

Vaccines and Public Health

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The Plan

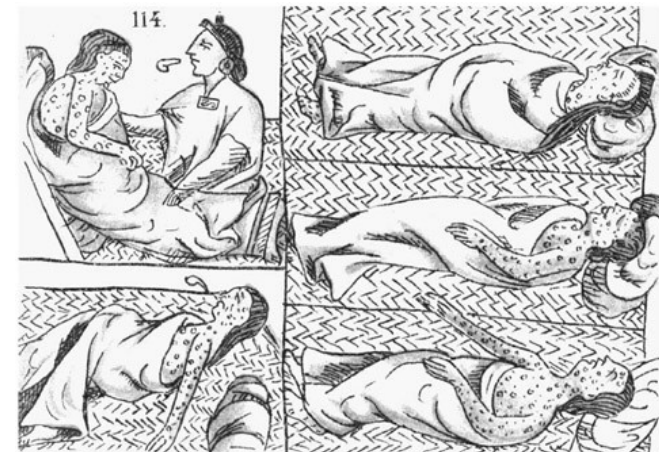
- History of Vaccines
- Immunity 101
- 20th Century Vaccines
- Epidemiology 101
- Safety of Vaccines
- 3 Common Vaccine Controversies

History of Vaccines

Smallpox, Variolation, and Jenner, Oh my!

Smallpox

- Smallpox is believed to have appeared ~10,000 BC
- Earliest (1570 – 1085 BCE)
 - Skin lesions on mummies
 - Egypt, Asia, India, China...
- Europe (5th – 7th Century)
 - Epidemics → decline of the Roman Empire
 - Spread → Crusades, discovery of West Indies and the Americas, slave trade
- 1st examples of biological warfare (French-Indian War)



Europe, 18th Century



- “The Great Pox”
- 400,000 deaths/year
- Case Fatality Rate (CFR)
 - Adults: 20 – 60%
 - Infants: 80 – 98%
- Survivors
 - Blindness
 - Disfiguring scars
 - **Became immune to the disease**

Inoculation/Variolation

- Africa, India, China



- Problems with this:
 - Disseminated smallpox
 - Transmission of other blood born disease (Syphilis)
- Turkey → Europe (18th C)
 - Lady Mary Montague (1721)
 - Royal Physician

- Trial variolation on prisoners, orphaned children
- 2-3% patients
 - Died from disease
 - Became a source of outbreak
 - Suffered from diseases transmitted (TB, syphilis)
- CFR was 10x **lower** than actual disease
- → New world
- Ben Franklin a proponent (Philadelphia Outbreak, 1747)

Dr. Edward Jenner

- First person to confer scientific status on vaccination
- Inoculated as a child
- Dairymaids: “I shall never have smallpox for I have had cowpox.”
 - Theory
 - If cowpox protects against smallpox, can we use cowpox as a **deliberate mechanism** of protection against smallpox?
 - May 14, 1796: Inoculated an 8-year-old boy with fresh cowpox
 - Mild fever, discomfort, loss of appetite
 - July 1796: Inoculated the boy with smallpox → **No Disease Developed**
- Spread of vaccination as credible: mostly word of mouth
 - Used during major outbreaks

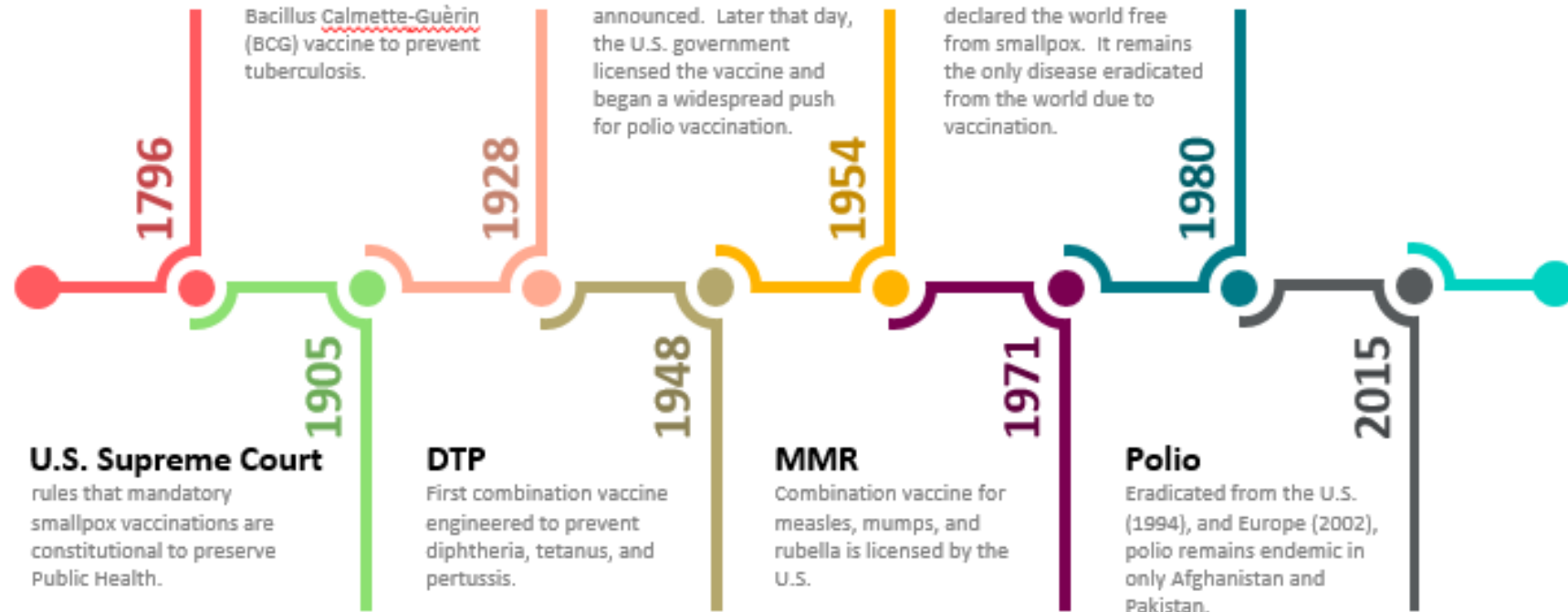


Edward Jenner
discovers the vaccine for
smallpox.

League of Nations
Recommends the use of the
Bacillus Calmette-Guèrin
(BCG) vaccine to prevent
tuberculosis.

Salk Poliovirus
Vaccine trial results are
announced. Later that day,
the U.S. government
licensed the vaccine and
began a widespread push
for polio vaccination.

Smallpox Eradicated
The World Health Assembly
declared the world free
from smallpox. It remains
the only disease eradicated
from the world due to
vaccination.



U.S. Supreme Court
rules that mandatory
smallpox vaccinations are
constitutional to preserve
Public Health.

DTP
First combination vaccine
engineered to prevent
diphtheria, tetanus, and
pertussis.

MMR
Combination vaccine for
measles, mumps, and
rubella is licensed by the
U.S.

Polio
Eradicated from the U.S.
(1994), and Europe (2002),
polio remains endemic in
only Afghanistan and
Pakistan.

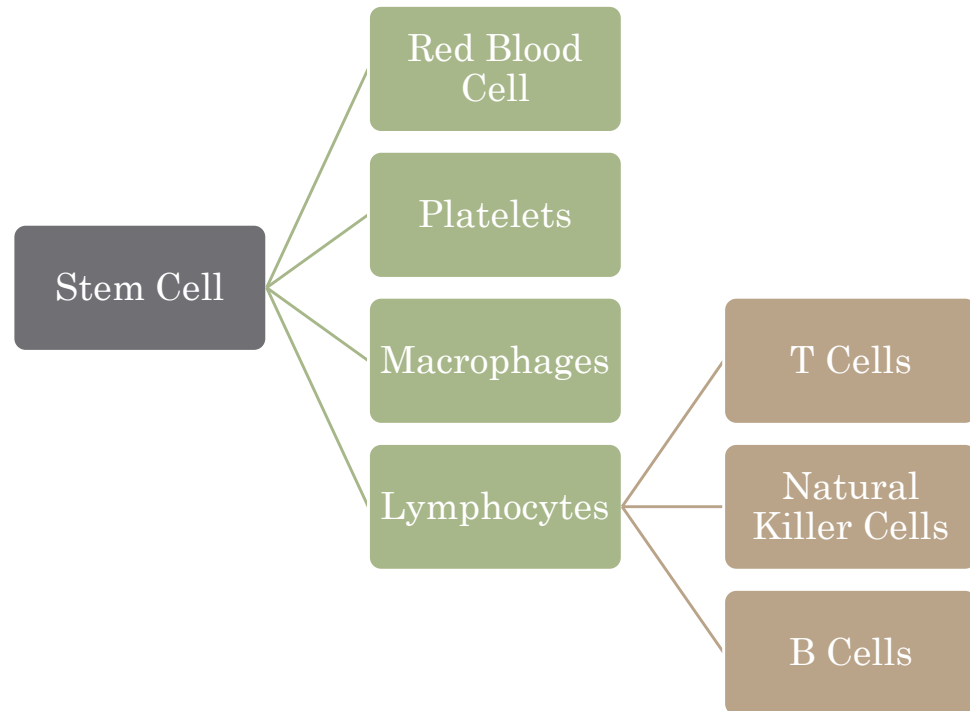
Vaccines are among the 20th century's most successful and cost-effective public health tools for **preventing** disease and death. - DE Department of Public Health

Immunity 101

Or, “My Body Can Do What, Now?”

