

# Timing of Adolescent Meningococcal Conjugate Vaccination

## Attitudes and Practices of Pediatricians and Family Medicine Physicians

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**Background:** The meningococcal conjugate vaccine (MCV4) was recommended for those aged 11–18 years in 2005. Initial supply issues led to an emphasis on immunizing older adolescents. When supply improved in 2007, routine immunization was recommended for those aged 11–12 years.

**Purpose:** Among a U.S. sample of pediatricians and family medicine physicians, describe (1) recommendation and administration practices for MCV4; (2) preferences regarding MCV4 administration; and (3) attitudes and characteristics associated with recommendation for those aged >12 years.

**Methods:** A mail and Internet survey in a nationally representative sample of physicians was conducted between December 2009 and March 2010. Analysis was conducted between March 2010 and October 2010, including a multivariable analysis to examine factors associated with deferring MCV4 to ages >12 years.

**Results:** Response rates were 88% (pediatricians 367/419) and 63% (family medicine physicians 268/423). In all, 95% of pediatricians and 73% of family medicine physicians reported administering MCV4 routinely to those aged 11–18 years ( $p<0.0001$ ); 83% (pediatricians) and 45% (family medicine physicians) reported strongly recommending MCV4 for those aged 11–12 years ( $p<0.0001$ ); 27% (pediatricians) and 40% (family medicine physicians) preferred to administer MCV4 to those aged >12 years ( $p<0.0001$ ). Compared with those who strongly recommend for those aged 11–12 years, physicians who do not regularly stock MCV4, family medicine physicians, and physicians concerned about waning immunity were more likely to defer their recommendation, whereas physicians practicing in the Northeast and those with more Latino patients were less likely to defer.

**Conclusions:** Most pediatricians and family medicine physicians administer MCV4, but many, especially family medicine physicians and those concerned about waning immunity, defer their recommendation for MCV4 to patients aged >12 years.

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## Introduction

Healthcare providers and family members who have cared for a patient with meningococcal disease can attest to the devastation it causes. Between 1998 and 2007 the annual incidence rates of meningococcal dis-

ease were 0.30 cases per 100,000 people aged 10–13 years, 0.74 cases per 100,000 people aged 14–18 years, and 0.76 cases per 100,000 people aged 19–24 years.<sup>1</sup> The incidence is particularly high among college students living in dormitories, with rates as high as 5.1 cases per 100,000 freshmen.<sup>2</sup> Up to 14% of adolescents infected with meningococci die from

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the infection,<sup>1,3</sup> and up to 19% suffer chronic morbidity such as hearing loss and limb loss.<sup>3</sup>

In 2005, based on the mortality and morbidity associated with meningococcal disease and the likelihood that a protein conjugate vaccine would impart long-term immunity, the Advisory Committee on Immunization Practices (ACIP),<sup>3</sup> American Academy of Pediatrics (AAP),<sup>4</sup> and American Academy of Family Physicians (AAFP)<sup>5</sup> recommended MCV4 for routine use among those aged 11–18 years. Supplies of MCV4 were limited early in its production. Therefore, the ACIP recommended deferral of MCV4 for those aged 11–12 years so supplies would be adequate for higher-risk adolescents entering high school and college.<sup>6</sup> When supply issues resolved in 2007, the ACIP recommended immunization of all adolescents aged 11–18 years with an emphasis on routine immunization at the preadolescent (age 11–12 years) visit.<sup>7</sup> Supply was further improved in February 2010 when a second MCV4 was licensed.<sup>8</sup> Finally, in October 2010, the ACIP recommended that a booster dose of MCV4 should be given to those aged 16 years because of concern about waning protection.<sup>9</sup>

Prior to the ACIP's 2005 recommendation, a survey of primary care physicians found that physicians thought immunization with MCV4 at the preadolescent visit would be the easiest to implement, most likely to be preferred by patients and their parents, and the "overall best fit." However, most of the physicians also indicated that based on the existing scientific evidence alone, immunization with MCV4 at older ages would be best because of concerns about waning immunity.<sup>10</sup> Since 2005, limited published data suggest that some primary care providers do not routinely immunize with MCV4 at the preadolescent visit.<sup>11,12</sup>

