

Immunization Principles and Vaccine Use

Chapter 129 | Part 5: Infectious Diseases

KEY CLINICAL POINTS

- 1 Herd immunity thresholds vary by disease: Measles requires $\approx 95\%$ population vaccination; Polio requires $\approx 80\%$ coverage.
- 2 Contraindication: A condition that increases the risk of a serious adverse reaction to vaccination (e.g., anaphylaxis).
- 3 Precaution: A condition that may increase the risk of an adverse event or compromise vaccine efficacy (e.g., moderate/severe acute illness).
- 4 Live-virus vaccines (MMR, Varicella) are contraindicated in severe immunosuppression ($CD4 \geq 15\%$ or count $\geq 200/\mu L$ for HIV) due to risk of disseminated infection.
- 5 Tdap vaccine is recommended during each pregnancy (27th through 36th week) to prevent pertussis in infants.
- 6 High-dose influenza vaccine is recommended for adults age ≥ 65 years rather than standard-dose vaccine.
- 7 Vaccine Information Statements (VIS) are one-page (two-sided) CDC sheets that inform patients about vaccine benefits and risks.
- 8 National Vaccine Injury Compensation Program (NVICP) offers compensation for injured vaccine recipients before suing providers.
- 9 Smallpox is the only vaccine-preventable disease of humans that has been globally eradicated.
- 10 Vaccine Safety Datalink (VSD) is a collaborative project between CDC's Immunization Safety Office and eight health care organizations.

1. DEFINITION & OVERVIEW

Immunization programs aim to control, eliminate, or eradicate diseases through vaccines that reduce health burdens. Safety and efficacy are ensured by rigorous systems, with herd immunity playing a critical role in protecting unimmunized populations.

- Direct and indirect effects of vaccines:
 - Prevent symptomatic illness (e.g., rotavirus vaccines reducing severe gastroenteritis)
 - Reduce complications (e.g., zoster vaccines decreasing postherpetic neuralgia)
 - Limit transmission through herd immunity
- Herd immunity: Defined as the population-level immunization threshold required for indirect protection.
 - Measles: $\approx 95\%$ coverage
 - Polio: $\approx 80\%$ coverage

Definition (Harrison's 22e): *Herd immunity is the level of immunization in a population that is required to achieve indirect protection of unimmunized persons.*

1.1 Vaccine Impact

- Control, elimination, and eradication:
- Smallpox: Globally eradicated
- Polio: Two wild types eradicated; type 1 remains endemic in Afghanistan/Pakistan
- Sentinel events (e.g., vaccine-derived poliovirus case in New York, 2022) require immediate public health reporting

1.2 Vaccine Safety Monitoring

- Systems for postlicensure safety monitoring:
- VAERS: Hypothesis-generating system for adverse event reporting
- VSD: Large-population studies of rare/serious events (initiated 1990)
- CISA: National network of vaccine safety experts

Definition (Harrison's 22e): *The Vaccine Adverse Event Reporting System (VAERS) functions more to raise hypotheses about whether receipt of a vaccine or vaccines causes an adverse event than it does to evaluate causation.*

1.3 Vaccine Hesitancy

- Factors contributing to hesitancy:
- Safety concerns
- Perceived vaccine necessity
- Mistrust in public health systems
- Amplified by antivaccine narratives during the COVID-19 pandemic
- Mitigation strategies:
- Address specific patient concerns
- Presumptive approach (present vaccines as standard of care)
- Strong provider recommendation
- Refer to CDC/NIH resources

2. EPIDEMIOLOGY

Vaccines prevent 21 diseases in the U.S., with most childhood vaccine-preventable diseases at historically low levels. Adult immunization recommendations have expanded significantly in recent years.

