Improving HPV Vaccination Rates: A Comprehensive Evaluation of a Clinician-Centered Educational Initiative in a Wisconsin Health Care System

Malia Jones, PhD, MPH; Nicholas B. Schmuhl, PhD; Jeff Pier, BS; Sarah Bradley, MD; Lindsay Geier, MD; James H. Conway, MD

ABSTRACT

Introduction: Human papillomavirus (HPV) infection poses significant public health concerns due to its prevalence and association with various cancers. This study assesses a 2014 quality improvement initiative in Wisconsin's largest health care system. The intervention aimed to improve HPV vaccine initiation and completion among eligible patients and to reduce the gap in vaccination rates between males and females.

Methods: Educational sessions delivered to health care providers and staff at select clinics focused on current HPV vaccination recommendations and strategies for patient communication. Preintervention and postintervention surveys assessed changes in clinician knowledge and attitudes. Clinic-level data on HPV vaccination rates compared intervention and control clinics at 12 and 36 months following the intervention.

Results: Postintervention knowledge and attitudes regarding HPV vaccination improved, and intervention clinics demonstrated notable increases in HPV vaccine initiation and completion rates across various age and sex groups at 12- and 36-month follow-up. The gap between female and male HPV vaccination rates narrowed in some age groups in intervention clinics, but the effect was inconsistent.

Conclusions: This study highlights the potential effectiveness of an in-person educational intervention in improving HPV vaccination rates in a health care system. Clinicians' enhanced understanding of vaccination guidelines, coupled with real-time data feedback, contributed to sustained improvements. To address resource challenges, future interventions may explore cost-effective alternatives. These findings underscore the pivotal role of clinicians in increasing HPV vaccine uptake, emphasizing the importance of aligning interventions with evolving vaccination recommendations to combat HPV-related cancers more effectively.

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Author Affiliations: Department of Community and Environmental Sociology, University of Wisconsin (UW)-Madison, Madison, Wisconsin (Jones); Population Health Institute, UW-Madison, Madison, Wisconsin (Schmuhl); UW Health Analytics, Madison, Wisconsin (Pier); UW Health, Northern Illinois Medical Group, Rockford, Illinois (Bradley); SSM Health Monroe Clinic Medical Group, Monroe, Wisconsin (Geier); UW School of Medicine and Public Health, Department of Pediatrics, Madison, Wisconsin (Conway).

Corresponding Author: Malia Jones, PhD, MPH, Assistant Professor, Department of Community and Environmental Health, UW-Madison College of Agriculture and Life Sciences, 354 Agricultural Hall, 1450 Linden Dr, Madison WI 53705; email malia.jones@wisc.edu; ORCID ID 0000-0002-8198-0826

INTRODUCTION

Human papillomavirus (HPV) accounts for more than 43 million new infections annually in the United States.[1] Selected HPV strains cause nearly all cervical and anal cancers and the majority of cancers of the vagina, vulva, and penis.[2] Each year between 2015 and 2019 in the US, an estimated 37 300 people were diagnosed with HPV-attributable cancer,[2] and about 4000 women died of cervical cancer.[3]

Since 2006, US Food and Drug Administration (FDA)-approved vaccines have effectively prevented infection from the HPV strains most closely linked to cervical cancer. Clinical trials of the first approved vaccine, Gardasil from Merck & Co, Inc (HPV4), demonstrated 90% to 100% reduction in infections for 4 target strains in both females and males.[4]

Recommendations for use of the HPV vaccines underwent gradual shifts in the first 5 years of licensure,[5] presenting challenges in adopting the vaccine as part of routine immunization. Shortly after its 2006 FDA licensure, the Centers for Disease Control and Prevention (CDC) recommended HPV4 for routine administration as a 3-dose series for females ages 11 to 12 years, with catch-up vaccinations up to age 26.[6] In 2010, the CDC indicated that males ages 9 to 26 years could receive HPV4[7] and recommended it as a routine vaccine the following year.[8] (Note that a bivalent vaccine was licensed for use in the US in 2009. Cervarix [Glaxosmithkline] was included in updated recommendations from the Advisory Committee on Immunization Practices for vaccination of female patients in 2010. However, it

was never licensed for use in males in the United States, and use was uncommon in females. It was withdrawn from the US market in 2016 due to very low demand.)

