

EPIDEMIOLOGY AND PREVENTION OF VACCINE- PREVENTABLE DISEASES

13TH EDITION

This book was produced by the Communication and Education Branch, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, who is solely responsible for its content. It was printed and distributed by the Public Health Foundation. For additional copies, contact the Public Health Foundation at 877-252-1200 or website <http://bookstore.phf.org/>.

Slide sets to accompany this book are available on the CDC Vaccines and Immunization website at <http://www.cdc.gov/vaccines/pubs/pinkbook/index.html>.

E-mail address for comments, questions or suggestions about the contents of this book: nipinfo@cdc.gov.

Edited by:

Jennifer Hamborsky, MPH, MCHES

Andrew Kroger, MD, MPH

Charles (Skip) Wolfe



U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

April, 2015

On the cover

This illustration depicts the influenza virus.
Graphic created by Dan J. Higgins, Division of Communication Services, CDC

Suggested Citation:
Centers for Disease Control and Prevention.
Epidemiology and Prevention of Vaccine-Preventable Diseases.
Hamborsky J, Kroger A, Wolfe S, eds. 13th ed. Washington D.C.
Public Health Foundation, 2015.

Use of trade names and commercial sources is for identification only and does not imply endorsement by the Public Health Services or the U.S. Department of Health and Human Services. References to non-CDC sites on the Internet are provided as a service to readers and do not constitute or imply endorsement of these organizations or their programs by CDC or the U.S. Department of Health and Human Services. CDC is not responsible for the content of these sites. URL addresses were current as of the date of publication.

The editors would like to thank Dr. William L. Atkinson, who summarized, standardized and compiled CDC's vaccine-preventable disease and vaccine teaching materials to create the Pink Book.

"He just thought it up and did it." – Apocalypse Now

Milestones in the History of Vaccination

400BCE

Hippocrates describes diphtheria, epidemic jaundice, and other conditions

1100s

Variolation for smallpox first reported in China

1721

Variolation introduced into Great Britain

1796

Edward Jenner inoculates James Phipps with cowpox, and calls the procedure vaccination ("vacca" is Latin for cow)

1 Principles of Vaccination	
Immunology and Vaccine-Preventable Diseases	1
Classification of Vaccines	4
Selected References	7
2 General Recommendations on Immunization	
Timing and Spacing of Vaccines	9
Adverse Reactions Following Vaccination	15
Contraindications and Precautions to Vaccination	17
Invalid Contraindications to Vaccination	24
Screening for Contraindications and Precautions to Vaccination	28
Selected References	31
3 Immunization Strategies for Healthcare Practices and Providers	
The Need for Strategies to Increase Immunization Levels	33
The AFIX Approach	34
Other Essential Strategies	39
Selected References	45
4 Vaccine Safety	
The Importance of Vaccine Safety Programs	47
Sound Immunization Recommendations and Policy	49
Assessing and Monitoring Safety of Vaccines	50
Vaccine Injury Compensation	54
The Immunization Provider’s Role	55
Selected References	60
5 Storage and Handling	
Vaccine Storage and Handling	63
Receiving and Unpacking Vaccine Deliveries	66
Vaccine Storage and Temperature Monitoring Equipment	67
Vaccine and Diluent Placement and Labeling	70
Vaccine Storage Troubleshooting	71
Vaccine and Diluent Inventory Control	73
Selected References	77
6 Vaccine Administration	
Staff Training and Education	79
Patient Care Before Administering Vaccine	80
Patient Care During Vaccine Administration	83
Infection Control	87
Vaccine Preparation	88

Milestones in the History of Vaccination

1870

Louis Pasteur creates the first live attenuated bacterial vaccine (chicken cholera)

1884-85

Pasteur creates the first live attenuated viral vaccine for use in humans

1900

Paul Ehrlich formulates receptor theory of immunity

1901

First Nobel Prize in Medicine to von Behring for diphtheria antitoxin

1909

Theobald Smith discovers a method for inactivating diphtheria toxin

Table of Contents

Route and Site	91
Nonstandard Administration	99
Managing Acute Vaccine Reactions	100
Documentation	101
Strategies to Prevent Administration Errors	102
Vaccine Adverse Event Reporting System (VAERS)	104
Selected References and Resources	104

