



Insurance reimbursements for human papillomavirus vaccination in the private sector, 2007–2014[☆]

Yuping Tsai*, Megan C. Lindley, Fangjun Zhou, Shannon Stokley

National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia

ARTICLE INFO

Keywords:

Human papillomavirus
Vaccines
Reimbursements

ABSTRACT

This study aims to assess payments to private providers for HPV vaccination. We used the 2007–2014 MarketScan Commercial Claims and Encounters Database and included 3,456,180 HPV vaccination visits made by adolescents aged 11–17 years and enrolled in a non-capitated insurance plan in 37 states. We examined insurance reimbursements and its time trend for vaccine purchase and vaccine administration. Using the vaccine purchase price published by the Centers for Disease Control and Prevention (CDC) and the vaccination payment recommended by the American Academy of Pediatrics (AAP), we evaluated the financial concerns of administering HPV vaccines among private providers. In 2007–2014, the mean vaccine purchase reimbursement was \$159.17 and the mean vaccine administration reimbursement was \$23.91. During the study period, vaccine purchase reimbursements did not significantly change, but vaccine administration reimbursements increased. On average, 89.9% of the HPV claims received vaccine purchase reimbursements greater than the CDC-published price and 14.1% of HPV claims received vaccine purchase reimbursements above the AAP-recommended payment. Our results suggest that private providers are likely to receive sufficient reimbursements to cover the costs of administering HPV vaccines. However, the profit margin is likely to be small.

1. Introduction

Human papillomavirus (HPV) is the most common sexually transmitted infection (Juckett & Hartman-Adams, 2010) and is the main cause of various cancers, such as anal, cervical, oropharyngeal, penile, and vaginal cancers (Chaturvedi et al., 2011; Jemal et al., 2013). Based on a nationally representative sample from the 2013–2014 National Health and Nutrition Examination Survey, the prevalence of any HPV among sexually experienced adults aged 14–59 years was 45.8% in males and 40.1% in females and the prevalence of high-risk HPV was 25.7% in males and 20.7% in females (Lewis et al., 2018). According to the Centers for Disease Control and Prevention (CDC), an average of 31,500 cancers attributable to HPV were diagnosed per year during 2009–2013, including 19,400 cases in women and 12,100 in men (Centers for Disease Control and Prevention, n.d.-a).

To prevent HPV infections, the Advisory Committee on Immunization Practices (ACIP) recommends HPV vaccination for boys and girls aged 11 or 12 years and for females aged 13 through 26 years and males aged 13 through 21 years who have not been previously

vaccinated (males 22 through 26 years may also be vaccinated) (Centers for Disease Control and Prevention, n.d.-b). Although HPV vaccination coverage has improved over time, it remains well below vaccination coverage observed for other vaccines recommended for adolescents. Based on the 2016 National Immunization Survey-Teen (NIS-Teen), the estimated coverage among adolescents aged 13–17 years having at least 3 doses of HPV vaccines was 43.0% for females and 31.5% for males (Walker et al., 2017).

Studies have attempted to identify barriers to HPV vaccination. Among parents, the barriers include costs of the vaccine, belief that the child is too young to receive the vaccine, concerns regarding vaccine adverse effects and safety, and never receiving vaccine recommendation from health care providers (Dorell et al., 2011; Laz et al., 2012; Sanders Thompson et al., 2012; Hamlish et al., 2012; Ylitalo et al., 2013; Holman et al., 2014; Luque et al., 2012). Among health care professionals, financial concerns, such as high vaccine purchase costs and inadequate insurance reimbursements, are commonly cited as barriers to HPV vaccination (Luque et al., 2012; Daley et al., 2010; Young et al., 2011; Quinn et al., 2012).

[☆] The findings and conclusions of this paper are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

* Corresponding author at: National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road NE, MS A19, Atlanta, GA 30329, United States.

E-mail address: ytsai@cdc.gov (Y. Tsai).

<https://doi.org/10.1016/j.pmedr.2019.100917>

Received 30 January 2019; Received in revised form 10 May 2019; Accepted 4 June 2019

Available online 07 June 2019

2211-3355/ Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

HPV vaccines are the most expensive vaccines currently recommended for routine administration in adolescents. In 2014, the 3-dose quadrivalent HPV vaccine (4vHPV) series cost \$423 in the private sector, \$141 per dose according to the vaccine price published by the CDC (Centers for Disease Control and Prevention, n.d.-c). Providers vaccinating Medicaid-eligible children receive HPV vaccines at no cost as Medicaid-enrolled children 18 years and younger are eligible for the Vaccines for Children (VFC) program (Santoli et al., 1999). By contrast, providers serving privately insured children are responsible for purchasing vaccines as well as other vaccination-related costs, such as storage costs, personnel costs for ordering and inventory, insurance payment against loss of the vaccine, and recovery of costs attributable to inventory shrinkage, wastage, and non-payment (American Academy of Pediatrics, n.d.). In 2014, ~50% of the children in the U.S. were covered by private insurance (Anon, n.d.). A national survey among private pediatricians and family physicians indicated that over 40% of physicians were dissatisfied with insurance reimbursements for vaccine purchase and 34% of the physicians surveyed had considered discontinuing vaccines to privately insured patients due to cost concerns (O'Leary et al., 2014). In order to understand the financial concerns among private providers, it is critical to understand private practices' insurance reimbursements for providing HPV vaccination services.