In December 2014, the FDA approved Gardasil-9 (HPV9), with coverage for 9 high-risk strains of HPV.[9] HPV9 replaced HPV4 as the recommended vaccination for routine use in both male and female children.[9]

In December 2016, the CDC again modified the vaccine administration guidance based on emerging evidence of immunogenicity, recommending a 2-dose schedule for females and males who initiate the vaccination series before age 15 years.[10]

As of 2022, 66% of females and 63% of males ages 13 to 18 years had initiated the HPV series, while 53% and 50%, respectively, had completed the series.[11] In 2013, just before the intervention described here, 59% of females and 31% of males ages 13 to 18 years in Wisconsin had initiated the 3-dose vaccine series, while 37% and 14%, respectively, had completed the series.[12]

Wisconsin adolescents who were getting vaccinated also were doing so later than recommended. The average age of series completion was 16.5 for females and 15.7 for males, whereas the CDC's recommendation was for series completion by the 13th birthday. Although some evidence exists to suggest that vaccination can decrease HPV-related disease risk in people who have previously acquired HPV,[13] timing HPV vaccine administration before sexual debut is important because the vaccine is most effective at preventing HPV infection if it is given prior to exposure.[14]

This study evaluated a quality improvement initiative conducted in the summer of 2014 in Wisconsin's largest health care system, UW Health. The goals of this initiative were to (a) improve series initiation and completion of the HPV vaccine among eligible UW Health System patients; (b) improve series initiation in the recommended age window; and (c) reduce the male-to-female vaccination rate gap. We present results of a pre-/post-intervention survey of clinic staff, as well as the clinic-level rates of HPV vaccination for eligible patients before and after the intervention with 1-year and 3-year follow-up.

METHODS

Intervention

In 2013, a UW Health internal system-wide survey of clinical nurse managers suggested that clinicians did not fully understand the latest HPV vaccine recommendations and were unaware of the low immunization rates among their own patient panels. Confusion likely stemmed from rapidly evolving recommendations for routine HPV vaccination in this time period—particularly with respect to recommendations for male patients. To promote HPV vaccination, an Immunization Task Force designed an intervention intended to encourage UW Health clinicians to provide a strong HPV vaccine recommendation to eligible patients—both male and female—and ultimately to improve HPV vaccine series initiation and uptake system-wide. The intervention was implemented in 2014 in UW Health's Division of General Pediatrics and Adolescent Medicine and Department of Family Medicine.

The intervention was delivered to clinicians and staff in selected UW Health clinics during an onsite "lunch and learn" session. Physicians, clinic managers, nurses, physician assistants, and medical assistants were invited and encouraged to attend via emails from department chairs, clinical nurse managers, and the Immunization Task Force. Attendees were offered complementary lunch and continuing medical education credit. The intervention was delivered in-person, onsite.

Education Session and Discussion

A 40-minute didactic session led jointly by a UW Health pediatrician and obstetrician-gynecologist covered HPV virus facts, prevalence data, vaccine coverage, safety, and the contemporaneous CDC recommendations for vaccination series completion before age 13. Presenters emphasized the vaccine's role in cancer prevention and provided strategies for discussing it with adolescents and parents, addressing common questions and concerns. Attendees reviewed clinic-specific HPV vaccine rates, which were lower than rates for other recommended adolescent vaccines (meningococcal, Tdap, and influenza vaccines). The intervention goal was to emphasize the importance of HPV vaccination, aligning it with routine adolescent vaccines. Presenters encouraged questions and discussion throughout the session and included a 15-minute question-and-answer session at the end.

