MINI MED SCHOOL: VACCINES

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PEDIATRIC INFECTIOUS DISEASES

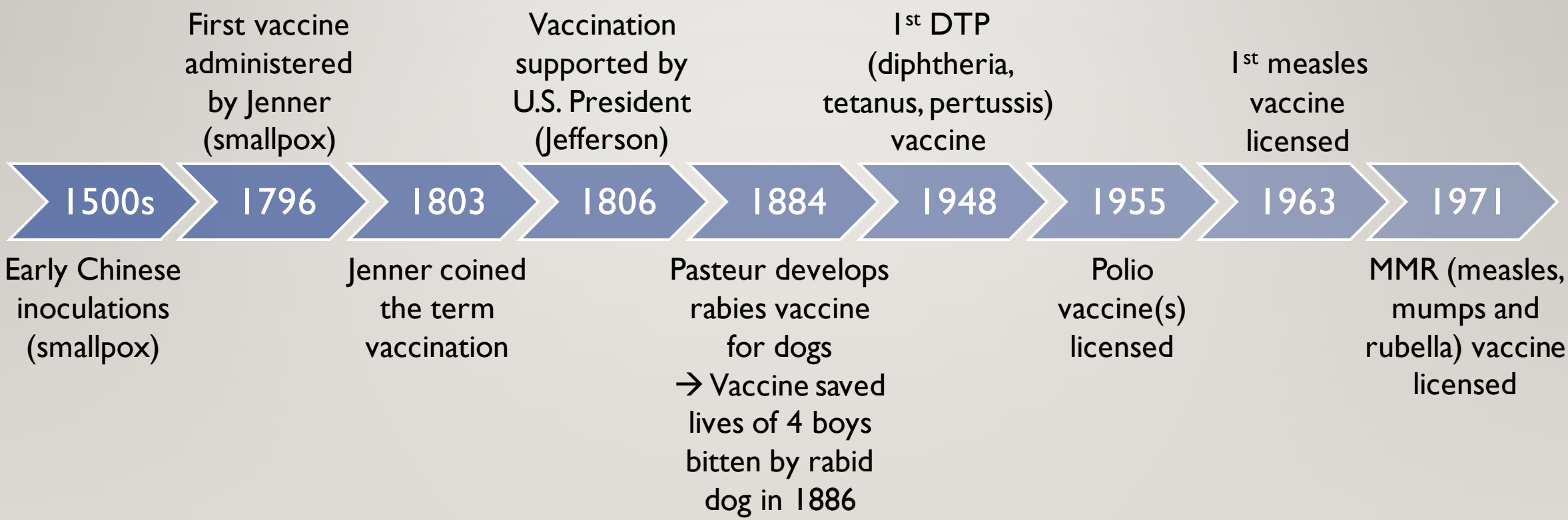
UNC HOSPITAL

FEBRUARY 24TH, 2020

OUTLINE

- **History of Vaccines**
- Basic Principles of Vaccines
- Cases
- Common Concerns about Vaccines

BRIEF HISTORY OF VACCINES



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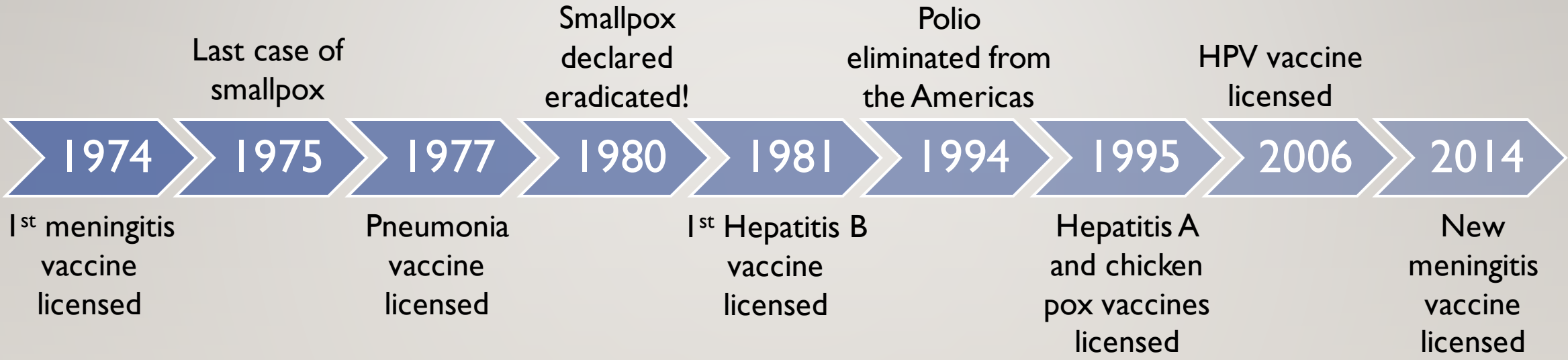