7 Diphtheria

<i>Corynebacterium diphtheriae</i>	107
Pathogenesis	107
Clinical Features	108
Complications	109
Laboratory Diagnosis	110
Medical Management	110
Epidemiology	111
Secular Trends in the United States	112
Diphtheria Toxoid	113
Vaccination Schedule and Use	114
Contraindications and Precautions to Vaccination	115
Adverse Events Following Vaccination	115
Adverse Reactions Following Vaccination	115
Vaccine Storage and Handling	116
Suspect Case Investigation and Control	116
Selected References	117

8 *Haemophilus influenzae*

<i>Haemophilus influenzae</i>	119
Pathogenesis	120
Clinical Features	121
Laboratory Diagnosis	121
Medical Management	122
Epidemiology	123
Secular Trends in the United States	123
<i>Haemophilus influenzae</i> type b Vaccines	125
Vaccination Schedule and Use	126
Monvalent Vaccines	128
Combination Vaccines	130
Contraindications and Precautions to Vaccination	131
Adverse Reactions Following Vaccination	132
Vaccine Storage and Handling	132
Surveillance and Reporting of Hib Disease	132
Selected References	132

Milestones in the History of Vaccination

1919

Calmette and Guerin create BCG, the first live attenuated bacterial vaccine for humans

1923

First whole-cell pertussis vaccine tested
Gaston Ramon develops diphtheria toxoid

1926

Ramon and Christian Zoeller develop tetanus toxoid

1931

Goodpasture describes a technique for viral culture in hens' eggs

1936

Thomas Francis and Thomas Magill develop the first inactivated influenza vaccine

9 Hepatitis A

Hepatitis A Virus	135
Pathogenesis	135
Clinical Features	136
Complications	136
Laboratory Diagnosis	136
Medical Management	137
Epidemiology	137
Secular Trends in the United States	139
Case Definition	141
Hepatitis A Vaccine	141
Vaccination Schedule and Use	142
Contraindications and Precautions to Vaccination	146
Adverse Reactions Following Vaccination	147
Vaccine Storage and Handling	147
Postexposure Prophylaxis	147
Selected References	147

10 Hepatitis B

Hepatitis B Virus	149
Clinical Features	150
Complications	151
Laboratory Diagnosis	152
Medical Management	154
Epidemiology	154
Secular Trends in the United States	156
Hepatitis B Prevention Strategies	157
Hepatitis B Vaccine	158
Vaccination Schedule and Use	161
Serologic Testing of Vaccine Recipients	166
Postexposure Management	168
Contraindications and Precautions to Vaccination	172
Adverse Events Following Vaccination	172
Adverse Reactions Following Vaccination	172
Vaccine Storage and Handling	173
Selected References	173

11 Human Papillomavirus

Human Papillomavirus	175
Pathogenesis	175
Clinical Features	176
Laboratory Diagnosis	176
Medical Management	177
Epidemiology	177
Disease Burden in the United States	178
Prevention	178

Milestones in the History of Vaccination

1948

John Enders and colleagues isolate Lansing Type II poliovirus in human cell line

1954

Enders and Peebles isolate measles virus
Francis Field Trial of inactivated polio vaccine

1955

Inactivated polio vaccine licensed

1961

Human diploid cell line developed

1963

Measles vaccine licensed
Trivalent oral polio vaccine licensed

Table of Contents

Human Papillomavirus Vaccine	179
Vaccination Schedule and Use	181
Contraindications and Precautions to Vaccination	183
Adverse Reactions Following Vaccination	184
Vaccine Storage and Handling	184
Selected References	185

12 Influenza

Influenza Virus	187
Pathogenesis	190
Clinical Features	190
Complications	190
Impact of Influenza	191
Laboratory Diagnosis	192
Epidemiology	192
Secular Trends in the United States	193
Influenza Vaccines	193
Vaccination Schedule and Use	196
Contraindications and Precautions to Vaccination	199
Adverse Events Following Vaccination	200
Adverse Reactions Following Vaccination	201
Vaccine Storage and Handling	203
Strategies for Improving Influenza Vaccine Coverage	203
Antiviral Agents for Influenza	204
Nosocomial Influenza Control	205
Influenza Surveillance	206
Selected References	206

13 Measles

Measles Virus	209
Pathogenesis	209
Clinical Features	210
Complications	210
Laboratory Diagnosis	212
Epidemiology	213
Secular Trends in the United States	214
Measles Vaccine	217
Vaccination Schedule and Use	218
Contraindications and Precautions to Vaccination	222
Adverse Events Following Vaccination	225
Adverse Reactions Following Vaccination	226
Vaccine Storage and Handling	227
Selected References	228

