



Alfred I. duPont
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What's Old is New: Reemerging Infectious Diseases

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Disclosures

- I have no disclosures.

Outline

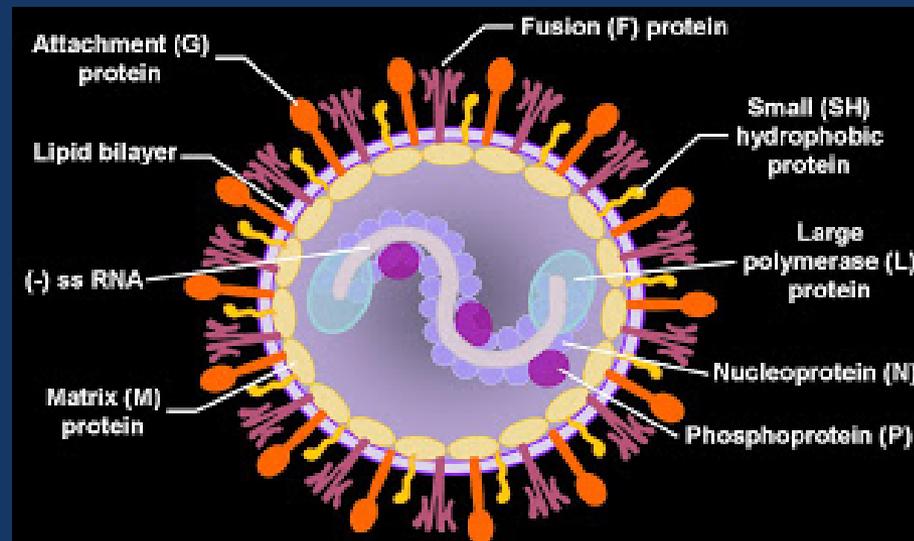
- Mumps
- Measles
- Hepatitis A
- Outbreaks of vaccine preventable diseases
- Vaccine schedules and resources



Mumps

Etiology

- RNA virus
- Genus *Rubulavirus*, family Paramyxoviridae
- Genus also includes human parainfluenza viruses types 2 and 4



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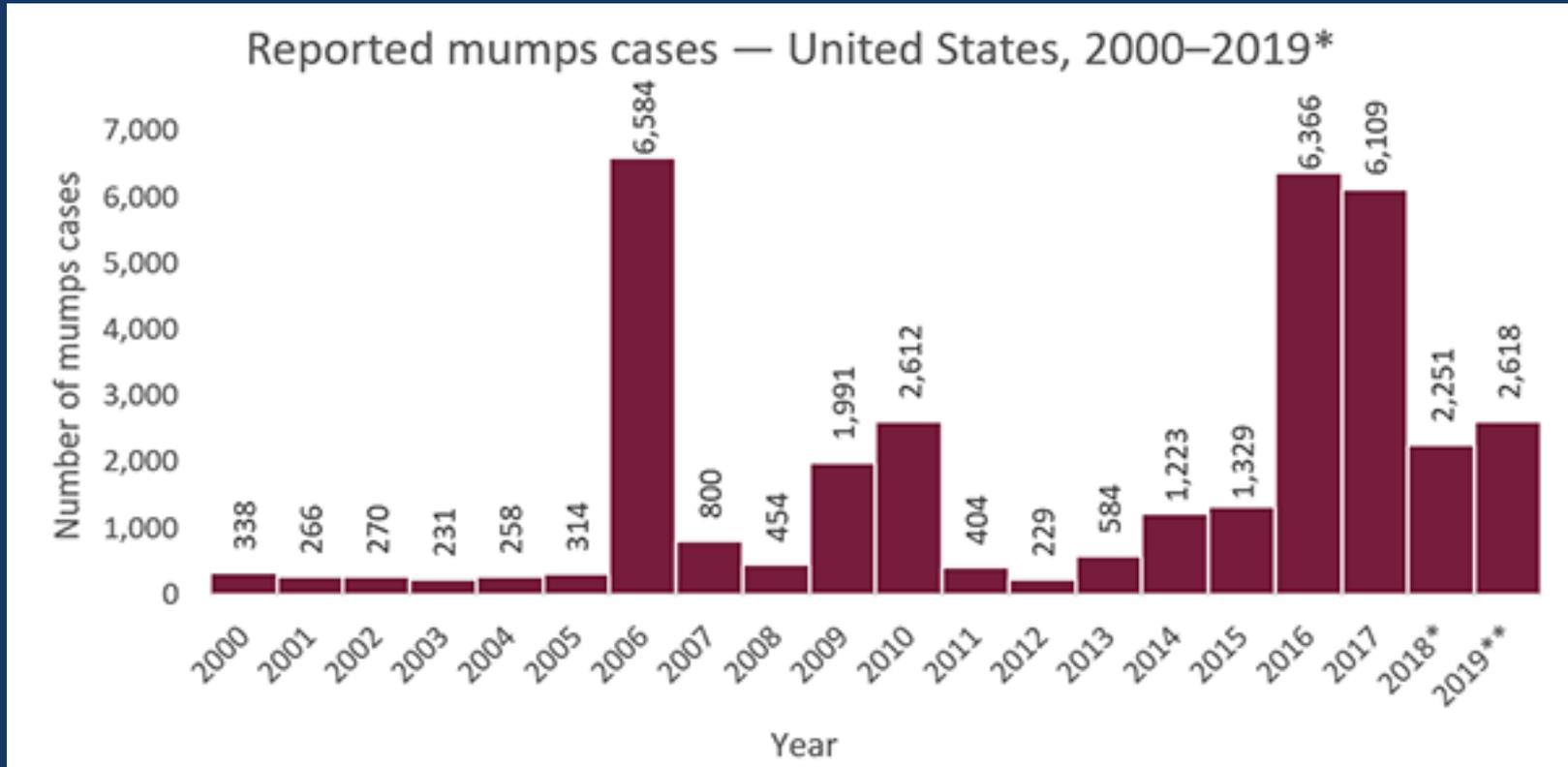
Epidemiology

- **Humans are the only known hosts**
- **Spread by contact with infectious respiratory tract secretions and saliva**
- **Only known cause of epidemic parotitis**
- **Incubation period is 16 to 18 days (range 12 to 25 days after exposure)**