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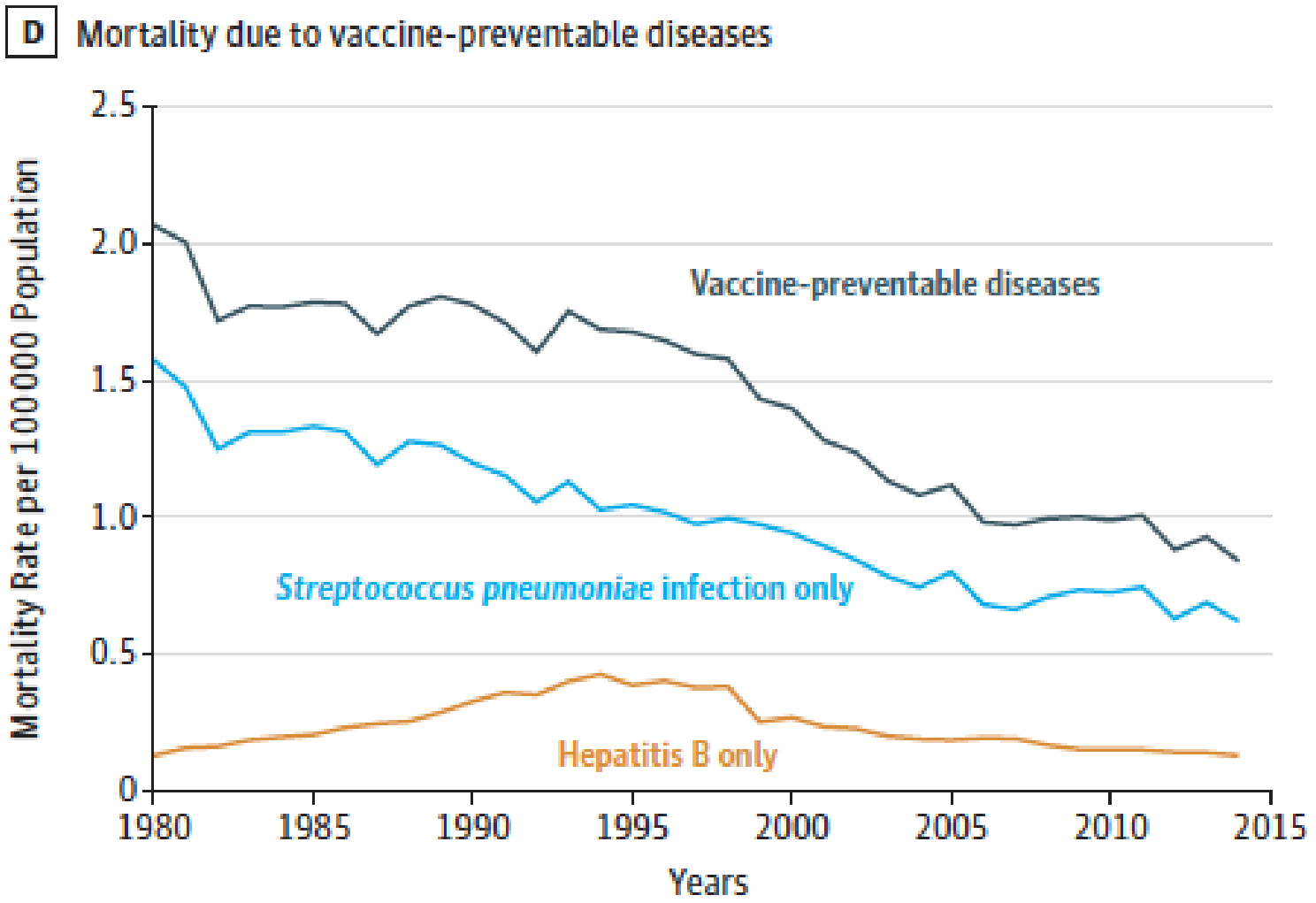
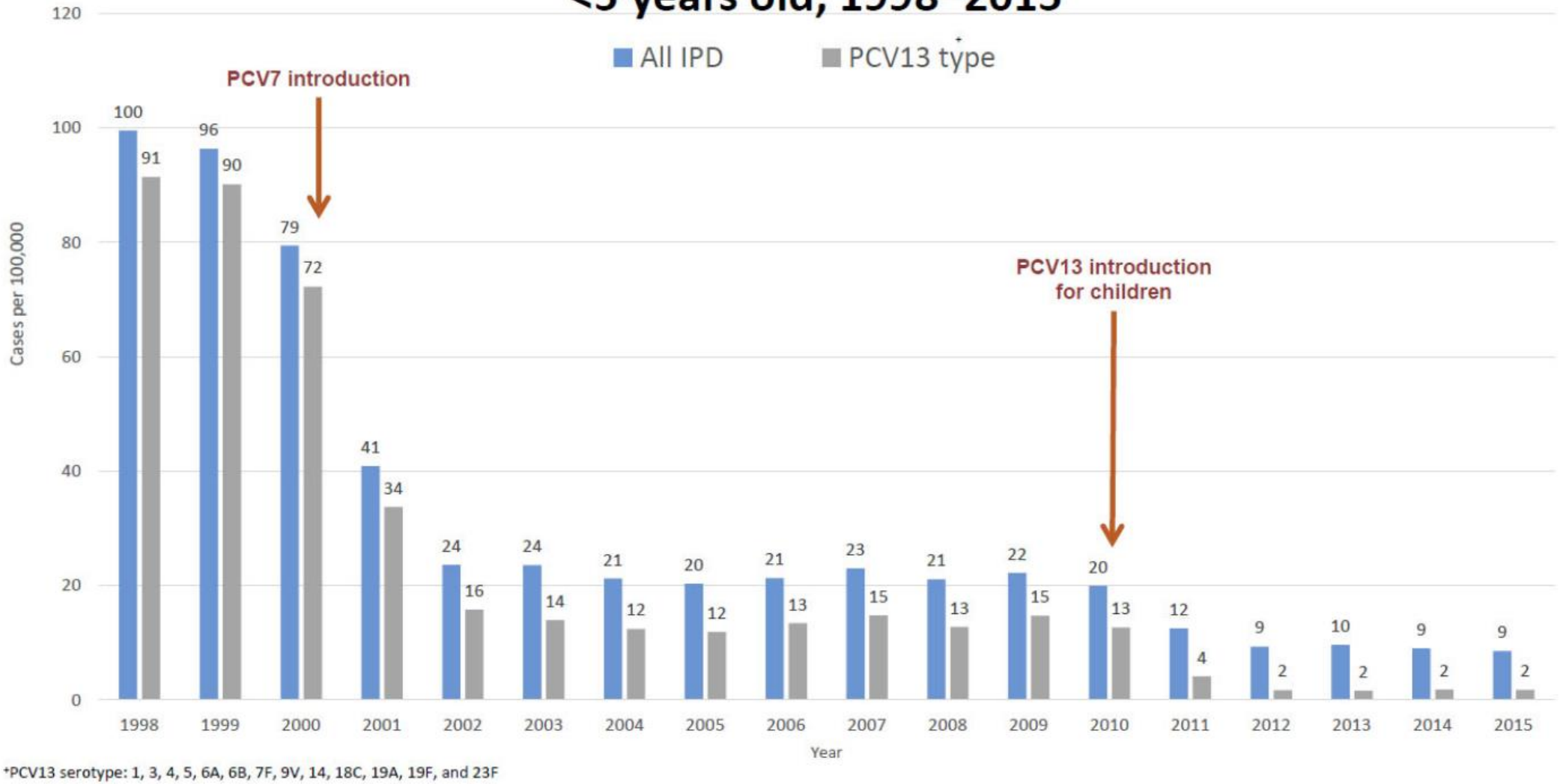
BASIC PRINCIPLES OF VACCINATION



JAMA 2016

Trends in invasive pneumococcal disease among children aged <5 years old, 1998–2015



*PCV13 serotype: 1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F, and 23F

CDC Pneumococcal

WE HAVE **MANY** EFFECTIVE VACCINES

Routine Childhood Vaccines

- Diphtheria, Tetanus, acellular Pertussis (DTaP/Tdap)
- *Haemophilus influenzae* type b (Hib)
- Hepatitis A
- Hepatitis B
- Human Papilloma virus (HPV)
- Influenza
- Measles, Mumps and Rubella (MMR)
- Meningococcal
- Pneumococcal
- Polio
- Rotavirus
- Varicella

Other Vaccines

- Adenovirus
- Anthrax
- Tuberculosis (BCG)
- Cholera
- Japenese Encephalitis (JEE)
- Meningitis B (MenB)
- Rabies
- Shingles
- Typhoid
- Vaccinia (Smallpox)
- Yellow Fever

CDC VACCINE SCHEDULE, AGES 0-18 YEARS

Birth to 15 Months

Vaccine	Birth	1 mo	2 mos	4 mos	6 mos	9 mos	12 mos	15 mos
Hepatitis B (HepB)	1st dose	2nd dose			←3rd dose→			
Rotavirus (RV) RV1 (2-dose series); RV5 (3-dose series)			1st dose	2nd dose	See notes			
Diphtheria, tetanus, & acellular pertussis (DTaP: <7 yrs)			1st dose	2nd dose	3rd dose			←4th dose→
Haemophilus influenzae type b (Hib)			1st dose	2nd dose	See notes		←3rd or 4th dose, See notes→	
Pneumococcal conjugate (PCV13)			1st dose	2nd dose	3rd dose		←4th dose→	
Inactivated poliovirus (IPV: <18 yrs)			1st dose	2nd dose	←3rd dose→			
Influenza (IIV)					Annual vaccination 1 or 2 doses			
or Influenza (LAIV)								
Measles, mumps, rubella (MMR)					See notes		←1st dose→	
Varicella (VAR)							←1st dose→	
Hepatitis A (HepA)					See notes		←2-dose series, See notes→	
Meningococcal (MenACWY-D: ≥9 mos; MenACWY-CRM: ≥2 mos)			See notes					
Tetanus, diphtheria, & acellular pertussis (Tdap: ≥7 yrs)								
Human papillomavirus (HPV)								
Meningococcal B (MenB)								
Pneumococcal polysaccharide (PPSV23)								

