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HPV vaccination of adolescents with chronic medical conditions: a national survey of pediatric subspecialists

Annika M. Hofstetter, MD, PhD, MPH^{a,b,c}, Lauren Lappetito^a, Melissa S. Stockwell, MD, MPH^{a,d,e}, and Susan L. Rosenthal, PhD^{a,d,f}

^aDepartment of Pediatrics, Columbia University, New York, NY

^bDepartment of Pediatrics, University of Washington, Seattle, WA

^cSeattle Children's Research Institute, Seattle, WA

^dNewYork-Presbyterian Hospital, New York, NY

^eMailman School of Public Health, Columbia University, New York, NY

^fDepartment of Psychiatry, Columbia University, New York, NY

Abstract

Study Objective—Many adolescents with chronic medical conditions (CMCs) are at risk of HPV infection, associated complications, and under-immunization and often identify a pediatric subspecialist as their main provider. This study aimed to assess the HPV-related understanding, beliefs, and practices of pediatric subspecialists, which are largely unknown.

Design and Setting—National cross-sectional study.

Participants—Pediatric endocrinologists, hematologist/oncologists, pulmonologists, and rheumatologists identified using the American Medical Association Physician Masterfile.

Interventions—Subspecialists caring for adolescents with CMCs in the outpatient setting were recruited to complete a web-based survey examining their HPV-related knowledge, attitudes, comfort, and practices.

Main Outcome Measures—HPV vaccination recommendation.

Results—Of respondents (n=418), 50.4% reported sometimes or always recommending HPV vaccination to adolescent patients with CMCs. Factors positively associated with recommendation included hematology/oncology (AOR 4.69, 95% CI 1.86–11.81) or rheumatology (AOR 6.55, 95% CI 1.67–25.74) specialization, seeing more adolescent patients with CMCs (AOR 1.01, 95% CI

Corresponding Author: Annika M. Hofstetter, MD, Ph.D., MPH, Assistant Professor of Pediatrics, Department of Pediatrics, University of Washington, 1900 Ninth Avenue, M/S JMB-9, Seattle, WA 98101, Tel: (206) 884-1699, Fax: (206) 884-7175, annika.hofstetter@seattlechildrens.org.

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1.00–1.02), and sometimes or always discussing sexual health (AOR 2.53, 95% CI 1.05–6.08) or checking vaccine status (AOR 3.83, 95% CI 1.59–9.20) with these patients. Those who thought it was important, but were uncomfortable discussing sexual health when recommending HPV vaccination (AOR 0.28, 95% CI 0.12–0.70) or who reported insufficient HPV vaccine information (AOR 0.45, 95% CI 0.23–0.88) or lack of primary-subspecialty care provider communication (AOR 0.38, 95% CI 0.16–0.93) as barriers to HPV vaccination were less likely to recommend HPV vaccination.

Conclusions—This study reveals that many subspecialists fail to recommend HPV vaccination to adolescents with CMCs and highlights potential targets for future interventions.

Keywords

adolescents; chronic medical conditions; HPV vaccination; pediatric subspecialist

INTRODUCTION

Human papillomavirus (HPV) is one of the most prevalent sexually transmitted infections and may lead to anogenital and oropharyngeal cancers as well as genital warts with significant morbidity and mortality.^{1,2} Although the Advisory Committee on Immunization Practices recommends routine HPV vaccination of all adolescents,³ only 39.7% of females and 21.6% of males aged 13–17 years in the United States completed the three-dose series in 2014.⁴

HPV vaccination may be particularly important for the growing population of adolescents with chronic medical conditions (CMCs). It is estimated that approximately one in every six to ten adolescents in the U.S. has a CMC or disability limiting daily activities.^{5–7} Studies suggest that adolescents with CMCs may be just as likely as healthy adolescents to engage in risky behaviors, including sexual activity.^{8–11} In addition, some may be at increased risk of HPV infection and adverse health outcomes due to their underlying conditions and treatment regimens, including patients with Fanconi's anemia, systemic lupus erythematosus, rheumatoid arthritis as well as cancer survivors and transplant recipients.^{12–17}