History

- First described in the 5th century BC by Hippocrates
- Maurice Hilleman isolated mumps virus in 1963
- Mumps vaccination program introduced in 1967
- Prior to this, 186,000 cases per year in the U.S.
- MMR licensed in 1971
- Two-doses of MMR recommended in 1989
 - Cases decreased by >99%
- Since 2006, increased cases and outbreaks every 5 years

Mumps outbreaks

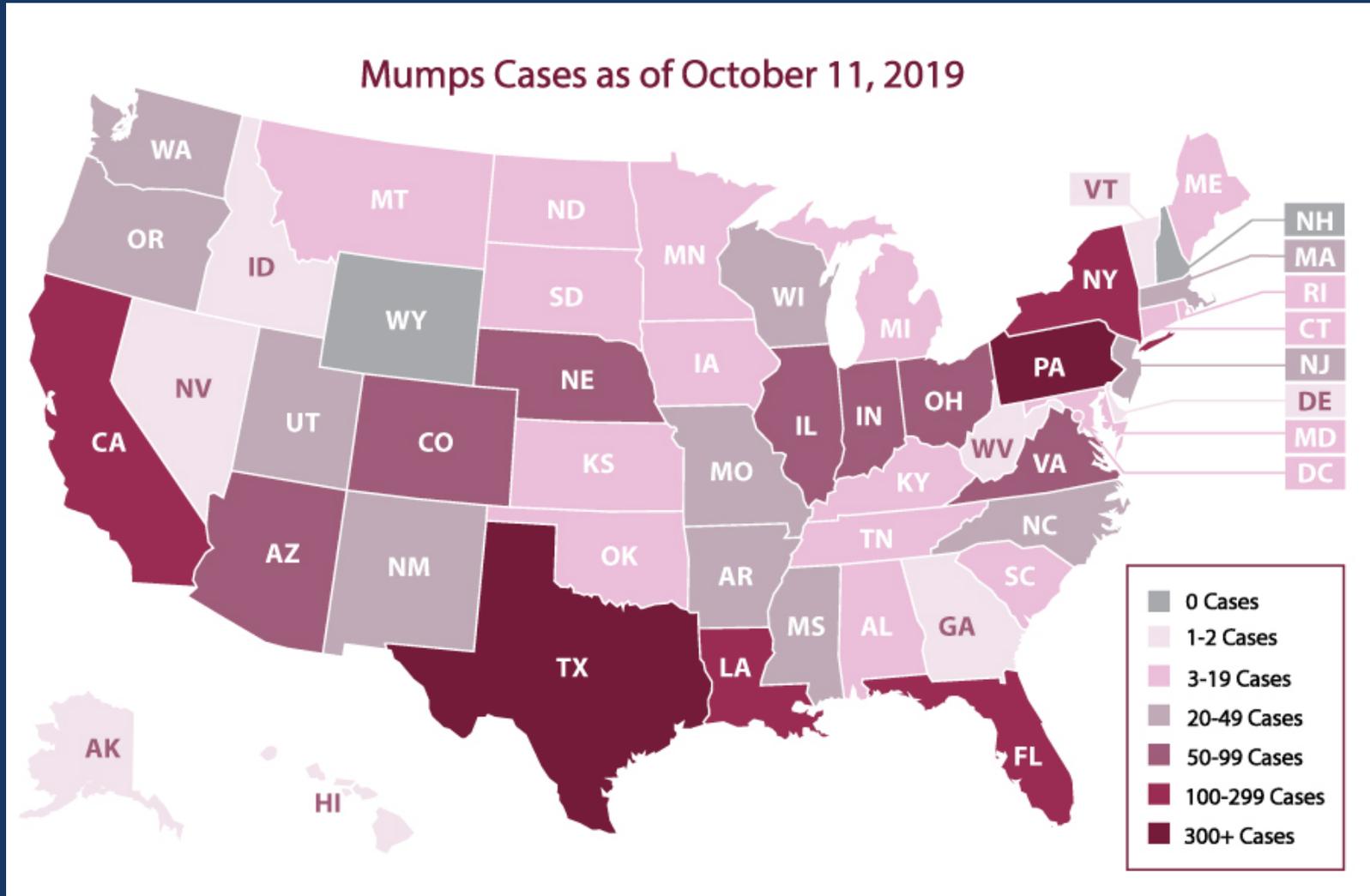


<https://www.cdc.gov/mumps/outbreaks.html>

Mumps outbreaks

- **2006**
 - Multi-state outbreak, > 6,500 cases
 - Predominantly college-aged students in the Midwest
- **2009-2010**
 - Two large outbreaks
 - Close-knit religious community in New York City, > 3,000 cases
 - School-aged children in Guam, ~ 500 cases
- **2015-2017**
 - Range of outbreaks of different settings and sizes
 - Close-knit community in northwest Arkansas, ~ 3,000 cases
 - Two large outbreaks from Iowa and Illinois each involving several hundred university students

Mumps cases 2019



Delaware Valley region

■ 2018

- Social dance “Baile Mejjicano” held in Wilmington
 - Two events in February and March
- Several cases of mumps associated with these events

■ 2019

- Temple University in Philadelphia, PA
 - Outbreak beginning in February ~ 186 cases
 - Involved other local universities and schools
 - Index case had traveled internationally
- Delaware County
 - High school: 4 cases
 - Local universities: 4 cases

Clinical manifestations

- **Systemic disease characterized by swelling of one or more of the salivary glands, usually the parotid gland**
 - One third of infections may be asymptomatic (subclinical)
- **50% of people with mumps infection have CSF pleocytosis**
 - Fewer than 10% have symptoms of viral meningitis
- **Orchitis commonly reported after puberty, sterility is rare**
- **Rare complications:**
 - Arthritis, glomerulonephritis, myocarditis, endocardial fibroelastosis, thrombocytopenia, cerebellar ataxia, transverse myelitis, encephalitis, pancreatitis, oophoritis and permanent hearing impairment