18 Months to 18 Years

Vaccines	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)	←3rd dose→								
Rotavirus (RV) RV1 (2-dose series); RV5 (3-dose series)									
Diphtheria, tetanus, & acellular pertussis (DTaP: <7 yrs)	←4th dose→			5th dose					
Haemophilus influenzae type b (Hib)									
Pneumococcal conjugate (PCV13)									
Inactivated poliovirus (IPV: <18 yrs)	←3rd dose→			4th dose					
Influenza (IIV)	Annual vaccination 1 or 2 doses				Annual vaccination 1 dose only				
or Influenza (LAIV)			Annual vaccination 1 or 2 doses	or	Annual vaccination 1 dose only				
Measles, mumps, rubella (MMR)				2nd dose					
Varicella (VAR)				2nd dose					
Hepatitis A (HepA)	← 2-dose series, See notes→								
Meningococcal (MenACWY-D: ≥9 mos; MenACWY-CRM: ≥2 mos)	See notes					1st dose		2nd dose	
Tetanus, diphtheria, & acellular pertussis (Tdap: ≥7 yrs)						Tdap			
Human papillomavirus (HPV)						See notes			
Meningococcal B (MenB)					See notes				
Pneumococcal polysaccharide (PPSV23)			See notes						

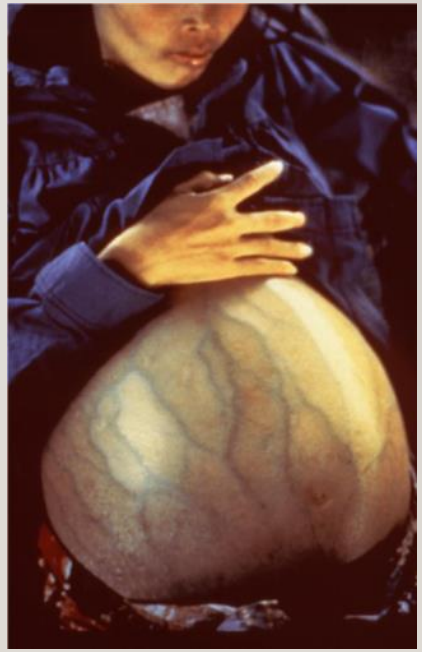
CDC 2019

OUTLINE

- History of Vaccines
- Basic Principles of Vaccines
- **Cases**
- Common Concerns about Vaccines

CASE #1

- A 23 year-old Burmese male develops liver dysfunction and goes on to develop liver cancer. He is on the liver transplant list but has not yet received his transplant.
- Further testing reveals that he is hepatitis B positive.
- What are the typical manifestations of hepatitis B?
- What could have prevented this disease course?



RedBook Online

HEPATITIS B: ACQUISITION

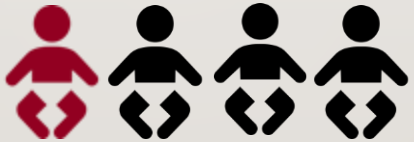
- Viral infection (hepadnavirus)
- Blood-borne pathogen
- Acquired by 2 major routes of transmission:
  - Vertical (mother-to-child)
  - Horizontal (person-to-person)

HEPATITIS B: CLINICAL

- Acute infection:
  - Ranges from no symptoms to acute hepatitis
  - May develop jaundice (yellowing of the skin), scleral icterus (yellowing of the whites of the eyes), joint pain, skin rashes etc.
  - Infection can clear or remain in the body (chronic)

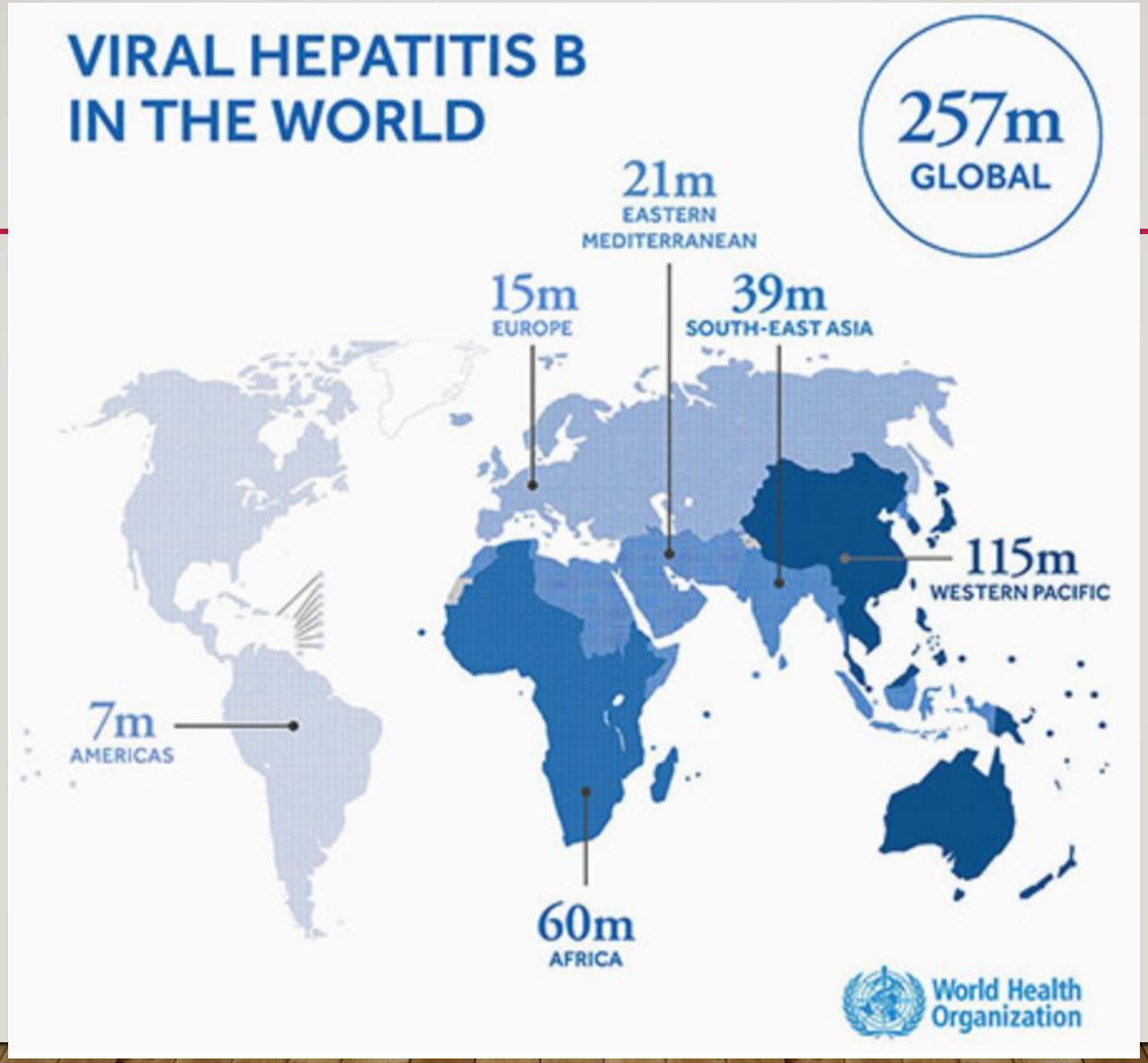
HEPATITIS B: CHRONIC INFECTION

9 of 10 infants infected in the first year of life develop chronic infection



1 of 4 chronically infected infants die in adulthood from cirrhosis or hepatocellular carcinoma