Although MCV4 coverage has increased steadily since the vaccine was recommended,<sup>13–15</sup> the most recent estimates of MCV4 coverage indicate that only 54% of those aged 13–17 years have been immunized and coverage varies by state with a range from 19% to 78%.<sup>15</sup> The cause of the wide variation among states is likely multifactorial, reflecting state policy or mandates, vaccine financing, healthcare access, and patient-level factors.<sup>11–15</sup> The low adoption rates in some states may also reflect variation in knowledge, attitudes, and behaviors of healthcare providers that could be modified to increase immunization coverage. The aims of the present study were to describe and compare physicians' practices regarding recommendation for MCV4 in adolescents; identify attitudes and characteristics associated with changing a recommendation for giving the vaccine to those aged 11–12 years to deferring it to older ages; and describe practices, preferences, and perceived barriers regarding administration of the vaccine in a nationally representative sample of pediatricians and family medicine physicians.

## Methods

### Study Setting

From December 2009 to March 2010, prior to the MCV4 booster recommendation, a survey was administered to primary care physicians recruited from the AAP and AAFP. The human subjects review board at the University of Colorado Denver approved this study as exempt research, not requiring written informed consent.

### Population

A method was developed for obtaining rapid and high response rates to surveys about policy-relevant immunization issues as part of a CDC-funded project.<sup>16</sup> Networks of physicians were recruited from the AAP and the AAFP who agreed to respond to several surveys each year. After obtaining twice the number of recruits needed for each network, a quota strategy was applied to ensure the representativeness of the samples.<sup>16,17</sup> A population-based sampling matrix was constructed using demographic and practice data from randomly drawn samples of the AAP and AAFP memberships. Using population-based estimates, quotas were created for each cell of the 36-cell matrix that crossed U.S. regions, practice location, and type of practice. Cells were then filled by randomly selecting from all of the recruits to yield a total of approximately 400 physicians in each network. In a previous study, demographic characteristics, practice attributes, and reported attitudes about a range of vaccination issues were generally similar when network physicians were compared with physicians of the same specialty randomly sampled from the American Medical Association (AMA) master physician listing.<sup>16</sup>

### Survey Design

The survey instrument was developed collaboratively with the CDC and pretested in a community advisory panel consisting of six pediatricians and six family medicine physicians from across the country. The survey was pilot-tested among 56 pediatricians and family medicine physicians. In addition to questions about physicians' and practices' characteristics, the survey included questions about their practices regarding recommendation and administration of MCV4 to adolescents, vaccine supply, level of concern about waning immunity, preferred age to immunize with MCV4, and barriers to MCV4 administration.

### Survey Administration

The survey was administered by Internet or regular mail based on physicians' preferences. The Internet survey was administered using a web-based program (Vovici Corp., Dulles VA). The Internet group received an initial email with a link to the survey and up to eight email reminders to complete the survey, while the mail group received an initial mailing and up to two additional mailed surveys at 2-week intervals. The Internet nonresponders also received up to two paper surveys by mail.

### Data Analysis

Analyses were conducted between March and October 2010. Internet and mail surveys were pooled, as provider attitudes have been found to be comparable when obtained by either method.<sup>18</sup> Items about physicians' current practices regarding recommendation and administration of the vaccine, vaccine supply, and preferred age to immunize used multiple-choice

responses. Items regarding physicians' concern about waning immunity and potential barriers to vaccine administration used 4-point Likert-type scale responses.

Univariate analysis was used to determine the proportions of pediatricians and family medicine physicians who recommend MCV4 to adolescents aged 11–12 years, 14–15 years, and/or 17–18 years; administer MCV4 to adolescents at different ages; and report different barriers to MCV4 administration. Bivariate analysis was conducted using Kolmogorov–Smirnov tests to compare the proportions of pediatricians and family medicine physicians who recommend and administer MCV4 at different ages and to compare the proportions of pediatricians and family medicine physicians who endorsed each barrier to MCV4 administration.

The proportions of physicians who defer their recommendation for MCV4 (defined as *do not* strongly recommend the vaccine for those aged 11–12 years but *do* strongly recommend the vaccine for adolescents aged 14–15 years and/or 17–18 years) and who are concerned about waning immunity were determined by specialty and compared using chi-square and Kolmogorov–Smirnov tests.