Over the course of 5 months in 2014, the intervention was presented at 17 clinic locations. Intervention clinics were selected non-randomly based on scheduling constraints and the size of the eligible patient populations, with the goal of maximizing system-wide impact.

This quality improvement intervention did not occur in isolation. According to an environmental scan of HPV vaccine promotion activities in Wisconsin around the time of this intervention, a variety of activities focused on educating clinical and health professionals, communities, and health systems regarding the importance of HPV immunization were concurrently in progress.[15]

Evaluation

We conducted 2 separate evaluations of this intervention. First, we used preintervention and postintervention surveys to assess the knowledge, attitudes, and practices of clinicians and staff at the clinics where interventions took place. Second, we conducted a post-hoc comparison of HPV vaccine series completion rates at intervention clinics and nonintervention clinics in the same health care system.

Preintervention Survey

Each educational session began with an anonymous, paper-and-pencil questionnaire assessing participants' knowledge about current age- and sex-specific recommendations for HPV vaccine, estimates of HPV vaccination rates among participants' own

patient panels, participants' perceptions of their patients' openness to HPV vaccination, and perceived barriers to vaccinating patients in their own practices. The survey was distributed and collected in person by the physicians leading the intervention. We did not collect information on the proportion of clinicians and staff who attended each session or completed the preintervention survey. In general, it was expected that clinicians and staff who were not engaged in patient care would attend the sessions. Clinic managers actively encouraged all present clinicians and staff to attend as each session began.

Table 1. Descriptive Statistics for Intervention and Nonintervention Clinics at the Time of Intervention

	Female Patients		Male Patients	
	Intervention Clinics (n = 17)	Nonintervention Clinics (n = 15)	Intervention Clinics (n = 17)	Nonintervention Clinics (n = 15)
Mean (SD) clinic patient panel size				
9–10 year olds	177 (118)	44 (25)	184 (140)[a]	49 (26)
11–12 year olds	170 (112)	26 (24)	179 (123)[a]	49 (24)
13–18 year olds	495 (281)	159 (79)	514 (346)	154 (71)
Mean (SD) HPV vaccine initiation rate				
9–10 year olds	1% (1%)	2% (4%)	0% (0%)[a]	0% (1%)
11–12 year olds	37% (8%)	37% (16%)	30% (9%)[a]	27% (15%)
13–18 year olds	73% (8%)*	65% (15%)[b]	54% (15%)[b]	44% (22%)[b]
Mean (SD) HPV vaccine series completion rate				
9–10 year olds	0% (0%)	1% (2%)	0% (0%)[a]	0% (0%)
11–12 year olds	11% (3%)	9% (6%)	7% (3%)[a]	5% (5%)
13–18 year olds	54% (9%)[b]	46% (13%)[b]	27% (12%)[b]	17% (11%)[b]
Mean (SD) sex difference in HPV vaccine initiation rate				
9–10 year olds	0.0% (1.0%)[a]	2.1% (4.0%)		
11–12 year olds	6.2% (7.2%)[a]	9.8% (10.6%)		
13–18 year olds	19.0% (10.1%)	21.3% (9.2%)		

[a]Note that one intervention clinic had no male patients in the 9- to 10-year-old or 11- to 12-year-old age groups. The n for these cells is 16.

[b]Intervention and nonintervention clinics were statistically different at the time of intervention, at α = 0.05.

Postintervention Survey

Three months after each session, all current clinicians and staff at each intervention clinic received an email invitation to complete a follow-up online questionnaire. This postintervention survey assessed the educational impact on participants' HPV vaccine knowledge and perceptions. It differed from the initial questionnaire in format and included additional questions about practice changes since the intervention. It also asked respondents to evaluate the intervention. Postintervention survey participants were asked to report whether they had attended the original educational session. We did not collect completion rate information on this survey.

