

Review article

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Recommended immunization schedule for children and adolescents: Immunization Guideline (8th edition) released by the Korean Pediatric Society in 2015

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This report includes the recommended immunization schedule table for children and adolescents based on the 8th (2015) and revised 7th (2012) Immunization Guidelines released by the Committee on Infectious Diseases of the Korean Pediatric Society (KPS). Notable revised recommendations include: reorganization of the immunization table with a list of vaccines on the vertical axis and the corresponding age on the horizontal axis; reflecting the inclusion of *Haemophilus influenzae* type b vaccine, pneumococcal conjugate vaccine, and hepatitis A vaccine into the National Immunization Program since 2012; addition of general recommendations for 2 new Japanese encephalitis (JE) vaccines and their interchangeability with existing JE vaccines; addition of general recommendations for quadrivalent meningococcal conjugate vaccines and scope of the recommended targets for vaccination; and emphasizing catch-up immunization of Tdap vaccine. Detailed recommendations for each vaccine may be obtained from the full KPS 8th Immunization Guidelines.

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Introduction

Since the Korean Pediatric Society (KPS) published the 7th edition of the Immunization Guideline in 2012^{1,2)}, there have been several changes in immunization practice in the Republic of Korea.

Between 2012 and 2015, 2 meningococcal quadrivalent conjugate vaccines (Menveo [GlaxoSmithKlein, Siena, Italy], Menactra [Sanofi Pasteur SA, Swiftwater, PA, USA]), 2 Japanese encephalitis (JE) vaccines (Vero cell-derived inactivated JE vaccine, Encevac [Boryung Biopharma, Seoul, Korea]; Vero cell-derived live-attenuated chimeric JE vaccine, Imojev [Sanofi Pasteur SA, Lyon, France]), and 2 new influenza vaccines (inactivated cell culture influenza vaccine, SKYCellflu [SK chemical, Andong, Korea]; inactivated quadrivalent influenza vaccine, Fluarix Tetra [GlaxoSmithKlein, Dresden, Germany]) were introduced. During the same period, optional vaccines such as *Haemophilus influenzae* type b vaccines, pneumococcal conjugate vaccines, hepatitis A vaccines, primary hamster kidney cell-derived live-attenuated JE vaccine (CD.JEVAX [Chengdu Institute of Biological

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Table 1. Recommended immunization schedule for children and adolescents: the Korean Pediatric Society, 2015

Vaccine	Birth	0–28 days	1 mo	2 mo	4 mo	6 mo	12 mo	15 mo	18 mo	19–23 mo	24–35 mo	4 yr	6 yr	11 yr	12 yr
Hepatitis B ^{a)}	1st dose		2nd dose			3rd dose									
BCG ^{b)}		1st dose													
Diphtheria, tetanus, acellular pertussis ^{c)} (DTaP)				1st dose	2nd dose	3rd dose		4th dose							
Inactivated poliovirus ^{d)}				1st dose	2nd dose	3rd dose			4th dose						
<i>Haemophilus influenzae</i> type b ^{e)}				1st dose	2nd dose	3rd dose	4th dose								
Pneumococcal conjugate ^{f)}				1st dose	2nd dose	3rd dose	4th dose								
Rotavirus ^{g)}															
Rotarix				1st dose	2nd dose										
Rotateq				1st dose	2nd dose	3rd dose									
Influenza ^{h)}															
Inactivated							Annual								
Live attenuated											Annual				
Hepatitis A ⁱ⁾							1st & 2nd dose								
Measles, mumps, rubella ^{j)}							1st dose				2nd dose				
Varicella ^{k)}							1st dose								
Japanese encephalitis ^{l)}															
Inactivated							1st & 2nd dose	3rd dose		4th dose			5th dose		
Live attenuated							1st dose	2nd dose							
Tetanus, diphtheria, acellular pertussis (Tdap) ^{m)}															1st dose
Human papillomavirus ⁿ⁾															1st-3rd (1st, 2nd) dose

*Rotavirus and human papillomavirus vaccines are optional vaccines, which are not provided by the National Immunization Program.