Multivariable analysis was conducted to identify physicians' attitudes and characteristics associated with deferring a recommendation for MCV4. Physicians who defer a recommendation were compared to those who *do* strongly recommend MCV4 for those aged 11–12 years. For this analysis, the independent variables were provider characteristics, MCV4 supply in the office, and concern about waning immunity. Variables with  $p < 0.25$  in the bivariate analyses were tested in multivariable logistic models with factors retained in the final model if  $p < 0.05$ . A manual backwards elimination approach to model reduction was used checking for evidence of confounding as each variable was removed. Risk ratios rather than ORs were reported because of the tendency of ORs to overestimate effect sizes when outcomes are common.<sup>19</sup> Unadjusted relative risks and 95% CIs were calculated from

the log binomial regression model using SAS PROC GENMOD with the binomial distribution and the log link function. Adjusted relative risks and 95% CIs were calculated from the logistic regression models using regression risk analysis.<sup>20</sup>

## Results

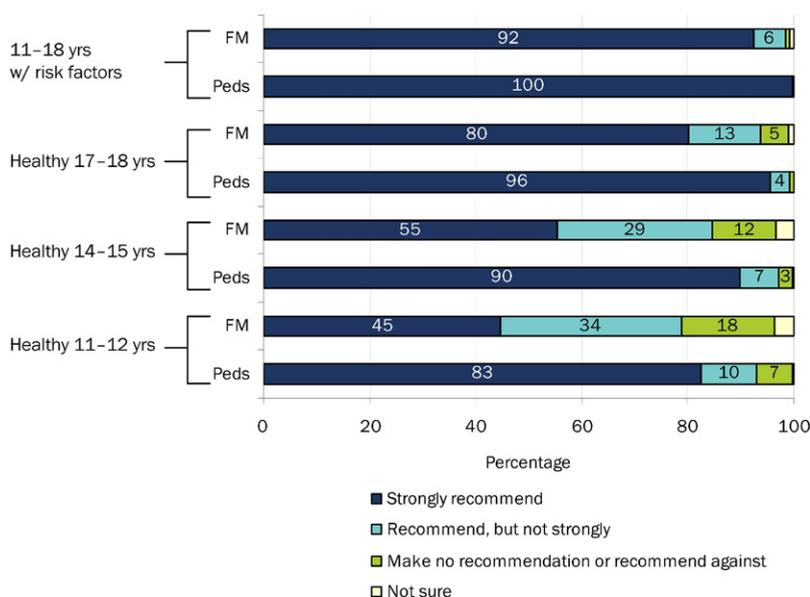
### Response Rates and Sample Characteristics

The response rate was 88% (367/419) for pediatricians and 63% (268/423) for family medicine physicians. Respondents and nonrespondents did not differ by year of medical/osteopathic school graduation, gender, region of country, practice location, or type of practice.

### Recommendation for Quadrivalent Meningococcal Conjugate Vaccine

Pediatricians were more likely than family medicine physicians to strongly recommend MCV4 for each age group. However, the difference between pediatricians and family medicine physicians decreased with increasing patient age (Figure 1). Almost all providers strongly recommended the vaccine for adolescents with risk factors—asplenic, complement deficiency, reside in a dormitory, entering the military, and travel to endemic countries (Figure 1). Very few family medicine physicians (3%) and no pediatricians reported recommending *against* the vaccine.

### Attitudes and Characteristics Associated with Deferring Recommendation for Quadrivalent Meningococcal Conjugate Vaccine



**Figure 1.** Pediatricians' and family medicine physicians' strength of recommendation for immunization with meningococcal conjugate vaccine at various ages

\* $p \leq 0.001$  using Kolmogorov–Smirnov test for comparison of distributions between pediatric and family medicine physicians

FM, family medicine physician; Peds, pediatrician; yrs, years

Fourteen percent (52/367) of pediatricians and 35% (95/268) of family medicine physicians reported that they *do not* strongly recommend MCV4 for those aged 11–12 years but *do* strongly recommend MCV4 for those aged 14–15 years and/or 17–18 years ( $p \leq 0.0001$ ). Both pediatricians (24%) and family medicine physicians (32%) reported being moderately or very concerned about waning immunity among adolescents who received MCV4 at age 11–12 years ( $p = 0.3$ ). Multivariable analysis comparing those who defer their recommendation to those who strongly

recommend the vaccine at 11–12 years revealed that family medicine physicians (adjusted RR=2.33, 95% CI=1.79, 3.17), providers who were concerned about waning immunity (2.09, 95% CI=1.61, 2.72), and providers who did not have a regular supply of the vaccine (1.64, 95% CI=1.15, 2.22) were more likely to defer their recommendation. Providers from the Northeast (0.42, 95% CI=0.24, 0.70) and those with more Latino patients (0.59, 95% CI=0.42, 0.81) were less likely to defer their recommendation.