Electronic Health Record Review of HPV Vaccine Rates

More than 4 years following the delivery of the intervention, we obtained HPV vaccine series completion rates from the electronic health record (EHR) for all UW Health System clinics from January 2013 to December 2019. In this post-hoc evaluation, we used all pediatric clinics in the same health care system and not in the intervention as controls. We excluded clinics that did not have patients in relevant age groups or were not in operation at the time of the intervention, leaving us with 15 nonintervention clinics. We evaluated change in HPV vaccination rates, observing series initiation and completion rates in specific age and sex subgroups each month 12 months before through 36 months after the intervention.

Statistical Analysis

To analyze data from both surveys, we used chi-squared tests and t tests to assess pre/post differences in survey respondents' understanding and perceptions of the HPV vaccine. Differences were assessed by comparing group means at time point A and B. We used SPSS Statistics version 26 (IBM Corp) for the comparative analyses.

To analyze HPV vaccine data from the UW Health System EHR data, we calculated HPV vaccine series initiation and completion rate data at the clinic level. Vaccine rates were calculated separately for males and females in the 9- to 10-, 11- to 12-, and 13- to 18-year age ranges for each month from 12 months prior to and 36 months after the intervention. Series initiation rates were calculated as the number of patients who had 1 dose of HPV vaccine divided by the total number of patients in each age/sex subgroup. Series completion rates are similarly calculated, using 3 doses as the definition for "completion" prior to the December 2016 change in recommendations and 2 doses afterwards. We conducted a difference-in-difference regression analysis with clinic fixed effects to compare the preintervention and postintervention change in vaccination rates among intervention clinics to the change in vaccination rates in nonintervention clinics. We also analyzed the change in the gap between male and female patients' HPV vaccine series initiation rates. Intervention impact analysis was performed in Stata 17 (StataCorp LLC). The study received UW-Madison Institutional Review Board exemption as a quality improvement initiative.

RESULTS

Table 1 describes baseline characteristics of both the intervention and nonintervention clinics. Intervention sites were selected non-randomly with a preference for larger sites and were predictably larger in terms of the number of patients. Both intervention and control sites had near-zero HPV vaccination among the youngest age group. Among 11 to 12 year olds, similar

HPV vaccination series initiation rates were observed at intervention sites (37% females, 30% males) and nonintervention sites (37% females, 27% males). For 13 to 18 year olds, intervention sites had higher HPV vaccine series initiation rates (73% females, 54% males) compared to nonintervention sites (65% females, 44% males).

Overall, similar patterns also were observed between intervention and nonintervention clinics for vaccine series completion rates (eg, 11% series completion for 11- to 12-year-old females in intervention clinics; 9% for the same group in nonintervention clinics). Sex differences in vaccination rates reported here always show higher HPV vaccine administration for female patients compared to male patients. Intervention clinics had smaller sex differences in HPV vaccine series initiation rates at the time of intervention (eg, Δ6.2% for 11 to 12 year olds in intervention clinics vs Δ9.8% in nonintervention clinics).

Table 2. Preintervention and Postintervention Measures of Knowledge, Attitudes, and Practices With Respect to HPV Vaccination

	Preintervention		Postintervention	
Knowledge measures	**Female Patients**	**Male Patients**	**Female Patients**	**Male Patients**
Correct minimum age for HPV vaccination	38%	26%	41%	34%
Correct maximum age for HPV vaccination	80%	87%	89%	73%
Recommendations for HPV vaccination				
Recommend in favor	91%	88%	97%	96%
Neither for nor against	8%	9%	3%	4%
Recommend against	1%	3%	0%	0%
Attitude measures				
Agree that patients react well to discussions about the HPV vaccine	57%		70%	
Respondent estimated percent of patients willing to receive HPV vaccination	63%		Not measured	
Respondent estimated percent of patients who had received the vaccine	59%		Not measured	

Preintervention Knowledge, Attitudes, and Practices

Before the intervention, many participants were unaware of the correct age range for HPV vaccination, and this varied by patient sex (Table 2). When asked about the earliest age for HPV vaccination, the majority incorrectly stated 11 to 12 years old. The second largest group correctly identified the youngest age range as 9 to 10 years. Few participants placed the lower age limit below 9 or above 12. Knowledge of upper age limits was also incomplete. Most correctly identified the upper age limit as 22 to 26 years. A few respondents thought it was over age 26, while a small number selected 18 to 21 years. A chi-square test confirmed a statistically significant difference in reported lower ($x^2 = 491.68$, $P < 0.001$) and upper ($x^2 = 335.98$, $P < 0.001$) age limits by sex.