Milestones in the History of Vaccination

1965

Bifurcated needle for smallpox vaccine licensed

1966

World Health Assembly calls for global smallpox eradication

1967

Maurice Hilleman develops Jeryl Lynn strain of mumps virus

1969

Stanley Plotkin develops RA 27/3 strain of rubella vaccine virus

1971

MMR vaccine licensed

14 Meningococcal Disease

<i>Neisseria meningitidis</i>	231
Pathogenesis	232
Clinical Features	232
Laboratory Diagnosis	233
Medical Management	234
Epidemiology	234
Secular Trends in the United States	234
Meningococcal Vaccines	236
Vaccination Schedule And Use	239
Contraindications and Precautions to Vaccination	241
Adverse Events Following Vaccination	241
Adverse Reactions Following Vaccination	242
Vaccine Storage and Handling	242
Surveillance and Reporting of Meningococcal Disease	243
Antimicrobial Chemoprophylaxis	243
Selected References	244

15 Mumps

Mumps Virus	247
Pathogenesis	247
Clinical Features	247
Complications	248
Laboratory Diagnosis	249
Epidemiology	251
Secular Trends in the United States	251
Mumps Vaccine	253
Vaccination Schedule and Use	253
Contraindications and Precautions to Vaccination	255
Adverse Events Following Vaccination	256
Adverse Reactions Following Vaccination	257
Vaccine Storage and Handling	257
Selected References	257

16 Pertussis

<i>Bordetella pertussis</i>	261
Pathogenesis	261
Clinical Features	261
Complications	262
Laboratory Diagnosis	263
Medical Management	265
Epidemiology	265
Secular Trends in the United States	266

Milestones in the History of Vaccination

1977

Last indigenous case of smallpox (Somalia)

1979

Last wild poliovirus transmission in the U.S.

1981

First hepatitis B vaccine licensed

1983

Smallpox vaccine withdrawn from civilian market

1986

First recombinant vaccine licensed (hepatitis B)
National Childhood Vaccine Injury Act

Table of Contents

Pertussis Vaccines	267
Vaccination Schedule and Use	269
Combination Vaccines Containing DTaP	272
Other DTaP Issues	273
Contraindications and Precautions to Vaccination	274
Adverse Reactions Following Vaccination	275
Vaccine Storage and Handling	276
Selected References	277

17 Pneumococcal Disease

<i>Streptococcus pneumoniae</i>	279
Clinical Features	280
Laboratory Diagnosis	282
Medical Management	283
Epidemiology	283
Secular Trends in the United States	284
Pneumococcal Vaccines	284
Vaccination Schedule and Use	287
Contraindications and Precautions to Vaccination	291
Adverse Events Following Vaccination	292
Adverse Reactions Following Vaccination	292
Vaccine Storage and Handling	293
Goals and Coverage Levels	293
Selected References	294

18 Poliomyelitis

Poliovirus	297
Pathogenesis	297
Clinical Features	298
Laboratory Testing	299
Epidemiology	299
Secular Trends in the United States	300
Poliovirus Vaccines	301
Vaccination Schedule and Use	303
Polio Vaccination of Adults	305
Contraindications And Precautions To Vaccination	306
Adverse Reactions Following Vaccination	306
Vaccine Storage and Handling	307
Outbreak Investigation and Control	308
Polio Eradication	308
Postpolio Syndrome	309
Selected References	310

Milestones in the History of Vaccination

1989

Two-dose measles vaccine recommendation

1990

First polysaccharide conjugate vaccine licensed (*Haemophilus influenzae* type b)

1994

Polio elimination certified in the Americas
Vaccines for Children program begins

1995

Varicella vaccine licensed
Hepatitis A vaccine licensed
First harmonized childhood immunization schedule published

1996

Acellular pertussis vaccine licensed for infants

19 Rotavirus

Rotavirus	311
Pathogenesis	311
Clinical Features.	312
Complications	312
Laboratory Diagnosis.	312
Epidemiology	313
Rotavirus Disease in the United States Pre and Post Vaccine Introduction.	314
Rotavirus Vaccines	315
Vaccination Schedule and Use	317
Contraindications and Precautions to Vaccination	319
Adverse Events Following Vaccination	320
Adverse Reactions Following Vaccination	321
Vaccine Storage and Handling.	321
Rotavirus Surveillance	322
Selected References	322

