RESEARCH PAPER

A quality improvement education initiative to increase adolescent human papillomavirus (HPV) vaccine completion rates

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ABSTRACT

HPV vaccine uptake is low, nationwide. Quality improvement (QI) principles have the potential to change practice; however, not all providers are confident with QI skills. We developed an educational program designed to enhance QI skills and improve HPV vaccination rates. Five pediatric practices participated in the pilot initiative. Training consisted of presentations regarding QI methods, data tracking and analysis, and system changes to reduce missed opportunities. Monthly for 6 months, participants performed chart audits, captured data, printed run charts, and developed, implemented, and tracked interventions. Outcome measures included rates of HPV vaccine completion and missed opportunities. A second phase included eight different pediatric practices who received similar training. Outcome measures included rates of HPV vaccine initiation and completion. Over the 6 months, mean HPV vaccine completion rates increased (45% to 65%) and missed opportunities for HPV vaccination decreased (45% to 19%) in the pilot program. When the program was replicated in phase 2, an increase was seen in both HPV vaccine initiation (46% to 61%) and completion (62% to 94%) rates. Combining QI education with workflow-focused strategies was associated with a reduction in missed opportunities and a substantial increase in HPV vaccine completion rates.

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Introduction

Oncogenic human papillomaviruses (HPV) are responsible for the majority of genitourinary and oropharyngeal cancers in the United States.¹ HPV vaccines routinely recommended for adolescents starting at age 11–12 years, are safe and effective in preventing vaccine-type infections and their sequelae.² Despite widespread vaccine availability, national adolescent HPV vaccine uptake remains poor, with vaccine series initiation and completion rates of 65.5% and 48.6%, respectively, leaving the majority of the adolescent population susceptible to infection and potential development of HPV-associated cancers.³

A variety of factors are known to influence HPV vaccine uptake. The most commonly cited reason for HPV non-vaccination is failure of the provider to recommend the vaccine. In contrast, a reported understanding that the vaccine prevents HPV-associated cancers and receiving a strong, presumptive vaccine recommendation are consistently associated with HPV vaccine acceptance.^{4–7} Despite vaccine availability and clear recommendations for its use for more than a decade, many providers are still delivering inconsistent and weak vaccine recommendations, describing the vaccine as optional, delaying vaccination to a later visit and/or reporting parental hesitancy. Others express their inability to change the mind of those who refuse or delay vaccination, and articulate that they have insufficient time to ask about reasons for parental hesitancy.^{5,8,9} Review of audio recordings of provider-parent visits regarding the HPV vaccine has led to suggestions that providers may benefit from training on how to deliver a stronger vaccine recommendation.^{8,9}

More than 40% of adolescent medical visits are associated with a missed opportunity to vaccinate against HPV.^{10,11} In fact, if all missed opportunities for HPV vaccination were eliminated for the 2000 birth cohort, more than 91% of the group would have initiated the vaccine series by age 13 years.¹² One strategy for reducing missed opportunities is a standard practice of reviewing immunization records at each medical visit. While providers primarily review and administer immunizations at well visits, many adolescents only seek medical care when they are sick.^{13,14} Practice changes that facilitate the review of immunization records at all acute visits reduce missed opportunities for immunization and result in significant increases in HPV vaccination rates.^{15–17}

Increasing vaccination rates among targeted populations can be challenging. The Community Preventive Services Task Force recommends using a combination of strategies in parallel to maximize the success of the interventions.¹⁸ We previously developed and implemented an educational program for adolescent patients and their parents that bundles HPV vaccine education with other commonly accepted cancer prevention guidance. This educational approach was modestly successful in raising HPV vaccination rates.¹⁹ While the practice change seen following education alone may not be sustainable, adding systematic changes to clinical workflow to an existing educational program has the potential to result in long-lasting improvements.^{20–23}

Quality improvement (QI) is the process of implementing practice changes in a systematic manner to result in measurable improvements in health-care outcomes.^{24,25} The

American Board of Pediatrics requires documentation of QI efforts for Maintenance of Certification (MOC), yet fewer than half of pediatric diplomats report feeling moderately confident in their use of: 1) QI tools to inform improvement efforts (29%), 2) QI methods to test intervention strategies (35%), and 3) data analysis to track those changes (47%).²⁵

Our goal was to provide an educational program to pediatric providers that taught the essential principles, methodology, data collection tools, and tracking skills needed to implement a QI program. Following the training session, providers implemented a real-world QI project focused on improving practice-specific HPV vaccination rates.