Edmunds et al; WHO HBV Fact Sheet; The Noun Project



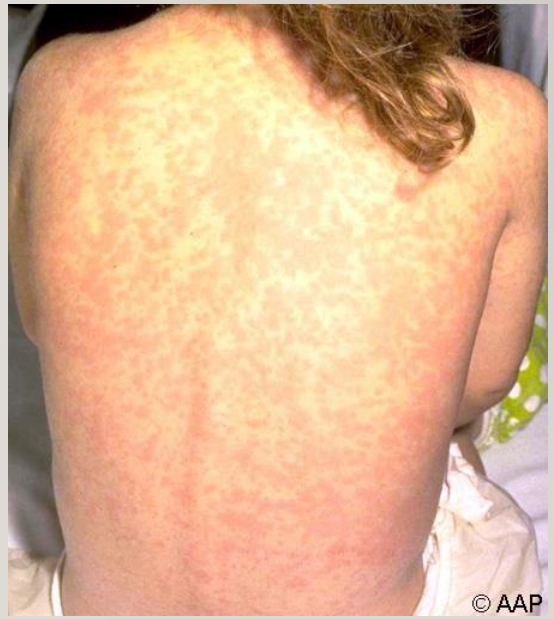
CDC Viral Hepatitis

HEPATITIS B: PREVENTION

- Hepatitis B vaccine
  - **First vaccine to prevent cancer!!**

CASE #2

- Parents of a 7 year-old unvaccinated female bring her to see you for a rash. The family returned from a trip to Paris 5 days ago. The child developed "cold-like" symptoms on the flight home, and then broke out in this pictured full-body rash last night.
- What is this illness?
- What could have been done to prevent it?

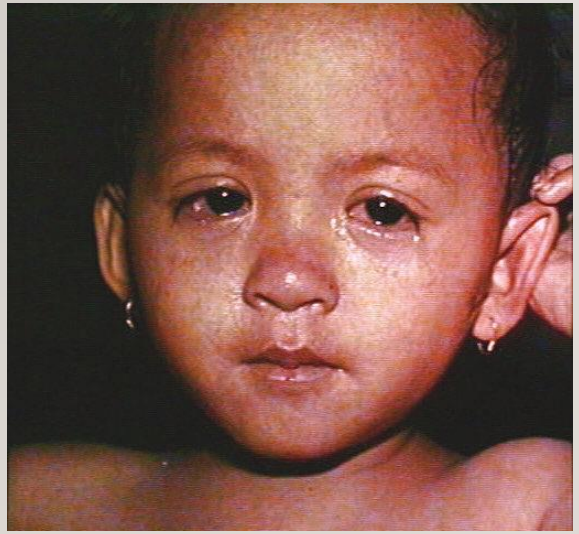


MEASLES: ACQUISITION

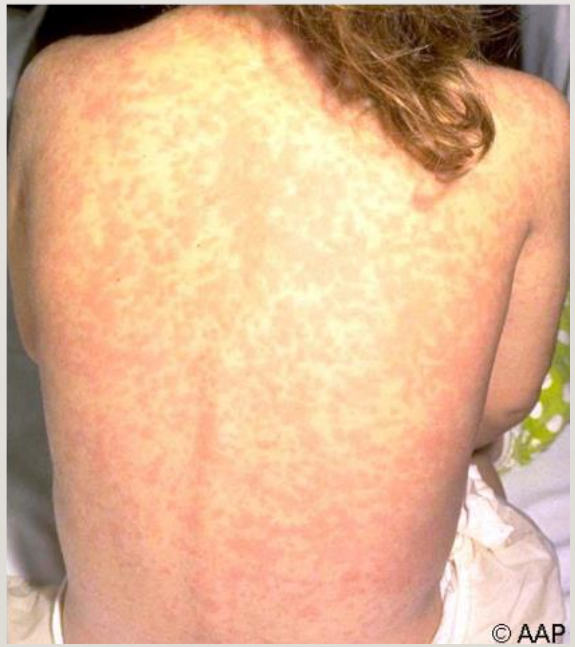
- Viral infection (paramyxovirus)
- One of the most contagious infectious diseases!
- Most contagious 4 days prior to rash appearance through 4 days after onset
- Airborne spread (similar to tuberculosis)