To our knowledge, two studies have attempted to find out the vaccine purchase price and the amount of insurance reimbursements from third-party payers among private physicians (Freed et al., 2008; Coleman et al., 2009). In 2007, Freed et al. collected data on vaccine purchase costs and insurance reimbursements for vaccines recommended for children and adolescents among 76 private practices located in California, Georgia, Michigan, New York, and Texas. The study reported that the purchase price for one dose of 4vHPV ranged from \$116.00 to \$129.57, with a mean of \$120.06; insurance reimbursements for 4vHPV ranged from \$119.25 to \$177.67, with a mean of \$135.81 (Freed et al., 2008). Coleman et al. surveyed 34 private pediatric practices in Georgia and reported that the average purchase price for one dose of 4vHPV was \$121.81, with a range between \$114.96 and \$155.00; insurance reimbursements for 4vHPV were between \$76.31 and \$147.23, with a mean of \$123.49 (Coleman et al., 2009). Three other survey studies aimed to identify the costs (excluding vaccine costs) of providing vaccination services to children and adolescents and all studies indicated that private practices were likely to suffer financial losses associated with providing vaccines to children and adolescents (Glazner et al., 2004; Glazner et al., 2009; Yoo et al., 2009). Nevertheless, the existing studies are limited in reporting older and cross-sectional data and surveying a small number of private practices located in a few states (Coleman et al., 2009).

The current study used insurance claims data to examine insurance reimbursements for HPV vaccine purchase and vaccine administration from 2007 to 2014. It adds to the current literature by using a large longitudinal dataset which includes 37 states and the District of Columbia (DC) in each study year and examining the time trend in insurance reimbursements for HPV vaccination services. Our findings could help policy makers and healthcare professionals to understand the amount of insurance reimbursements of HPV vaccination in the private sector.

2. Methods

This study used the 2007–2014 MarketScan Commercial Claims and Encounters (CCAIE) Database (MarketScan Research Databases, n.d.). The CCAIE contains individual-level enrollment information and medical claims for individuals ≤ 64 years and covered by large self-insured employers or regional health plans. All U.S. states and DC are represented. The data represent a large proportion of the U.S. privately insured population — about 47 million individuals were included in 2014 (~23% of the privately insured population).

In each year, we included HPV vaccination visits made by

adolescents aged 11–17 years. The analyses excluded visits made by ~1.3 million adolescents enrolling in a capitated insurance plan (i.e., providers deliver a defined set of services for beneficiaries and the payment usually occurs on a capitated per-beneficiary per-month basis) as the CCAIE usually sets the payment amount to zero for services covered by capitated plans. Providers resided in states with a universal or universal select vaccine purchase program (i.e., the state purchases all or select routinely recommended vaccines and provides these vaccines free to participating providers) do not necessarily submit insurance claims to receive HPV vaccine reimbursements, and thus the number of HPV vaccination visits included in the analysis is likely to be very small in universal and universal select states. To ensure that changes in physician payments over time were not due to variations in the states included in the analysis, we excluded 326,985 HPV claims (~0.08%) in the 13 states in which a universal or universal select (that covered the HPV vaccine) program was in effect any time during 2007–2014 (i.e., Alaska, Hawaii, Idaho, Maine, Massachusetts, South Dakota, New Hampshire, New Mexico, Rhode Island, Vermont, Washington, Wisconsin, and Wyoming).

An HPV vaccination visit was defined as an outpatient visit for which the claim included the Current Procedural Terminology [CPT] code, 90649 (i.e., 4vHPV). This study focused on 4vHPV as the 9-valent HPV (9vHPV) vaccine was not licensed for use until December 2014 and only about 0.2% of the HPV claims in our data were associated with the bivalent HPV vaccine. Our outcome variables include insurance reimbursements for vaccine purchase and vaccine administration. We reported vaccine administration reimbursements for claims with the CPT codes 90460 or 90471 (i.e., first or the only vaccine administered during the visit). To exclude HPV claims with unusual high or low vaccine purchase reimbursement amount, we used the approach generally adopted by researchers and the Centers for Medicare & Medicaid Services (Centers for Medicare & Medicaid, CMS, n.d.; Ruttner et al., 2015; Krishnan et al., 2017); we excluded 0.04% of the HPV claims (154,509 claims) for which insurance reimbursements for vaccine purchase was greater than \$250 or lower than \$52 (i.e., three standard deviations from the mean of the vaccine reimbursements before this exclusion condition, \$151). All dollar amounts reported in the study were rounded to the two decimal places and were adjusted to 2014 dollars based on the Consumer Price Index.

We presented the mean by year, state, metropolitan statistical area (MSA; MSA versus non-MSA), health plan type (self-insured employers versus regional health plans), insurance plan type, and provider type. Insurance plans were categorized into three types — fee-for-service (FFS) plans, managed care plans (preferred provider organization, exclusive provider organization, and point-of-service), and high deductible plans. We considered six types of health care providers — family physicians, internists, pediatricians, obstetricians and gynecologists, specialists/subspecialists, and others (e.g., providers in health care facilities and non-physician professionals). We used regression models to estimate the average annual rate of change in the reimbursement amount; the key independent variable was the time trend variable that took the value of zero in the year 2007 and increased by one in each of the subsequent years. We used two-tailed *t*-tests with robust standard errors clustered at the state level to determine statistical significance of differences in the average reimbursement amount across the 8 study years by MSA, health plan type, insurance plan type, and provider type.

To promote maximum immunization coverage for children and adolescents, the American Academy of Pediatrics (AAP) stated that physicians should be paid for the full costs of vaccine-related expenses (e.g., vaccine purchase price, vaccine administration fees, personnel costs for ordering and inventory, storage costs, insurance against loss of the vaccine, etc.) and a margin to incentivize immunization (American Academy of Pediatrics, n.d.). The AAP recommended that the appropriate payment for vaccine purchase should be at least 125% of the vaccine purchase price published by the CDC (Centers for Disease Control and Prevention, n.d.-c). Glazner et al. reported that the average

Table 1
HPV vaccination visits by patient and provider characteristics, 2007–2014 MarketScan^a.