Methods

Pilot program

In 2016, the American Academy of Pediatrics (AAP), NY Chapter 1 received funding from the AAP-sponsored District Hub and Spoke Initiative²⁶ to implement a pilot QI program designed to increase HPV vaccine completion rates among 11–12-year-olds by at least 10 percentage points from the pre-intervention practice-specific baseline. Providers who completed the 6-month program were eligible for MOC Part 4 credit as an incentive for participation. As this quality improvement program was designed to assess the implementation of existing knowledge, this program is exempt from institutional IRB review.

Five pediatric practices from AAP NY Chapter 1, each employing between 4 and 10 providers, were recruited for participation. Each practice designated one physician provider and one staff member to serve in the role of QI champion for this initiative.

In December 2016, the QI champion pairs from each practice attended an off-site education training day that included three 1-h didactic sessions and 1 h-long interactive session. The first didactic session focused on the definition of QI, its process, and commonly used data visualization tools such as value stream maps, impact matrixes, and run charts. Plan-do-study-act (PDSA) cycles were discussed using several examples. The second didactic session focused on HPV disease and prevention including the epidemiology of HPV infection and HPV-associated cancers, current HPV vaccine recommendations, national, regional, local, and practice-specific immunization coverage rates, and factors known to be associated with HPV vaccine acceptance. Time was spent during this session modeling strategies for delivering a strong, presumptive vaccine recommendation. The third session included an introduction to the AAP's web-based data collection tool, QIDA – Quality Improvement Data Aggregator. The final session of the training day was an interactive discussion between the trainers and the practice representatives regarding feasible, evidence-based, systematic interventions that practices could implement as QI initiatives to improve their HPV vaccine completion rates. Such interventions included the use of reminder-recall systems, electronic health record prompts, pre-review of adolescent charts to determine vaccine eligibility for all scheduled visits, attaching immunization records to the chart at each visit, and standing orders. After attending the training session, QI champions shared the QI education materials

with all providers and staff in their practice. Their first monthly QI cycle began immediately thereafter.

Each practice began cycle 1 with a chart review of the first 10–20 patients aged 11–12 years seen consecutively beginning on the first workday of the month. As per the Agency for Healthcare Research and Quality, review of at least 10 patient records during a target time period is sufficient to generate practice-specific performance data.²⁷ Information collected during chart audit included patient gender, age, visit type (well, acute, follow-up, nurse-only), HPV vaccine eligibility, documentation of provider vaccine recommendation, and all vaccines administered during the visit. Data from the chart review were entered directly into the QIDA site; run charts were developed and printed. The providers and staff reviewed the run chart data at a practice team meeting and discussed the implementation of an intervention to reduce missed opportunities and improve HPV vaccination rates. Use, feasibility, and balance measures of the selected interventions were tracked over the course of the following month, with changes made as needed. The QI cycle was repeated each month for five consecutive months. Full participation in the program required completion of five monthly cycles during the 6-month study period.

Phase 2

In 2017, the AAP NY Chapter 1 received further funding from the AAP-sponsored District Hub and Spoke Initiative to expand on the pilot program. The aim of phase 2 of the program was to increase practice-specific HPV vaccine *initiation* and *completion* rates among 11–12-year-olds by at least 10 percentage points from the pre-intervention, practice-specific baseline. Providers who completed the 6-month program were eligible for MOC part 4 as an incentive for participation.

Eight different pediatric practices from AAP NY Chapter 1, each employing between 1 and 10 providers, were recruited for participation. Each practice designated one physician provider and one staff member to serve in the role of the QI champion for this initiative.