The Immune System: A Primer

- **Antigen** – anything that causes an immune system response
 - Grass, pollen, flu
- **Pathogen** – disease causing antigen



Types of Immunity

INNATE

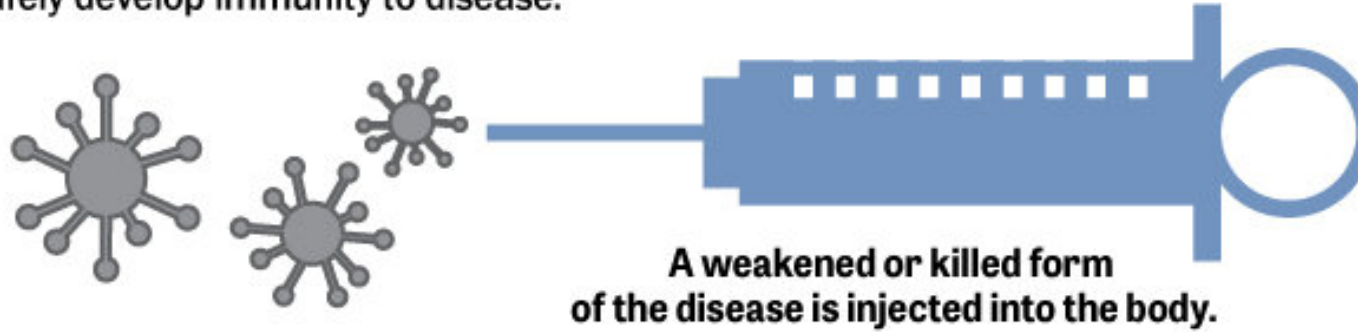
- Non Specific (Immediate)
- Physical Barriers
 - Skin
 - Chemicals in Blood
 - Macrophages & NK Cells
- Maternal Protection for Fetus

ADAPTIVE

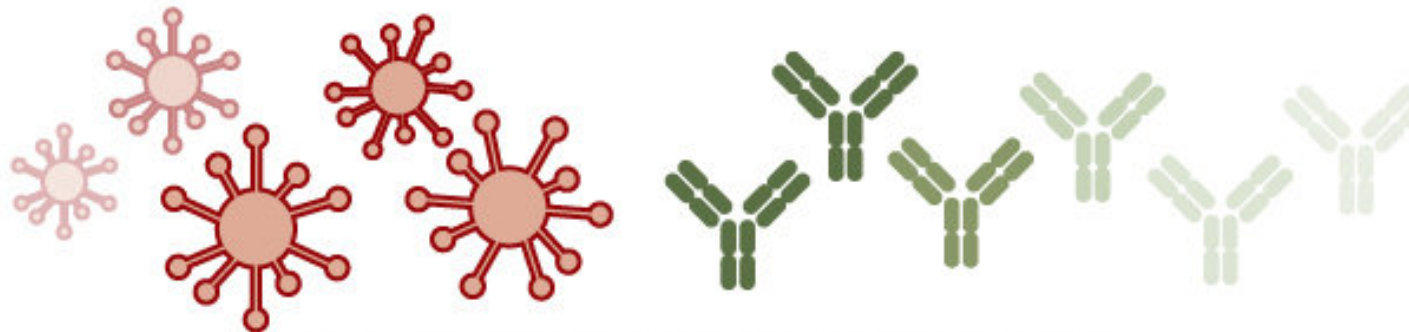
- Antigen-Specific (Takes Time)
 1. T- & B-Cells Recognize Antigen as foreign
 2. T- & B-Cells Differentiate – make specific **antibody**
 3. Copy/Paste → army of immune cells specific to that antigen
 4. Memory – keep some cells for later
Next time an antigen is in the body, the response is MUCH faster

HOW DO VACCINES WORK?

Vaccines reduce the risk of infection by working with the body's natural defenses to safely develop immunity to disease.

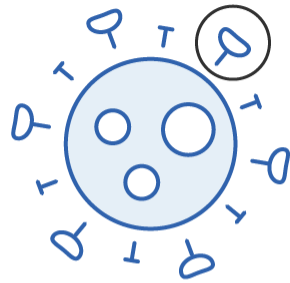


The body creates antibodies to fight the germs.



If the actual disease germs ever attack the body, the antibodies return to destroy them.

mRNA Vaccines

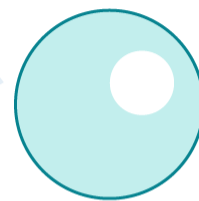


The RNA vaccine contains messenger RNA, which contains an instruction to make a SARS-CoV-2 spike protein.

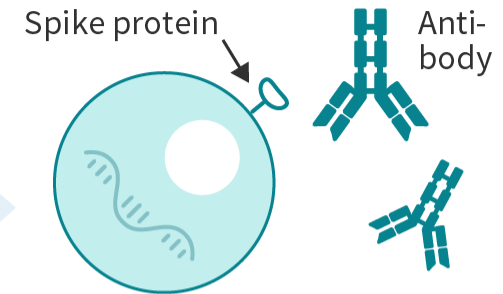
mRNA
(in a fatty particle)



Cell



For messenger RNA (mRNA) to enter the muscle cell at the injection site, it is packaged inside a very small fatty particle.



Messenger RNA instructs cells to produce a coronavirus spike protein.

The body's defence system recognises the spike protein as foreign and begins to protect itself against it.

#coronavirus

Source: Finnish Institute for Health and Welfare 2020

Types of Vaccines

Type	What is it?	Examples
Live Attenuated	Weakened version of living pathogen that cannot cause disease	Measles, mumps, rubella, polio (oral), yellow fever
Inactivated (“killed”)	Pathogen has been killed with chemicals, heat, or radiation	Cholera, flu, hepatitis A, plague, polio (IM), rabies
Subunit	Includes antigens that best stimulate the immune system	Hepatitis B, pertussis, pneumonia
Toxoid	Inactivated toxins from bacteria	Diphtheria, tetanus
Conjugate	Antigens linked to sugars	H. Influenzae type B, pneumonia
DNA	DNA	Flu, herpes, HIV
mRNA	Messenger RNA	COVID-19

20th Century Vaccines

Or, “Why I hated the doctor when I was little.”

Table 1

Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger, United States, 2023

See Addendum for new or updated ACIP vaccine recommendations

These recommendations must be read with the notes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars. To determine minimum intervals between doses, see the catch-up schedule (Table 2).