<https://redbook.solutions.aap.org/visual-library.aspx>

Diagnostic tests

- **Reverse transcriptase-polymerase chain reaction (RT-PCR) assay**
 - Buccal swabs
 - Throat washings
 - Saliva
 - Cerebrospinal fluid
- **Mumps-specific IgM serum antibody**
- **Acute and convalescent serum mumps IgG antibody titer**

Treatment and infection prevention and control

- **Treatment:**
 - Supportive care
- **Infection prevention and control**
 - Droplet precautions until 5 days after onset of parotid swelling

Care of exposed people

- **Mumps vaccine has not been demonstrated to be effective in preventing infection after exposure**
- **Susceptible people should still receive MMR vaccine**
 - Provides protection against subsequent exposures
- **People previously vaccinated with 2 doses of a mumps-containing vaccine who are identified by public health officials as being at increased risk due to an outbreak should receive a third dose**
- **Immune globulin (IG) preparations are not effective as postexposure prophylaxis**

Immunization recommendations

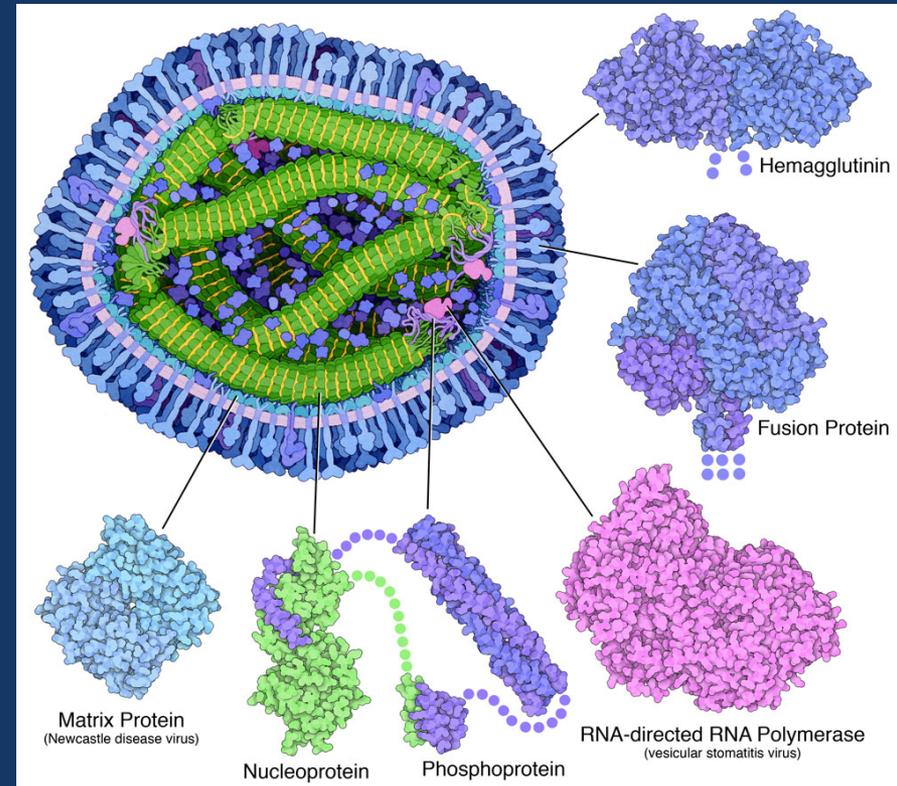
- Live attenuated mumps vaccine (MMR or MMRV)
- Two dose series:
 - First dose at 12-15 months
 - Second dose at 4-6 years



Measles

Etiology

- Enveloped RNA virus with 1 serotype
- Member of genus **Morbillivirus**
- **Paramyxoviridae** family



<http://pdb101.rcsb.org/motm/231>

Epidemiology

- **Humans are the only natural host**
- **Transmitted by direct contact with infectious droplets or airborne spread**
- **Incubation period is 8-12 days from exposure to onset of symptoms**
- **Patients are contagious from 4 days before onset of rash through 4 days after appearance of the rash**
- **Case-fatality rate: 1-3 out of 1,000 cases**
 - Higher in children < 5 years of age, pregnant women and immunocompromised children

History

- **First written account in 9th century Persia**
- **In 1757, a Scottish physician, Francis Home, demonstrated that measles is caused by an infectious agent in the blood**
- **John Enders and Thomas Peebles isolated measles in 1954**
- **First measles vaccine licensed in 1963**
- **Improved vaccine developed by Maurice Hilleman and colleagues in 1968**
- **Prior to vaccine development, an estimated 3-4 million people in the U.S. were infected and 400-500 died annually**
- **Measles declared eliminated from the U.S. in 2000**
 - **U.S. most populous country to have documented elimination**