In February 2018, the QI champion pairs from each chapter attended an off-site education training day, which presented the same content in the same format as the pilot program. Information collected during the chart audits for this phase of the program included patient gender, age, visit type, documentation of HPV vaccine series initiation and documentation of HPV vaccine series completion. The monthly cycles of data collection, entry into the QIDA site, creation of run charts, team meetings with discussion of results and analysis, and the implementation of chosen interventions with tracking of implementation occurred in a similar manner to the pilot program. Full participation in phase 2 of the program required completion of five monthly cycles during the 6-month study period.

Measures and analysis

Pilot program

The primary outcome measure for the pilot initiative was HPV vaccine series completion among 11–12-year-old patients who

had already started the vaccine series and who were seeking medical care during the QI initiative. Vaccine series completion, defined by the 2016 recommendations of the Advisory Committee on Immunization Practices, includes the receipt of two doses of HPV vaccine at least 5 months apart, or three doses of HPV vaccine with more than 5 months between the first and third dose.² The calculation for this measure was the number of patients who completed the HPV vaccine series divided by the number of patients who had initiated the series and received their first dose more than 5 months prior.

The secondary measure for this program was the rate of missed opportunities for HPV vaccination, defined as patient visits where the HPV vaccine was due but not given. The calculation for this measure was the number of patients who were due for a dose of HPV vaccine but were not vaccinated divided by the number of all patients who were due for a dose of HPV vaccine at their visit. This measure was then further classified by type of medical visit (well, acute, follow-up, and nurse).

Phase 2

The primary outcome measures in phase 2 of the program were HPV vaccine series initiation and HPV vaccine series completion rates among 11–12-year-old patients seeking medical care during the QI initiative. The calculation for vaccine initiation rates was the number of patients who had received at least one dose of HPV vaccine divided by the number of patients who were eligible to receive vaccine. The calculation for vaccine series completion rates was the same as in the pilot program.

Data analysis

Data analysis was performed by the generation of run charts, which were interpreted using run chart interpretation rules.²⁸ Data were analyzed and presented in aggregate form. Due to the exploratory nature of this study, there was no sample size calculation. Chi-square tests or Fisher exact tests were used, as appropriate, to compare the aggregate vaccination rates prior to and at the end of the QI program.

Balance measures

The practices completed an online survey monthly to assess the delivery of a strong vaccine recommendation, and the perceived impact of the QI program on visit length, provider satisfaction with parent communication, and the operational

and clinical practice flow. Telephone-based learning collaboratives, held at 3 and 6 months, facilitated by the study team, were an opportunity for clinicians to share best practices and obstacles encountered.

Results

Pilot program

Practice and patient demographics

Five pediatric practices completed the pilot QI program. Each practice is a private, office-based site that uses electronic health records and participates in the federal Vaccines for Children program. All practices serve suburban communities, two of the practices also serve rural and urban communities. In total, between 71 and 82 charts of patients ages 11–12 years were reviewed each cycle. Patient age, gender, and medical visit type are listed in Table 1. During the QI initiative, implemented practice-level interventions included a commitment to deliver a strong provider vaccine recommendation and introduction of systematic changes to reduce missed opportunities such as review of immunization records at every medical visit, electronic medical records to deliver automatic provider prompts, and standing orders for HPV vaccination.

HPV vaccine completion

Across the five participating practices, run chart analysis demonstrates that HPV vaccine completion rates among eligible 11–12-year-old patients increased by 19% after 5 QI cycles ($p < .05$) (Figure 1(a)). During the same period, the run chart showed that aggregate data for all missed opportunities for HPV vaccination decreased from 45% to 19% ($p < .05$) (Figure 1(b)). Of note, missed opportunities for vaccination during well visits and nurse's visits decreased to 0 for all practices by cycle 3. Among all charts reviewed, 180/232 (78%) of children due for HPV vaccine were immunized during these visits. Among the 52 visits where the HPV vaccine was due but not given, adolescents received influenza vaccine (2), hepatitis A vaccine (2), varicella vaccine (2). Forty-seven (90%) adolescents received no vaccines. Documentation of provider vaccine recommendation increased by over 20% after cycle 1 and strongly correlated with adolescent HPV vaccination (Figure 2(a,b)).

Table 1. Aggregate patient characteristics and medical visit types documented during each QI cycle.