Vaccine	Birth	1 mo	2 mos	4 mos	6 mos	9 mos	12 mos	15 mos	18 mos	19–23 mos	2–3 yrs	4–6 yrs	7–10 yrs	11–12 yrs	13–15 yrs	16 yrs	17–18 yrs			
Hepatitis B (HepB)	1 st dose	← 2 nd dose →			← 3 rd dose →															
Rotavirus (RV): RV1 (2-dose series), RV5 (3-dose series)			1 st dose	2 nd dose	See Notes															
Diphtheria, tetanus, acellular pertussis (DTaP <7 yrs)			1 st dose	2 nd dose	3 rd dose				← 4 th dose →			5 th dose								
Haemophilus influenzae type b (Hib)			1 st dose	2 nd dose	See Notes			← 3 rd or 4 th dose, See Notes →												
Pneumococcal conjugate (PCV13, PCV15)			1 st dose	2 nd dose	3 rd dose			← 4 th dose →												
Inactivated poliovirus (IPV <18 yrs)			1 st dose	2 nd dose	← 3 rd dose →						4 th dose						See Notes			
COVID-19 (1vCOV-mRNA, 2vCOV-mRNA, 1vCOV-aPS)					2- or 3- dose primary series and booster (See Notes)															
Influenza (IIV4)					Annual vaccination 1 or 2 doses									Annual vaccination 1 dose only						
Influenza (LAIV4)												Annual vaccination 1 or 2 doses		Annual vaccination 1 dose only						
Measles, mumps, rubella (MMR)					See Notes	← 1 st dose →						2 nd dose								
Varicella (VAR)						← 1 st dose →						2 nd dose								
Hepatitis A (HepA)					See Notes	2-dose series, See Notes														
Tetanus, diphtheria, acellular pertussis (Tdap ≥7 yrs)																	1 dose			
Human papillomavirus (HPV)																		See Notes		
Meningococcal (MenACWY-D ≥9 mos, MenACWY-CRM ≥2 mos, MenACWY-TT ≥2years)				See Notes													1 st dose		2 nd dose	
Meningococcal B (MenB-4C, MenB-FHbp)																		See Notes		
Pneumococcal polysaccharide (PPSV23)																		See Notes		
Dengue (DEN4CYD; 9-16 yrs)																		Seropositive in endemic dengue areas (See Notes)		

 Range of recommended ages for all children
 Range of recommended ages for catch-up vaccination
 Range of recommended ages for certain high-risk groups
 Recommended vaccination can begin in this age group
 Recommended vaccination based on shared clinical decision-making
 No recommendation/ not applicable

17 Diseases

Children (birth – 7 years)

- Hepatitis A & B
- Rotavirus
- Hemophilus influenza type b
- Diphtheria, tetanus & pertussis
- Pneumococcal
- Polio
- Measles, mumps & rubella
- Varicella



Yearly

- Flu
- COVID-19

Teens

- HPV
- Meningitis

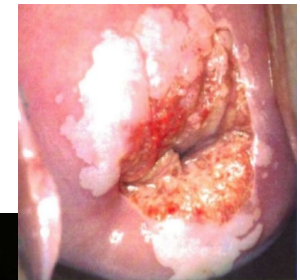


Table 1 Recommended Adult Immunization Schedule for ages 19 years or older, United States, 2023

Vaccine	19–26 years	27–49 years	50–64 years	≥65 years
COVID-19	2- or 3- dose primary series and booster (See Notes)			
Influenza inactivated (IIV4) or Influenza recombinant (RIV4)	1 dose annually			
Influenza live, attenuated (LAIV4)	1 dose annually			
Tetanus, diphtheria, pertussis (Tdap or Td)	1 dose Tdap each pregnancy; 1 dose Td/Tdap for wound management (see notes)			
	1 dose Tdap, then Td or Tdap booster every 10 years			
Measles, mumps, rubella (MMR)	1 or 2 doses depending on indication (if born in 1957 or later)			For healthcare personnel, see notes
Varicella (VAR)	2 doses (if born in 1980 or later)		2 doses	
Zoster recombinant (RZV)	2 doses for immunocompromising conditions (see notes)		2 doses	
Human papillomavirus (HPV)	2 or 3 doses depending on age at initial vaccination or condition	27 through 45 years		
Pneumococcal (PCV15, PCV20, PPSV23)	1 dose PCV15 followed by PPSV23 OR 1 dose PCV20 (see notes)			See Notes
				See Notes
Hepatitis A (HepA)	2, 3, or 4 doses depending on vaccine			
Hepatitis B (HepB)	2, 3, or 4 doses depending on vaccine or condition			
Meningococcal A, C, W, Y (MenACWY)	1 or 2 doses depending on indication, see notes for booster recommendations			
Meningococcal B (MenB)	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations			
	19 through 23 years			
Haemophilus influenzae type b (Hib)	1 or 3 doses depending on indication			

Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection

Recommended vaccination for adults with an additional risk factor or another indication

Recommended vaccination based on shared clinical decision-making

No recommendation/ Not applicable

- Boosters (2-4)
- 2 new vaccine
 - Zoster
 - HSV

Table 2 Recommended Adult Immunization Schedule by Medical Condition or Other Indication, United States, 2023

Vaccine	Pregnancy	Immuno-compromised (excluding HIV infection)	HIV infection CD4 percentage and count		Asplenia, complement deficiencies	End-stage renal disease, or on hemodialysis	Heart or lung disease; alcoholism ^a	Chronic liver disease	Diabetes	Health care personnel ^b	Men who have sex with men
			<15% or <200 mm ³	≥15% and ≥200 mm ³							
COVID-19		See Notes									
IIV4 or RIV4 or LAIV4	1 dose annually					Contraindicated		Precaution		1 dose annually	
Tdap or Td	1 dose Tdap each pregnancy	1 dose Tdap, then Td or Tdap booster every 10 years									
MMR	Contraindicated*	Contraindicated	1 or 2 doses depending on indication								
VAR	Contraindicated*	Contraindicated		2 doses							
RZV		2 doses at age ≥19 years			2 doses at age ≥50 years						
HPV	Not Recommended*	3 doses through age 26 years			2 or 3 doses through age 26 years depending on age at initial vaccination or condition						
Pneumococcal (PCV15, PCV20, PPSV23)		1 dose PCV15 followed by PPSV23 OR 1 dose PCV20 (see notes)									
HepA				2, 3, or 4 doses depending on vaccine							
HepB	3 doses (see notes)	2, 3, or 4 doses depending on vaccine or condition									
MenACWY	1 or 2 doses depending on indication, see notes for booster recommendations										
MenB	Precaution	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations									
Hib		3 doses HSCT ^c recipients only		1 dose							

Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection

Recommended vaccination for adults with an additional risk factor or another indication

Recommended vaccination based on shared clinical decision-making

Precaution—vaccination might be indicated if benefit of protection outweighs risk of adverse reaction

Contraindicated or not recommended—vaccine should not be administered.
*Vaccinate after pregnancy.

No recommendation/ Not applicable

Epidemiology 101

Or, “There is a reason I did not major in math.”

Endemic

- Disease exists permanently in a particular region or population

Epidemic

- An outbreak of disease that attacks many people at the same time and may spread through communities
- Cases are over and above the “normal” case rate of an endemic disease
- Flu epidemic, Cholera, Ebola

Pandemic

- An epidemic that spreads around the world
- SARS, Swine Flu, Zika, COVID-19
- Way more likely in the era of fast transportation

Infection Exposure

- Incubation
 - Time it takes to show symptoms after infection
- Contagious
 - Time disease can spread to others

Disease	Incubation	Contagious
Chickenpox	10-21 days	6-7 days
Measles*	8-12 days	4 days before and after rash
Diphtheria	2-5 days	Sore throat – antibiotic for 4 days
Flu	1-2 days	Symptoms

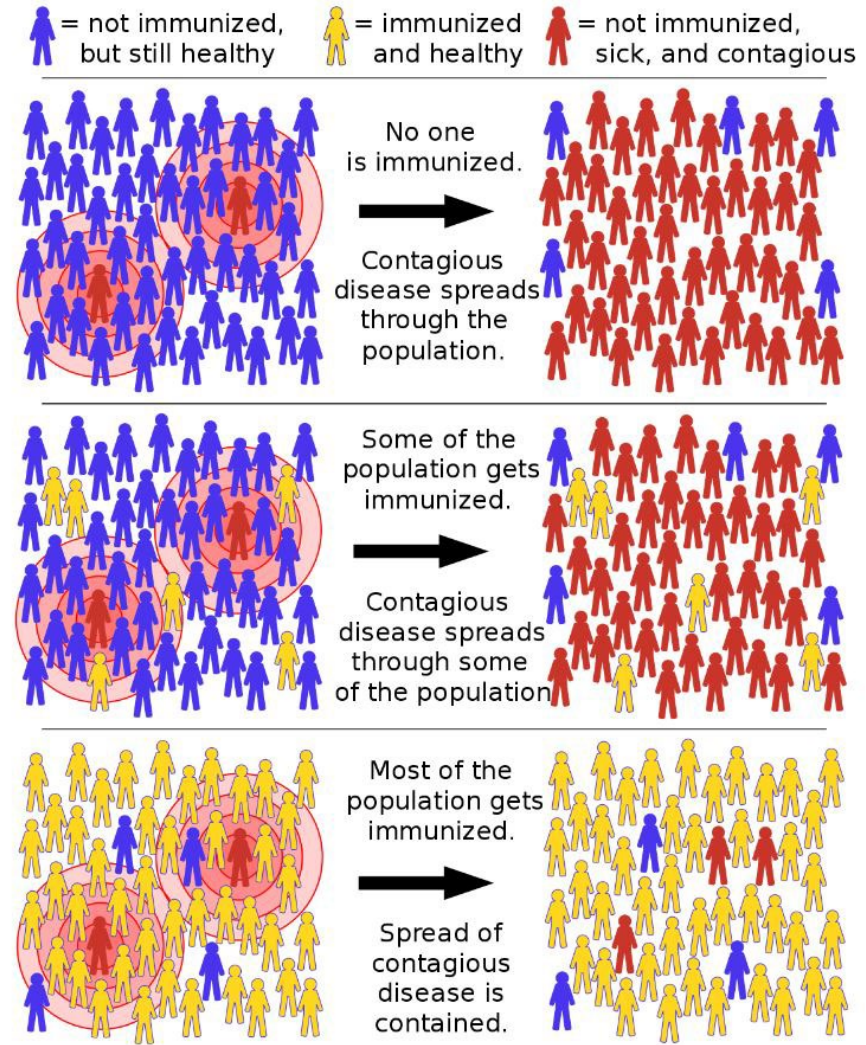
*The most contagious disease (90% of contacts). It was declared eliminated from the US in 2000 (no endemic transmission); in 2016 came close to losing that declaration