	2007	2008	2009	2010	2011	2012	2013	2014
Number of HPV vaccination visits	346,730	336,276	268,097	227,035	403,189	604,811	608,778	661,264
	% of HPV vaccination visits							
Age group								
11–12 years	19.0	20.1	25.4	31.0	31.3	30.8	31.6	34.2
13–14 years	27.2	27.8	28.2	28.5	29.8	29.9	29.8	29.3
15–17 years	53.8	52.1	46.4	40.5	39.0	39.3	38.6	36.5
Sex								
Males	–	–	–	–	29.6	46.5	51.2	50.9
Females	100.0	100.0	100.0	100.0	70.4	53.5	48.8	49.1
MSAs								
Yes	87.4	87.9	87.6	88.8	88.7	89.7	90.7	90.8
No	12.6	12.1	12.4	11.2	11.3	10.3	9.3	9.2
Health plan type								
Regional health plans	55.3	51.6	55.2	59.1	64.6	62.8	46.0	49.8
Self-insured employers	44.8	48.4	44.8	40.9	35.4	37.2	54.0	50.2
Insurance plan type								
FFS	2.4	1.8	1.4	0.8	0.6	0.8	1.1	1.1
Managed care plans								
PPO	74.4	71.7	75.2	70.3	64.5	65.2	65.0	59.0
POS or EPO	13.2	12.5	10.5	10.8	9.4	8.2	10.2	7.6
High deductible	2.9	4.7	4.1	9.8	8.7	9.3	15.6	17.9
Unknown	7.1	9.3	8.9	8.2	16.8	16.5	8.1	14.3
Provider type								
Family physicians	19.1	19.3	19.6	19.8	16.2	13.7	14.4	14.9
Internists	7.0	7.8	6.6	6.7	6.8	6.8	4.0	3.8
Obstetricians & gynecologists	10.5	8.9	8.0	7.0	3.7	2.3	1.9	1.6
Pediatricians	44.9	44.9	48.9	54.1	59.7	63.3	71.6	72.8
Specialists/subspecialists	6.7	7.2	6.3	5.3	5.8	6.3	4.4	3.1
Others	3.2	2.9	3.0	3.0	2.8	3.1	3.2	3.3
Unknown	8.6	9.0	7.7	4.1	4.9	4.4	0.6	0.5

^a Abbreviation: HPV, human papillomavirus; MSAs, metropolitan statistical areas; FFS, fee-for-service; PPO, preferred provider organization; POS, point-of-service; EPO, exclusive provider organization. The analysis included 3,456,180 HPV vaccination visits made by adolescents aged 11–17 years and enrolled in a non-capitated private insurance plan. An HPV vaccination visit was an outpatient visit with the CPT code, 90649.

total variable cost per vaccine injection was \$11.51 (\$13.14 in 2014 dollars). To gauge the financial well-being of the providers, we reported the proportions of the HPV claims with vaccine purchase reimbursements greater than the CDC-published purchase price and greater than the AAP recommendation. We also calculated the total vaccination costs (the sum of the CDC-published purchase price and the CPI-adjusted vaccine administration cost reported in Glazner et al.) and reported the proportion of the HPV claims with total vaccination reimbursement (the sum of reimbursements for vaccine purchase and vaccine administration) greater than the total vaccination cost. We displayed the distribution of vaccine purchase reimbursements and total vaccination reimbursements using the 2014 data. Stata software, version 15 (Stata Corporation, College Station, TX) was used for the analyses.

As an analysis of secondary data without identifiers, the study did not require institutional review board review.

3. Results

A total of 3,456,180 HPV vaccination visits were included in the study. Table 1 presents the distribution of the HPV vaccination visits by patient and provider characteristics. Adolescents aged 15–17 years accounted for the largest proportion of HPV vaccination visits while the proportion of the 11–12 age group increased over time, from 19.0% in 2007 to 34.2% in 2014. In 2011, the proportion of HPV vaccination visits made by males were considerably smaller than visits made by females as the ACIP did not recommend routine use of HPV vaccines in males until October 2011; by 2014, the proportion was equally distributed between males and females. In each year, the annual proportion was higher for adolescents living in a MSA (> 87%) compared to those not living in a MSA and for adolescents enrolled in a managed care plan (> 65%) compared to those in other insurance plan types.

Pediatricians were the most common provider type to administer HPV vaccines; the proportion of HPV vaccination visits provided by pediatricians increased by 28 percentage points, from 44.9% in 2007 to 72.8% in 2014.

Table 2 displays the mean vaccine purchase reimbursements by year and patient and provider characteristics. In 2007–2014, the mean reimbursement was \$159.17. There was a flat time trend in vaccine purchase reimbursements, with an average annual increase of \$0.71 ($P = 0.11$). There was no significant difference in vaccine purchase reimbursements within groups during the study period, except for provider type. Providers in the “others” category were statistically significantly lower ($P < 0.05$) than reimbursements to pediatricians.

Table 3 displays the mean vaccine administration reimbursements by year and patient and provider characteristics. During the study period, the mean reimbursement amount was \$23.91. There was an increasing trend with the average annual increase rate of \$1.23 ($P < 0.001$). Vaccination visits in MSAs had higher average vaccine administration reimbursements than in non-MSAs ($P < 0.05$) in 2007–2014; family physicians and obstetricians and gynecologists received statistically significantly lower vaccine administration reimbursements compared to pediatricians ($P < 0.05$).