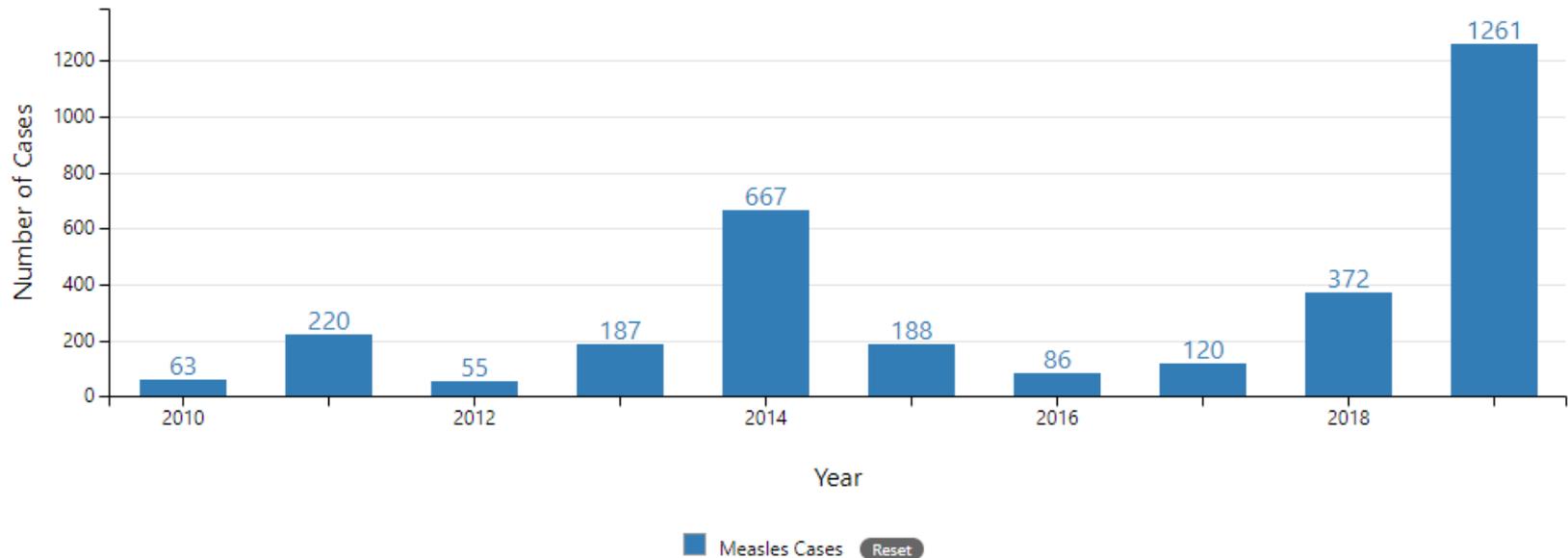
Measles outbreaks

- **2014**
 - Several outbreaks
 - One large outbreak in unvaccinated Amish communities in Ohio
 - Many cases associated with travel from Philippines
- **2015**
 - Large outbreak centered around Disneyland in California
 - No source identified, strain identical to virus type circulating in the Philippines
- **2018**
 - Three outbreaks in New York state, NYC and New Jersey
 - Most cases among unvaccinated people in Orthodox Jewish communities
 - Associated with travel to Israel
- **2019**
 - Most cases since 2000: 1,261 cases
 - Multistate outbreak:
 - New York: Brooklyn and Queens and Rockland County
 - California: Butte , LA and Sacramento Counties
 - Pennsylvania: Allegheny County
 - Washington State

Measles cases, 2010-2019

Number of Measles Cases Reported by Year

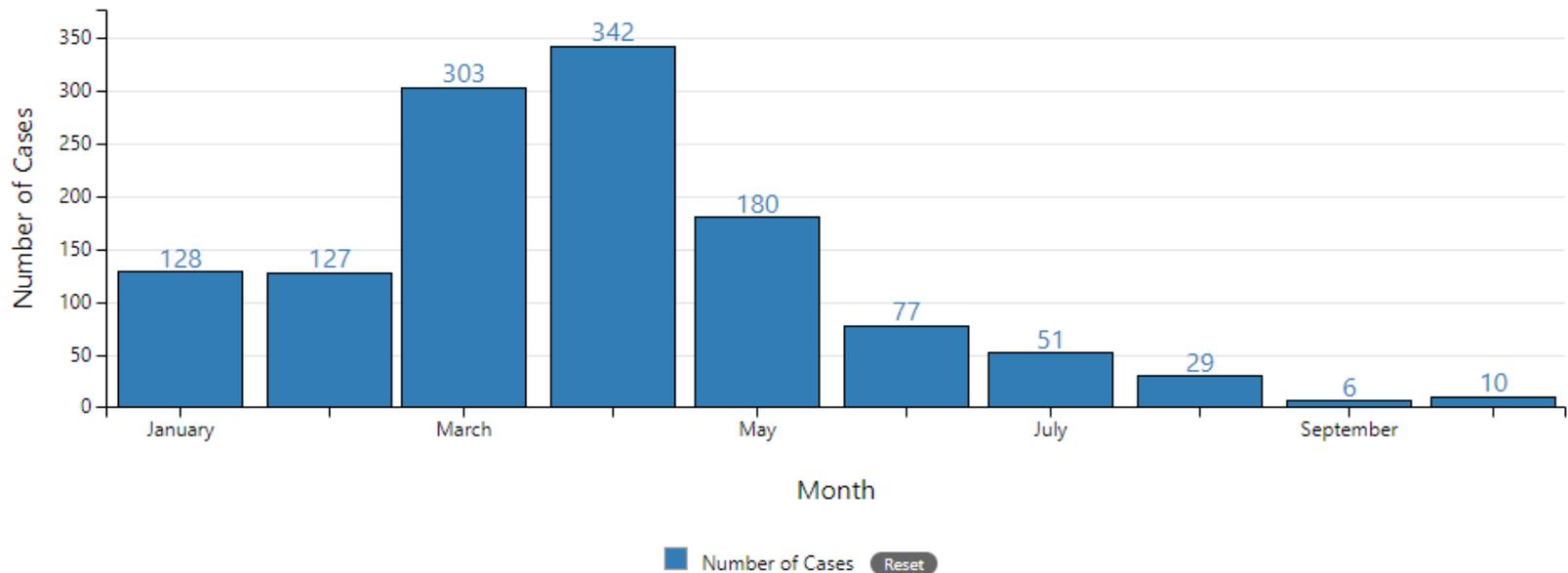
2010-2019**(as of November 7, 2019)



Measles cases in 2019

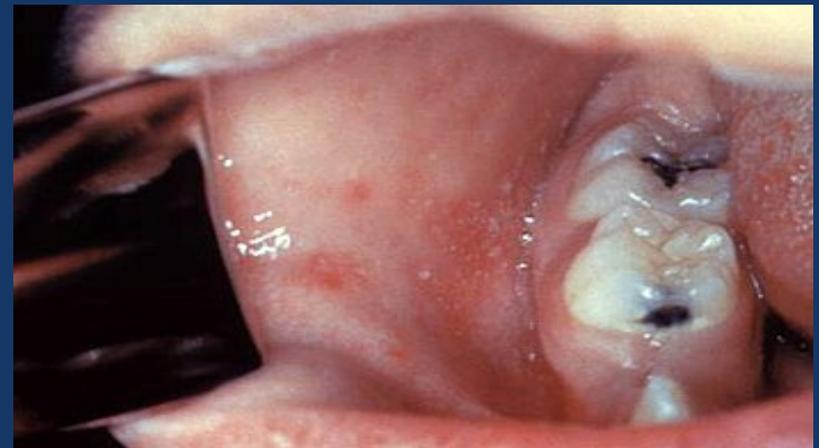
From January 1 to November 7, 2019, 1,261* individual cases of measles have been confirmed in 31 states. CDC will now be updating these data monthly.