MEASLES: CLINICAL

Phase 1



Phase 2

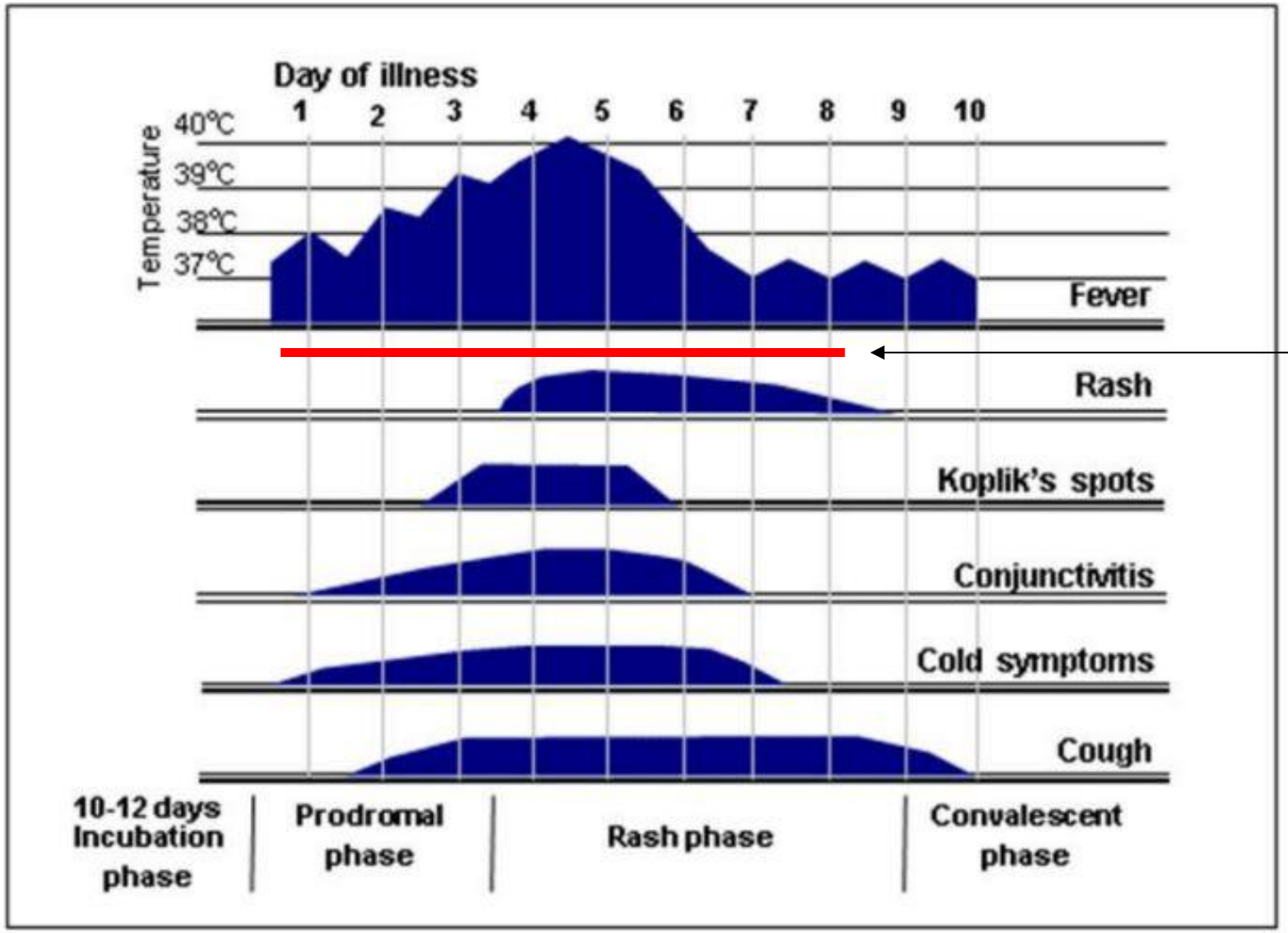


Phase 3

Healing

Complications
- Ear infections
- Pneumonia
- Encephalitis (1:1,000)
- Death (1-3:1,000)

Figure 1.2 Clinical features of primary measles infection – time course from onset of illness

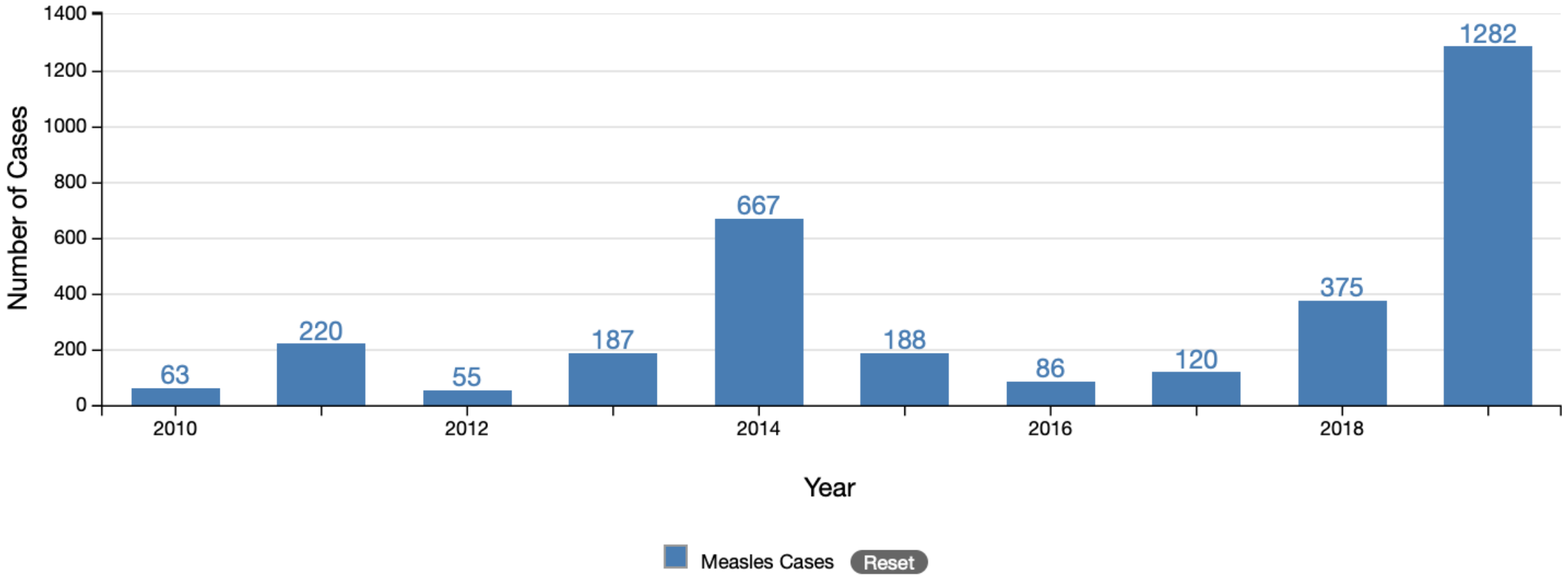


Contagious period

Source: WHO Measles

Number of Measles Cases Reported by Year

2010-2019**(as of December 31, 2019)



Source: CDC

NC DEPARTMENT OF HEALTH AND HUMAN SERVICES

ROY COOPER • Governor
MANDY COHEN, MD, MPH • Secretary
MARK T. BENTON • Assistant Secretary for Public Health
Division of Public Health

To: North Carolina Clinicians
From: Erica Wilson, MD, MPH, Medical Epidemiologist
Subject: Measles in Traveler in Guilford County (2 pages)
Date: October 11, 2019

Summary:
A case of measles has been diagnosed in an individual who traveled through Guilford County while contagious on October 2nd and 3rd.

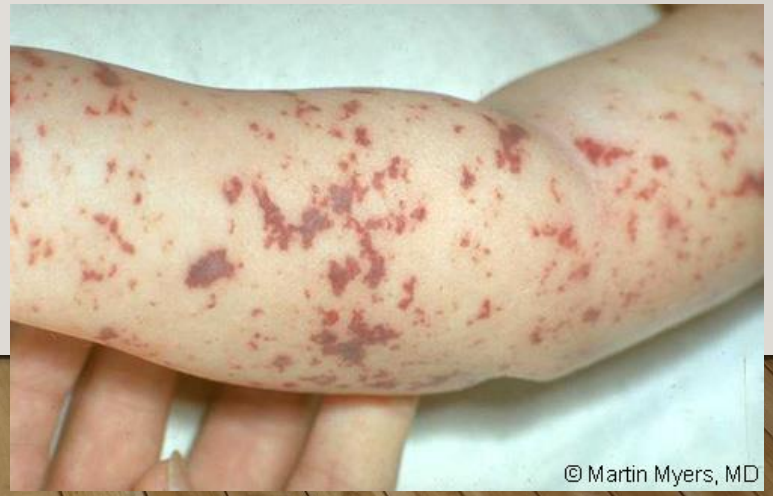
Individuals could have been exposed at the Piedmont Triad International Airport and at the Greensboro Wyndham Garden Hotel on those dates. Every effort is being made to contact persons with known exposure; however, it is possible that other unrecognized contacts may have been exposed at these locations.