- Disease decline statistics (Table 129-1, Table 129-2):
- Smallpox: 29,005 → 0 cases (100% reduction)
- Measles: 530,217 → 47 cases (>99% reduction)
- Pertussis: 200,752 → 5,611 cases (97% reduction)
- Polio: 16,316 → 0 cases (100% reduction)
- Global impact:
- Vaccines prevent ≈ 3.5–5 million deaths annually

- COVID-19 disrupted routine immunization in >100 countries
 - 'The Big Catch-Up' initiative aims to restore prepandemic vaccination rates
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3. ETIOLOGY & PATHOPHYSIOLOGY

Vaccines induce immune responses that prevent infection, reduce disease severity, and limit transmission.

- Vaccine types:
 - Live-virus vaccines (e.g., MMR, Varicella): Contraindicated in severe immunosuppression (CD4 $\geq$ 15% or count $\geq$ 200/ μ L for HIV)
 - Inactivated/subunit vaccines: Safe during pregnancy when benefits outweigh risks
 - Immunosenescence:
 - Age-related decline in immune responses increases susceptibility to infections and reduces vaccine efficacy
 - Older adults require specific vaccines:
 - Zoster ($\geq$ 50 years)
 - Pneumococcal conjugate ($\geq$ 50 years)
 - RSV ($\geq$ 75 years or 60–74 with risk factors)
 - High-dose influenza vaccine recommended for $\geq$ 65 years
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4. CLINICAL FEATURES

- Vaccine hesitancy:
 - Multifactorial, exacerbated by the pandemic
 - Address through patient-centered communication and provider recommendation

Definition (Harrison's 22e): *A Vaccine Information Statement (VIS) is a one-page (two-sided) information sheet produced by the CDC that informs vaccine recipients and providers about vaccine benefits and risks.*

- Adverse events:
 - Monitored through VAERS, VSD, and CISA systems
 - NVICP provides compensation for injured recipients
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5. DIFFERENTIAL DIAGNOSIS

- Distinguishing vaccine reactions from disease manifestations is critical.

Definition (Harrison's 22e): *A contraindication is a condition that increases the risk of a serious adverse reaction to vaccination.*

Definition (Harrison's 22e): *A precaution is a condition that may increase the risk of an adverse event or that may compromise the ability of the vaccine to evoke immunity.*

- Administration logic:
 - Contraindication present → Do not administer

- Precaution present → Assess if benefits outweigh risks (e.g., mild acute illness is a transient precaution)
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6. INVESTIGATIONS & DIAGNOSIS

- Surveillance systems:
 - VAERS, VSD, CISA, and NVICP support safety monitoring
 - Public health reporting required for diseases targeted for elimination/eradication (e.g., measles, pertussis)
 - Reporting requirements:
 - Clinicians must report nationally notifiable vaccine-preventable diseases (e.g., measles, Hib) to local/state authorities
 - Prompt outbreak response enhances control measures
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7. MANAGEMENT & TREATMENT

1. Pre-vaccination Screening:

- Screen all patients for contraindications and precautions.
- Specific Contraindication: History of immediate hypersensitivity to neomycin (Hepatitis A).
- Specific Precaution: Current herpes zoster infection (Zoster vaccine).

2. Guideline Adherence:

- ACIP recommendations guide vaccine administration for U.S. civilian population.

3. Shared Clinical Decision-Making:

- Utilized for specific vaccines (e.g., HPV, Meningococcal B).

4. Pregnancy Protocol:

- Tdap: Administer during each pregnancy (27th through 36th week) to prevent pertussis in infants.
- Live-virus: Contraindicated.