Measles Cases Reported by Month in 2019*



Clinical manifestations

- Characterized by fever, cough, coryza and conjunctivitis
- Followed by maculopapular rash which begins on the head and spreads to the rest of the body
- Koplik spots may be present during prodromal period



Complications

- Otitis media
- Conjunctivitis
- Croup
- Pneumonia
- Diarrhea
- Post-infectious encephalomyelitis (PIE)
- Subacute sclerosing panencephalitis (SSPE)

Pathogenesis

- Measles targets epithelial, reticuloepithelial and white blood cells (monocytes, macrophages and T lymphocytes)
- Highly immunosuppressive effect
- Mortality from other pathogens increases after measles infection
 - Effect persists for up to 5 years
- Children lose about 20-70% of their antibody repertoire following infection
- Measles reduces the diversity of memory B cells
 - Replaces previous memory cells with measles specific lymphocytes
 - Results in “immune amnesia”

Mina et al. Science 2019;366:599-606

Mina et al. Science 2015;348:694-699

Diagnostic testing

- **Reverse transcriptase-polymerase chain reaction (RT-PCR) of blood; throat, nasal and posterior nasopharyngeal swab specimens; bronchial lavage samples; or urine samples***
 - RT-PCR is rapid and sensitive
 - Collect as soon as possible after rash onset
- **Detection of measles-specific immunoglobulin (Ig) M**
- **Fourfold increase in measles IgG antibody concentration**
 - Paired acute and convalescent serum specimens (collected at least 10 days apart)
- **Isolation of measles virus in cell culture**
 - *Serum plus respiratory sample and urine for RT-PCR testing are preferred, higher yield with sampling of 3 sites

Treatment: Antiviral therapy

- **No specific antiviral therapy**
- **Measles virus is susceptible to ribavirin in vitro**
 - Used for severely ill and immunocompromised patients
 - Not licensed by FDA for treatment

Treatment: Vitamin A

- **Associated with decreased morbidity and mortality rates in resource-limited countries**
- **Recommended for all children with measles**
- **Once daily for 2 days**
 - 200,000 IU for children 12 months or older
 - 100,000 IU for infants 6 through 11 months of age
 - 50,000 IU for infants younger than 6 months
- **Additional dose 2-4 weeks later in children with signs of vitamin A deficiency**

Infection prevention and control

- **Airborne transmission precautions**
 - For 4 days after the onset of the rash in healthy children
 - Duration of illness in immunocompromised children
- **Exposed susceptible patients should be placed on precautions from day 5 after first exposure until day 21 after last exposure**

Care of exposed people

- **Evaluate for presumptive evidence of immunity:**
 1. Documentation of age-appropriate vaccination with a live measles virus-containing vaccine:
 - Preschool-aged children: 1 dose administered after their first birthday;
 - School-aged children (grades K-12): 2 doses; the first dose administered after the first birthday and the second dose administered at least 28 days after their first;
 2. Laboratory evidence of immunity;
 3. Laboratory confirmation of disease; or
 4. Born before 1957
- **If no evidence of immunity:**
 - Administer MMR vaccine within 72 hours of initial exposure, **or** immunoglobulin (IG) within six days of exposure

Immunization recommendations

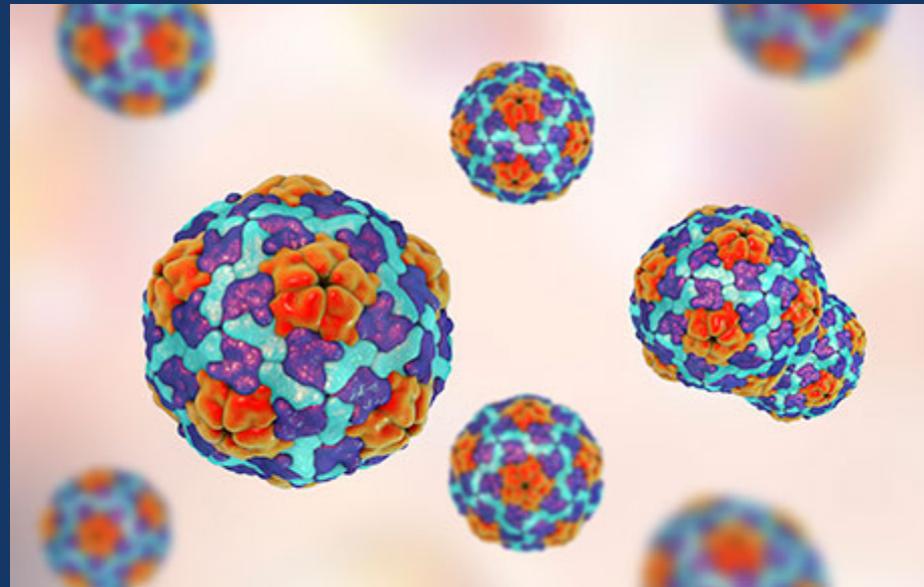
- **Vaccine is highly immunogenic**
 - 93% effective after first dose
 - 97% effective after second dose
- **Two dose series**
 - First dose at 12-15 months
 - Second dose at 4-6 years
- **Can be given at 6 months of age**
 - Community outbreaks
 - International travel to endemic areas



Hepatitis A

Etiology

- Nonenveloped RNA virus
- Picornavirus
- Genus *Hepatovirus*



<https://www.cdc.gov/features/viralhepatitis/index.html>

Epidemiology

- Occurs throughout the world
- Highly endemic in Central and South America, Africa, the Middle East, Asia and the Western Pacific
- Humans are the only natural host
- Fecal-oral transmission
 - Person-to-person contact
 - Ingestion of contaminated food or water
- Viral replication in the liver
- Viral shedding for 1-3 weeks after infection