MEASLES: VACCINATION

- Combined with mumps and rubella (MMR)

CASE #3

- A 15 year-old male comes to the emergency room with 1 day of fever, chills, and flu-like symptoms. He tests negative for influenza. He is discharged home with instructions to drink plenty of fluids and take Tylenol & Advil as needed for fever.
- The next day, his parents find him in his room unresponsive and he has a purple-colored rash on his arms and legs.
- What is the cause of his illness?
- What could have been done to prevent it?

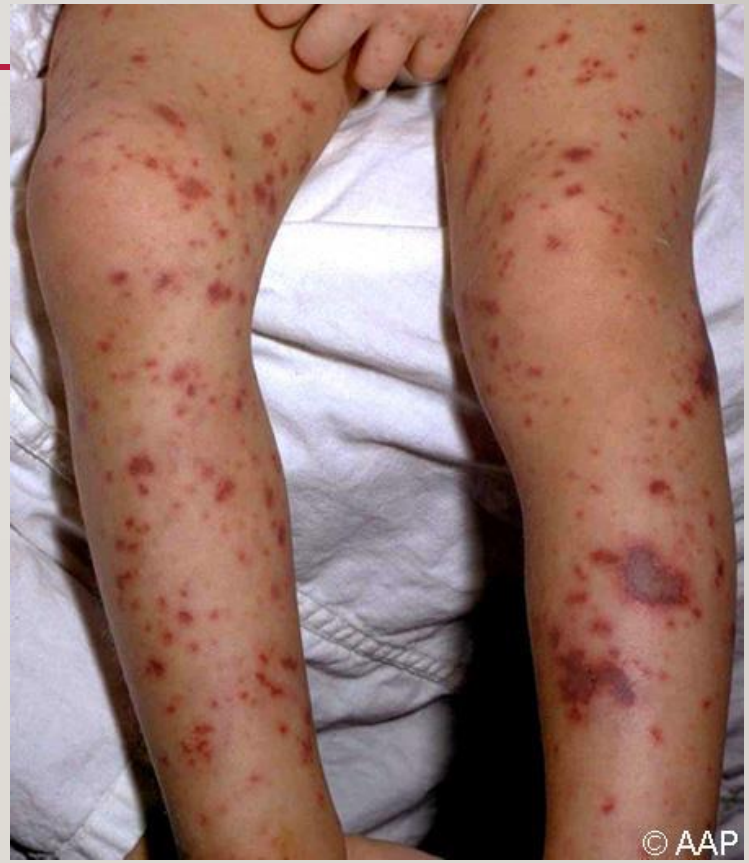


MENINGOCOCCEMIA: ACQUISITION

- Bacterial infection (*Neisseria meningitidis)*
- Spread by respiratory droplets
  - Contagious up to 24 hours after starting effective antibiotics
- Most cases are sporadic
- Outbreaks may occur in child care settings, colleges, military recruit camps

MENINGOCOCCEMIA: CLINICAL

- Abrupt onset
- Fever, chills, body aches
- Meningitis in 50%
- Bloodstream infection in 35-40%
- Characteristic rash
- Complications: loss of limbs, hearing loss, shock, death



MENINGOCOCCEMIA: VACCINATION

- Routine vaccine:

- MenB vaccine:
  - Approved for use in children >10 years; recommended between ages 16-23

CASE #4

The parents of a 17-year-old college student in your practice call to ask your advice. The student awoke this morning to find a bat flying around his dormitory room. He and his roommate opened the window and the bat flew out. He feels well and on self-examination noticed no skin lesions or bite marks. His immunizations are up to date, including receipt of diphtheria-tetanus-pertussis vaccine at 11 years of age.

Of the following, the BEST course of action is:

A. Begin a 5-day course of amoxicillin-clavulanic acid (antibiotic)

B. Begin a rabies vaccine series

C. Give a tetanus vaccine booster

D. Monitor his skin for signs of new skin lesions over the next 2 weeks

E. Provide reassurance

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RABIES: ACQUISITION

- Viral infection (rhabdoviridae)
- Most U.S. cases transmitted by bats
  - May not have bite marks
  - If a bat is found in a child's room, he or she should be considered exposed and should get a vaccine series
- Other animals: dogs and cats (more rare with routine rabies vaccination), raccoons, skunks, foxes, coyotes, bobcats
  - Unlikely in rodents and rabbits

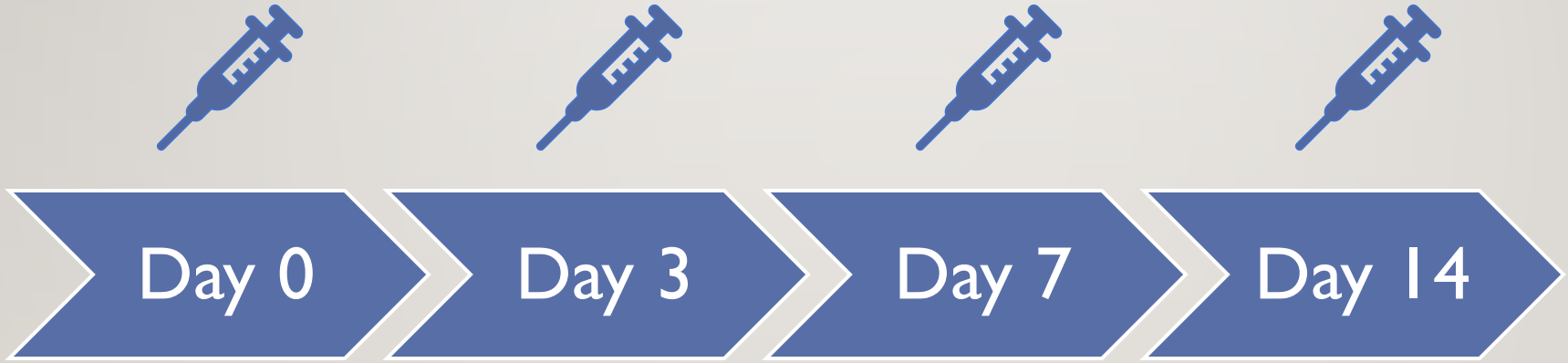
RABIES: CLINICAL

- Rapidly progressive neurological impairment
  - Characterized by hydrophobia (fear of water)
- Universally fatal if not vaccinated promptly

Source: https://www.scienceabc.com/humans/why-does-rabies-cause-fear-of-water.html

RABIES: VACCINATION

- Prevention is key, as we do not have effective treatment!!