Adolescents with CMCs may have increased risk of under-vaccination against HPV beyond that of the general adolescent population. Earlier studies have found that patients with CMCs often fail to receive other needed vaccines^{18–23} and frequently experience missed vaccination opportunities.^{24,25} Small studies among adolescent cancer survivors have demonstrated low HPV vaccination coverage (32–33% with 1 dose; n=66 and n=235).^{26,27} Similarly, a recent study found that significantly fewer patients with systemic inflammatory diseases had initiated HPV vaccination than those without these diseases (20.6% vs. 23.1%).²⁸

Strong provider recommendation is a major determinant of HPV vaccine uptake in the general population.^{29–36} For those with CMCs, subspecialists may play a particularly important role since earlier data suggests that many adolescents with CMCs identify their

subspecialist as their main provider.^{37–39} However, there are few, if any, studies examining subspecialists' understanding of and attitudes about HPV vaccination.

This study aimed to further elucidate the knowledge, beliefs, and practices of pediatric subspecialists caring for adolescents with CMCs in the outpatient setting. We hypothesized that many would lack understanding of HPV infection risk and HPV vaccination recommendations for their patient population, and most would support HPV vaccination in the primary care rather than subspecialty setting.

MATERIALS AND METHODS

Study Population

In this national web-based survey study, individuals were eligible for participation if they were physicians in one of 4 pediatric subspecialties (hematology/oncology, pulmonology, rheumatology, or endocrinology) and had an email address listed in the American Medical Association (AMA) Physician Masterfile. These subspecialties were selected since they serve a large proportion of adolescents with CMCs, including many of those at higher risk of HPV infection and related complications.^{12–17} This study was approved by the Columbia University Medical Center Institutional Review Board.

Study Procedures

Individuals fulfilling eligibility criteria were identified using a contracted vendor, Mail Marketing Service, Inc. (MMS), of the AMA Physician Masterfile. Their email listing is updated on a regular basis. For this study, an email was sent via MMS in September 2013 to all identified eligible individuals, requesting the participation of “physicians who provide subspecialty care to adolescents with CMCs in the outpatient setting.” The message also contained general study information and an embedded link to the web-based anonymous survey. The email request was sent again at 2 and 5 weeks after the initial request to all subspecialists fulfilling eligibility criteria, but excluding anyone who previously participated in the survey. Therefore, individuals could have been solicited between 1–3 times. All survey participants received a \$10 e-gift card for their time.

Survey Instrument

This survey was designed based upon expert opinion and previous studies.^{40–48} Most items were closed-ended with pre-coded responses. Questions addressed provider characteristics (e.g., gender, age, subspecialty), outpatient practice attributes (e.g., type, location, region, available vaccination support tool), and patient demographics (e.g., age, race/ethnicity, insurance). Perceptions of patient risk as well as knowledge about HPV infection and HPV vaccination were elicited using multiple choice and true/false response options. Participants were also asked about their beliefs and comfort related to HPV vaccination (e.g., “In your opinion, who should discuss HPV vaccine with adolescent patients who have a CMC?”; “Do you think it is important to discuss sexual health when recommending HPV vaccine to a patient who is [age range]?”; “If you needed to discuss sexual health when recommending HPV vaccine to a patient who is [age range], how comfortable would you be doing so?”). In addition, questions addressed the frequency (“always”, “sometimes”, “rarely”, “never”) of

provider practices such as discussing sexual health, discussing HPV vaccination, and recommending HPV vaccination. Lastly, participants were asked to categorize potential barriers to HPV vaccination of adolescents with CMCs using a 4-point Likert scale where “1” was “no barrier” and “4” was an “extremely large barrier”. The survey was created using Qualtrics web-based survey software.

Measures

The primary dependent variable was HPV vaccination recommendation to adolescent patients with CMCs, defined as a response of “always” or “sometimes” (vs. “rarely” or “never”) to the question “With your adolescent patients who have CMCs, how often do you recommend HPV vaccine?” Independent variables of interest included provider characteristics, outpatient practice attributes, and patient demographics as well as provider knowledge (all 7 questions correct), attitudes, comfort, practices, and reported barriers to HPV vaccination of adolescent patients with CMCs. Responses to the question, “Do you believe your adolescent patients with CMCs perceive you as their primary care provider?” were dichotomized into “yes, [they all/some of them] perceive me as their primary care provider” vs. “[yes, a few of them/no, none of them] perceive me as their primary care provider.” Comfort in discussing sexual health when recommending HPV vaccination was dichotomized into “extremely/somewhat comfortable” vs. “extremely/somewhat uncomfortable.” Questions assessing frequency of provider practices were dichotomized into “always/sometimes” vs. “rarely/never”. Identified barriers to HPV vaccination were defined as any barrier categorized as a “3” or “4” on the 4-point Likert scale described above.