From: **Hepatitis A**

Red Book® 2018, 2018

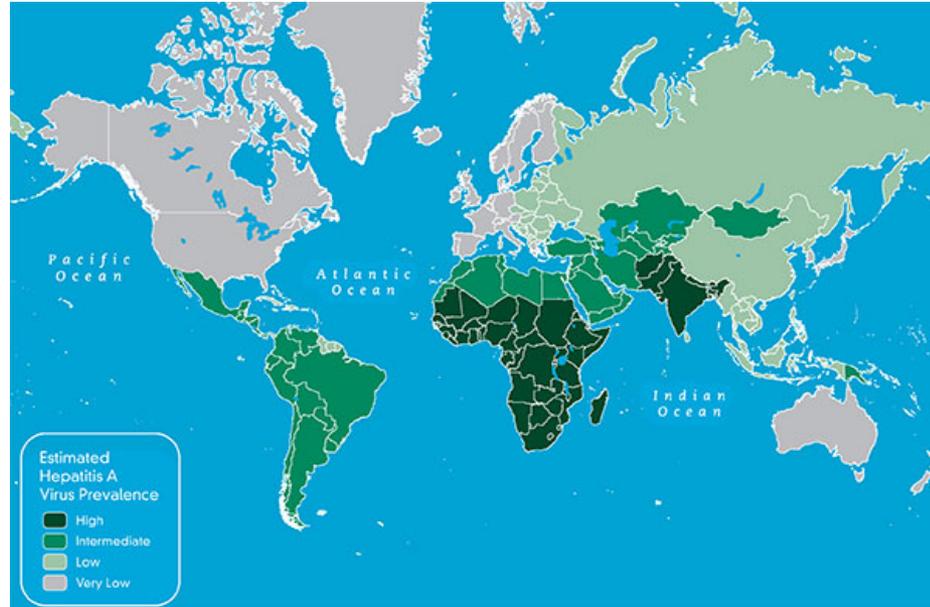


Figure Legend:

Estimated prevalence of hepatitis A virus. Courtesy of Centers for Disease Control and Prevention

History

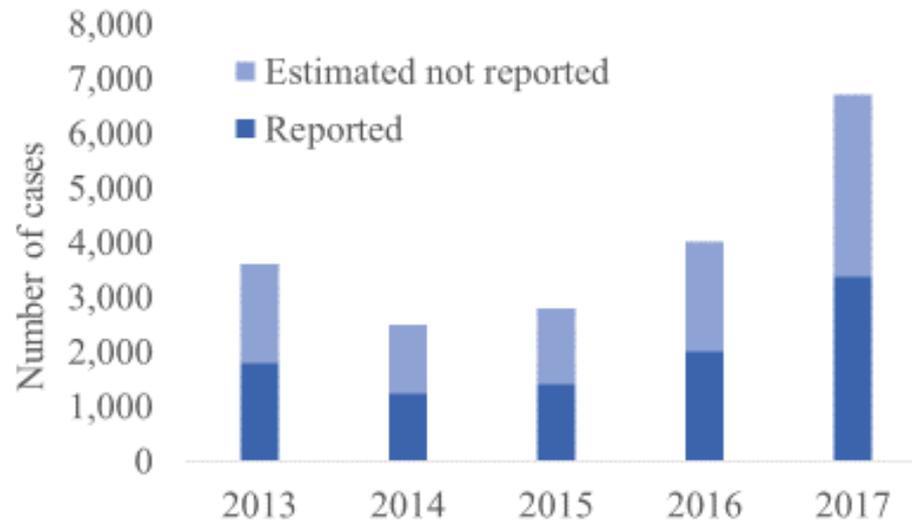
- Descriptions of epidemic jaundice attributed to Hippocrates
- Outbreaks of jaundice in 17th and 18th centuries
- Differentiated from hepatitis B in the 1940s
- During prevaccine era, occurred in large nationwide epidemics in the U.S.
 - Largest number of cases in 1971 (59,606)
 - Historically, children 2-18 years had the highest rates
- Prior to 2000, incidence was higher in western U.S.
- Rates declined following licensing of vaccine in 1996

Outbreaks

- **Since 2016: 30 states have reported 28,466 cases, 17,217 hospitalizations, and 288 deaths**
 - Hawaii
 - Large foodborne outbreak
 - California, Kentucky, Michigan and Utah
 - Outbreaks associated with person-to-person transmission
- **2016-2017 increase in cases among persons who use drugs and persons experiencing homelessness**
- **Risk factors: injection drug use, ingestion of contaminated foods, sexual/household contact with a known case**
- **Rates are low in children and adolescents due to childhood immunization**

Hepatitis A cases

Figure 2.1. Actual number of hepatitis A cases submitted to CDC by states and estimated* number of hepatitis A cases — United States, 2013–2017



Source: CDC, National Notifiable Diseases Surveillance System.

Delaware valley region

- **Outbreak in Pennsylvania**
 - 80% increase in cases statewide in 2018
- **Philadelphia: elevated transmission since 2017**
 - Majority of cases in men who have sex with men
- **Allegheny County noted an increase in cases in late 2018**
- **Many cases in persons using drugs or experiencing homelessness**

Clinical manifestations

- Incubation period 15-50 days (average 28 days)
- Abrupt onset of illness with fever, malaise, anorexia, nausea, abdominal discomfort, dark urine and jaundice
- Children < 6 years are more likely to be symptomatic
- Fulminant hepatitis is the most severe complication



<https://redbook.solutions.aap.org/visual-library.aspx>

Diagnostic testing

- **Serologic testing:**
 - IgM anti-HAV
 - IgM becomes detectable 5-10 days before the onset of symptoms and can persist for up to 6 months
 - IgG anti-HAV
 - Appears in convalescent phase and remains present for life
- **Nucleic acid amplification test (NAAT)**
 - PCR

Care of exposed people

- **Post-exposure prophylaxis (PEP) can be given within two weeks of exposure**
 - One dose of vaccine
 - Healthy individuals \geq 12 months of age who have not received two doses of vaccine
 - Immune globulin (IG)
 - Infants $<$ 12 months of age or persons for whom vaccine is contraindicated
 - One dose of vaccine plus IG
 - Healthy individuals $>$ 40 years of age
 - Individuals \geq 12 months who are immunocompromised or have chronic liver disease
- **Who requires PEP?**
 - Close personal contacts of a case
 - Child-care center staff, attendees, and attendees' household members
 - Persons exposed to a common source, such as an infected food handler