Herd Immunity

- When many are immunized, there is little opportunity for outbreak
- Some are not eligible for vaccines
 - Infants
 - Pregnant women
 - Immunocompromised
 - Allergies

Contagious

Disease	Herd Immunity Threshold
Measles	92-95%
Pertussis	92-94%
Diphtheria	83-86%
Rubella	
Smallpox	80-86%
Polio	



<https://www.theguardian.com/society/ng-interactive/2015/feb/05/-sp-watch-how-measles-outbreak-spreads-when-kids-get-vaccinated>

From the training course titled "Smallpox: Disease, Prevention, and Intervention". The Centers for Disease Control and Prevention and the World Health Organization. Slide 17. Retrieved 13 March 2015

Death due to...

Disease	Cases	Deaths	Vaccine	Cases (2006)	Deaths (2004)
Diphtheria	21,053	1,822	1943	0	0
Measles	530,217	440	1960s	55	0
Mumps	162,344	39	1940s	6584	0
Pertussis	200,752	4,034	1941	15,632	27
Polio (paralytic)	16,316	1,879	1955	0	0
Rubella	47,745	17	1969	11	0
Smallpox	29,005	337	1798	0	0
Tetanus	580	472	1949	41	4

Vaccines available before 1980

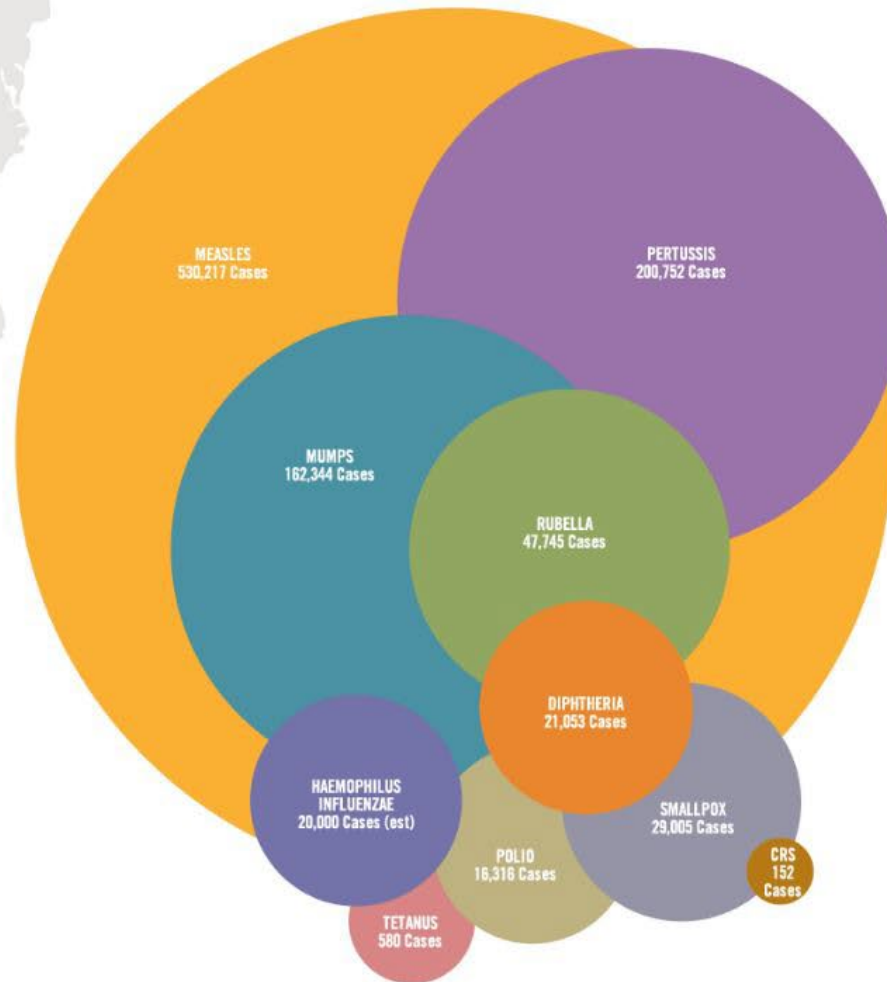
VACCINES WORK

These bubbles are sized according to the annual number of disease cases in the US during the 1900s versus 2010. We've come so far. It's a reminder that while disease rates are low, most diseases haven't disappeared. This is why we continue to vaccinate.

SMALLPOX	THEN 29,005 NOW 0	MEASLES	THEN 530,217 NOW 61
DIPHTHERIA	THEN 21,053 NOW 0	MUMPS	THEN 162,344 NOW 2,528
PERTUSSIS	THEN 200,752 NOW 21,291	RUBELLA	THEN 47,745 NOW 6
TETANUS	THEN 580 NOW 8	CRS	THEN 152 NOW 0
POLIO	THEN 16,316 NOW 0	HAEMOPHILUS INFLUENZAE	THEN 20,000 NOW 270

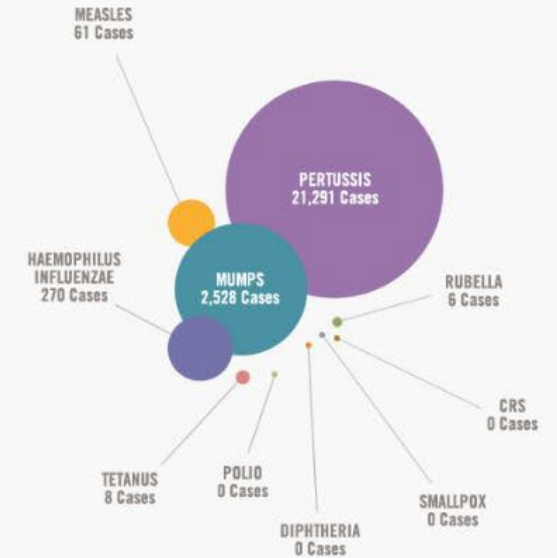
THEN

Annual US disease cases in the 1900s



NOW

US disease cases in 2010



⁹. Centers for Disease Control and Prevention (CDC). Parents Guide to Childhood Immunizations. <http://www.cdc.gov/vaccines/pubs/parents-guide/default.htm>. Accessed August 15, 2011.

¹⁰ CDC. Impact of Vaccines in the 20th & 21st Centuries. <http://www.cdc.gov/vaccines/pubs/pinkbook/downloads/appendices/G/impact-of-vaccines.pdf>. Updated January 2011. Accessed August 15, 2011.

If vaccines are so amazing, why do I need a booster shot?

- An additional dose of a vaccine needed to periodically “boost” the immune system.
- Immunology 101 – “memory” cells
 - If enough time has passed since vaccination, and the pathogen in question can cause disease rapidly, it may spread faster than the immune system can respond
 - Tetanus, Pertussis, Influenza (kind of)
 - HPV? Chicken pox? Diphtheria?
 - Immunocompromised people – ask a doctor!
- If the disease is a slow-moving one, the immune system will be able to respond before the disease “takes over”

But how do we know
they're safe?