Statistical Analyses

Survey responses were described using frequency distributions based upon the number of individuals who answered a given question. Pearson’s chi squared test examined the association between provider characteristics, outpatient practice attributes, patient demographics as well as provider knowledge, attitudes, comfort, practices, and reported barriers with HPV vaccination recommendation. Factors significant at $p < 0.10$ were included in a multivariable logistic regression model. Analyses were performed using SAS Version 9.4 (Cary, NC).

RESULTS

The initial recruitment email was sent to 3,828 physicians. Two additional emails were sent to survey non-respondents and a small number (n=220) of new physicians in the MMS email listing who fulfilled eligibility criteria. Of all messages sent (n=11,349), 182 (1.6%) were suppressed (i.e., provider previously opted out of messaging) and 127 (1.1%) were undeliverable. Of the remaining messages (n=11,040), 2392 (21.7%) were opened. There were 450 individuals who initiated the survey. Of these, 418 were included in the final analytic sample. The remaining 32 completed only demographic questions and were excluded. The survey response rate falls between 18.8% (assuming no overlap in email openings) and 53.9% (assuming complete overlap in email openings).

Study Population Characteristics

Respondents were primarily female and practicing in urban academic centers across the U.S. (Table 1). They spent slightly over half their time in the outpatient setting, seeing between 1–400 patients (median: 25) aged 11–17 years with CMCs per month. The most common area of specialization was hematology/oncology (48.3%). One individual listed his main clinical practice area as infectious diseases and 14 listed theirs as “primary care”. Of the latter group, 3 noted their expertise in one of the aforementioned disciplines (i.e., hematology) or related sub-discipline (i.e., asthma). After excluding those who identified their main clinical practice area as “primary care”, over half (56.3%) reported that some or all of their adolescent patients with CMCs perceive them to be their primary care provider. This was reported by a greater proportion of hematologists/oncologists (72.8%) than endocrinologists (38.0%), pulmonologists (40.7%), or rheumatologists (41.5%) ($p<0.001$). Subspecialists reporting that some or all adolescent patients with CMCs identify them as their primary care provider were more likely to sometimes or always offer primary care services to these patients compared to those reporting that few or no adolescent patients with CMCs perceive them as their primary care provider (79.6% vs. 32.6%; $p<0.001$). Hematologists/oncologists (76.1%) and rheumatologists (56.1%) were more likely than pulmonologists (41.4%) and endocrinologists (36.6%) to offer primary care services ($p<0.001$). Of all respondents, most reported that they sometimes or always discuss sexual health behaviors (81.3%), check vaccination status (79.0%), and offer vaccines (non-specific) (69.7%) during visits with their adolescent patients who have CMCs.

Provider Knowledge, Attitudes, and Comfort

Most respondents knew that HPV vaccination offers protection against genital warts and certain cancers. However, many were misinformed about patient risk, HPV infection prevalence, and HPV vaccination recommendations (Table 2). For example, 34.0% reported that adolescents with CMCs are less likely to engage in sexual activity, and 60.1% thought that they are equally or less likely to experience HPV-related complications compared to adolescents without CMCs. In addition, 34.7% believed there are contraindications to HPV vaccination based upon underlying medical conditions. Only 6.5% answered all knowledge questions correctly; this did not differ by provider characteristics or outpatient practice attributes.

The majority of respondents (95.6%) agreed that HPV vaccination is the best way to protect their patients from genital warts and certain cancers. Most respondents felt that the ideal age range for HPV vaccination is 11–12 years (61.7%). The majority thought it is important to discuss sexual health when recommending HPV vaccination: 72.0% when recommending HPV vaccination to an 11–12 year-old and 98.5% when recommending to a 13–17 year-old. The proportions that felt somewhat or extremely comfortable doing so were 57.0% and 94.5%, respectively.