	Pilot program cycle					Phase 2 program cycle				
	1	2	3	4	5	1	2	3	4	5
Charts reviewed	71 n (%)	82 n (%)	77 n (%)	77 n (%)	76 n (%)	125 n (%)	127 n (%)	148 n (%)	130 n (%)	135 n (%)
Gender										
Female	38 (54)	39 (48)	40 (52)	41 (53)	31 (41)	62 (50)	64 (50)	71 (48)	59 (45)	70 (52)
Male	33 (46)	43 (52)	37 (48)	36 (47)	45 (59)	63 (50)	63 (50)	77 (52)	71 (55)	65 (48)
Age										
11 years	24 (34)	29 (35)	26 (34)	36 (47)	31 (41)	64 (51)	64 (50)	75 (51)	67 (52)	68 (50)
12 years	47 (66)	53 (65)	51 (66)	41 (53)	45 (59)	61 (49)	63 (50)	73 (49)	63 (48)	67 (50)
Type of visit										
Well child	14 (20)	17 (21)	20 (26)	19 (25)	24 (32)	42 (34)	53 (42)	61 (41)	59 (45)	76 (56)
Acute	33 (46)	28 (34)	25 (32)	26 (34)	30 (39)	58 (46)	41 (32)	47 (32)	45 (35)	32 (24)
Follow-up	15 (21)	8 (10)	4 (5)	5 (6)	5 (7)	22 (18)	28 (22)	30 (20)	22 (17)	20 (15)
Nurse's visit	9 (13)	29 (35)	28 (36)	27 (35)	17 (22)	3 (2)	5 (4)	10 (7)	4 (3)	7 (5)

Figure 1. (a) HPV vaccine series completion rates and (b) Rates of missed opportunities for 11–12-year-olds seeking care at the five pediatric practices participating in the pilot program over five cycles. (c) HPV vaccine series initiation and (d) HPV vaccine series completion rates among 11–12-year-olds seeking care at the eight pediatric practices participating in phase 2 of the QI program over five cycles.

Program evaluation and learning collaboratives

Participating practices completed a group survey after each monthly team meeting. Survey results indicated that all practices emphasized the role for HPV vaccine in cancer prevention, informed the entire office staff about the QI program and provided strategies on how to best support the physician recommendation as a practice-wide philosophy, while also reporting no change in patient visit length. The majority of practices incorporated bundling HPV vaccine with Tdap and meningococcal vaccines and used personal attestations regarding vaccinating their own children against HPV. Responses from 7 (35%) and 12 (60%) reported no change or an increase, respectively, in provider satisfaction with vaccine communication, and 13 (65%) and 7 (35%) reported no change or an easier operational and clinical flow during the work day, respectively. Reported reasons for parent refusal of HPV vaccine included beliefs that the child is not sexually active, the need for more HPV vaccine information, the desire to wait until the child is older, and concern that the child was not anticipating vaccination at an acute visit.

Phase 2 program

Practice and patient demographics

Eight different pediatric practices completed phase 2 of this QI program to improve HPV vaccine series initiation and completion rates. Two practices are associated with large academic universities, while the remaining six practices are private, office-based sites. In total, between 125 and 148 charts of patients aged 11–12 years were reviewed each cycle. Patient age, gender, and medical visit are listed in Table 1. During the QI initiative, practice-level interventions implemented included a commitment to deliver a strong provider vaccine recommendation and introduction of systematic changes, including updating the electronic medical record to facilitate review of immunization records, reminder-recall systems, and implementation of clinical decision support tools as provider reminders for vaccine-eligible patients.

HPV vaccination

Across the eight pediatric practices, run chart analysis demonstrates that HPV vaccine initiation rates increased by 15%,

Figure 2. (a) Provider recommendation and vaccine receipt when HPV vaccination due at visit (b) Correlation between provider recommendation and vaccine receipt for all 11–12-year-olds seeking care at the five participating pediatric practices over five cycles.

from 46% to 61% ($p < .05$), after 5 QI cycles (Figure 1(c)). Similarly, aggregate data show an increase in HPV vaccine series completion rates by 32%, from 62% to 94% ($p < .05$), after 5 QI cycles (Figure 1(d)).