- High-risk individuals (such as veterinarians) should receive rabies vaccination as prophylaxis

OUTLINE

- History of Vaccines
- Basic Principles of Vaccines
- Cases
- **Common Concerns about Vaccines**

5 COMMON CONCERNS ABOUT VACCINATIONS

Questions that parents bring to their provider regarding vaccines

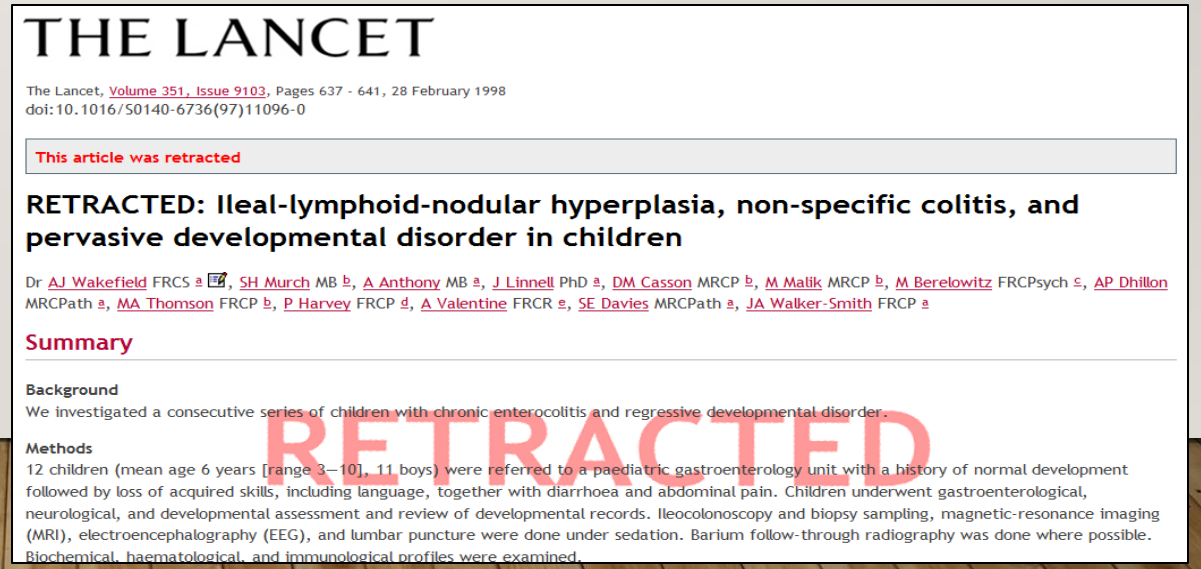
http://whyimmunizekids.org/role-playing-video-clips/

Full Video: Addressing Vaccine-Hesitant Parents

1. ARE VACCINES SAFE?

- Safety monitoring:
  - National Immunization Hotline 1-800-CDC-INFO
  - VAERS (Vaccine Adverse Event Reporting System)
  - VSD (Vaccine Safety Datalink)

- Absolutely NO link to autism
  - 2014 Meta-Analysis



THE LANCET

The Lancet, Volume 351, Issue 9103, Pages 637 - 641, 28 February 1998
doi:10.1016/S0140-6736(97)11096-0

This article was retracted

RETRACTED: Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children

Dr AJ Wakefield FRCS [a], SH Murch MB [b], A Anthony MB [a], J Linnell PhD [a], DM Casson MRCP [b], M Malik MRCP [b], M Berelowitz FRCPsych [c], AP Dhillon MRCPath [a], MA Thomson FRCP [b], P Harvey FRCP [d], A Valentine FRCR [e], SE Davies MRCPath [a], JA Walker-Smith FRCP [a]

Summary

Background
We investigated a consecutive series of children with chronic enterocolitis and regressive developmental disorder.

Methods
12 children (mean age 6 years [range 3–10], 11 boys) were referred to a paediatric gastroenterology unit with a history of normal development followed by loss of acquired skills, including language, together with diarrhoea and abdominal pain. Children underwent gastroenterological, neurological, and developmental assessment and review of developmental records. Ileocolonoscopy and biopsy sampling, magnetic-resonance imaging (MRI), electroencephalography (EEG), and lumbar puncture were done under sedation. Barium follow-through radiography was done where possible. Biochemical, haematological, and immunological profiles were examined.

RETRACTED

2. AREN'T THE INGREDIENTS IN VACCINES DANGEROUS?

- Thimerosal:
  - No link to autism
  - No longer an ingredient in most vaccines
- Aluminum:
  - Necessary to induce an immune response
  - Total amount of aluminum in 1st 6 months:
    - Vaccines: 4-6mg
    - Breastmilk: ~10mg in breastmilk
    - Formula: ~40mg (~120mg in soy based formula)

THIMEROSAL (CONT.)

DTaP-HepB-IPV	Pediarix (GlaxoSmithKline Biologicals)	Free	Never contained more than a Trace of Thimerosal, approval date for thimerosal-free formulation 1/29/2007
DTaP-IPV/Hib	Pentacel (sanofi pasteur Ltd.)	Free	Approved June 20, 2008, never contained thimerosal
DTaP-IPV	KINRIX (Glaxo SmithKline Biologicals)	Free	Approved October 8, 2009, never contained thimerosal
Pneumococcal conjugate	Prevnar (Wyeth Pharmaceuticals Inc.)	Free	Never contained Thimerosal
	Prevnar 13 (Wyeth Pharmaceuticals Inc.)	Free	Approved February 24, 2010, never contained thimerosal
Inactivated Poliovirus	IPOL (Sanofi Pasteur, SA)	Free	Never contained Thimerosal
Varicella (chicken pox)	Varivax (Merck & Co, Inc.)	Free	Never contained Thimerosal
Mumps, measles, and rubella	M-M-R-II (Merck & Co, Inc.)	Free	Never contained Thimerosal
Mumps, measles, rubella and varicella	ProQuad (Merck & Co., Inc.)	Free	Approved September 6, 2005, never contained thimerosal.
Heptatitis A	Havrix (GlaxoSmithKline Biologicals)	Free	Never contained thimerosal
	Vaqta (Merck & Co., Inc.)	Free	Never contained thimerosal
Hepatitis B	Recombivax HB (Merck & Co, Inc.)	Free	08/27/99
	Engerix B (GlaxoSmithKline Biologicals)	Free	03/28/00, approval date for thimerosal-free formulation 1/30/2007

3. WON'T MULTIPLE VACCINES AT ONCE "OVERWHELM" MY CHILD'S IMMUNE SYSTEM?

- Multiple vaccines work WITH the immune system to BOOST it, not to overload it
- Normal newborn is exposed to 100,000 antigens a day (versus 150 antigens total in childhood vaccine series)
- Fewer antigens in vaccines now than in past, despite larger total number of vaccines

TABLE 2.

Number of Immunogenic Proteins and Polysaccharides Contained in Vaccines Over the Past 100 Years

1900		1960		1980		2000	
Vaccine	**Proteins**	**Vaccine**	**Proteins**	**Vaccine**	**Proteins**	**Vaccine**	**Proteins/Polysaccharides**
Smallpox*	~200	Smallpox	~200	Diphtheria	1	Diphtheria	1
Total	**~200**	Diphtheria†	1	Tetanus	1	Tetanus	1
		Tetanus‡	1	WC-Pertussis	~3000	AC-Pertussis¶¶	2–5
		WC-Pertussis§	~3000	Polio	15	Polio	15
		Polio‖	15	Measles¶	10	Measles	10
		Total	**~3217**	Mumps#	9	Mumps	9
				Rubella**	5	Rubella	5
				Total	**~3041**	Hib††	2
						Varicella‡‡	69
						Pneumococcus§ §	8
						Hepatitis B‖Verbar;	1
						Total	**123–126**