While most respondents (84.0%) indicated that the primary care provider office is the best setting for HPV vaccination, 45.4% believed it should also occur in the subspecialist office. Over half (58.6%) thought both primary and subspecialty care providers should discuss HPV vaccination with patients with CMCs. Of these, 60.9% reported sometimes or always doing

so. Conversely, only 17.3% of those who believed that *only* primary care providers should discuss HPV vaccination reported sometimes or always discussing HPV vaccination with patients with CMCs.

Reported Barriers to HPV Vaccination of Adolescents with CMCs

Several general, perceived parental, provider, and systems-based barriers to HPV vaccination of adolescents with CMCs were identified (Table 3). The most commonly reported general barrier was insufficient information about HPV vaccine. The greatest perceived parental barriers were reluctance to discuss sexual health, reluctance to vaccinate against an STI, HPV vaccine safety concerns, and lack of HPV knowledge. Lack of communication between primary and subspecialty care providers, sporadic health care visits, and time constraints to discussing HPV vaccination were common provider and systems-based barriers.

Provider HPV Vaccination Recommendation

Only half (50.4%) reported sometimes or always recommending HPV vaccination to patients with CMCs. In the adjusted multivariable logistic regression model, hematology/oncology and rheumatology subspecialties, number of adolescent patients with CMCs seen per month, discussing sexual health with adolescent patients with CMCs, and checking vaccine status with adolescent patients with CMCs were positive predictors of HPV vaccination recommendation (Table 4). The proportion who sometimes or always recommend HPV vaccination is presented by subspecialty in Figure 1. In the multivariable model, respondents who reported it is important, yet feel uncomfortable (*vs.* those who believe it is important and are comfortable) discussing sexual health when recommending HPV vaccination as well as those who reported “insufficient information about HPV vaccine” and “lack of communication between primary and subspecialty providers” as barriers to HPV vaccine administration were less likely to recommend HPV vaccination to their adolescent patients with CMCs (Table 4). The proportion who recommended HPV vaccination did not differ by provider gender, time spent in the outpatient setting, practice type, location, region, or proportion of adolescent patients, including by race/ethnicity or insurance status. There was also no association between provider knowledge about HPV-related topics and HPV vaccination recommendation. Of note, age and time since subspecialty training were positively correlated. Upon removal of age from the multivariable model, time since subspecialty training became a positive predictor of HPV vaccination recommendation. Given that the findings were otherwise similar, both variables were retained in the final model.

DISCUSSION

Given that a large number of adolescents with CMCs are at increased risk of HPV infection and related complications,^{12–17} that many perceive a subspecialist as their main provider,^{37–39} and that physician recommendation plays a critical role in HPV vaccine acceptability and uptake,^{26,27,49} it is concerning that this study found that half of all pediatric subspecialists surveyed do not routinely recommend HPV vaccination to these patients. This finding may help to explain why many adolescents with CMCs remain under-immunized against HPV.^{26–28} It is also consistent with earlier work demonstrating that

pediatric subspecialists often do not discuss or offer other preventive health services.^{9,39} The present study found that certain subspecialists are currently embracing their role in primary care and HPV vaccination specifically. However, strategies are needed to engage and support other pediatric subspecialists in promoting HPV vaccination of these high-risk patients, especially since patients, families, and other providers may rely on them for guidance. This study, by offering critical insight into the knowledge, beliefs, comfort, and practices of pediatric subspecialists, highlights particular areas to target in such efforts.