Because we test them. A lot.

The Vaccine Life Cycle

safety at every phase

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IMMUNIZATION
PRACTICES

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BIOLOGICS LICENSE
APPLICATION

CDC

CENTERS FOR
DISEASE CONTROL
AND PREVENTION

FDA

FOOD AND DRUG
ADMINISTRATION

IND

INVESTIGATIONAL
NEW DRUG
APPLICATION

VACCINE DEVELOPMENT

**safety
is a priority
during vaccine
development
+ approval**

PHASE 1
safety

PHASE 2
effectiveness

PHASE 3
*safety +
effectiveness*

BASIC
RESEARCH

DISCOVERY

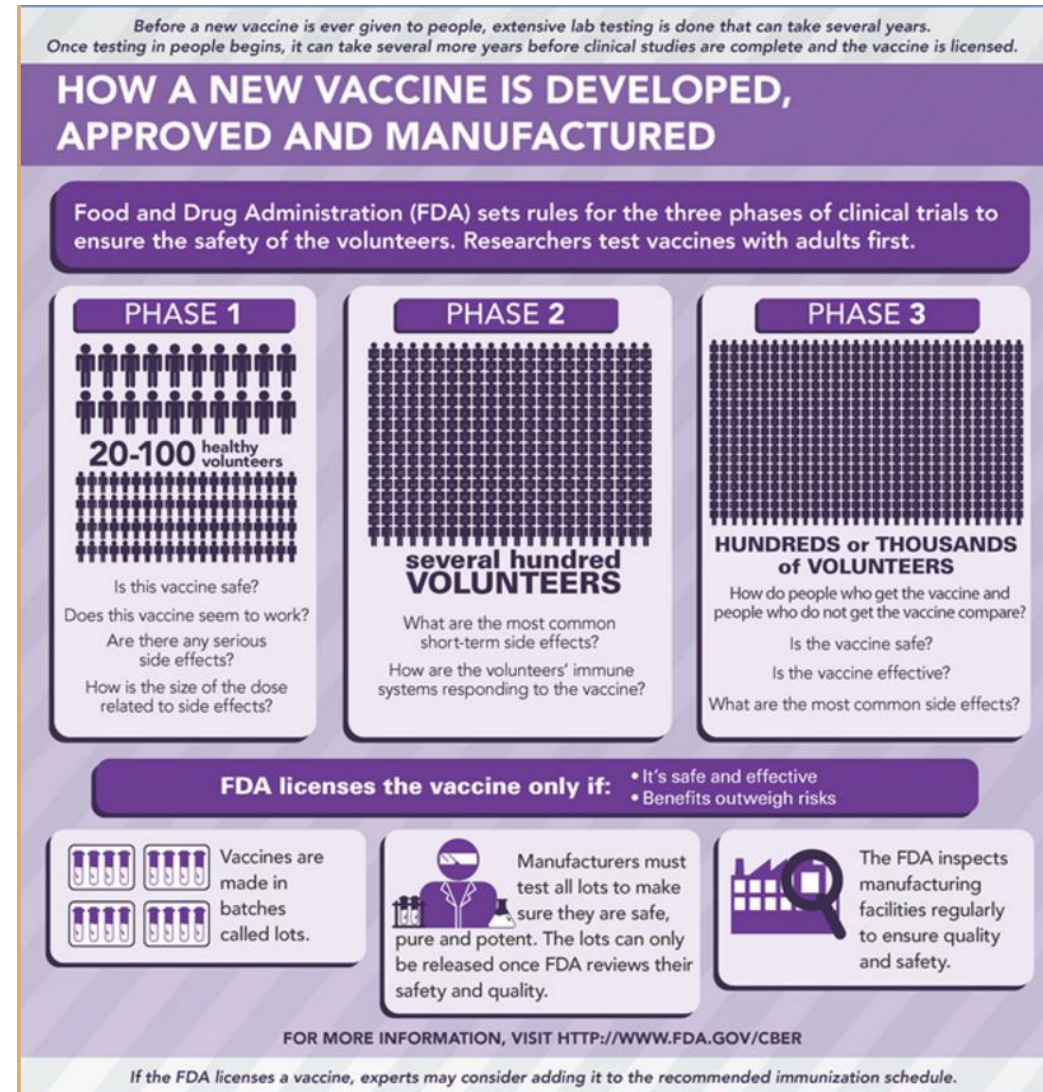
PRE-
CLINICAL
STUDIES

IND
SUBMITTED

CLINICAL STUDIES / TRIALS

Drug Trial Phases

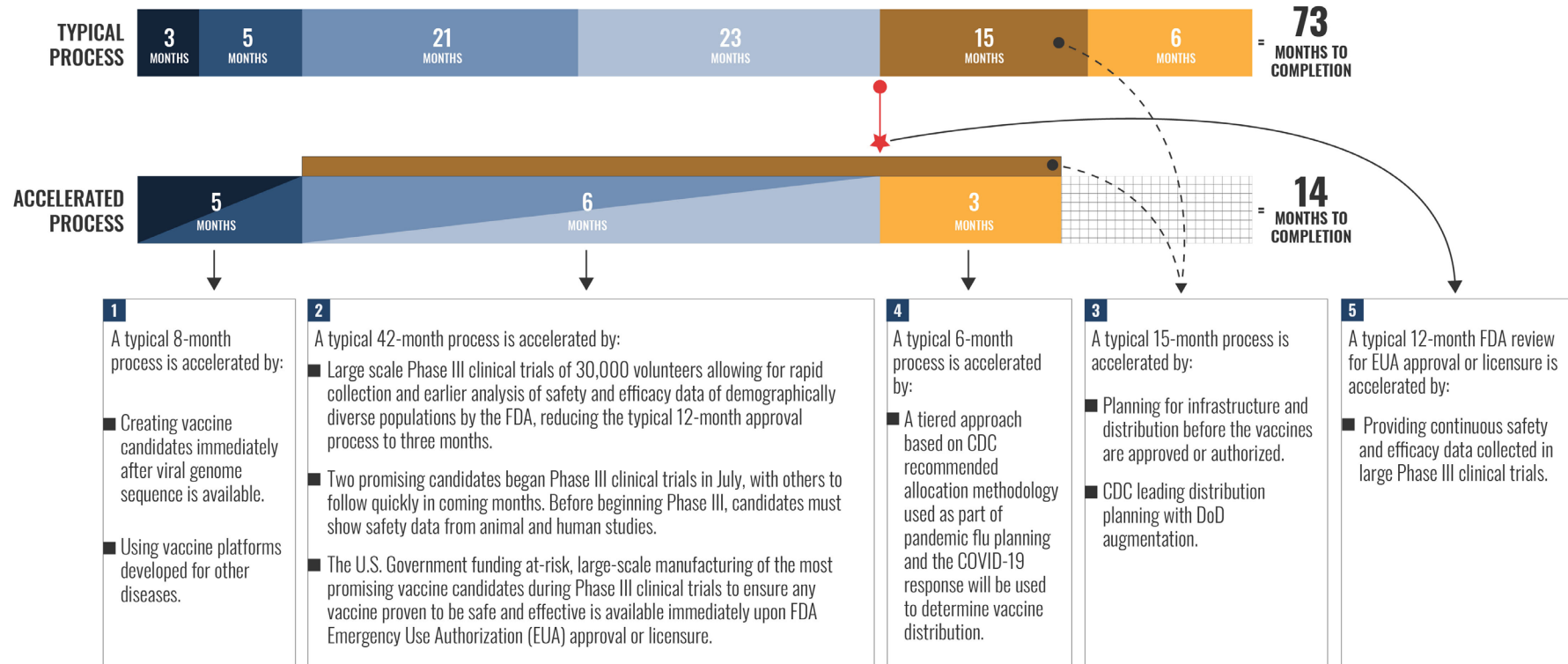
- Phase 0
 - 10-15 subjects
 - What does drug do to body?
 - What does body do to drug?
 - Absorption, distribution, metabolism, removal/excretion
- Phase I
 - Screening for **safety**
 - Safe dosage, common side effects
- Phase II
 - **Efficacy** – does it do what it's supposed to do?
 - Less common side effects
- Phase III
 - Confirmation of efficacy, monitor side effects, compare it to common treatment





OPERATION WARP SPEED ACCELERATED VACCINE PROCESS

MISSION: Deliver 300 million doses of safe and effective vaccine by 1 January 2021.