### Administration of Quadrivalent Meningococcal Conjugate Vaccine

Only 2% of pediatricians and 13% of family medicine physicians reported not stocking the meningococcal vaccine in their offices. Among the providers who stock the vaccine, most reported that the vaccine was available in their offices for 10 or more months over the past year (95% pediatricians, 75% family medicine physicians,  $p=0.007$ ). Family medicine physicians were less likely than pediatricians to administer the vaccine routinely to all eligible children aged 11–18 years in their offices (95% pediatricians, 73% family medicine physicians,  $p<0.0001$ ). They were more likely than pediatricians to administer the vaccine only when it was requested (1% pediatricians, 6% family medicine physicians) or only to adolescents with risk factors (2% pediatricians, 13% family medicine physicians,  $p<0.0001$ ). Although 68% of pediatricians preferred to administer the vaccine to those aged 11–12 years, only 35% of family medicine physicians preferred to administer the vaccine at this age, and 40% of family medicine physicians preferred to administer the vaccine to those aged  $\geq 14$  years ( $p<0.0001$ ).

### Perceived Barriers to Quadrivalent Meningococcal Conjugate Vaccine Administration

Family medicine physicians were more likely to report barriers to MCV4 administration than pediatricians (Table 1). For both types of providers, the most common barrier was infrequent visits by adolescent patients (pediatricians 68%, family medicine physicians 85%). For pediatricians, the next most common barriers were parents' concern about vaccine safety in general (32%) and failure of some insurance companies to cover the vaccine (22%). For family medicine physicians, the next most common barriers were the inability of parents to pay out-of-pocket costs for the vaccine (48%) and parents not thinking that the vaccine is necessary for their adolescents (40%). Few ( $\leq 13\%$ ) providers reported barriers related to their own concerns about the safety or effectiveness of the vaccine.

### Discussion

Overall, the quadrivalent meningococcal conjugate vaccine (MCV4) is well accepted by pediatricians and family medicine physicians. Despite the Advisory Committee on Immunization Practices' (ACIP's) recommendation to focus immunization efforts on those aged 11–12 years at the preadolescent preventive visit, 17% of pediatricians and 55% of family medicine physicians do not strongly recommend the vaccine at this age. The most common provider-reported barrier to MCV4 administration was infrequent adolescent visits followed by barriers related to vaccine financing and parental concerns about vaccine safety and effectiveness.

Vaccine delivery is affected by several factors, including vaccine financing, state and local policies and their enforcement, healthcare access, patient/parent-level factors, and provider-level factors. The present study and that of Schaffer and colleagues<sup>21</sup> found that more physicians from the Northeast reported recommending MCV4 at the preadolescent visit compared with other regions of the country. One explanation for this difference could be state mandates for meningococcal disease prevention education and/or immunization with MCV4 for students, which are more common in the Northeast.<sup>22</sup> Other explanations for this regional variation could be outreach by meningococcal disease prevention advocacy groups and professional organizations, providers' and the communities' exposure to outbreaks of meningococcal disease, and resulting differences in providers' and patients'/parents' knowledge and attitudes about MCV4, which were not measured in the current study. This study also found that physicians with a high proportion of Latino patients were more likely to report recommending MCV4 at the preadolescent visit. This difference has not been noted in previous studies, and the reasons for this finding are unclear.

Providers' recommendations for MCV4 are critical because MCV4 coverage is higher among adolescents who receive a recommendation for MCV4 from their healthcare providers.<sup>13</sup> The present study's findings that pediatricians are more likely than family medicine physicians to recommend adolescent vaccines routinely is consistent with previous research.<sup>21,23–25</sup> One possible explanation for the difference between family medicine physicians and pediatricians is that pediatricians are more likely to see young adolescents than family medicine physicians,<sup>26,27</sup> so family medicine physicians may not discuss immunizations routinely in this age group.