There were large variations in insurance reimbursements for HPV vaccination across states (Table 4). The state mean vaccine purchase reimbursement ranged from \$143.93 (DC) to \$176.99 (Pennsylvania). South Carolina had the lowest vaccine administration reimbursement (below \$15.88, Truven Analytics prohibits the publication of the estimates generated from MarketScan databases for the state of South Carolina) and Oregon had the highest vaccine administration reimbursement (\$38.63). The lowest five vaccine purchase reimbursement states were Arkansas, Connecticut, DC, Michigan, and Maryland; DC and Maryland were also among the five lowest vaccine administration reimbursement states.

Table 2
Vaccine purchase reimbursements by year and characteristics, 2007–2014 MarketScan^a.

	2007	2008	2009	2010	2011	2012	2013	2014	All year
HPV vaccine purchase reimbursements (\$)									
Overall (mean)	155.76	155.59	160.87	159.03	160.55	157.92	158.97	162.65	159.17
MSAs									
Yes (reference group)	155.75	155.63	161.28	159.22	160.39	157.88	159.10	162.80	159.27
No	155.82	155.29	157.91	157.56	161.74	158.26	157.73	161.13	158.38
Health plan type									
Regional health plans (reference group)	153.36	152.88	157.34	157.83	161.00	158.49	158.76	164.02	158.67
Self-insured employers	158.72	158.47	165.20	160.78	159.72	156.96	159.14	161.29	159.79
Insurance plan type									
FFS (reference group)	155.16	154.96	155.78	162.37	161.95	155.97	159.11	160.65	157.65
Managed care plans									
PPO	155.62	155.86	160.76	159.00	158.88	157.28	159.07	161.63	158.59
POS or EPO	153.51	151.93	159.91	157.18	157.61	154.88	157.99	160.17	156.57
High deductible	166.20	163.64	168.58	161.77	159.72	155.98	160.19	162.10	160.78
Provider type									
Pediatricians (reference group)	155.67	155.54	160.97	158.99	161.12	158.54	158.92	162.79	159.64
Family physicians	155.57	155.29	160.31	159.14	161.57	159.03	160.02	163.34	159.52
Internists [*]	158.80	156.65	160.64	158.15	155.92	151.99	155.51	159.37	156.51
Obstetricians & gynecologists	153.70	153.57	159.35	156.30	157.81	157.17	158.41	161.19	156.30
Specialists/subspecialists	155.64	159.89	165.89	163.71	162.55	159.67	163.90	166.94	161.81
Others [*]	150.59	151.42	156.77	155.85	156.80	156.42	154.22	157.78	155.27

^a Abbreviation: HPV, human papillomavirus; MSAs, metropolitan statistical areas; FFS, fee-for-service; PPO, preferred provider organization; POS, point-of-service; EPO, exclusive provider organization. The analysis included 3,456,180 HPV vaccination visits made by adolescents aged 11–17 years and enrolled in a non-capitated private insurance plan. An HPV vaccination visit was an outpatient visit with the CPT code, 90649. Reimbursement amounts were translated to 2014 dollars based on the Consumer Price Index. We used the t-tests to determine statistical differences in the average reimbursement amount within each group during the study period.

^{*} Differences in reimbursements were statistically significant at $p < 0.05$ when compared to the reference group.

Columns (1), (3), and (5) of Table 5 list the CDC-published vaccine purchase price for a dose of 4vHPV in the private sector, the AAP recommended vaccine purchase payment, and the total vaccination cost, respectively. Columns (2) and (4) present the proportion of HPV claims for which vaccine purchase reimbursements were greater than the CDC-published price and greater than the AAP recommended payment amount, respectively; column (6) presents the proportion of HPV claims for which total vaccination reimbursement was greater than the total

vaccination cost. The numbers in Table 5 indicate that on average, 89.9% of the HPV claims had vaccine purchase reimbursements higher than the CDC-published price and 91.0% had total vaccination reimbursement above the total vaccination cost; the proportion of HPV claims with vaccine purchase reimbursement above the AAP-recommended payment was 14.1% during the study period. Fig. 1a and b display the distribution of vaccine purchase reimbursements and total vaccination reimbursements using the 2014 CCAE data.

Table 3
Vaccine administration reimbursements by year and characteristics, 2007–2014 MarketScan^a.

	2007	2008	2009	2010	2011	2012	2013	2014	All year
HPV vaccine administration reimbursements (\$)									
Overall (mean)	18.27	19.15	21.18	21.83	24.80	25.78	26.05	26.34	23.91
MSAs									
Yes (reference group)	18.20	19.13	21.02	21.83	24.95	25.93	26.18	26.47	24.01
No	18.88	19.26	22.38	21.80	23.63	24.43	24.76	25.05	23.03
Health plan type									
Regional health plans (reference group)	18.34	19.04	21.19	21.69	24.63	25.44	26.17	26.47	23.84
Self-insured employers	18.20	19.25	21.16	22.03	25.12	26.38	25.94	26.22	24.00
Insurance plan type									
FFS (reference group)	16.45	17.17	19.93	18.99	23.59	24.53	24.90	25.17	21.48
Managed care plans									
PPO	18.29	19.15	21.16	21.59	24.97	26.06	25.76	26.09	26.66
POS or EPO	18.23	19.26	21.06	22.38	25.34	25.86	26.76	27.92	23.87
High deductible	18.17	19.16	21.70	22.86	25.94	26.55	27.03	27.03	25.89
Provider type									
Pediatricians (reference group)	18.10	19.02	20.73	21.55	25.16	26.15	26.22	26.53	24.46
Family physicians [*]	18.94	19.64	22.36	22.50	23.73	24.67	25.60	25.87	23.39
Internists	18.00	19.14	21.31	22.88	25.53	26.32	26.32	26.61	23.78
Obstetricians & gynecologists [*]	18.36	19.56	21.62	21.69	22.45	22.41	23.25	23.54	21.01
Specialists/subspecialists	17.22	17.54	18.84	19.43	23.84	24.72	25.79	25.82	22.24
Others	20.21	21.41	24.40	23.51	24.58	25.20	25.70	25.85	24.42