Adolescents with CMCs commonly identify a subspecialist as their main provider.^{37–39} In the present study, many subspecialists were aware of this perceived role and offered preventive health services to these patients. Such alignment between patient perceptions of their subspecialist's role and the subspecialist's awareness and practices may not be equally present across all subspecialties. The greater reporting of this role and frequency of providing comprehensive care, including recommendation of HPV vaccination, among hematology/oncology and rheumatology subspecialists may reflect the unique circumstances (i.e., patient disease), culture, and infrastructure in those disciplines. This may facilitate efforts to capture all visit opportunities for receipt of needed preventive health services, including vaccination, which is particularly important for those adolescent patients with CMCs who have no medical home or usual source of primary care.^{37,50}

Nonetheless, there is still a need for subspecialists who do not assume this role to engage in preventive care messaging and support the efforts of pediatric and adolescent health care providers. Patients and families may rely on these subspecialists for vaccine advice. In addition, other providers may require their input on issues related to vaccine safety, efficacy, and scheduling for certain high-risk patients.⁵¹ All subspecialists, therefore, should be comfortable and sufficiently prepared to do so. Here, the majority of subspecialists voiced the opinion that it is important to package HPV vaccination recommendations with discussion of adolescent sexual health, yet nearly half felt uncomfortable doing so with 11–12 year-old patients, i.e., the target age range for HPV vaccination. Perhaps consequently, these subspecialists were less likely to recommend HPV vaccination. Subspecialists seeing more adolescents and who routinely discussed sexual health with them were more likely to recommend HPV vaccination, which is in accordance with prior work among nurse practitioners.⁵² These findings are also consistent with an earlier study showing that the general pediatricians and family physicians who thought it was necessary to discuss sexual health before recommending HPV vaccination—approximately half of the study sample—were less likely to strongly recommend HPV vaccination to 11–12 year-old females.⁴⁰

The present study also demonstrated a lack of knowledge about patient risk, HPV infection prevalence, HPV vaccine, and HPV vaccination recommendations among some subspecialists, as shown previously among pediatricians, family physicians, internal medicine physicians, and obstetrician/gynecologists.^{40,53} Those subspecialists reporting insufficient information about the HPV vaccine as a barrier were less likely to recommend HPV vaccination. Thus, interventions that address critical knowledge gaps with respect to adolescents, sexual health, and HPV vaccination and that enhance comfort with these topics are needed for all providers. In addition, efforts to de-couple the HPV vaccination recommendation from conversations addressing adolescent sexual health and, instead, to

bundle all vaccine recommendations into one common message for adolescents and their families would be beneficial. Further, poor communication between primary and subspecialty care providers was a commonly reported barrier that was negatively associated with HPV vaccination recommendation. Thus, strategies to facilitate better communication between pediatric and adolescent health care providers and subspecialists, including greater clarity of preventive health responsibilities, are needed.

Subspecialists identified several systems-based barriers to HPV vaccination of their adolescent patients with CMCs, including vaccine supply, staffing requirements, and time constraints during the visit. These barriers resemble those reported previously by primary care physicians.^{47,54–57} Although most were not significant predictors of HPV vaccination recommendation in multivariable analysis, they may be important to assess in individual practices nonetheless. For example, time constraints could be particularly pronounced given the need to establish a trusting relationship with families of adolescents with CMCs and to address the varied concerns that may arise for their patients with complex health care needs.⁵⁸

One of the greatest predictors of recommending HPV vaccination was the subspecialist routinely checking patient vaccination status. This finding is in accordance with evidence supporting flagging of medical charts of patients due for vaccination, electronic health record alerts that include forecasting of vaccines that are due or upcoming, and immunization information systems (IIS).^{59–61} It is encouraging that many practices in the present study already have some of these support tools in place. The use of IIS may be particularly valuable for patients with CMCs given that many receive care in multiple locations and may lack complete written documentation.⁶² Thus, consolidating vaccine records across practice sites could result in less under- or over-vaccination⁶³ and may indirectly facilitate communication between primary and subspecialty care providers. Bidirectional data exchange between the electronic health record (EHR) and an IIS could also facilitate these efforts by allowing providers to access vaccine records at the point of care in the EHR rather than entering the IIS separately.

There are limitations of this study. First, the number of unique individuals who opened and clicked on the survey link in the three recruitment emails was unobtainable. In addition, the recruitment emails targeted an unknown number of subspecialists caring for adolescents with CMCs in the outpatient setting. Thus, it was not possible to calculate the true response rate, although it likely falls in a range (19–54%) commonly observed in other web-based provider surveys.^{64,65} Nonetheless, selection bias may have occurred. Second, although this survey was conducted in a national sample of subspecialists, participants were primarily limited to four pediatric subspecialties and were from predominantly urban academic centers; thus, the findings may not be generalizable to other providers or in alternative settings. Lastly, the survey did not assess whether subspecialists actually offered or administered HPV vaccine in their clinics.