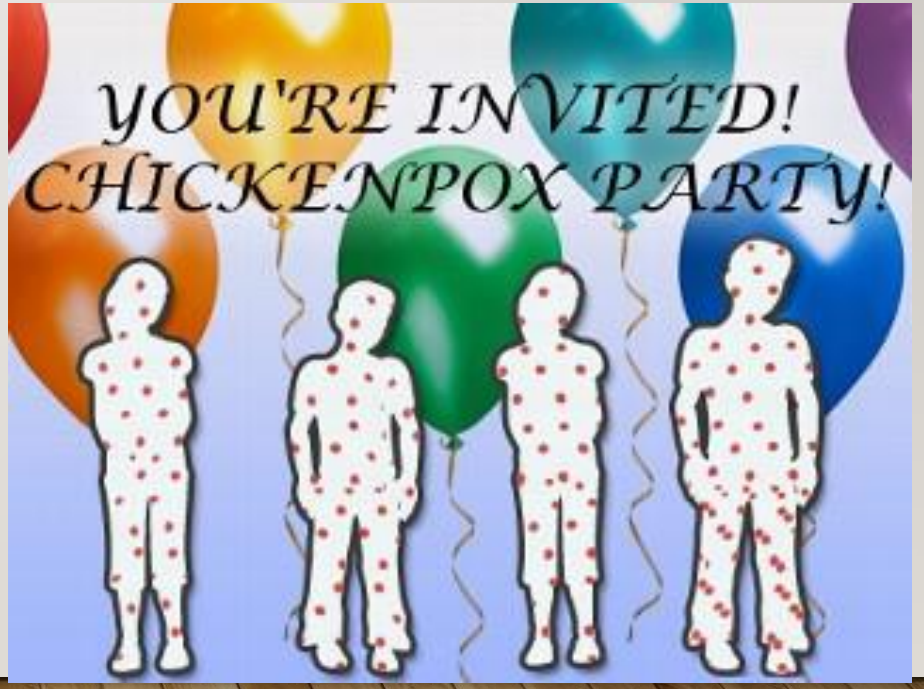
Taken taken from: Offit P, et al. Addressing parents' concerns: Do multiple vaccines overwhelm or weaken the infant's immune system? *Pediatrics.* 2002;109:124-129.

4. ISN'T NATURAL IMMUNITY BETTER?

- For some infections, natural immunity is better because it lasts longer

  BUT...

- It comes at a price (deafness, brain damage, pneumonia, paralysis, death)
  - Risk of encephalitis from measles is 1 in 1,000…versus 1 in 1,000,000 from the MMR vaccine



5. IT'S MY RIGHT TO DECIDE WHAT'S BEST FOR MY CHILD.

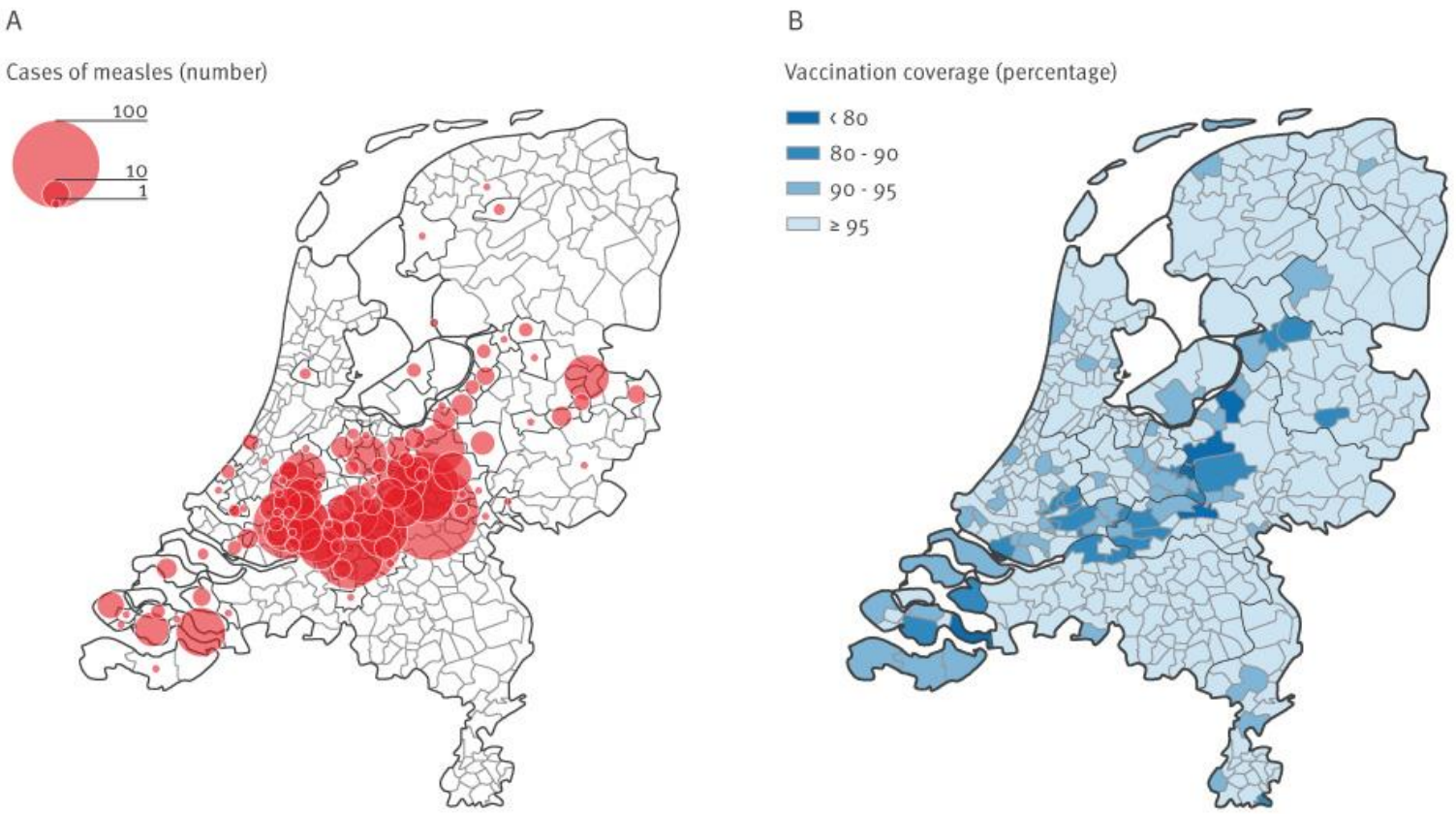
- Yes it definitely is, AND you need to be aware of the risks of not vaccinating your child
  - Lethality of these diseases

- What about homeschooling?
  - Laws differ by state
  - "It's a small world…"

HOW HERD IMMUNITY WORKS…

FIGURE 3

Reported measles cases by municipality, 1 May–28 August 2013 (panel A, n=1,226) and vaccination coverage of first MMR vaccine dose by municipality[a] for birth cohort 2010 at the age of two years (panel B, n=184,230), the Netherlands



MMR: measles-mumps-rubella.

[a] There are 30 municipalities with MMR-1 vaccination coverage below 90%, of which 29 are within the 'Bible belt'. The other municipality is Vaals, in the far south-east of the Netherlands. A considerable number of the infants living in Vaals receive their vaccinations in Germany and are therefore not registered in the Dutch vaccination registration, which explains the low vaccination coverage (84.3%).

QUESTIONS?

Jenner and the Milkmaid - Steve Meshnick