^a Abbreviation: HPV, human papillomavirus; MSAs, metropolitan statistical areas; FFS, fee-for-service; PPO, preferred provider organization; POS, point-of-service; EPO, exclusive provider organization. Numbers in the table represent the mean of insurance reimbursements for vaccine administration (CPT codes 90460 and 90471). Reimbursement amounts were translated to 2014 dollars based on the Consumer Price Index. We used the t-tests to determine statistical differences in the average reimbursement amount within each group during the study period.

^{*} Differences in reimbursements were statistically significant at $p < 0.05$ when compared to the reference group.

Table 4
Reimbursements for HPV vaccine purchase and vaccine administration by state, 2007–2014 MarketScan^a.

State	Vaccine purchase reimbursements (\$)	Vaccine administration reimbursements (\$)
Pennsylvania	176.99	20.90
California	169.12	26.34
South Carolina ^b	–	–
Delaware	166.60	15.88
Ohio	166.52	24.00
West Virginia	165.67	24.12
Kansas	162.99	18.58
Colorado	162.49	28.65
Illinois	162.20	21.18
North Carolina	161.40	26.62
Nevada	160.35	21.75
Arizona	160.04	21.68
Tennessee	159.97	23.91
Missouri	159.54	22.45
Georgia	159.54	25.32
Nebraska	159.16	32.35
Florida	158.15	24.82
Minnesota	157.65	30.87
Alabama	157.58	22.58
Utah	157.11	24.30
Oklahoma	157.03	25.61
Montana	156.38	29.63
Indiana	156.26	22.71
New Jersey	155.89	21.27
Virginia	155.41	21.37
Louisiana	154.60	21.84
Kentucky	153.56	21.84
Oregon	153.49	38.63
Texas	153.39	24.71
Iowa	152.27	27.94
New York	151.60	24.42
Mississippi	150.56	25.93
North Dakota	150.12	29.03
Connecticut	148.65	26.64
Arkansas	146.19	27.07
Michigan	145.44	27.73
Maryland	145.01	17.67
DC	143.93	20.18

^a Abbreviation: HPV, human papillomavirus. An HPV vaccination visit was an outpatient visit with the CPT code, 90649. Reimbursement amounts were translated to 2014 dollars based on the Consumer Price Index.

^b Truven Health Analytics prohibits the publication of the estimates generated from MarketScan databases for the state of South Carolina.

4. Discussion

This study used the 2007–2014 MarketScan CCAE data to examine insurance reimbursements to private physicians for administering a dose of 4vHPV in 37 states and DC. During the study period, the mean vaccine purchase reimbursement did not significantly change but the mean vaccine administration reimbursement increased. Insurance reimbursements for HPV vaccination varied widely by state. Most HPV vaccination visits received vaccine purchase reimbursements greater than the CDC-published vaccine purchase cost, but only about 14% of the HPV vaccination visits had vaccine purchase reimbursements higher than the AAP-recommended payment amount.

Our mean vaccine purchase reimbursement (\$159.17) was higher than that reported in Freed et al. (\$155.06 in 2014 dollars) and Coleman et al. (\$135.78 in 2014 dollars) (Freed et al., 2008; Coleman et al., 2009). Our findings showed large geographic variations in insurance reimbursements for HPV vaccination across states. Differences between our findings and theirs are likely attributable to differences in study methods (e.g., surveying providers versus insurance claims data; cross-sectional versus longitudinal data) and geographic variations (Freed et al. covered five states and Coleman et al. only included Georgia).

in a limited number of states () Our mean reimbursement for vaccine administration was \$23.91, which was in the range of the costs per vaccine shot (excluding vaccine costs) reported in Yoo et al. (\$14.73–\$42.63, with a median of \$23.96 in 2014 dollars) (Yoo et al., 2009) and in the range of vaccine administration reimbursements reported in Freed et al. (\$4.42–\$30.31, with a mean of \$18.98 in 2014 dollars) (Freed et al., 2008).

4vHPV was licensed in June 2006 and was recommended by the ACIP for use in adolescent girls in 2007. Since the licensure of the vaccine, private providers have expressed concerns regarding high vaccine purchase costs and inadequate insurance reimbursements (Luque et al., 2012; Daley et al., 2010; Young et al., 2011; Quinn et al., 2012). The issue has attracted much attention among policy makers and healthcare professionals. In the 2012–2013 President's Cancer Annual Report on accelerating HPV vaccine uptake, one of the objectives proposed by the panel was to make sure insurers reimburse providers adequately for the direct and indirect costs of the vaccine (<https://deainfo.nci.nih.gov/advisory/pcp/annualreports/hpv/Part3Goal1.htm>, n.d.).