In addition, family medicine physicians face more barriers related to vaccine financing and supply for several reasons. Many family medicine practices follow a small business model for which the high cost of vaccines is prohibitive.<sup>28</sup> They are also less likely than pediatricians to participate in VFC and are more

**Table 1.** Barriers to routinely administering MCV4 to adolescents aged 11–18 years, as reported by physicians, %<sup>a</sup>

Barrier	Pediatricians (n=367)	Family medicine physicians (n=268)
<b>Infrequent office visits by adolescent patients*</b>	68.2	84.7
<b>Parental concerns about safety/effectiveness</b>		
Vaccine safety in general	32.2	34.2
Thinking the vaccine is not necessary for their adolescents*	20.6	39.5
Safety of the vaccine itself*	16.2	26.3
Time it takes to discuss the vaccine with parents*	1.9	10.1
<b>Providers' concerns about safety/effectiveness</b>		
Personal belief that meningococcal disease is not common enough in adolescents to justify a vaccination*	3.0	13.3
Safety of the vaccine itself	1.6	3.1
Personal belief that meningococcal disease is not severe enough in adolescents to justify a vaccination*	0.3	3.6
<b>Vaccine financing and supply issues</b>		
Failure of some insurance companies to cover the vaccine for adolescents*	22.1	37.5
Lack of adequate reimbursement for vaccination*	21.3	32.3
Parents unable to pay the out-of-pocket cost for vaccine*	18.2	48.1
The "up-front" costs for practice to purchase the vaccine*	15.3	25.8
General administrative burden to practice*	8.5	16.5
Difficulty obtaining adequate vaccine supplies*	5.2	11.4

<sup>a</sup>Reported as definitely/somewhat a barrier

\* $p < 0.05$  for comparison between pediatricians and family medicine physicians  
MCV4, quadrivalent meningococcal conjugate vaccine

likely to serve in rural and underserved areas where many patients may lack insurance.<sup>29</sup>

Regardless of specialty, physicians concerned about waning immunity were less likely to recommend the vaccine to those aged 11–12 years compared with those who were not concerned in the current study and two previous studies.<sup>10,12</sup> Conjugate vaccines can provide protection against bacterial pathogens via three mechanisms: herd immunity, memory response, and circulating antibodies.<sup>30</sup> MCV4 coverage in the U.S. is currently too low to provide herd immunity.<sup>31</sup> Herd immunity might be achieved by immunizing infants and younger children as is done in other countries,<sup>32</sup> and the ACIP is considering expanding its recommendation of MCV4 to include these age groups. However, no decision has been made to date.

Recent data<sup>33</sup> suggest that the onset of meningococcal disease is too fast for memory response to provide protection. Therefore, circulating antibodies are critical for

providing protection against meningococcal disease. Further, recent findings<sup>31</sup> indicate that circulating antibodies may not persist at protective levels 3–5 years after immunization with MCV4. These considerations prompted the ACIP to recommend continued immunization at age 11–12 years with an additional booster dose of MCV4 at age 16 years.<sup>31</sup>

A study of adolescents' healthcare utilization patterns over 10 years supports the ACIP's and other experts' emphasis on immunization with MCV4 at age 11–12 years.<sup>27</sup> Compared with older adolescents, those aged 11–12 years are more likely to have a preventive care visit with a pediatrician or family medicine physician whose traditional role is to provide immunizations.<sup>27</sup> In addition, those aged 11–12

years are accompanied to visits by their parents, so providers are less likely to encounter consent issues that might be encountered with older adolescents who attend visits without their parents.<sup>11,12,34</sup>

The current study's findings regarding the barriers to administration of MCV4 are similar to other studies.<sup>21,23,24,35</sup> In their recent surveys of pediatricians and family medicine providers regarding barriers to adolescent immunization, Oster and Dempsey and colleagues<sup>23,24</sup> found that infrequent adolescent visits was the most commonly endorsed barrier by both specialties. Lack of insurance coverage and parents' inability to pay were also important barriers in the present study and several other studies.<sup>21,23,35</sup>

The present study has important strengths and limitations. The surveyed physicians were shown in previous studies<sup>16</sup> to be generally representative of physicians in the AAP and AAFP with respect to demographic and

practice characteristics and locations throughout the U.S. Although the response rate was high, the response rate was lower from family medicine physicians than pediatricians. Although the sample seemed representative, those who agreed to be surveyed might not have expressed similar views as those who chose not to be in the network and those who did not respond to the survey. In addition, the current data relied on self-reports of practices rather than observation of actual practices.