R&D + Preclinical Trials Vaccine Candidate/s Identified
 Phase II Clinical Trials
 Phase III Clinical Trials
 Manufacturing
 Distribution

The Vaccine Life Cycle

safety at every phase

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VACCINE

DEVELOPMENT

safety is a priority during vaccine development + approval

PHASE 1
safety

PHASE 2
effectiveness

PHASE 3
safety + effectiveness

BASIC RESEARCH

DISCOVERY

PRE-CLINICAL STUDIES

IND SUBMITTED

CLINICAL STUDIES / TRIALS

BLA SUBMITTED

FDA REVIEW

FDA APPROVAL OF 1 NEW VACCINE

Vaccines and Related Biological Products Advisory Committee

Full Agency Approval



The Vaccine Life Cycle

safety at every phase

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INVESTIGATIONAL NEW DRUG APPLICATION

safety is a priority during vaccine development + approval

VACCINE DEVELOPMENT

PHASE 1
safety

PHASE 2
effectiveness

PHASE 3
safety + effectiveness

CLINICAL STUDIES / TRIALS

BASIC RESEARCH

DISCOVERY

PRE-CLINICAL STUDIES

IND SUBMITTED

BLA SUBMITTED

FDA REVIEW

FDA APPROVAL OF 1 NEW VACCINE

ACIP REVIEW

ACIP RECOMMENDATION

Advisory Committee on Immunization Practices
Full Agency Approval



Advisory Committee on Immunization Practices (ACIP)

HOW A VACCINE IS ADDED TO THE U.S. RECOMMENDED IMMUNIZATION SCHEDULE

The Advisory Committee on Immunization Practices (ACIP) is a group of medical and public health experts. Members of the American Academy of Pediatrics (AAP) and American Academy of Family Physicians (AAFP) are among some of the groups that also bring related immunization expertise to the committee. This group carefully reviews all available data about the vaccine from clinical trials and other studies to develop recommendations for vaccine use.

When making recommendations, ACIP considers:



How safe is the vaccine when given at specific ages?
How well does the vaccine work at specific ages?
How serious is the disease this vaccine prevents?
How many children would get the disease the vaccine prevents if we didn't have the vaccine?

ACIP recommendations are not official until the CDC Director reviews and approves them and they are published. These recommendations then become part of the United States official childhood immunization schedule.

New vaccine to protect your child against a disease is added to the schedule.

FOR MORE INFORMATION, VISIT [HTTP://WWW.CDC.GOV/VACCINES](http://www.cdc.gov/vaccines)

After being added to the U.S. Recommended Immunization Schedule, health experts continue to monitor the vaccine's safety and effectiveness.

- Chair
- Exec. Secretary
- 15 voting members
- 8 ex-officio members
- Liaisons from 26 health-related professional organizations

The Vaccine Life Cycle

safety at every phase

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IND

INVESTIGATIONAL NEW DRUG APPLICATION

VACCINE DEVELOPMENT

safety is a priority during vaccine development + approval

safety continues with CDC + FDA safety monitoring

Vaccine is added to schedule.

BASIC RESEARCH

DISCOVERY

PRE-CLINICAL STUDIES

IND SUBMITTED

CLINICAL STUDIES / TRIALS

PHASE 1
safety

PHASE 2
effectiveness

PHASE 3
safety + effectiveness

BLA SUBMITTED

FDA REVIEW

FDA APPROVAL OF 1 NEW VACCINE

ACIP REVIEW

ACIP RECOMMENDATION

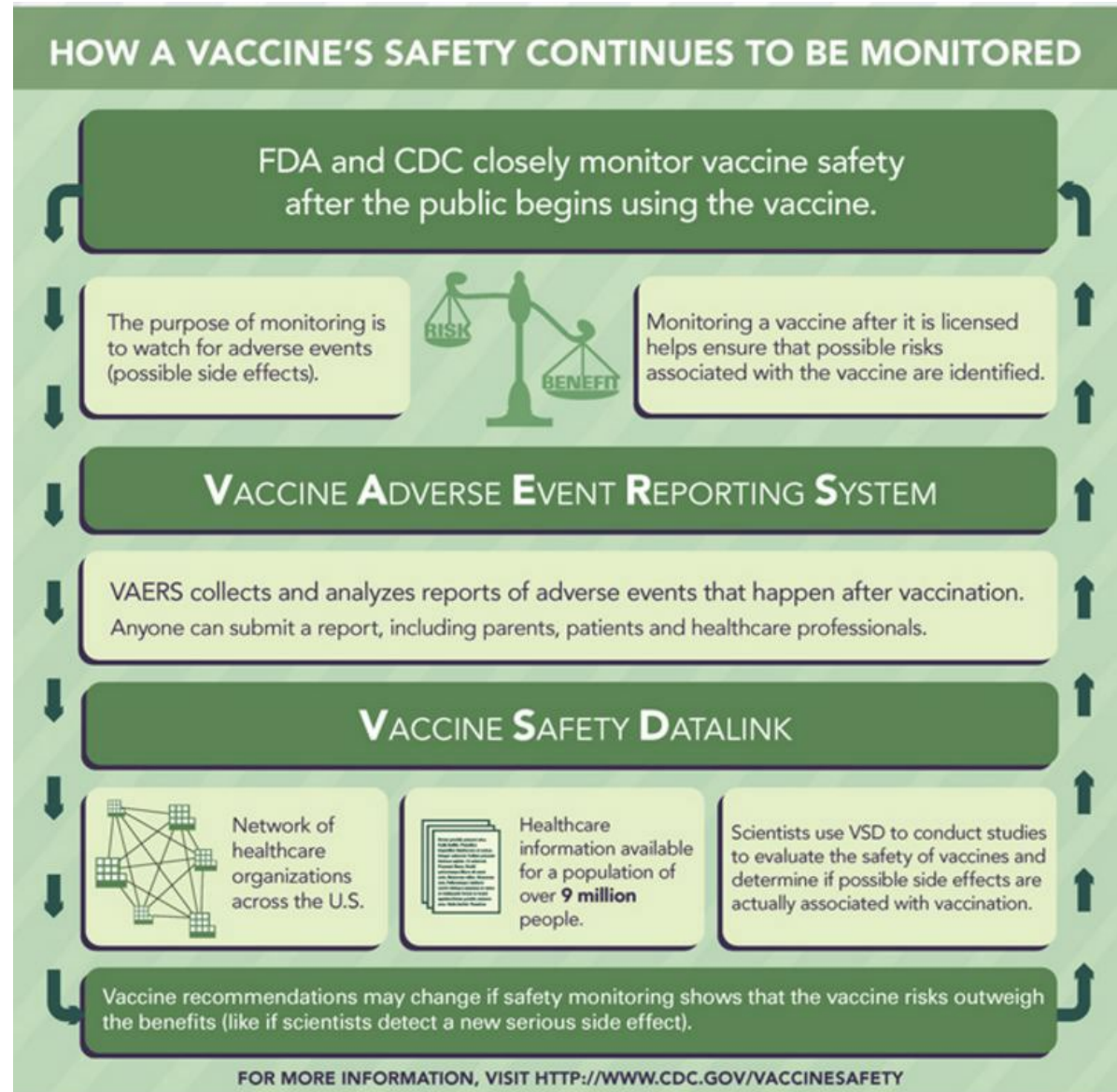
POST-APPROVAL MONITORING + RESEARCH

PHASE 4

safety monitoring for serious, unexpected adverse events

“Phase IV Trial”

- Continuous Monitoring
- VAERS
- Datalink



Vaccine Controversies

The “Anti-Vax Movement”

1. Vaccines cause autism

Quick answer: No. Just, no.