In the private sector, providers negotiate vaccine purchase price with vaccine manufacturers or distributors and negotiate vaccine purchase and vaccine administration reimbursements with insurers (Lindley et al., 2009). Due to limited availability of information on prices and reimbursements, private providers and insurers are likely to use the CDC-published price as their baseline during the negotiation process for vaccine purchase reimbursements. This may contribute to our finding that vaccine purchase reimbursements for most HPV vaccination claims were greater than the CDC-published purchase price. Negotiating an adequate level of vaccine administration reimbursements requires a full understanding of all practice costs associated with vaccination. Our findings showed most vaccine administration claims received reimbursements greater than the per-injection cost reported in Glazner et al. (\$13.14 in 2014 dollars). Evaluating the total vaccination reimbursement from administering an HPV vaccine, we observed that most HPV claims received more reimbursements than the total vaccination cost. Nevertheless, only a small proportion of the HPV claims received reimbursements greater than the AAP-recommended level. Because the AAP recommendation considers a profit margin to incentivize providers, these results suggest that most private providers may receive sufficient insurance reimbursements to cover the costs of HPV vaccination. However, their profit margin of administering an HPV vaccine might be very small.

Our findings showed that pediatricians are the most common provider type to administer 4vHPV and received the highest vaccine administration reimbursements compared to other provider types. Glazner et al. found that costs per vaccine shot were higher among pediatricians as pediatricians spent more time on immunization during well-child visits than providers in family practices (Glazner et al., 2004). This factor may contribute to the higher reimbursements for pediatricians. Pediatricians as a whole may also have higher negotiation power because of their larger volume of vaccines administered and/or because they have the support of the AAP business case for vaccines.

This findings should be interpreted with caution. First, the study included HPV vaccination visits made by a convenience sample of patients residing in 37 states and DC covered by large self-insured employers or regional health plans. The results may not generalize to all private physicians administering HPV vaccines. However, our data included over 3.4 million HPV vaccination claims over an eight-year study period, with variations in patients' characteristics, geographic locations, and health insurance plans. Second, when HPV vaccine was administered during a well or sick visit, providers may not submit claims for HPV vaccine but only submit claims for other medical services provided during the same visit. However, we believe that it is unlikely for providers to do so as reimbursements are much higher if providers submit claims for both HPV vaccine administration and other

Table 5
Proportion of HPV vaccine claims above the CDC-published private sector per-dose price, 2007–2014 MarketScan^a.

Year	CDC-published vaccine purchase price in the private sector ^b	% of HPV claims with vaccine purchase reimbursements > the CDC-published price	The AAP recommendation ^c	% of HPV claims with vaccine purchase reimbursements > the AAP recommendation	Total vaccination cost	% of HPV claims with total vaccination reimbursement > the total vaccination cost ^d
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2007	139.78	85.1% (295,220)	174.73	12.0% (41,710)	152.92	81.4% (282,364)
2008	139.07	85.2% (286,555)	173.84	12.8% (43,014)	152.21	85.2% (286,544)
2009	144.60	84.8% (227,339)	180.75	11.7% (31,265)	157.74	86.1% (230,914)
2010	140.69	90.3% (204,934)	175.86	11.7% (26,665)	153.83	90.4% (205,238)
2011	138.09	95.1% (383,499)	172.61	18.8% (75,974)	151.23	95.6% (385,387)
2012	139.51	89.3% (540,142)	174.39	17.0% (10,2676)	152.65	95.4% (576,878)
2013	138.16	95.0% (578,258)	172.70	12.8% (78,167)	151.30	97.0% (590,408)
2014	141.38	94.3% (623,456)	176.73	15.8% (104,715)	154.52	97.0% (641,593)

^a Abbreviation: HPV, human papillomavirus. Prices were translated to 2014 dollars based on the Consumer Price Index. The analysis included 3,456,180 HPV vaccination visits made by adolescents aged 11–17 years and enrolled in a non-capitated private insurance plan. An HPV vaccination visit was an outpatient visit with the CPT code, 90649.

^b Per-dose HPV vaccine price for the private sector can be accessed on the Centers for Disease Control and Prevention (CDC) vaccine price list website, <https://www.cdc.gov/vaccines/programs/vfc/awardees/vaccine-management/price-list/index.html>

^c American Academy of Pediatrics recommends that physician payments for vaccines should cover the full costs of vaccine-related expenses and a margin to incentivize immunization. The payment should be targeted at least 125% of the CDC vaccine price for the private sector.

^d Total vaccination reimbursement equals to the sum of insurance reimbursements for vaccine purchase and vaccine administration. Total vaccination cost equals to the sum of CDC-published price and CPI-adjusted vaccine administration cost reported in Glazner et al.