<https://www.thenation.com/article/toilet-urination-disability-access/>

Public health considerations

- **By the early 1970s there were an estimated 50,000 pay toilets in the U.S.**
- **Pay toilets became the target of protest in the late '60s and early '70s**
 - Committee to End Pay Toilets in America (CEPTIA)
- **By 1980, pay toilets had virtually disappeared**
 - Lack of public restrooms and hand washing facilities
- **Many municipalities are bringing back public restrooms**
 - Los Angeles now operates 31 public restrooms
 - Portland installed stainless steel porta potties directly connected to the plumbing system
 - Philadelphia considering reintroducing public restrooms and hand washing stations

Immunization recommendations

- **Routine childhood immunization schedule**
 - Two dose series given 6-12 months apart
 - Starting at 12 months of age
- **Those at increased risk for hepatitis A:**
 - Chronic liver disease
 - Clotting factor disorders
 - Men who have sex with men
 - Injection or non-injection drug use
 - Homelessness
 - Work with hepatitis A virus in research laboratory or nonhuman primates with hepatitis A virus infection
 - Travel in countries with high or intermediate endemic hepatitis A
 - Close personal contact with international adoptee



Why?

Outbreaks of vaccine preventable diseases

■ Why?

- Increase in travelers who contract illnesses abroad and bring them to the U.S.
- Vaccine refusal
- Spread of diseases in U.S. communities within pockets of unvaccinated people
- Loss of herd immunity
- Decreased vaccine effectiveness
- Epidemiological shifts

Omer et. al N Engl J Med 2009; 360:1981-1988.

Importation of vaccine-preventable infections

- **Vaccine preventable diseases are still endemic in many countries**
- **Some have suboptimal vaccination coverage**
- **Susceptible travelers can become infected abroad**
- **A significant number of measles outbreaks have been associated with importation of the virus**
 - In 2018, 82 people brought measles to the U.S. from other countries

Gautret, et al. Clin Microbiol Infect 2012;18:77-84
Ruderfer and Krilov Pediatr Ann 2015;44:e76-e81

Vaccine refusal

- **Rates of nonmedical vaccine exemptions have increased over the past 20 years**
 - Most frequent reason for vaccine refusal: concern that it might cause harm
- **Low level of concern about the risk of vaccine preventable diseases**
- **Unvaccinated children who had a vaccine exemption were 35 times more likely to contract measles compared with vaccinated children**
- **Compared with undervaccinated children, unvaccinated children are more likely to be:**
 - Male, white, belong to households with higher income, to have a married mother with a college education and live with four or more children

Spread of diseases in U.S. communities

- **Evidence for substantial geographic heterogeneity in nonmedical exemption rates between and within states**
- **Reasons:**
 - Characteristics of the local population
 - Beliefs of local health care providers and opinion leaders
 - Local media coverage
- **Leads to increase in local risk of vaccine preventable diseases**
 - “Clustering” high local aggregation of individuals with exemptions associated with greater measles incidence
 - Decline in herd immunity

Erosion of herd immunity

- **Herd immunity**
 - If a large percentage of the population is immune, the entire population is protected
- **Decreasing population level immunity**
 - Immunity wanes over time following both vaccine and infection
 - Clustering of unvaccinated individuals
- **Loss of immunity over time PLUS lack of re-exposure to disease**

Erosion of herd immunity

- **Waning of vaccine-induced immunity to mumps**
 - Absence of continued natural exposure and boosting
 - Suggested by mathematical modeling
 - Immunity persists for on average 27.4 years
 - Individuals who received the vaccine 13 years or more before an outbreak had a > 9 times risk of contracting mumps

Kutty, et al. PIDJ 2014;33:121-5

Lewnard and Grad Sci Transl Med 2018;10: eaao5945

Decreased vaccine effectiveness

- **Vaccine effectiveness for mumps vaccine less than other vaccines**
 - Single dose effectiveness is 78%
 - Two dose effectiveness is 88%
- **Genotype switch from A to G over time**
 - Vaccine contains Jeryl-Lynn strain (genotype A)
 - Cross-reacts with other strains
- **Third dose of vaccine is effective for outbreak control**
 - Boosted response from vaccine

Kutty, et al. Hum Vacc Immunother 2014;10:1373-81

Epidemiological shifts

- **Specific population level risk factors for mumps**
 - Intense exposures to one or more cases
 - Face-to-face studying or interactions
 - Close, communal settings
- **Hepatitis A**
 - Shift from younger children and adolescents to adults
 - Increased risk with homelessness and injection drug use

Cardemil, et al. N Engl J Med 2017; 377:947-56



What can we do?

Table 1 Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger United States, 2019

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 in Table 1. To determine minimum intervals between doses, see the catch-up schedule (Table 2). School entry and adolescent vaccine age groups are shaded in gray.

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)			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					
Influenza (IIV) or Influenza (LAIV)										Annual vaccination 1 or 2 doses						Annual vaccination 1 dose only	
												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								
Meningococcal (MenACWY-D ≥9 mos; MenACWY-CRM ≥2 mos)															1 st dose		2 nd dose
Tetanus, diphtheria, & acellular pertussis (Tdap: ≥7 yrs)															Tdap		
Human papillomavirus (HPV)															See Notes		
Meningococcal B															See Notes		
Pneumococcal polysaccharide (PPSV23)															See Notes		

Range of recommended ages for all children
 Range of recommended ages for catch-up immunization
 Range of recommended ages for certain high-risk groups
 Range of recommended ages for non-high-risk groups that may receive vaccine, subject to individual clinical decision-making
 No recommendation

Table 2 Catch-up immunization schedule for persons aged 4 months–18 years who start late or who are more than 1 month behind, United States, 2019

The figure below provides catch-up schedules and minimum intervals between doses for children whose vaccinations have been delayed. A vaccine series does not need to be restarted, regardless of the time that has elapsed between doses. Use the section appropriate for the child's age. Always use this table in conjunction with Table 1 and the notes that follow.

