

Group on Immunization Education  
Society of Teachers of Family Medicine



## **CLINICAL SCENARIO SERIES ON IMMUNIZATION**

### Adolescent Immunization

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## Clinical Scenario – Adolescent Immunization

### Learning Objectives

1. State which vaccines are routinely required in adolescents or preadolescents.
2. Understand what additional immunizations may be required in certain at-risk conditions.

### Scenario

Katie, a 12 year old girl comes into your office for a sports physical before starting junior high school in the fall. She lives at home with her mother who works in a daycare center and her grandmother, who has emphysema. Her older brother, Matt, will be starting college in the fall. She is reported to have had all the routine childhood immunizations required prior to school entry, including one dose of varicella vaccine.



### Questions

1. Which vaccines are indicated for Katie? Why?
2. Are any additional vaccines indicated because of her family situation?
3. What would you advise her mother about her son's need for immunizations?
4. What are the doses and administration routes for these vaccines?
5. What schedule should be followed in administering these vaccines?



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### Answers

1. Adolescent acellular pertussis-diphtheria-Tetanus vaccine (Tdap), quadrivalent conjugate meningococcal vaccine (MCV4), human papilloma virus (HPV) vaccine, and influenza vaccine are indicated for Katie in addition to a second (booster) dose of varicella vaccine

### Explanation

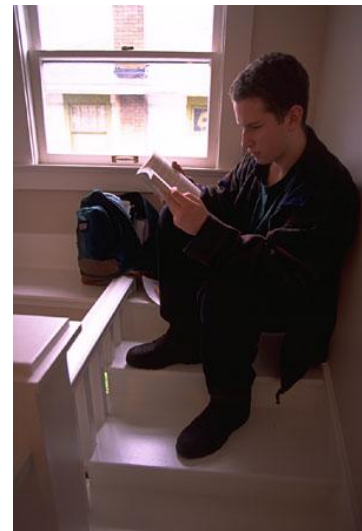
#### Disease Risk

During the past 20 years reported cases of *Bordetella pertussis* in the United States steadily increased reaching 25,827 in 2004(1). The incidence of pertussis declined but is once again increasing having reached almost 17,000 reported cases in 2009. Infants < 6 months of age continue to have the highest reported rate of pertussis but adolescents (ages 10-19) and adults ages 20 years and older accounted for about half of reported cases in 2009 (2). They then serve as a reservoir of disease for younger infants because immunity after childhood vaccination wanes in about 5 to 10 years.

*Neisseria meningitidis* causes approximately 1000 to 2000 reported cases of invasive disease in the United States that result in a case-fatality rate of 9% to 12% and sequelae such as neurologic disability, limb loss, or hearing loss, in another 20%. The fatality rate in 15- to 24- year olds approaches 25% and freshmen college students living in dormitories are at increased disease risk (3).

Human papillomavirus (HPV) currently infects approximately 20 million people in the United States. An estimated 6.2 million Americans will develop a new genital HPV infection each year (4). In addition to genital warts, High-risk HPV types are detected in 99% of cervical cancers for which an estimated new 12,700 cases and 4300 deaths will occur in the United States during 2011 (5). HPV also causes many anal, vulvar, vaginal, and penile cancers. Its prevalence among adolescent girls is estimated at about 60% and up to 75% of new infections occur among persons 15—24 years of age (6).

Seasonal influenza-associated deaths varied from about 3300 during 1985-86 to over 48,600 during 2003-04 with an average annual rate of about 23,600.in





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the United States. Influenza-associated hospitalizations average more than 200,000 per year with at least 57% among persons less than 65 years old. Children have the highest infection rate and hospitalization rates in children < age 2 years old are comparable to adults  $\geq$  65 years old (7). Persons at high risk for influenza-related complications and disease include but are not limited to children ages 6-59 months, pregnant women, and persons with chronic medical conditions such as metabolic or renal diseases, pulmonary or cardiovascular disorders, and immunodeficiency states. During the 2009 H1N1 influenza pandemic, children, adolescents, and young adults accounted for a higher percentage of hospitalized cases, especially if they had co-morbidities such as asthma, diabetes or pregnancy (8).

### Efficacy– Pertussis Vaccine

Two Tdap vaccines are licensed in the United States. Boostrix (GlaxoSmithKline) is approved for persons 10 and older and contains three pertussis antigens (pertussis toxin, PT; filamentous hemagglutinin, FHA; and pertactin). Adacel (sanofi pasteur) is approved for persons 11 through 64 years of age and contains 5 antigens (PT, FHA, pertactin, and fimbriae types 2 and 3). Neither vaccine contains preservatives. Efficacy of both vaccines was demonstrated by comparing the immune response to each company's pediatric (DTaP) formulations. For both vaccines, antibody response after a single of Tdap was comparable to infants receiving 3 doses of the DTaP vaccine. Consequently the vaccines are presumed to have similar clinical efficacy as DTaP vaccine (9).