Conclusion

This study is among the first to describe the knowledge, attitudes, and practices of pediatric subspecialists in relation to HPV vaccination of adolescents with CMCs. The findings illustrate a need to 1) increase understanding and comfort related to adolescents, sexual health, and HPV vaccination; 2) promote a common adolescent vaccination message; 3) clarify roles and strengthen communication between providers and across disciplines; and 4) enhance and utilize systems that promote HPV vaccination of these high-risk patients. Future interventions targeting each of these areas and tailored for individual subspecialties—given the differences highlighted here—should be considered. If successful, such approaches may be expanded to other needed preventive care services or high-risk populations.

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Abbreviations

AMA	American Medical Association
CMC	chronic medical condition
EHR	electronic health record
HPV	human papillomavirus
IIS	immunization information system
MMS	Mail Marketing Service, Inc

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Figure 1.
HPV vaccination recommendation by pediatric subspecialty

Table 1

Study population (n = 418)

<u>Provider Characteristics</u>	
Gender, % (n) ^a	
Female	57.8 (241)
Male	42.2 (176)
Age (years), mean (SD)	41.4 (9.5)
Subspecialty, % (n)	
Hematology/oncology	48.3 (202)
Endocrinology	24.2 (101)
Pulmonology	14.1 (59)
Rheumatology	9.8 (41)
Other	3.6 (15)
Time since subspecialty training (years), mean (SD) ^a	9.9 (9.1)
Time in outpatient setting (%), mean (SD) ^a	54.4 (28.3)
<u>Outpatient Practice Attributes</u>	
Type, % (n) ^b	
Academically-affiliated	74.9 (313)
Other hospital-affiliated	16.0 (67)
Private practice	8.4 (35)
Community health center	2.2 (9)
Location, % (n) ^a	
Urban	76.0 (317)
Suburban	20.1 (84)
Rural	2.4 (10)
Multiple	1.4 (6)
Region (U.S.), % (n) ^a	
East	34.8 (145)
South	22.5 (94)
Midwest	22.1 (92)
West	20.4 (85)
Territories	0.2 (1)
Available vaccination support tool, % (n) ^{a,b}	
Standing vaccination orders	49.9 (205)
Reminder/recall systems	43.1 (178)
Clinician decision support for vaccination	41.0 (168)
Flagging charts for due/overdue vaccines	38.9 (161)
Provider feedback of vaccination practices	17.7 (73)
<u>Patient Demographics</u>	
Age 11–17 years (%), mean (SD) ^a	40.6 (17.1)
Adolescents with CMCs seen per month, mean (SD) ^a	39.8 (46.3)

Race/Ethnicity (%), mean (SD) ^a	
Non-Latino White	48.1 (22.8)
Non-Latino Black	20.5 (17.1)
Latino	21.6 (17.5)
Asian	7.6 (7.5)
Other (including multi-racial)	7.0 (6.5)
Insurance, (%), mean (SD) ^a	
Public	49.6 (20.5)
Private	44.7 (21.4)
Uninsured	7.8 (6.7)
Other	22.7 (34.3)

^aMissing data.

^bSome individuals selected >1 response option. Each proportion calculated among all respondents for that particular question.

Table 2

HPV-related knowledge of pediatric subspecialists (n = 418)

Survey Item	Correct Response % (n)
The HPV vaccines offer protection against most cervical cancers. (<i>T</i>) ³	93.8 (378)
One of the HPV vaccines offers protection against genital warts. (<i>T</i>) ³	85.1 (342)
A pregnancy test is recommended before HPV vaccination of females. (<i>F</i>) ³	74.1 (298)
The HPV vaccines are most effective if given to people who have never had sex. (<i>T</i>) ³	66.4 (267)
HPV vaccine is contraindicated in patients with certain chronic medical conditions. (<i>F</i>) ³	65.4 (264)
Please indicate which of the following ranges most closely approximates the prevalence of HPV infection among sexually experienced adolescent females? (<i>0–30%</i>) ^{66,67}	58.2 (234)
Please indicate which of the following ranges most closely approximates the % of adolescents aged 15–19 years nationally who are sexually experienced? (<i>41–60%</i>) ^{68,69}	42.4 (172)

^aCorrect responses indicated in parentheses.