^{a)}Hepatitis B (HepB) vaccine: Administer monovalent HepB vaccine at 0, 1, and 6 months of age; administer the third dose at least 8 weeks after the second dose and at least 16 weeks after the first dose, and no earlier than age 24 weeks. Administer the first dose according to the maternal hepatitis B surface antigen (HBsAg) status as follows.

a. If maternal HBsAg is positive, administer HepB vaccine and 0.5 mL of hepatitis B immune globulin (HBIG) within 12 hours of birth at different sites.

b. If maternal HBsAg status is unknown, administer HepB vaccine within 12 hours of birth and determine maternal HBsAg status as soon as possible. If maternal HBsAg is positive, also administer HBIG as soon as possible, but no later than age 7 days.

c. If maternal HBsAg is negative, administer HepB vaccine within 24 hours of birth (acceptable before hospital discharge).

^{b)}Bacille Calmette-Guérin (BCG) vaccine: Administer BCG vaccine to neonates at birth through age 4 weeks. Infants over 3 months old require a tuberculin skin test before BCG vaccination.

^{c)}Diphtheria, tetanus toxoid, and acellular pertussis (DTaP) vaccine: Administer a 5-dose series of DTaP vaccine at ages 2, 4, and 6 months as primary series, and at 15 through 18 months and 4 through 6 years as boosters.

^{d)}Inactivated poliovirus vaccine (IPV): Administer a 4-dose series of IPV at ages 2, 4, 6 months as primary series, and at 4 through 6 years as a booster.

^{e)}*Haemophilus influenzae* type b (Hib) vaccine: Administer a 4-dose series of Hib vaccine at ages 2, 4, 6 months as primary series, and at 12 through 15 months as a booster.

^{f)}Pneumococcal conjugate vaccine (PCV): Administer a 4-dose series of PCV at ages 2, 4, 6 months as primary series, and at 12 through 15 months as a booster.

^{g)}Rotavirus (RV) vaccine: The first dose of any RV vaccines can be administered as early as at 6 weeks of age. The maximum age for the first dose in the series is 14 weeks 6 days; vaccination should not be initiated for infants aged 15 weeks 0 days or older. For Rotarix (GlaxoSmithKline, Research Triangle Park, NC, USA), administer a 2-dose series at 2 and 4 months of age. For Rotateq (Merck & Co Inc., Whitehouse Station, NJ, USA), administer a 3-dose series at 2, 4, and 6 months of age. The minimum interval between any doses is 4 weeks, and the maximum age for the final dose in the series is 8 months 0 days

^{h)}Influenza vaccine: Administer the influenza vaccine annually to all children aged 6 through 59 months anytime during an influenza season, preferably before the increase of incidence. Additionally, administer influenza vaccine to caregivers and family members of children aged 0 through 59 months, children and adolescents 5 years and older who have any underlying medical conditions with a high risk of complication for influenza infection, the caregivers of high-risk children and adolescents, and all people who opt for the vaccine. Administer 2 doses (separated by at least 4 weeks) to children younger than 9 years who are receiving influenza vaccine for the first time. Administer 1 dose to children and adolescents aged 9 years and older. If inactivated influenza vaccine (IIV) is used, administer 0.25 mL of IIV intramuscularly to children aged 6 through 35 months and 0.5 mL of IIV to those aged 3 years and older. Live attenuated influenza vaccine (LAIV) is approved for persons aged 2 years and older; if LAIV is used, administer 0.2 mL of LAIV intranasally.

ⁱ⁾Hepatitis A (HepA) vaccine: Initiate the 2-dose HepA vaccine series at 12 through 23 months, and separate the 2 doses by 6 to 18 months in accordance with the products.

^{j)}Measles, mumps, rubella (MMR) vaccine: Administer a 2-dose series of MMR vaccine at ages 12 through 15 months and at 4 through 6 years. Administer 1 dose of monovalent measles (or MMR) vaccine to infants aged 6 through 11 months when a measles outbreak occurs in the community. These children should be revaccinated with 2 doses of MMR vaccine, and the first dose should be administered at age 12 through 15 months and the second dose at age 4 through 6 years. The second dose may be administered before age 4 years with an interval of 4 weeks or more from the first dose in special situations.