Almost 17,000 pertussis cases and 12 infant deaths were reported in the United States during 2009 and it is estimated that only 1/10 of cases are reported. As a result, the Advisory Committee on Immunization Practices (ACIP) expanded their recommendations for Tdap coverage on October 27<sup>th</sup>, 2010. A single Tdap dose is recommended for persons aged 11 through 18 years who have completed the recommended childhood DTP/DTaP vaccination series and for adults aged 19 through 64 years old. The Tdap may be given regardless of interval since the last tetanus- or diphtheria-toxoid containing vaccine and may be used in adults 65 years and older who anticipate having close contact with an infant aged less than 12 months. In addition, Tdap may be used in children ages 7 through 10 years who did not complete their DTaP series. Adverse events from the vaccines are primarily local reactions such as pain, redness, and swelling (10).



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### Efficacy and Safety – Conjugate Meningococcal Vaccine

The quadrivalent (serogroups A, C, Y, and W-135) meningococcal conjugate vaccines (MCV4; Menveo, Novartis and Menactra, sanofi pasteur) are licensed for use in the U.S. for children, adolescents and adults ages 2 through 55 years. These vaccines can stimulate immunologic memory in contrast to the unconjugated meningococcal polysaccharide vaccine (MPSV4, Menomune-A/C/Y/W-135, sanofi pasteur). In the United Kingdom, a conjugate serogroup C meningococcal vaccine was shown to decrease nasopharyngeal carriage of meningococcal serogroup C and induce herd immunity (11,12) However, follow up data of bactericidal antibody persistence and vaccine efficacy in the United States has indicated that many adolescents might not be protected for more than 5 years as immunity wanes.

Consequently the ACIP now recommends that adolescents immunized with MCV4 at age 11 or 12 be revaccinated at age 16 years. If an adolescent was first vaccinated at age 13—15 years, a one-time booster should be given at age 16—18 years. Those immunized at or after age 16 years do not require a booster dose unless they are in a high risk group, e.g., have a persistent complement component deficiency or anatomic or functional asplenia. Those persons should receive a 2-dose primary series 2 months apart and then given a booster every 5 years (13).

A history of a severe allergic (anaphylactic) reaction to a vaccine component or after a previous dose of MCV4 is a contraindication to receipt of further doses. Local reactions such as pain, redness, and swelling at the injection site occur in almost 50% of recipients. A fever of 100°—103° F may occur within 7 days in about 3% of recipients while headache and malaise may also occur within 7 days in up to 60% of vaccinees (14).



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### Efficacy and Safety – Influenza Vaccine

Influenza vaccines have a variable rate of efficacy depending on the age of the recipient, whether or not the person is at high risk, and of the match of vaccine strains to those circulating in the community. For the trivalent influenza vaccine (TIV), efficacy rates against influenza illness ranges from about 50% to 80% in children. Children less than 9 years old who have never previously received vaccine should receive two doses of influenza vaccine as one dose does not confer protection. The TIV is up to 90% effective in preventing influenza illness in healthy persons less than 65 years old when vaccine and circulating virus strains are similar. It is 30% to 40% effective in older, non-institutionalized adults in preventing illness but is 50% to 70% effective in preventing hospitalization and 80% effective in preventing influenza-related death.

The live, attenuated influenza vaccine (LAIV) demonstrated an efficacy of 87% in preventing culture-confirmed influenza in children ages 60-84 months during year 1 of a two-season study when vaccine and circulating virus strains were well matched. The efficacy continued to be 87% during year 2 despite a poor match between the vaccine and the circulating strains. Otitis media with antibiotic use was also decreased by 28% during this time. In healthy adults ages 18-64 years old, influenza vaccination was associated with fewer lost work days, health-care provider visits, and medication use (15).

Common local reactions from TIV are redness, pain and swelling at the injection site that usually last 1 to 2 days. Systemic reactions from TIV are such as fever, malaise, and myalgias occur in less than 1% of recipients. Allergic reactions such as hives or angioedema may result from sensitivity to a vaccine component or egg protein. However, the ACIP now recommends that persons with a history of egg allergy without anaphylaxis may receive TIV only if they are observed for 30 minutes afterward and the provider is trained and equipped to handle anaphylactic emergencies. In some seasons, there may be a theoretical risk of Guillain-Barré syndrome of 1 additional case/1 million persons vaccinated.

Adverse effects in recipients of LAIV include runny nose, headache, cough, sore throat, and chills in a range of 10% to 40%. Children 6—23 months old have an increased risk of wheezing. The vaccine is not licensed for use in children less than 2 years old, or adults 50 years and older, or those individuals with high-risk conditions such as diabetes, chronic heart or lung



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disease, etc. The LAIV virus is also grown in egg embryos and patients who report a history of egg allergy should not be given LAIV although TIV is an option for those with non-anaphylactic allergy to egg (see above) (16,17).