5. Age-Specific Selection:

- High-dose influenza: ≥ 65 years.
 - Zoster: ≥ 50 years.
 - Pneumococcal conjugate: ≥ 50 years.
 - RSV: ≥ 75 years or 60–74 with risk factors.
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8. PROGNOSIS & COMPLICATIONS

- Disease control goals:
 - Elimination: Zero cases in a defined area
 - Eradication: Sustained elimination without interventions
- Vaccine failure:
 - May result from mishandling (e.g., improper storage) or suboptimal effectiveness
 - Higher-risk groups may require additional doses or alternative schedules

9. SPECIAL CONSIDERATIONS

- Pregnant persons:
 - Most inactivated/subunit vaccines safe when benefits outweigh risks
 - Live-virus vaccines contraindicated
- Immunocompromised persons:
 - Live_virus vaccines contraindicated in severe immunosuppression (CD4 $\geq$ 15% or count $\geq$ 200/ μ L for HIV)
- Older adults:
 - Specific vaccines: Zoster ($\geq$ 50), Pneumococcal conjugate ($\geq$ 50), RSV ($\geq$ 75 or 60–74 with risk factors), high-dose influenza ($\geq$ 65)
- Health care workers:
 - Routine vaccination (e.g., influenza, hepatitis B) to prevent transmission

10. KEY PEARLS & CLINICAL TRAPS

- Clinical pearls:
 - Strong provider recommendation reduces hesitancy
 - VISs are essential for informed consent
 - High-dose influenza vaccine is preferred for $\geq$ 65 years
- Clinical traps:
 - Confusing contraindications (serious risk) vs. precautions (potential risk/reduced efficacy)
 - Overlooking shared decision-making for HPV and MenB
 - Underestimating the impact of immunosenescence in older adults

REFERENCE TABLES

TABLE 129-2

Decline in Vaccine-Preventable Diseases in the United States following Widespread Implementation of National Vaccine...

CONDITION	TARGET POPULATION(S) FOR ROUTINE USE
Pertussis	Children, adolescents, adults

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Decline in Vaccine-Preventable Diseases in the United States following Widespread Implementation of National Vaccine...

CONDITION	ANNUAL NO. OF PREVACCINE CASES (AVERAGE)	NO. OF CASES REPORTED IN 2023a	REDUCTION (%) IN CASES AFTER WIDESPREAD VACCINATION
Smallpox	29,005	0	100

CONDITION	ANNUAL NO. OF PREVACCINE CASES (AVERAGE)	NO. OF CASES REPORTED IN 2023a	REDUCTION (%) IN CASES AFTER WIDESPREAD VACCINATION
	21,053	2	
Measles	530,217	47	>99
	162,344	429	
Pertussis	200,752	5611	97
	16,316	0	
Rubella	47,745	3	>99
	152	0	
Tetanus	580	15	97
	20,000	27b	
Hepatitis A	117,333	11,500c	90
	66,232	13,300c	
Invasive pneumococcal infection: all ages	63,067	17,700d	72
	62,500	16,250e	
Varicella	4,085,120	26,919f	99
Tetanus	Children, adolescents, adults		
Measles	Children		
Rubella, congenital rubella syndrome	Children		
Haemophilus influenzae type b infection	Children and high-risk adults		
Influenza	Children, adolescents, adults		
Pneumococcal disease	Children, older adults, and high-risk adults ^a		
Serogroup B meningococcal disease	High-risk children and adults ^a		
Human papillomavirus infection, cervical and anogenital cancers	Adolescents and young adults ^a		

CONDITION	ANNUAL NO. OF PREVACCINE CASES (AVERAGE)	NO. OF CASES REPORTED IN 2023a	REDUCTION (%) IN CASES AFTER WIDESPREAD VACCINATION
Respiratory syncytial virus	Infants, high-risk children, pregnant personsa		
Dengue	High-risk children (i.e., those living in endemic areas and with laboratory confirmation of prior infection)		

TABLE 129-3

Contraindications and Precautions for Commonly Used Vaccines in Adults

VACCINE FORMULATION	CONTRAINDICATIONS AND PRECAUTIONS
Pneumococcal polysaccharide	None, other than those listed for all vaccines
Hepatitis A	Contraindication History of immediate hypersensitivity to neomycin
Meningococcal conjugate	None, other than those listed for all vaccines
Zoster	Precaution Current herpes zoster infection
Respiratory syncytial virus	None, other than those listed for all vaccines