

148 Immunization Principles and Vaccine Use

Anne Schuchat, Lisa A. Jackson

Few medical interventions of the past century can rival the effect that immunization has had on longevity, economic savings, and quality of life. Seventeen diseases are now preventable through vaccines routinely administered to children and adults in the United States (Table 148-1), and most vaccine-preventable diseases of childhood are at historically low levels (Table 148-2). Health care providers deliver the vast majority of vaccines in the United States in the course of providing routine health services and therefore play an integral role in the nation's public health system.

VACCINE IMPACT

Direct and Indirect Effects Immunizations against specific infectious diseases protect individuals against infection and thereby prevent symptomatic illnesses. Specific vaccines may blunt the severity of clinical illness (e.g., rotavirus vaccines and severe gastroenteritis) or reduce complications (e.g., zoster vaccines and postherpetic neuralgia). Some immunizations also reduce transmission of infectious disease agents from immunized people to others, thereby reducing the impact of infection spread. This indirect impact is known as *herd immunity*. The level of immunization in a population that is required to achieve indirect protection of unimmunized people varies substantially with the specific vaccine.

Since childhood vaccines have become widely available in the United States, major declines in rates of vaccine-preventable diseases among both children and adults have become evident (Table 148-2). For example, vaccination of children <5 years of age against seven types of *Streptococcus pneumoniae* led to a >90% overall reduction in invasive disease caused by those types. A series of childhood vaccines targeting 13 vaccine-preventable diseases in a single birth cohort leads to prevention of 42,000 premature deaths and 20 million illnesses and saves nearly \$70 billion (U.S.).

Control, Elimination, and Eradication of Vaccine-Preventable Diseases

Immunization programs are associated with the goals of controlling,

TABLE 148-1 DISEASES PREVENTABLE WITH VACCINES ROUTINELY ADMINISTERED IN THE UNITED STATES TO CHILDREN AND/OR ADULTS

Condition	Target Population(s) for Routine Use
Pertussis	Children, adolescents, adults
Diphtheria	Children, adolescents, adults
Tetanus	Children, adolescents, adults
Poliomyelitis	Children
Measles	Children
Mumps	Children
Rubella, congenital rubella syndrome	Children
Hepatitis B	Children
<i>Haemophilus influenzae</i> type b infection	Children
Hepatitis A	Children
Influenza	Children, adolescents, adults
Varicella	Children
Invasive pneumococcal disease	Children, older adults
Meningococcal disease	Adolescents
Rotavirus infection	Infants
Human papillomavirus infection, cervical and anogenital cancers	Adolescents and young adults
Zoster	Older adults

TABLE 148-2 DECLINE IN VACCINE-PREVENTABLE DISEASES IN THE UNITED STATES FOLLOWING WIDESPREAD IMPLEMENTATION OF NATIONAL VACCINE RECOMMENDATIONS

Condition	Annual No. of Prevacine Cases (Average)	No. of Cases Reported in 2012 ^a	Reduction (%) in Cases After Widespread Vaccination
Smallpox	29,005	0	100
Diphtheria	21,053	1	≥99
Measles	530,217	55	≥99
Mumps	162,344	229	≥99
Pertussis	200,752	48,277	76
Polio (paralytic)	16,316	0	100
Rubella	47,745	9	>99
Congenital rubella syndrome	152	2	99
Tetanus	580	37	94
<i>Haemophilus influenzae</i> type b infection	20,000	30 ^b	99
Hepatitis A	117,333	2,890 ^c	98
Hepatitis B (acute)	66,232	18,800 ^c	72
Invasive pneumococcal infection: all ages	63,067	31,600 ^d	50
Invasive pneumococcal infection: <5 years of age	16,069	1,800 ^d	89
Varicella	4,085,120	216,511	95

^aExcept for cases of hepatitis A and hepatitis B, for which 2011 figures are shown. ^bAn additional 13 type b infections are estimated to have occurred among 210 reports of *H. influenzae* infection caused by unknown types among children <5 years of age. ^cData are from the CDC's Viral Hepatitis Surveillance, 2011. ^dData are from the CDC's Active Bacterial Core Surveillance 2012 Provisional Report.

Source: Adapted from SW Roush et al: JAMA 298:2155, 2007; and MMWR 62(33): 669, 2013.

eliminating, or eradicating a disease. *Control* of a vaccine-preventable disease reduces poor illness outcomes and often limits the disruptive impacts associated with outbreaks of disease in communities, schools, and institutions. Control programs can also reduce absences from work for ill persons and for parents caring for sick children, decrease absences from school, and limit health care utilization associated with treatment visits.

Elimination of a disease is a more demanding goal than control, usually requiring the reduction to zero of cases in a defined geographic area but sometimes defined as reduction in the indigenous sustained transmission of an infection in a geographic area. As of 2013, the United States had eliminated indigenous transmission of measles, rubella, poliomyelitis, and diphtheria. Importation of pathogens from other parts of the world continues to be important, and public health efforts are intended to react promptly to such cases and to limit forward spread of the infectious agent.

Eradication of a disease is achieved when its elimination can be sustained without ongoing interventions. The only vaccine-preventable disease of humans that has been globally eradicated thus far is smallpox. Although smallpox vaccine is no longer given routinely, the disease has not reemerged naturally because all chains of human transmission were interrupted through earlier vaccination efforts and humans were the only natural reservoir of the virus. Currently, a major health initiative is targeting the global eradication of polio. Sustained transmission of polio has been eliminated from most nations but has never been interrupted in three countries—Afghanistan, Nigeria, and Pakistan—while recent outbreaks in Syria and the Horn of Africa underscore that other countries remain at risk for importation until these reservoirs have been addressed. Detection of a case of disease that has been targeted for eradication or elimination is considered a sentinel event that could permit the infectious agent to become reestablished in the community or region. Therefore, such episodes must be promptly reported to public health authorities.