^{k)}Varicella vaccine: Administer a single dose of varicella vaccine to all children aged 12 through 15 months. The second dose of vaccine may be administered to children aged 12 months to 12 years who attend daycare centers, schools, or facilities where chicken pox is prevalent, provided at least 3 months have elapsed since the first dose.

^{l)}Japanese encephalitis vaccine (JEV): The first dose of any JE vaccine, which is a 5-dose series of inactivated JEV (IJEV) or a 2-dose series of live attenuated JEV (LAJEV), may be administered to children aged 12 through 23 months. If IJEV is used, administer the second dose 7 to 30 days after the first dose and the third dose, 12 months after the second dose. As booster doses, administer the fourth and the fifth doses at ages 6 and 12 years, respectively. If LAJEV is used, administer the second dose at least 12 months after the first dose.

^{m)}Tetanus and diphtheria toxoid and acellular pertussis (Tdap) vaccine: Administer 1 dose of Tdap to adolescents aged 11 through 12 years who are fully immunized with the DTaP vaccine. Administer tetanus and diphtheria toxoid (Td) as boosters every 10 years thereafter.

ⁿ⁾Human papillomavirus (HPV) vaccine: Administer a 3-dose series of either HPV vaccines, Cervarix (GSK, HPV2) with 0-, 1-, and 6-month schedule or Gardasil (MSD, HPV4) with 0-, 2-, and 6-month schedule, to girls aged 11 through 12 years. Additionally, a 2-dose series of HPV vaccines with a 6-months interval is acceptable for girls aged 9 through 14 years for HPV2 or girls aged 9 through 13 years for HPV4.

Table 2. Catch-up immunization schedule for persons aged 4 months through 18 years who start late or who are more than 1 month behind: the Korean Pediatric Society, 2015

Vaccine	Minimum age for dose 1	Children aged 4 months through 6 years			
		Minimal 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 ^{a)}	Birth	4 Weeks	8 Weeks (at least 16 weeks after 1st dose) ^{a)} Minimum age for the 3rd dose is 24 weeks		
Diphtheria, tetanus, acellular pertussis (DTaP) ^{b)}	6 Weeks	4 Weeks	4 Weeks	6 Months	6 Months ²⁾
Inactivated poliovirus ^{c)}	6 Weeks	4 Weeks	4 Weeks	6 Months ³⁾	
<i>Haemophilus influenzae</i> type b ^{d)}	6 Weeks	4 Weeks: if 1st dose was administered before the 1st birthday 8 Weeks (as final dose): if 1st dose was administered at age 12 through 14 months No further doses needed: if 1st dose was administered at age 15 months or older	4 Weeks ⁴⁾ : if current age is younger than 12 months and 1st dose was administered at younger than age 7 months 8 Weeks and age 12 through 59 months (as final dose): if current age is younger than 12 months and 1st dose was administered at age 7 through 11 months 8 Weeks and age 12 through 59 months (as final dose): if current age is 12 through 59 months and 1st dose was administered before the 1st birthday, and second dose administered at younger than 15 months No further doses needed: if previous dose was administered at age 15 months or older	8 Weeks (as final dose): this dose only necessary for children age 12 through 59 months who received 3 doses before the 1st birthday	
Pneumococcal conjugate ^{e)}	6 Weeks	4 Weeks: if 1st dose administered before the 1st birthday 8 Weeks (as final dose for healthy children): if 1st dose was administered at age 12 through 23 months 8 Weeks (as final dose for healthy children): if 1st dose of PCV10 administered at age 24 months or older No further doses needed for healthy children: if 1st dose of PCV13 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 through 11 months (wait until at least 12 months old) 8 Weeks (as final dose for healthy children): if current age is 12 months or older and at least 1 dose was given before age 12 months No further doses needed for healthy children: if previous dose administered at age 24 months or older.	8 Weeks (as final dose): this dose only necessary for children aged 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	
Rotavirus ^{f)}	6 Weeks	4 Weeks	4 Weeks		
Hepatitis A ^{g)}	12 Months	6 Months			
Measles, mumps, rubella (MMR) ^{h)}	12 Months	4 Weeks			
Varicella ⁱ⁾	12 Months	3 Months			
Japanese encephalitis ^{j)}	12 Months	7 days: inactivated vaccine 12 Months (as final dose): live vaccine	6 Months: inactivated vaccine	2 Years: inactivated vaccine	5 Years: inactivated vaccine
Children and adolescents aged 7 through 18 years					
Hepatitis B ^{a)}	NA	4 Weeks	8 Weeks and at least 16 weeks after 1st dose ¹⁾		
Inactivated poliovirus ^{c)}	NA	4 Weeks	4 Weeks	6 Months	
Hepatitis A ^{g)}	NA	6 Months			
Measles, mumps, rubella (MMR) ^{h)}	NA	4 Weeks			
Varicella ⁱ⁾	NA	3 Months	3 Months: if younger than age 13 years 4 Weeks: if age 13 years or older		
	NA	7 days: inactivated vaccine 12 Months (as final dose): live vaccine	6 Months: inactivated vaccine	2 Years: inactivated vaccine off	
Tetanus, diphtheria, acellular pertussis (Tdap)/Tetanus, diphtheria (Td) ^{k)}	7 Years	4 Weeks	4 Weeks: if 1st dose of DTaP was administered before age 12 months 6 Months: if 1st dose of DTaP was administered at or after age 12 months	6 Months: if 1st dose of DTaP was administered before age 12 months 10 Years: if 1st dose of DTaP was administered at or after age 12 months	
Human papillomavirus ^{l)}	9 Years	Routine dosing intervals are recommended	Routine dosing intervals are recommended		