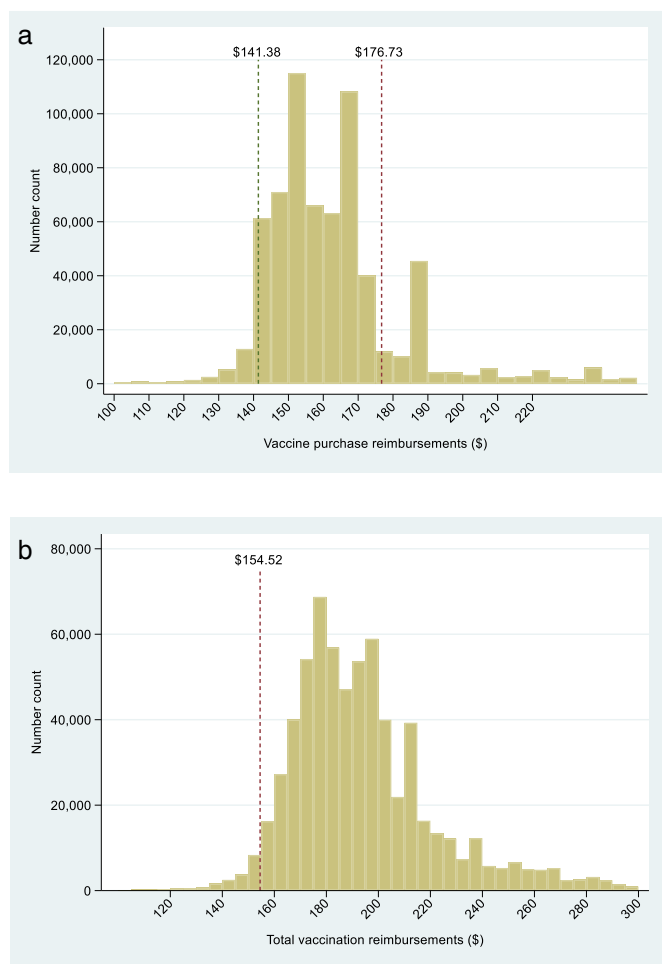


Fig. 1. a. Distribution of vaccine purchase reimbursements, 2014 MarketScan \$141.38 and \$176.73 represent the 2014 CDC-published vaccine purchase price and the AAP-recommended payment amount, respectively. b. Distribution of total vaccination reimbursements, 2014 MarketScan.

medical services provided during the same visit. Accordingly, our data should include most HPV vaccination visits. Third, we used the CDC-published vaccine purchase price as a measure to gauge the financial well-being of private providers when administering an HPV vaccine. However, the CDC price was highly likely to differ from how much individual private practice actually paid for the vaccine. Studies have shown large variations in vaccine purchase prices among private practices (Freed et al., 2008; Coleman et al., 2009). Whether individual practices suffer financial losses or make a profit depends on practice-specific costs to vaccinate. Nevertheless, vaccine wholesale prices are proprietary data and no published data on these prices at the individual practice level are currently available. Accordingly, this study provided an overall look of HPV vaccination reimbursements at the mean level. We also provided additional measures, such as the AAP recommended payment and total vaccination costs, to evaluate the financial well-being of private providers. Despite these limitations, our results provide statistical evidence on insurance reimbursements for HPV vaccination in the private insurance market from a claims database covering a significant proportion of the population.

Since October 2016, 9vHPV is the only vaccine available for purchase in the U.S. The financial concerns for HPV vaccination among private providers may exacerbate as one dose of 9vHPV currently costs over \$60 more than the 2014 price for a dose of 4vHPV. Tsai et al. showed a positive association between HPV vaccine reimbursements and HPV vaccination uptakes among adolescents (Tsai et al., 2018). Although individual practices could seek ways to reduce vaccination practice costs, efforts made by vaccine manufacturers, insurers, and policy makers, could also be helpful to address private providers' financial concerns and ultimately increase providers' willingness to recommend HPV vaccine.

Funding source

None.

Financial disclosure

None.

Declaration of Competing Interest

None.