### Efficacy and Safety—Human Papillomavirus Vaccine

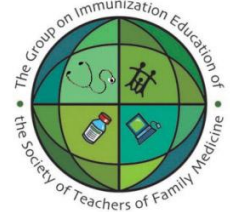
Two HPV vaccines are currently available. HPV4 vaccine (Gardasil, Merck and Co., Inc) contains noninfectious VLPs (virus-like particles) to HPV types 6, 11, 16, and 18. HPV2 (Cervarix, GlaxoSmithKline) contains VLPs to HPV types 16 and 18. Type 16 causes about 50% of cervical cancers and with type 18 accounts for about 70% of cervical cancers worldwide. HPV types 6 and 11 cause approximately 90% of all anogenital warts in addition to laryngeal papillomas.

Vaccine recipients who were not infected with the HPV16 or 18 serotypes and remained HPV PCR-negative for 1 month after receiving all 3 doses of HPV vaccine demonstrated 97% efficacy against HPV 16- or 18-cervical intraepithelial neoplasia (CIN) 2/3 or adenocarcinoma in situ (AIS). Similar efficacy was demonstrated against HPV 6-, 11-, 16-, 18- related genital warts.

The vaccines do not protect against non-vaccine HPV types or against disease caused by previous HPV infection with a HPV type present in the vaccine. Protection has lasted for more than 60 months in follow-up studies. Vaccination is most effective when all doses are given before the initiation of sexual activity. HPV4 and HPV2 are routinely recommended for all girls 11—12 years old in 3 doses over 6 months. Catch-up immunization may be given to females ages 13 through 26 years old. HPV 4 may be given to males 9—26 years old to decrease their risk of genital warts (18).

Local reactions including pain, swelling, and erythema occur commonly in HPV vaccine recipients (84%, 25%, and 25% respectively). Fever  $\geq 100^{\circ}\text{F}$  ( $\geq 38^{\circ}\text{C}$ ) may occur in about 4%-5% of recipients. Serious adverse events were rare and similar to the placebo group in clinical trials (19).

2. Influenza vaccine is indicated for household contacts of high risk individuals, in this case, Katie's grandmother. Because there is no history of severe immunosuppression requiring reverse isolation in Katie or her family, either the live, attenuated influenza vaccine (LAIV) or the trivalent inactivated influenza vaccine (TIV) may be used.



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3. Katie's older brother, Matt, should receive MCV4 prior to starting college in the fall. He should also receive a Tdap if he has completed his DTP/DTaP immunizations as a child but has not yet had a Tdap. Tdap can be given regardless of the interval since the last tetanus- or diphtheria-toxoid containing vaccine (20). Tdap is now also approved for use in pregnant women past 20 weeks gestation (21). Annual influenza vaccine is indicated.

### 4. Doses and Administration

Both Tdap vaccines are given as a 0.5 mL intramuscular injection. Boostrix (GlaxoSmithKline Biologicals) is approved for use in persons 10 years and older including those age 65 years and older. Adacel (Sanofi Pasteur) is currently approved for persons 11-64 years of age but has also been found to be immunogenic in adults 65 and older. Because of the increasing number of pertussis cases, either vaccine may be given to older adults who have not yet received a Tdap and will be in contact with infants younger than 12 months of age. Tdap may be administered regardless of the interval since the previous tetanus- or diphtheria-toxoid containing vaccine (22).

Meningococcal conjugate vaccine (MCV4) is dosed as a single 0.5 mL injection given intramuscularly. Both MCV4s are approved for use in individuals ages 2 to 55-years old. If MCV4 is unavailable, MPSV4 may be given subcutaneously for high-risk individuals.

HPV2 or HPV4 vaccines are recommended for all females 11 or 12 years of age preferably before the initiation of sexual activity. They are given as 0.5 mL intramuscularly at times 0, 1 month (HPV2) or 2 months (HPV4), and 6 months. The third dose must follow the first dose by an interval of 24 weeks. Females who may have already been exposed to HPV should also be vaccinated. Catch up vaccination of females aged 13-26 years old who are unvaccinated or partially vaccinated is also recommended and the vaccine can be started in girls as young as 9 years old.

The administration of live and inactivated influenza vaccine varies according to vaccine product and is described elsewhere.

Varicella vaccine is given as 0.5 mL subcutaneously. It is now recommended that all children receive a second dose prior to school entry at age 4-6 years old or earlier if at least 3 months have elapsed following the first dose. The combined MMR-V vaccine can be given at 4-6 years of age or each vaccine can be given separately at the same visit. A second dose of varicella vaccine



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is recommended for persons older than 6 years old if they have only received one previous dose. It is recommended that an interval of at least 3 months separate doses for children younger than 13 years old. Varicella vaccine should be given to all adolescents and adults 13 years of age and older who do not have evidence of immunity to chickenpox. In this age group, two doses of vaccine separated by at least 4 weeks is recommended (23).

### 5. Immunization Schedule

HPV vaccine has been given simultaneously with hepatitis B vaccine. Because it is not a live vaccine, HPV vaccine can be administered at the same time as Tdap and MCV4 vaccines. Each vaccine must be administered using a separate syringe at a different anatomic site. The HPV vaccine is administered at 0, 1-2, and 6 months in a 3 dose schedule. The Recommended Immunization Schedule, US, is available from CDC or at [www.immunizationed.org](http://www.immunizationed.org) for smart phones.



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