PCV10, pneumococcal conjugate 10-valent vaccine; PCV13, pneumococcal conjugate 13-valent vaccine; NA, not applicable.

*A vaccine series does not need to be restarted, regardless of the time that has elapsed between doses. For additional information regarding each vaccine, vaccination providers should refer to appropriate part of the Korean Pediatric Society Immunization Guideline or the insert paper for each vaccine.

^aHepatitis B vaccine: Unvaccinated children or adolescents should complete a 3-dose series. Minimum age at the third dose is 24 weeks.

^bDiphtheria, tetanus toxoid, and acellular pertussis (DTaP) vaccine: The fifth dose of the DTaP vaccine is not necessary if the fourth dose was administered at age 4 years or older.

^cInactivated poliovirus vaccine (IPV): In the first 6 months of life, minimum age and minimum intervals are only recommended if the person is at risk of imminent exposure to circulating poliovirus. The final dose in the series should be administered on or after the fourth birthday and at least 6 months after the previous dose. The 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. If both the oral poliovirus vaccine (OPV) and IPV were administered as part of a series, a total of 4 doses should be administered, regardless of the child's current age.

^d*Haemophilus influenzae* type b (Hib) vaccine: For unvaccinated children aged 15 through 59 months, administer only 1 dose. Hib vaccine is not recommended for healthy children 5 years or older.

^ePneumococcal conjugate vaccine (PCV): For unvaccinated children aged 24 through 59 months, administer only 1 dose. PCV is not recommended for healthy children 5 years or older.

^fRotavirus (RV) vaccine: The first dose of any RV vaccines can be administered as early as at 6 weeks of age. According to the product, administer a 2-dose (Rotarix, GSK) or 3-dose series (RotaTeq, MSD). The minimum interval between any doses is 4 weeks, the maximum age for the first dose in the series is 14 weeks 6 days, and the maximum age for the final dose in series is 8 months 0 days.

^gHepatitis A vaccine: Children should receive a second dose 6 to 18 months after the first dose.