T = True. *F* = False.

Table 3

Barriers to HPV vaccination of adolescents with CMCs reported by pediatric subspecialists (n = 418)

General Barriers	% (n)
Insufficient information about HPV vaccine	41.1 (159)
Difficulty ensuring HPV vaccination completion	37.2 (144)
HPV vaccine is relatively new vaccine	34.4 (133)
Too many vaccines in adolescent schedule	16.8 (65)
HPV vaccination may encourage riskier sexual health behaviors	7.0 (27)
Perceived Parental Barriers	
Reluctance to discuss sexual health/STIs	58.9 (228)
Reluctance to vaccinate adolescent against STI	53.6 (208)
Concern about HPV vaccine safety	52.3 (203)
Lack of education/understanding about HPV	50.5 (196)
Mistrust of vaccines	46.9 (181)
Concern about HPV vaccine efficacy	41.1 (159)
Provider Barriers	
Lack of PCP-subspecialist communication	51.0 (198)
Comfort discussing sexual health/STIs	14.9 (58)
Concern about HPV vaccine safety	10.6 (41)
Concern about HPV vaccine efficacy	8.2 (32)
Systems-Based Barriers	
Sporadic adolescent visits	52.5 (203)
Time constraints to discussing HPV vaccination	51.2 (199)
Unclear medical home for HPV vaccination	46.5 (181)
Increased staffing requirements	33.2 (126)
Insurance coverage	30.5 (117)
HPV vaccine purchasing cost	30.2 (116)
HPV vaccine storage cost	27.5 (106)
HPV vaccine administration cost	25.6 (99)
HPV vaccine supply	23.8 (92)

CMC: chronic medical condition; HPV: human papillomavirus; PCP: primary care provider; STI: sexually transmitted infection.

Table 4Factors^a associated with pediatric subspecialist recommendation of HPV vaccination

Variables	AOR (95% CI)
<u>Provider/Outpatient Practice/Patient Characteristics</u>	
Provider age	1.05 (0.96–1.16)
Subspecialty (Ref: Endocrinology)	
Hematology/oncology	4.69 (1.86–11.81)
Pulmonology	1.07 (0.37–3.12)
Rheumatology	6.55 (1.67–25.74)
Time since subspecialty training	1.01 (0.92–1.12)
Perceived as primary care provider	0.76 (0.36–1.64)
Available vaccination support tool	1.29 (0.59–2.81)
No. of adolescents with CMCs seen per month	1.01 (1.00–1.02)
<u>Provider Attitudes and Comfort</u>	
HPV vaccine offers best protection to my patients	4.48 (0.72–27.91)
HPV sequelae are a serious threat to patients	0.97 (0.29–3.27)
Sexual health discussion with HPV vaccination recommendation (Ref: important/comfortable)	
Important/Not comfortable	0.28 (0.12–0.70)
Not important	0.58 (0.27–1.26)
<u>Provider Practices</u>	
Offer primary care services	1.73 (0.78–3.83)
Discuss sexual health with patients	2.53 (1.05–6.08)
Check patient vaccination status	3.83 (1.59–9.20)
<u>Reported Barriers</u>	
Insufficient information about HPV vaccine	0.45 (0.23–0.88)
Sporadic adolescent visits	1.22 (0.55–2.74)
Time constraints to discussing HPV vaccination	0.83 (0.39–1.74)
Increased staffing requirements	0.52 (0.19–1.43)
Unclear medical home for HPV vaccination	1.39 (0.60–3.24)
Lack of primary care-subspecialist communication	0.38 (0.16–0.93)
HPV vaccine supply	1.72 (0.60–4.93)
HPV vaccine storage cost	0.66 (0.20–2.17)
HPV vaccine administration cost	1.61 (0.44–5.90)

CMC: chronic medical condition; HPV: human papillomavirus; PCP: primary care provider.

^a All factors were significant at $p < 0.10$ on bivariate analysis and were included in the final multivariable logistic regression model.