Delivery of MCV4 should be improved to protect adolescents against a devastating and often deadly vaccine-preventable disease. Immunization delivery experts and professional organizations have published recommendations for improving MCV4 and other vaccine coverage among adolescents.<sup>34,36,37</sup> These recommendations include ensuring adequate insurance coverage for vaccines, ensuring adequate supply of vaccines, use of immunization information systems with reminder–recall capability, use of sites other than medical offices for immunization, and use of social marketing strategies to reach adolescents.<sup>34,36,37</sup> These strategies would help address the barriers to vaccine administration identified in the current study and others.

Additional strategies include implementation of state or local mandates and improved education and outreach about meningococcal disease and MCV4 to healthcare providers and the community. The new booster recommendation provides an opportunity to educate physicians about the importance of MCV4, reassure them about vaccine supply, and clarify the rationale about the timing of immunization. In addition to determining which strategies are most effective for improving adolescent vaccine coverage, further investigation could identify reasons other than concerns about waning immunity that result in some providers not recommending MCV4 for those aged 11–12 years, especially in relation to the Tdap and human papillomavirus (HPV) vaccines also recommended by professional organizations at the preadolescent visit.<sup>38</sup>

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## References

- Cohn AC, MacNeil JR, Harrison LH, et al. Changes in *Neisseria meningitidis* disease epidemiology in the U.S., 1998–2007: implications for prevention of meningococcal disease. *Clin Infect Dis* 2010;50(2):184–91.
- Bruce MG, Rosenstein NE, Capparella JM, Shutt KA, Perkins BA, Collins M. Risk factors for meningococcal disease in college students. *JAMA* 2001;286(6):688–93.
- Bilukha OO, Rosenstein N. Prevention and control of meningococcal disease. Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2005;54(RR-7):1–21.
- American Academy of Pediatrics Committee on Infectious Diseases. Prevention and control of meningococcal disease: recommendations for use of meningococcal vaccines in pediatric patients. *Pediatrics* 2005;116(2):496–505.
- Kimmel SR. Prevention of meningococcal disease. *Am Fam Physician* 2005;72(10):2049–56.
- CDC. Limited supply of meningococcal conjugate vaccine, recommendation to defer vaccination of persons aged 11–12 years. *MMWR Morb Mortal Wkly Rep* 2006;55(20):567–8.
- CDC. Revised recommendations of the Advisory Committee on Immunization Practices to vaccinate all persons aged 11–18 years with meningococcal conjugate vaccine. *MMWR Morb Mortal Wkly Rep* 2007;56(31):794–5.
- CDC. Licensure of a meningococcal conjugate vaccine (Menveo) and guidance for use—Advisory Committee on Immunization Practices (ACIP), 2010. *MMWR Morb Mortal Wkly Rep* 2010;59(9):273.
- Advisory Committee on Immunization Practices Meeting. October 27–28, 2010; CDC, Atlanta, Georgia.
- Clark SJ, Cowan AE, Stokley S, Bilukha O, Davis MM. Physician perspectives to inform a new recommendation for meningococcal conjugate vaccine (MCV4). *J Adolesc Health* 2006;39(6):850–5.
- Ford CA, English A, Davenport AF, Stinnett AJ. Increasing adolescent vaccination: barriers and strategies in the context of policy, legal, and financial issues. *J Adolesc Health* 2009;44(6):568–74.
- Humiston SG, Albertin C, Schaffer S, et al. Health care provider attitudes and practices regarding adolescent immunizations: a qualitative study. *Patient Educ Couns* 2009;75(1):121–7.
- Lu PJ, Jain N, Cohn AC. Meningococcal conjugate vaccination among adolescents aged 13–17 years, U.S., 2007. *Vaccine* 2010;28(11):2350–5.
- CDC. National, state, and local area vaccination coverage among adolescents aged 13–17 years—U.S., 2008. *MMWR Morb Mortal Wkly Rep* 2009;58(36):997–1001.
- CDC. National, state, and local area vaccination coverage among adolescents aged 13–17 years—U.S., 2009. *MMWR Morb Mortal Wkly Rep* 2010;59(32):1018–23.
- Crane LA, Daley MF, Barrow J, et al. Sentinel physician networks as a technique for rapid immunization policy surveys. *Eval Health Prof* 2008;31(1):43–64.
- Babbie E. *The practice of social research*. 4th ed. Belmont CA: Wadsworth Publishing, 1986.
- McMahon SR, Iwamoto M, Massoudi MS, et al. Comparison of e-mail, fax, and postal surveys of pediatricians. *Pediatrics* 2003;111(4 Pt 1):e299–303.

19. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. *JAMA* 1998;280(19):1690–1.
20. Kleinman LC, Norton EC. What's the risk? A simple approach for estimating adjusted risk measures from nonlinear models including logistic regression. *Health Serv Res* 2009;44(1):288–302.
21. Schaffer SJ, Humiston SG, Shone LP, Averhoff FM, Szilagyi PG. Adolescent immunization practices: a national survey of U.S. physicians. *Arch Pediatr Adolesc Med* 2001;155(5):566–71.
22. Immunization Action Coalition. State mandates on immunization and vaccine-preventable diseases. [www.immunize.org/laws/](http://www.immunize.org/laws/).
23. Dempsey AF, Cowan AE, Broder KR, Kretsinger K, Stokley S, Clark SJ. Adolescent Tdap vaccine use among primary care physicians. *J Adolesc Health* 2009;44(4):387–93.
24. Oster NV, McPhillips-Tangum CA, Averhoff F, Howell K. Barriers to adolescent immunization: a survey of family physicians and pediatricians. *J Am Board Fam Pract* 2005;18(1):13–9.
25. Davis MM, Broder KR, Cowan AE, et al. Physician attitudes and preferences about combined Tdap vaccines for adolescents. *Am J Prev Med* 2006;31(2):176–80.
26. Freed GL, Nahra TA, Wheeler JR. Which physicians are providing health care to America's children? Trends and changes during the past 20 years. *Arch Pediatr Adolesc Med* 2004;158(1):22–6.
27. Rand CM, Shone LP, Albertin C, Auinger P, Klein JD, Szilagyi PG. National health care visit patterns of adolescents: implications for delivery of new adolescent vaccines. *Arch Pediatr Adolesc Med* 2007;161(3):252–9.
28. Campos-Outcalt D, Jeffcott-Pera M, Carter-Smith P, Schoof BK, Young HF. Vaccines provided by family physicians. *Ann Fam Med* 2010;8(6):507–10.
29. Fryer GE, Green LA, Dovey SM, Phillips RI Jr. The U.S. relies on family physicians unlike any other specialty. *Am Fam Physician* 2001;63(9):1669.
30. Pollard AJ, Perrett KP, Beverley PC. Maintaining protection against invasive bacteria with protein-polysaccharide conjugate vaccines. *Nat Rev Immunol* 2009;9(3):213–20.
31. CDC. Updated recommendations for use of meningococcal conjugate vaccines—Advisory Committee on Immunization Practices (ACIP), 2010. *MMWR Morb Mortal Wkly Rep* 2011;60(3):72–6.
32. Pelton SI, Gilmet GP. Expanding prevention of invasive meningococcal disease. *Expert Rev Vaccines* 2009;8(6):717–27.
33. Snape MD, Kelly DF, Salt P, et al. Serogroup C meningococcal glycoconjugate vaccine in adolescents: persistence of bactericidal antibodies and kinetics of the immune response to a booster vaccine more than 3 years after immunization. *Clin Infect Dis* 2006;43(11):1387–94.
34. Stokley S, Freed G, Curtis R, et al. Adolescent vaccination: recommendations from the National Vaccine Advisory Committee. *Am J Prev Med* 2009;36(3):278–9e6.
35. Daley MF, Crane LA, Markowitz LE, et al. Human papillomavirus vaccination practices: a survey of U.S. physicians 18 months after licensure. *Pediatrics* 2010;126(3):425–33.
36. Rupp R, Rosenthal SL, Middleman AB. Vaccination: an opportunity to enhance early adolescent preventative services. *J Adolesc Health* 2006;39(4):461–4.
37. Szilagyi PG, Rand CM, McLaurin J, et al.; Working Group on Adolescent Vaccination in the Medical Home. Delivering adolescent vaccinations in the medical home: a new era? *Pediatrics* 2008;121(S1):S15–24.
38. CDC. Recommended immunization schedule for persons aged 7 through 18 years—U.S. [www.cdc.gov/vaccines/recs/schedules/child-schedule.htm#printable](http://www.cdc.gov/vaccines/recs/schedules/child-schedule.htm#printable).

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