Before the intervention, most participants recommended the HPV vaccine for females (91%) and males (88%), with a smaller group who said they recommended neither against nor in favor of the vaccine for females (8%) and males (9%). Only 1 participant said they recommended against the vaccine for females (1%), and a few more recommended against the vaccine for males (3%). A chi-square test confirmed a statistically significant difference in recommendation patterns between female and male patients ($x^2 = 172.6$, $P < 0.001$).

Prior to the intervention, most participants (57%) agreed or strongly agreed with the statement, "My patients (and/or their parents) react well to discussions about the HPV vaccine." About one-third (33%) neither agreed nor disagreed, while 10% indicated that patients/parents reacted negatively.

Respondents dramatically overestimated HPV vaccine series and completion rates in their own patient panels. On average, they believed that 63% of their patients were willing to receive the HPV vaccine and that 59% had received it. However, at the time of the intervention, the average initiation rate across the intervention clinics was just 38% (41% for females and 34% for males). The vaccine series completion rate was 18% (23% for female patients and 14% for males).

Postintervention Knowledge, Attitudes, and Practices

Three months postintervention, most participants still incorrectly placed the lower age limit for HPV vaccination at 11 to 12 years (Table 2). A large minority correctly identified the range as to 10 years. A few inaccurately placed the lower age limit above the age of 12, while 1 participant said males could receive it before age 9.

Following the intervention, strong majorities placed the upper age limits between 22 and 26 years. One in 5 (21%) placed the upper limit for males in the 18- to 21-year range, while only 4% said the upper limit was 18 to 21 years for female patients. Small numbers of responders said that the upper limit for HPV vaccine was below the age of 18 years or above age 26 years for males. Differences in lower ($x^2 = 129.8$, $P < 0.001$) and upper ($x^2 = 176.3$, $P < 0.001$) age limits reported on the postintervention survey were significantly different by patient sex.

At 3 months postintervention, respondents almost universally indicated that they did recommend in favor of the HPV vaccine for females (97%) and males (96%). A few respondents said they neither recommended in favor nor against the HPV vaccine, and none reported recommending against the HPV vaccine for either sex. Differences in recommendations for females and males were not statistically significant.

Following the intervention, more than two-thirds (69%) of participants agreed or strongly agreed with the statement, "My patients (and/or their parents) react well to discussions about the HPV vaccine."

Changes in Knowledge, Attitudes, and Practices

Postintervention knowledge improvements regarding HPV immunization age ranges were observed but did not reach statistical significance. After the intervention, participants showed stronger support for recommending the HPV vaccine to both female (pre mean = 6.44, post mean = 6.68) and male (pre mean = 6.31, post mean = 6.57) patients ($P < 0.05$). Additionally, they reported better patient reactions to HPV vaccine discussions after the intervention (pre mean = 4.73, post mean = 5.05; $P = 0.016$).

Clinic-Level Change in HPV Vaccination Rates at 12- and 36-month Follow-up

Based on review of the electronic health records at the clinic level, intervention clinics showed increases in HPV vaccine initiation and completion rates for all age and sex groups at both 12- and 36-month follow-up, though not all changes were statistically significant. For example, at 12 months, female patients aged 11 to 12 years had 5.8% higher HPV series initiation rates and 1.2% higher completion rates as compared to baseline. Male patients aged 11 to 12 years had 10.1% higher series initiation and 3.2% higher series completion rates (results available from the authors).