^hMeasles, mumps, rubella (MMR) vaccine: Administer the second dose at age 4 through 6 years. However, the second dose may be administered at least 4 weeks after the first dose in special situations.

ⁱVaricella vaccine: For children aged less than 13 years without evidence of immunity for varicella zoster, administer only 1 dose. For adolescents aged 13 years or older without evidence of immunity for varicella zoster, administer 2 doses with a 4 to 8-week interval. The second dose of vaccine may be administered to children aged 12 months to 12 years who attend facilities where chicken pox is prevalent, provided at least 3 months have elapsed since the first dose.

^jJapanese encephalitis vaccine (JEV): If the third dose of inactivated JEV was administered at age 4 through 9 years, the fourth dose may be administered as a final dose at age 12 years. If the third dose of inactivated JEV was administered at age 10 years or more, an additional dose is not necessary. If live attenuated JEV is used, administer the second dose at least 12 months after the first dose.

^kTetanus and diphtheria toxoid and acellular pertussis (Tdap)/tetanus and diphtheria toxoid (Td) vaccine: Persons aged 7 years and older who are not fully immunized with DTaP vaccine should receive Tdap vaccine as 1 dose (preferably the first) in the catch-up series and if additional doses are needed, use the Td vaccine.

^lHuman papillomavirus (HPV) vaccine: Administer the vaccine series to females at age 13 through 18 years if not previously vaccinated. Administer a 3-dose series of either HPV vaccines, Cervarix (GSK, HPV2) with 0-, 1-, and 6-month schedule or Gardasil (MSD, HPV4) with 0-, 2-, and 6-month schedule. In addition, a 2-dose series of HPV vaccines with a 6-month interval may be administered to females aged 9 through 14 years for HPV2 or aged 9 through 13 years for HPV4.

Products, Chengdu, China)], and Vero cell-derived inactivated JE vaccine were included in the National Immunization Program (NIP). To reflect these changes, the Committee on Infectious Diseases of KPS published the 8th Immunization Guideline in October 2015, 3 years after the 7th edition³.

Major changes include: (1) reorganization of the immunization table with a list of vaccines on the vertical axis and corresponding age on the horizontal axis; (2) reflecting the inclusion of *H. influenzae* type b vaccine, pneumococcal conjugate vaccine, and hepatitis A vaccine into the NIP since 2012; (3) addition of general recommendations for 2 new JE vaccines and their interchangeability with existing JE vaccines; (4) addition of general recommendations for quadrivalent meningococcal conjugate vaccines and scope of the recommended targets for vaccination; and (5) emphasizing catch-up immunization of Tdap vaccine.

This report focuses solely on the immunization schedule table; therefore, detailed recommendation guidelines for each vaccine may be obtained from the full KPS 8th Immunization Guideline.

Recommended immunization schedule

The schedule shown in Table 1 is for persons aged 0 through 18 years without delayed vaccination. The meningococcal quadrivalent conjugate vaccine is not included in the table, as the decision by the KPS Committee on Infectious Diseases excluded the universal recommendation of the vaccine after considering the epidemiology of invasive meningococcal diseases in Korea⁴.

Therefore, the meningococcal quadrivalent conjugate vaccine is only recommended for increased risk groups such as functional or anatomic asplenia, complement component deficiency, or outbreak situation of the disease.

For further guidance of each vaccine, refer to each chapter of the 8th Immunization Guideline 2015, and also the KPS official website (<http://www.pediatrics.or.kr>) and newsletters including the important updates of guidelines.

Catch-up immunization schedule

For children and adolescents whose vaccination has been delayed for more than 1 month, the catch-up immunization schedule should be referred to Table 2. The schedule is classified into 2 parts; for infants and preschoolers aged 0 through 6 years and for school-aged children and adolescents from 7 to 18 years of age.

Conclusions

The current KPS recommendation of immunization proposes that all children and adolescents residing in or planning to reside in Korea should receive vaccination according to the schedules provided in this report. Pediatricians should be aware of these updated recommendations and advice parents and caregivers on proper immunization practices based on these updated guidelines.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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