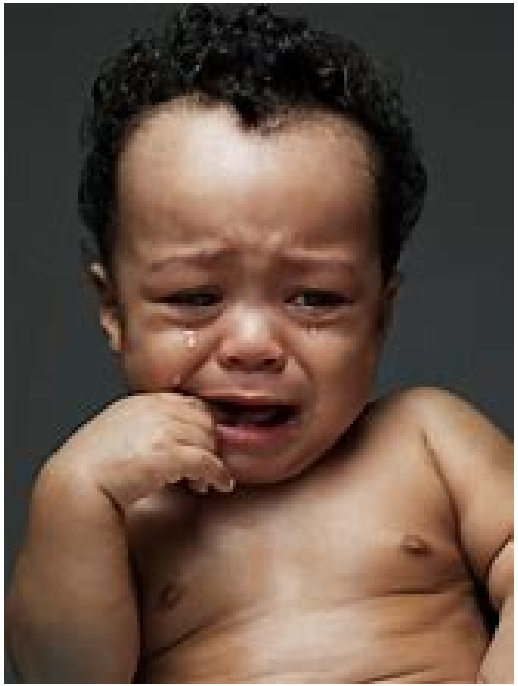


Contraindications and Precautions
Advisory Committee on Immunization Practices (ACIP)

www.cdc.gov

Prolonged Crying

- Defined as 3+ hours of crying within 2 days of being vaccinated
- Neither a precaution or contraindication for future vaccinations



Hypotonic Hyporesponsive Episode (HHE)

- Worrisome shock like reaction following vaccination, where child becomes hypotonic and unresponsive for a brief period then returns to baseline
- Originally associated with whole-cell pertussis vaccine
- No long-term consequences. Not a contraindication for future vaccinations

Quiz

Saliva

Innate Immunity

Adaptive Immunity

Innate Immunity

Adaptive Immunity

- **Saliva**

Helper
T-cell

Innate Immunity

Adaptive Immunity

- Saliva

Innate Immunity

- Saliva

Adaptive Immunity

- **Helper T-cell**

Neutrophil

Innate Immunity

- Saliva

Adaptive Immunity

- Helper T-cell

Innate Immunity

- Saliva
- **Neutrophil**

Adaptive Immunity

- Helper T-cell

Macrophage

Innate Immunity

- Saliva
- Neutrophil

Adaptive Immunity

- Helper T-cell

Innate Immunity

- Saliva
- Neutrophil
- **Macrophage**

Adaptive Immunity

- Helper T-cell

IgG antibody

Innate Immunity

- Saliva
- Neutrophil
- Macrophage

Adaptive Immunity

- Helper T-cell

Innate Immunity

- Saliva
- Neutrophil
- Macrophage

Adaptive Immunity

- Helper T-cell
- **IgG antibody**

Complement

Innate Immunity

- Saliva
- Neutrophil
- Macrophage

Adaptive Immunity

- Helper T-cell
- IgG antibody

Innate Immunity

- Saliva
- Neutrophil
- Macrophage
- **Complement**

Adaptive Immunity

- Helper T-cell
- IgG antibody

Which vaccine is made of only sugars?

Polysaccharide vaccine

Conjugate vaccine

Which vaccine is made of only sugars?

Polysaccharide vaccine

Which can be given to children < 2 years of age?

Polysaccharide vaccine

Conjugate vaccine

Which can be given to children < 2 years of age?

Conjugate vaccine

Which vaccine **does not** induce long-term immunity?

Polysaccharide vaccine

Conjugate vaccine

Which vaccine **does not** induce long-term immunity?

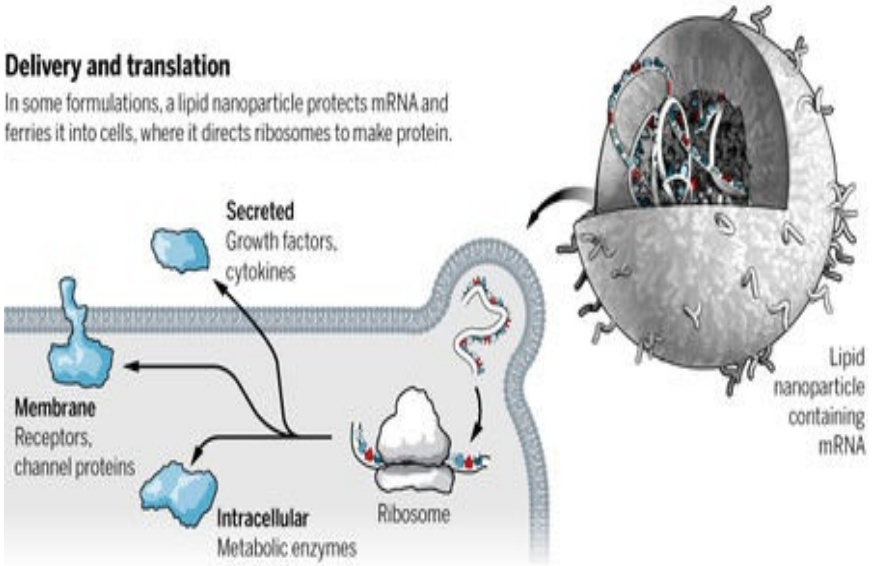
Polysaccharide vaccine

COVID Vaccines

- mRNA
  - Pfizer-BioNTech
  - Moderna

- Adenovirus vector vaccines
  - Chimpanzee adenovirus vector
    - AstraZeneca-Oxford
  - Human adenovirus
    - Johnson and Johnson
    - Sputnik (Russian vaccine)

mRNA Vaccines



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