Difference-in-difference regression models indicated that for most age and sex groups, intervention clinic gains were larger than the nonintervention gains at follow-up (Table 3). For example, at 12-month follow-up, intervention clinic female patients aged 11 to 12 years had 8.7% greater gains in HPV series initiation rates than in nonintervention clinics. Intervention clinic male patients in this age group had 8.4% greater gains in HPV series initiation rates than in nonintervention clinics. (Full results are available from the authors.)

To assess the change in the female-to-male gap in HPV vaccine rates between intervention and nonintervention clinics, we assessed sex differences in the change in HPV vaccination rates, comparing intervention to nonintervention clinics. Results showed that at the 12-month follow-up, the gap between females and males in HPV vaccine initiation rates decreased significantly in intervention clinics but only for 9- to 10-year-old patients. Completion rate gaps narrowed in intervention clinics only for 11 to 12 year olds and 13 to 18 year olds. Findings at the 36-month follow-up also were mixed. (Complete results are available from the authors.)

Table 3. Difference in HPV Series Initiation Rates Between Intervention and Nonintervention Clinics at 12-month Follow-up, by Sex and Age Group

	Females	Males
9–10 year olds	+2.0%[a]	-0.3%[a]
11–12 year old	+8.7%[a]	+8.4%[a]
13–18 year olds	+2.5%	+4.1%

[a]Statistically significant difference in difference at α = 0.05.

Note: Positive numbers indicate that the preintervention/postintervention gain was greater in intervention clinics compared to nonintervention clinics. Negative number indicates that the pretreatment/posttreatment gain was greater in nonintervention clinics compared to intervention clinics.

DISCUSSION

Clinicians, being trusted information sources, play a pivotal role in influencing patient choices through strong clinical recommendations.[16] Considering the universal susceptibility to HPV and its association with various cancers in all sexes,[17] vaccination emerges as a vital preventive measure. In addition, widespread vaccination can reduce the risk that all individuals are exposed by producing herd immunity.[18]

Our study endeavored to bring clinicians current on rapidly shifting HPV vaccine guidance and offer them their own patient vaccination data, encouraging higher vaccination rates across patient demographics. Postintervention assessments illustrated an elevated understanding of the revised eligibility guidelines for male patients and fostered greater eagerness to recommend the vaccine to all individuals, complemented by positive shifts in perception regarding vaccine receptiveness from patients and parents.

Long-term follow-up revealed significantly greater improvements in intervention clinics over 12 and 36 months, showcasing sustained improvements. However, differences in changes in the gap between female and male HPV vaccination rates were inconsistent between intervention and nonintervention clinics. Future studies should further investigate whether improving clinicians' understanding of their performance on HPV vaccination rates can change their HPV vaccine practices, as well as whether such conversations can encourage collaboration among clinic staff through real-time data feedback.

Limitations

This analysis has several limitations. Intervention clinics were selected based on patient panel size, not through random selection, potentially implicating other concurrent quality improvement endeavors in the observed results.[15] Further, the study uses a clinic-level analysis—a method that overlooks staff changes and multiclinic clinicians, making it difficult to rule out possible cross-contamination of the intervention in nonintervention clinics. Such cross-contamination, if it exists, likely weakened any observable effect of the intervention. Our analysis of knowledge, attitudes, and practices relies on self-reported attendance at the educational intervention, which we cannot verify independently. We also do not have any information on the completion rates—particularly for the postintervention survey among all staff at participating clinics. Low participation could affect how we interpret postintervention survey data. This is one reason we decided after the fact to conduct an analysis of HPV vaccine uptake data for all clinics.

CONCLUSIONS

Our results suggest that in-person educational interventions that include elements of real-time data feedback and didactic

content may enhance HPV vaccination rates at the clinic level for extended periods. However, this intervention required substantial resources and intricate scheduling. Considering more cost-effective solutions, such as prerecorded or remote sessions despite potential compromises on customization, is advisable. Future studies should evaluate the tradeoffs of various intervention approaches.

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