Long Answer:



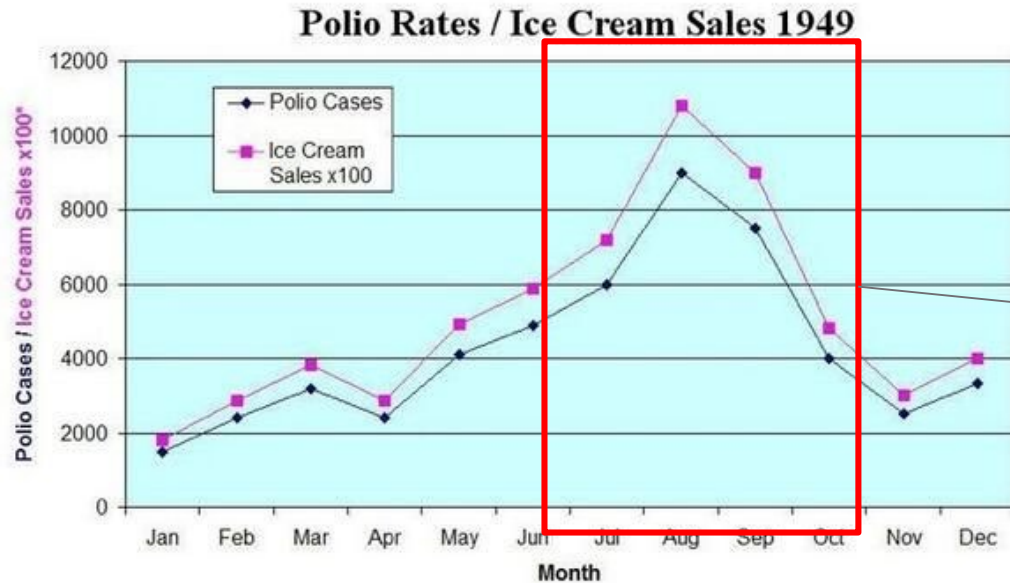
- In 1998, Dr. Andrew Wakefield published a study in the British Medical Journal, *The Lancet*
- In it, he claimed that “the onset of behavioral symptoms was associated, by the parents, with MMR vaccination in 8 of the 12 children”

“The most damaging Medical Hoax of the last 100 years”

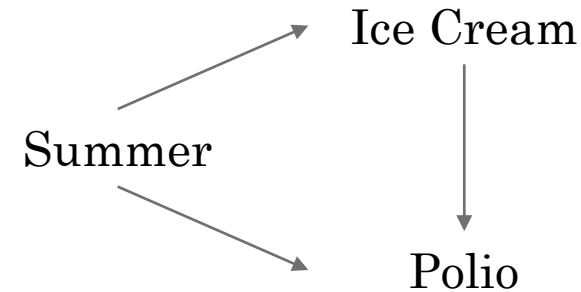
- Why was it bad?
 - **Manipulated Evidence**
 - Reports of 8 out of 12 children
 - **Retrospective data:** Parents/Physicians linked the start of their behavior symptoms to MMR vaccination
 - Bowel symptoms, endoscopy findings, biopsy → “autistic enterocolitis”
 - Suggested connection between autism and gastrointestinal issues was real, but did not prove an association between triple vaccine and autism
 - Press Conference
 - Wakefield “thought it prudent” to use single vaccines instead of the MMR triple vaccine until the triple vaccine could be ruled out as an autism trigger
 - Major health scare in the UK

Correlation Does Not Imply Causation

The Real Cause of Polio!



Polio outbreaks were most common during summer, when people naturally eat more ice cream.



In the late 1940s, before there was a polio vaccine, public health experts in America noted that polio cases increased in step with the consumption of ice cream and soft drinks.

The elimination of such treats was recommended as part of an anti-polio diet.

NO LINK WAS FOUND

So people started investigating his claims

Following Dr. Wakefield's study, here's what other more rigorous studies found

1999

a study of
500 CHILDREN
no connection was found

2001

a study of
10,000 CHILDREN
still found no connection

2002

a study from Denmark of
537,000 CHILDREN
found no connection

a study from Finland of
535,000 CHILDREN
once again found no connection

2012

A review of 27 cohort studies, 17 case control studies, 6 self-controlled case series studies, 5 time series trials, 2 ecological studies, 1 case cross-over trial covering over
14,700,000 CHILDREN

2005

A review of 31 studies covering more than
10,000,000 CHILDREN
Also found no connection

2004

Lancet released a statement **REFUTING** the original findings

NO LINK TO AUTISM WAS FOUND IN ANY CASE, IN ALL OF THE STUDIES.

“

They had conducted invasive investigations on the children without obtaining the necessary ethical clearances... picked and chose data that suited their case:

THEY FALSIFIED FACTS.”

Then what?

- Wakefield was found to have undisclosed **conflicts of interest**
 - Paid to conduct the study by lawyers of parents
 - Received £55,000 from solicitors seeking evidence
 - Had applied for patent on a rival, single vaccine (measles)
- His co-authors withdrew their support for the interpretations
- There were **ethical** considerations:
 - Children were subjected to unnecessary invasive medical procedures (colonoscopies, lumbar punctures)
 - Bought blood samples from children at his son's birthday party
 - Acted without institutional review board approval
- Feb 2, 2010, *the Lancet* “fully retracted the paper from the published record”
- May 24, 2010, Wakefield's **medical license was revoked** for “serious and wide-ranging findings of misconduct.”

2. Vaccines have mercury in them.

Quick answer: Kind of.

Long Answer

- **TRUE:** Mercury (methylmercury) has been found to damage the nervous system
- **HOWEVER**
 - **Thimerosal** (the preservative used in vaccines) contains ethylmercury
 - Multiple studies have found **NO LINK** between
 - Thimerosal and autism
 - Thimerosal and neurologic issues in children
- **ALSO**
 - Thimerosal was removed from all childhood vaccines between 1999 and 2001
 - Mainly due to the studies at the time that stated Mercury was bad for everyone
 - Thimerosal is still found in some multi-dose vials of some flu vaccines
 - Single-dose vials are the general rule

<https://www.cdc.gov/vaccinesafety/concerns/autism.html>

3. That many vaccines
at once is bad for
children.

Quick answer: No, it's not.

Long Answer

- **Adaptive Immune System**

- Passive protection from mother (transplacentally, breastmilk)
- Gradually matures during infancy
- T cells can produce a large immune response to brief stimulation
- Vaccines
 - Stimulate protective immune responses
 - Immunological memory accumulation

- **Exposure**

- Womb is sterile
- Bacterial exposure: birth canal, skin contact, breathing, eating, putting things in mouths, gut bacteria
- Exposure to microorganisms is **CONTINUOUS**

- **Combined Vaccine**

- Decreased risk of catching disease while waiting for full immunization coverage.
- 2 injections = less pain and distress than 6
- Extra visits for more vaccines → delayed and missed coverage

Vaccines and Autism

1940

DTP
SMALLPOX

**some children got 4 shots before the age of 2. NEVER with more than 1 shot per visit



*49 DOSES of 14 vaccines by the age of 6 (in 2012)

Educate Before You Vaccinate

proud parents of unvaccinated children find us on facebook

1980

DTP (2 months)
Polio (2 months)
DTP (4 months)
Polio (4 months)
DTP (6 months)
Polio (6 months)
MMR (12 months)
DTP (18 months)
DTP (5 years old)

**children got 8 shots before age 2 and NEVER with more than 2 shots per visit

2012

Flu/H1N1 (Prenatal)
HepB (Birth)
Dtap (2 months)
Polio (2 months)
Hib (2 months)
Pneu (2 months)
Rotavirus (2 months)
HepB (2 months)
Dtap (4 months)
Polio (4 months)
Hib (4 months)
Pneu (4 months)
Rotavirus (4 months)
Dtap (6 months)
Polio (6 months)
Hib (6 months)
Flu/H1N1 (6 months)
Flu/H1N1 (7 months)
Pneu (12 months)
MMR (12 months)
Varicella (15 months)
HepA (15 months)
Dtap (18 months)
Polio (18 months)
Hib (18 months)
HepA (18 months)
Flu/H1N1 (18 months)
Flu/H1N1 (2.5 years)
Dtap (4-6 years)
Polio (4-6 years)
MMR (4-6 years)
Varicella (4-6 years)
Flu/H1N1 (4-6 years)

AUTISM

by the numbers

1970: 1 in 10,000

1975: 1 in 5,000

1985: 1 in 2,500

1995: 1 in 500

2001: 1 in 250

2004: 1 in 166

2007: 1 in 150

2009: 1 in 110

2012: 1 in 88

2013: 1 in 50

2014: ?

www.VACceptableinjuries.com

So explain this!