References

- American Academy of Pediatrics. The Business Case for Pricing Vaccines. Series Retrieved from. https://www.aap.org/en-us/Documents/immunizations_thebusinesscase.pdf.
- Anon Health insurance coverage of children 0–18. Series Retrieved from. <https://www.kff.org/other/state-indicator/children-0-18/?activeTab=graph¤tTimeframe=1&startTimeframe=2&selectedDistributions=employer-non-group-medicaid&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D>.
- Centers for Disease Control and Prevention. Number of HPV-Attributable Cancer Cases per Year. Series Retrieved from. <https://www.cdc.gov/cancer/hpv/statistics/cases.htm#3>.
- Centers for Disease Control and Prevention. Human Papillomavirus (HPV) ACIP Vaccine Recommendations. Series Retrieved from. <https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/hpv.html>.
- Centers for Disease Control and Prevention. Pediatric/VFC Vaccine Price List. Series Retrieved from. <https://www.cdc.gov/vaccines/programs/vfc/awardees/vaccine-management/price-list/index.html>.
- Centers for Medicare & Medicaid, CMS. Methodology for calculating the national average drug acquisition cost (NADAC) for Medicaid covered outpatient drugs. Series Retrieved from. <https://www.medicaid.gov/medicaid-chip-program-information/by-topics/prescription-drugs/ful-nadac-downloads/nadacmethodology.pdf>.
- Chaturvedi, A.K., Engels, E.A., Pfeiffer, R.M., Hernandez, B.Y., Xiao, W., Kim, E., et al., 2011. Human papillomavirus and rising oropharyngeal cancer incidence in the United States. *J. Clin. Oncol.* 29 (32), 4294–4301.
- Coleman, M.S., Lindley, M.C., Ekong, J., Rodewald, L., 2009. Net financial gain or loss from vaccination in pediatric medical practices. *Pediatrics.* 124 (Suppl. 5), S472–S491.
- Daley, M.F., Crane, L.A., Markowitz, L.E., Black, S.R., Beaty, B.L., Barrow, J., et al., 2010. Human papillomavirus vaccination practices: a survey of US physicians 18 months after licensure. *Pediatrics.* 126 (3), 425–433.
- Dorell, C.G., Yankey, D., Santibanez, T.A., Markowitz, L.E., 2011. Human papillomavirus vaccination series initiation and completion, 2008–2009. *Pediatrics.* 128 (5), 830–839.
- Freed, G.L., Cowan, A.E., Gregory, S., Clark, S.J., 2008. Variation in provider vaccine purchase prices and payer reimbursement. *Pediatrics.* 122 (6), 1325–1331.
- Glazner, J.E., Beaty, B.L., Pearson, K.A., Berman, S., 2004. The cost of giving childhood vaccinations: differences among provider types. *Pediatrics.* 113 (6), 1582–1587.
- Glazner, J.E., Beaty, B., Berman, S., 2009. Cost of vaccine administration among pediatric practices. *Pediatrics.* 124 (Suppl. 5), S492–S498.
- Hamlisch, T., Clarke, L., Alexander, K.A., 2012. Barriers to HPV immunization for African American adolescent females. *Vaccine.* 30 (45), 6472–6476.
- Holman, D.M., Benard, V., Roland, K.B., Watson, M., Liddon, N., Stokley, S., 2014. Barriers to human papillomavirus vaccination among US adolescents: a systematic review of the literature. *JAMA Pediatr.* 168 (1), 76–82.
- Accelerating HPV Vaccine uptake: urgency for action to prevent cancer. Series Retrieved from. <https://deainfo.nci.nih.gov/advisory/pcp/annualreports/hpv/Part3Goal1.htm>.
- Jemal, A., Simard, E.P., Dorell, C., Noone, A.M., Markowitz, L.E., Kohler, B., et al., 2013. Annual report to the nation on the status of cancer, 1975–2009, featuring the burden and trends in human papillomavirus (HPV)-associated cancers and HPV vaccination coverage levels. *J. Natl. Cancer Inst.* 105 (3), 175–201.
- Juckett, G., Hartman-Adams, H., 2010. Human papillomavirus: clinical manifestations and prevention. *Am. Fam. Physician* 82 (10), 1209–1213.
- Krishnan, A., Xu, T., Hutfless, S., Park, A., Stasko, T., Vidimos, A.T., et al., 2017. Outlier practice patterns in Mohs micrographic surgery: defining the problem and a proposed solution. *JAMA Dermatol.* 153 (6), 565–570.
- Laz, T.H., Rahman, M., Berenson, A.B., 2012. An update on human papillomavirus vaccine uptake among 11–17 year old girls in the United States: National Health Interview Survey. 2010. *Vaccine.* 30 (24), 3534–3540.
- Lewis, R.M., Markowitz, L.E., Gargano, J.W., Steinau, M., Unger, E.R., 2018. Prevalence of genital human papillomavirus among sexually experienced males and females aged 14–59 years, United States, 2013–2014. *J. Infect. Dis.* 217 (6), 869–877.
- Lindley, M.C., Shen, A.K., Orenstein, W.A., Rodewald, L.E., Birkhead, G.S., 2009. Financing the delivery of vaccines to children and adolescents: challenges to the current system. *Pediatrics.* 124 (Suppl. 5), S548–S557.
- Luque, J.S., Raychowdhury, S., Weaver, M., 2012. Health care provider challenges for reaching Hispanic immigrants with HPV vaccination in rural Georgia. *Rural Remote Health* 12 (2), 1975.
- MarketScan Research Databases. Series Retrieved from. <http://truvenhealth.com/your-healthcare-focus/analytic-research/marketscan-research-databases>.
- O’Leary, S.T., Allison, M.A., Lindley, M.C., Crane, L.A., Hurley, L.P., Brtnikova, M., et al., 2014. Vaccine financing from the perspective of primary care physicians. *Pediatrics.* 133 (3), 367–374.
- Quinn, G.P., Murphy, D., Malo, T.L., Christie, J., Vadaparampil, S.T., 2012. A national survey about human papillomavirus vaccination: what we didn’t ask, but physicians wanted us to know. *J. Pediatr. Adolesc. Gynecol.* 25 (4), 254–258.
- Ruttner, L., Borck, R., Nysenbaum, J., Williams, S., 2015. Guide to MAX Data. In: Mathematica Policy Research, . https://www.cms.gov/Research-Statistics-Data-and-Systems/Computer-Data-and-Systems/MedicaidDataSourcesGenInfo/Downloads/MAX_IB21_MAX_Data_Guide.pdf.
- Sanders Thompson, V.L., Arnold, L.D., Notaro, S.R., 2012. African American parents’ HPV vaccination intent and concerns. *J. Health Care Poor Underserved* 23 (1), 290–301.
- Santoli, J.M., Rodewald, L.E., Maes, E.F., Battaglia, M.P., Coronado, V.G., 1999. Vaccines for children program, United States, 1997. *Pediatrics.* 104 (2), e15.
- Tsai, Y., Lindley, M.C., Zhou, F., Stokley, S., 2018. Provider payments and the receipt of human papillomavirus vaccine among privately insured adolescents. *Health Aff (Millwood).* 37 (10), 1587–1595.
- Walker, T.Y., Elam-Evans, L.D., Singleton, J.A., Yankey, D., Markowitz, L.E., Fredua, B., et al., 2017. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years — United States, 2016. *MMWR Morb. Mortal. Wkly Rep.* 66 (33), 874–882.
- Ylitalo, K.R., Lee, H., Mehta, N.K., 2013. Health care provider recommendation, human papillomavirus vaccination, and race/ethnicity in the US National Immunization Survey. *Am. J. Public Health* 103 (1), 164–169.
- Yoo, B.K., Szilagyi, P.G., Schaffer, S.J., Humiston, S.G., Rand, C.M., Albertin, C.S., et al., 2009. Cost of universal influenza vaccination of children in pediatric practices. *Pediatrics.* 124 (Suppl. 5), S499–S506.
- Young, J.L., Bernheim, R.G., Korte, J.E., Stoler, M.H., Guterbock, T.M., Rice, L.W., 2011. Human papillomavirus vaccination recommendation may be linked to reimbursement: a survey of Virginia family practitioners and gynecologists. *J. Pediatr. Adolesc. Gynecol.* 24 (6), 380–385.