20 Rubella

Rubella Virus	325
Pathogenesis	325
Clinical Features.	325
Complications	326
Congenital Rubella Syndrome	326
Laboratory Diagnosis.	327
Epidemiology	328
Secular Trends in the United States	329
Rubella Vaccine	330
Vaccination Schedule and Use	331
Rubella Immunity.	333
Contraindications and Precautions to Vaccination	334
Adverse Events Following Vaccination	336
Adverse Reactions Following Vaccination	336
Rubella Vaccination of Women of Childbearing Age	337
Vaccine Storage and Handling.	338
Strategies to Decrease Rubella and CRS	338
Selected References	339

21 Tetanus

<i>Clostridium tetani</i>	341
Pathogenesis	342
Clinical Features.	342
Complications	343

Milestones in the History of Vaccination

1997

Sequential polio vaccination recommended

1998

First rotavirus vaccine licensed

1999

Exclusive use of inactivated polio vaccine recommended
Rotavirus vaccine withdrawn

2000

Pneumococcal conjugate vaccine licensed for infants

2003

Live attenuated influenza vaccine licensed

Table of Contents

Laboratory Diagnosis	343
Medical Management	343
Wound Management	344
Epidemiology	344
Secular Trends in the United States	345
Tetanus Toxoid	346
Vaccination Schedule and Use	347
Contraindications and Precautions to Vaccination	349
Adverse Events Following Vaccination	349
Adverse Reactions Following Vaccination	349
Vaccine Storage and Handling	350
Selected References	350

22 Varicella

Varicella Zoster Virus	353
Pathogenesis	353
Clinical Features	353
Complications	355
Laboratory Diagnosis	357
Epidemiology	358
Secular Trends in the United States	359
Vaccines Containing Varicella Virus	360
Vaccination Schedule and Use	363
Varicella Immunity	367
Contraindications and Precautions to Vaccination	368
Adverse Reactions Following Vaccination	372
Transmission of Varicella Vaccine Virus	373
Vaccine Storage and Handling	373
Varicella Zoster Immune Globulin	374
Selected References	375

APPENDICES

A Schedules and Recommendations

Immunization Schedules on the Web	A-1
Recommended Immunization Schedules for Persons Aged 0 Through 18 Years	A-2
Recommended Adult Immunization Schedule	A-8
Recommended and Minimum Ages and Intervals Between Doses of Routinely Recommended Vaccines	A-13
Summary of Recommendations for Child/Teen Immunization	A-15
Summary of Recommendations for Adult Immunization	A-20

Milestones in the History of Vaccination

2004

Inactivated influenza vaccine recommended for all children 6–23 months of age

2004

Indigenous transmission of rubella virus interrupted

2005

Acellular pertussis vaccines licensed for adolescents and adults

2005

MMR-varicella (MMRV) licensed

2006

Second generation rotavirus vaccine licensed

Recommended intervals between administration of immune globulin preparations and measles-or varicella-containing vaccine A-24

Healthcare Personnel Vaccination Recommendations A-25

Vaccination of Persons with Primary and Secondary Immune Deficiencies A-26

Guide to Contraindications and Precautions to Commonly Used Vaccines A-28

Guide to Contraindications and Precautions to Commonly Used Vaccines in Adults. A-30

B Vaccines

U.S Vaccines. B-1

Selected Discontinued U.S. Vaccines B-5

Vaccine Excipient and Media Summary, by Vaccine B-7

Latex in Vaccine Packaging. B-11

Thimerosal Table B-13

Foreign Language Terms. B-15

C Vaccine Information Statements

It's Federal Law. C-1

Instructions for Use of VISs C-3

VIS Questions and Answers C-4

CDC's Vaccine Information Statement Webpage C-9

D Vaccine Safety

The Vaccine Adverse Event Reporting System (VAERS) D-1

The Vaccine Injury Compensation Program (VICP) D-3

Vaccine Injury Table D-5

Countermeasures Injury Compensation Program (CICP). D-7

E Data and Statistics

Reported Cases and Deaths from Vaccine Preventable Diseases, United States, 1950-2013 E-1

Impact of Vaccines in the 20th and 21st Centuries E-7

Vaccine Coverage Levels, United States, 1962-2012 E-8

F Immunization Resources

CDC Contact Information and Resources F-1

Selected Online Resources F-2

Contact Information: Selected Vaccine Manufacturers and Distributors F-3

Immunization Grantees F-4

Milestones in the History of Vaccination

2006 First human papillomavirus vaccine licensed	2006 First herpes zoster vaccine licensed	2009 H1N1 influenza pandemic declared	2010 Influenza vaccine recommended for all persons 6 months and older	2013 First quadrivalent influenza vaccine licensed
--	---	---	---	--