Children age 4 months through 6 years					
Vaccine	Minimum Age for Dose 1	Minimum Interval Between Doses			
		Dose 1 to Dose 2	Dose 2 to Dose 3	Dose 3 to Dose 4	Dose 4 to Dose 5
Hepatitis B	Birth	4 weeks	8 weeks and at least 16 weeks after first dose. Minimum age for the final dose is 24 weeks.		
Rotavirus	6 weeks Maximum age for first dose is 14 weeks, 6 days	4 weeks	4 weeks Maximum age for final dose is 8 months, 0 days.		
Diphtheria, tetanus, and acellular pertussis	6 weeks	4 weeks	4 weeks	6 months	6 months
<i>Haemophilus influenzae</i> type b	6 weeks	No further doses needed if first dose was administered at age 15 months or older. 4 weeks if first dose was administered before the 1 st birthday. 8 weeks (as final dose) if first dose was administered at age 12 through 14 months.	No further doses needed if previous dose was administered at age 15 months or older. 4 weeks if current age is younger than 12 months and first dose was administered at younger than age 7 months, and at least 1 previous dose was PRP-T (ActHib, Pentacel, Hiberix) or unknown. 8 weeks and age 12 through 59 months (as final dose) if current age is younger than 12 months and first dose was administered at age 7 through 11 months; OR if current age is 12 through 59 months and first dose was administered before the 1 st birthday, and second dose administered at younger than 15 months; OR if both doses were PRP-OMP (PedvaxHIB; Comvax) and were administered before the 1 st birthday.	8 weeks (as final dose) This dose only necessary for children age 12 through 59 months who received 3 doses before the 1 st birthday.	
Pneumococcal conjugate	6 weeks	No further doses needed for healthy children if first dose was administered at age 24 months or older. 4 weeks if first dose administered before the 1 st birthday. 8 weeks (as final dose for healthy children) if first dose was administered at the 1 st birthday or after.	No further doses needed for healthy children if previous dose administered at age 24 months or older. 4 weeks if current age is younger than 12 months and previous dose given at <7 months old. 8 weeks (as final dose for healthy children) if previous dose given between 7-11 months (wait until at least 12 months old); OR if current age is 12 months or older and at least 1 dose was given before age 12 months.	8 weeks (as final dose) This dose only necessary for children age 12 through 59 months who received 3 doses before age 12 months or for children at high risk who received 3 doses at any age.	
Inactivated poliovirus	6 weeks	4 weeks	4 weeks if current age is < 4 years. 6 months (as final dose) if current age is 4 years or older.	6 months (minimum age 4 years for final dose).	
Measles, mumps, rubella	12 months	4 weeks			
Varicella	12 months	3 months			
Hepatitis A	12 months	6 months			
Meningococcal	2 months MenACWY-CRM 9 months MenACWY-D	8 weeks	See Notes	See Notes	
Children and adolescents age 7 through 18 years					
Meningococcal	Not Applicable (N/A)	8 weeks			
Tetanus, diphtheria; tetanus, diphtheria, and acellular pertussis	7 years	4 weeks	4 weeks if first dose of DTaP/DT was administered before the 1 st birthday. 6 months (as final dose) if first dose of DTaP/DT or Tdap/Td was administered at or after the 1 st birthday.	6 months if first dose of DTaP/DT was administered before the 1 st birthday.	
Human papillomavirus	9 years	Routine dosing intervals are recommended.			
Hepatitis A	N/A	6 months			
Hepatitis B	N/A	4 weeks	8 weeks and at least 16 weeks after first dose.		
Inactivated poliovirus	N/A	4 weeks	6 months A fourth dose is not necessary if the third dose was administered at age 4 years or older and at least 6 months after the previous dose.	A fourth dose of IPV is indicated if all previous doses were administered at <4 years or if the third dose was administered <6 months after the second dose.	
Measles, mumps, rubella	N/A	4 weeks			
Varicella	N/A	3 months if younger than age 13 years. 4 weeks if age 13 years or older.			

Table 3

Recommended Child and Adolescent Immunization Schedule by Medical Indication United States, 2019

VACCINE	INDICATION									
	Pregnancy	Immunocompromised status (excluding HIV infection)	HIV infection CD4+ count ¹		Kidney failure, end-stage renal disease, on hemodialysis	Heart disease, chronic lung disease	CSF leaks/cochlear implants	Asplenia and persistent complement component deficiencies	Chronic liver disease	Diabetes
			<15% and total CD4 cell count of <200/mm ³	≥15% and total CD4 cell count of ≥200/mm ³						
Hepatitis B	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Rotavirus	Yellow	Red (SCID ²)	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Diphtheria, tetanus, & acellular pertussis (DTaP)	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
<i>Haemophilus influenzae</i> type b	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Pneumococcal conjugate	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Inactivated poliovirus	Orange	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Influenza (IIV) or Influenza (LAIV)	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Influenza (LAIV)	Red	Red	Red	Red	Orange (Asthma, wheezing: 2-4yrs ³)	Red	Red	Red	Orange	Orange
Measles, mumps, rubella	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Varicella	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Hepatitis A	Purple	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Meningococcal ACWY	Purple	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Tetanus, diphtheria, & acellular pertussis (Tdap)	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Human papillomavirus	Pink	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Meningococcal B	Orange	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple
Pneumococcal polysaccharide	Purple	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

1 For additional information regarding HIV laboratory parameters and use of live vaccines, see the General Best Practice Guidelines for Immunization "Altered Immunocompetence" at www.cdc.gov/vaccines/hcp/acip-recs/general-recs/immunocompetence.html, and Table 4-1 (footnote D) at: www.cdc.gov/vaccines/hcp/acip-recs/general-recs/contraindications.html.
 2 Severe Combined Immunodeficiency
 3 LAIV contraindicated for children 2–4 years of age with asthma or wheezing during the preceding 12 months.

Vaccine resources

- **CDC:** <https://www.cdc.gov/vaccines/schedules/hcp/index.html>
 - CDC vaccine schedules app
 - Vaccine Information Statements (VISs)
 - Catch-up guidance
 - Vaccine safety
 - Vaccines for travelers
 - Advisory Committee on Immunization Practices (ACIP) recommendations and guidelines
- **Immunization Action Coalition (IAC)** www.immunize.org
 - Clinic tools
 - Handouts and educational materials
 - Ask the Experts



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Thank you