Identified Prevalence of Autism Spectrum Disorder

Surveillance Year	Birth Year	Sites Reporting	Prevalence per 100,000	Approx.
2020	2012	11	27.6 (23.1-44.9)	1 in 36
2018	2010	11	23.0 (16.5-38.9)	1 in 44
2016	2008	11	18.5 (8.0-19.1)	1 in 54
2014	2006	11	16.8 (13.1-29.3)	1 in 59

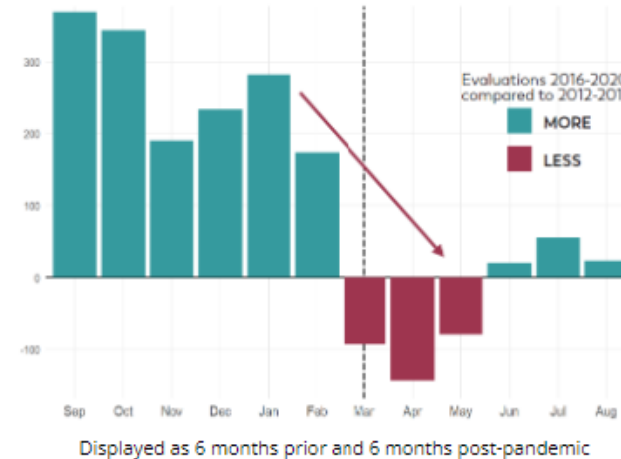
- 4x more common in boys

General population of 8 year olds in 11 states, extrapolated to the rest of the US

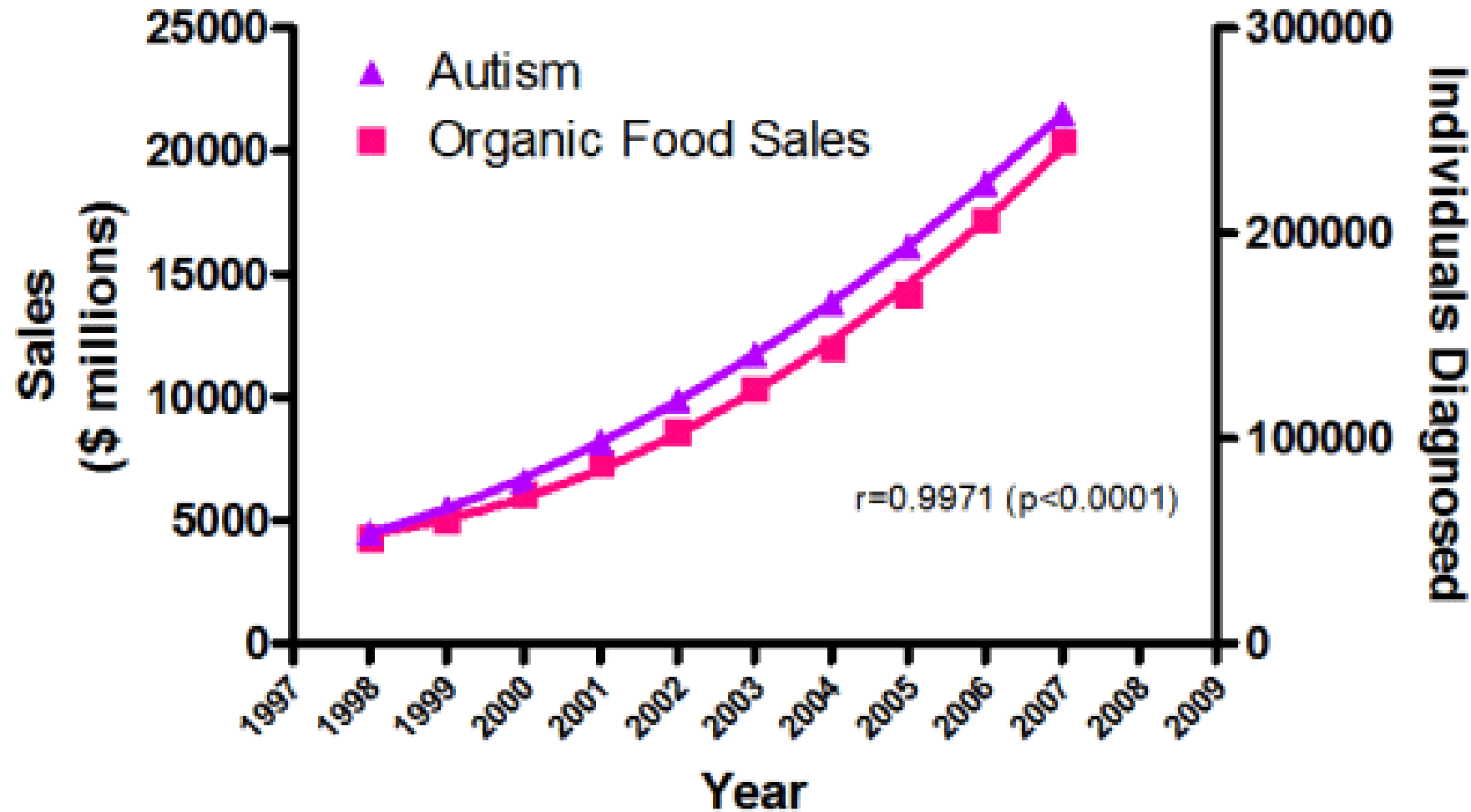
Autism is “increased” because...

- Awareness & Diagnostic Criteria Changed
 - 1966 (1 in 250,000) – focused on children at the severe end of the spectrum
 - 1980 – Autism is added to the DSM
 - Before this, many with autism were institutionalized and “invisible”
 - 1987 – expanded diagnostic criteria (1 in 1,400)
 - 1991 – diagnosis of Autism qualifies for special education services
 - Previously, children may have been listed as “intellectual disability”
 - 1994 – definition broadens even further (includes Aspergers as mildly Autistic)
 - 2006 – AAP recommends screening all children for autism between 18 and 24 months of age
 - 2010 – AHA increased access to care

From 2016 to the beginning of 2020, 4-year-old children had more evaluations and identifications than children aged 8-years (when they were 4) had from 2012 through 2015.



- Biological factors
 - Older parents (especially fathers)
 - Prematurity



Sources: Organic Trade Association, 2011 Organic Industry Survey; U.S. Department of Education, Office of Special Education Programs, Data Analysis System (DANS), OMB# 1820-0043: "Children with Disabilities Receiving Special Education Under Part B of the Individuals with Disabilities Education Act"

Number people who drowned by falling into a pool

correlates with

Number of films Nicolas Cage appeared in



**Correlation \neq
Causation**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number people who drowned by falling into a pool (CDC)	109	102	102	98	85	95	96	98	123	94
Number of films Nicolas Cage appeared in (IMDB)	2	2	2	3	1	1	2	3	4	1

Take Home Message

Vaccines are Backed by Science

- Must pass stringent Phase I, II, and III trials before it is regulated for use and are continuously monitored following licensure
- All vaccines routinely recommended for children 6 years of age or younger and marketed in the U.S. contain no thimerosal or only trace amounts
- Infants and young children who follow immunization schedules that spread out shots – or leave out shots – are at risk of developing diseases during the time that shots are delayed
- Vaccines keep communities healthy, and protect some of the most vulnerable in our society

American Academy of Pediatrics. (2017). *American Academy of Pediatrics Emphasizes Safety and Importance of Vaccines*. Retrieved from <https://www.aap.org/en-us/about-the-aap/aap-press-room/Pages/American-Academy-of-Pediatrics-Emphasizes-Safety-and-Importance-of-Vaccines.aspx>

Centers for Disease Control and Prevention. (2016). *Infant Immunizations FAQs*. Retrieved from <https://www.cdc.gov/vaccines/parents/parent-questions.html>

U.S. Food and Drug Administration. (2015). *Thimerosal in Vaccines: Questions and Answers*. Retrieved from <http://www.fda.gov/BiologicsBloodVaccines/Vaccines/QuestionsaboutVaccines/UCM070430#q5>

Other Resources

- [CDC.gov/vaccines](https://www.cdc.gov/vaccines)
- [Immunizedelaware.org](https://immunizedelaware.org)
- [Vaxopedia.org](https://vaxopedia.org)
- [HistoryofVaccines.com](https://historyofvaccines.com)



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Public Health Is Awesome!



- Bachelors from Penn State
 - Nuclear Engineering/ Engineering Mechanics
- MD from Xavier University School of Medicine
 - Aruba!
 - Atlanta and Chicago
- MPH from Arcadia
 - International internship → vaccine safety, cold chain breaks in Australia
- Delaware Academy of Medicine
 - Patient Centered Care, Immunizations, Chronic Disease, Built Environment/Environmental Health, Education, Biostatistics, Epidemiology, ...



Clearinghouse for Vaccine information

- www.immunizedelaware.org
- Info for public and providers
 - Flu season
 - Clinic locations, dates, times
 - Types of vaccines in this season's shot
 - Specific vaccine information
 - Links to the CDC
 - Vaccine Information Statements
 - News
 - New vaccines
 - Continuing Education
 - New controversies