Program evaluation and learning collaborative

A total of 31 practice-specific group surveys were received and analyzed. Five of the eight participating practices used personal attestations regarding vaccinating their own children against HPV, while all eight practices incorporated the bundling of HPV vaccine with Tdap and meningococcal vaccines during discussion and emphasized the role for HPV vaccine in cancer prevention. All but one of the practices informed their office staff about the QI program and provided them with strategies on how to best support the physician recommendation as a practice-wide philosophy.

Of the 31 surveys with the question answered, 29 (94%) reported a perceived no change or decrease in length of patient visit. The two surveys reporting a perceived increase in patient visit were from a single practice which also commented that “sick visits took a few minutes longer but the system worked well.” Twenty-two (71%) and eight (26%) reported no change or an increase, respectively, in provider satisfaction with vaccine communication. Similarly, 23 (61%) and eight (21%) reported no change or easier operational and clinical flow during the work day, respectively.

Discussion

HPV vaccine uptake remains low nationally. QI principles can be utilized for implementing systematic changes to increase HPV vaccination rates; however, reports have shown that many pediatricians are not confident in their QI skills. We implemented a program, combining essential QI education with evidence-based interventions to improve the measured

outcomes. Results from the pilot program included a reduction in missed opportunities for HPV vaccination and a 19% increase in HPV vaccine completion rates among 11–12-year-old adolescents from participating pediatric practices, exceeding our goal of 10% nearly twofold. Similarly, execution of a second phase with different practices resulted in an increase of vaccine series initiation and completion rates by 15% and 32%, respectively, over the five cycles. During this program, each practice tracked their own data and developed and implemented systematic interventions specific to their practice. While all practices worked to improve the delivery of a strong provider HPV vaccine recommendation, they also unanimously adopted one or more system-based changes.

The QI interventions selected by the practices in the pilot program completely eliminated missed opportunities for HPV vaccination at well and nurse’s visits. Practical and feasible changes to standard workflow, including standing orders and review of immunization records at each medical visit, were also associated with reductions in missed opportunities without any reported increases in the length of patient visits. Missed opportunities for vaccination contribute to non-completion rates for all pediatric and adolescent vaccines.^{15,29} The success of the system changes that were incorporated in this QI program are quite likely generalizable to all universal-recommended vaccines across all pediatric age groups offering the potential to improve vaccine completion rates across the entire practice population.

In an effort to improve the strength of their vaccine recommendation, providers reported bundling HPV vaccine with the other adolescent vaccines, delivering the message of HPV vaccine as another tool for lifelong cancer prevention, and/or providing a personal attestation to the vaccine recommendation. Not unexpectedly, documentation of a provider vaccine recommendation in the medical records correlated with HPV vaccine receipt. This finding is consistent with

other published reports emphasizing the provider's role in patient's acceptance of HPV and other vaccines.^{30–32}

Participants in our program reported an increase in provider satisfaction during communication with patients and their families about HPV vaccine. High-quality, presumptive provider recommendations that strongly endorse the vaccine, use cancer prevention messaging, and express urgency (same day vaccination) are associated with HPV vaccine receipt; however, reports show that providers are not yet proficient at recommending the vaccine in this manner.^{5,6,8,9} Kumar et al. reported that a 20-min training video used to model a strong HPV vaccine recommendation improved provider vaccine confidence and comfort with recommending the HPV vaccine.³³ Lockhart et al. described a 5-component health-care professional HPV vaccine communication intervention that improved adolescent HPV vaccination rates.³⁴ The providers in Lockhart's study reported that the training on the use of a presumptive vaccine recommendation was particularly helpful.^{34,35} Communication training should be incorporated into future provider-gearred interventions aimed at improving HPV vaccine uptake.

For improvement programs to be sustainable and effective, system changes should improve workflow efficiency while optimizing patient care. Enrolled practices reported that the participation in this QI program was not associated with changes in the length of patient visit and either had no effect on clinical operations throughout the office, or made them easier. Practice engagement increases ownership, accountability, and confidence in the model for change.³⁶ The most effective interventions in changing practice combine workflow-focused and provider-focused strategies. All office staff have the ability to identify, influence and implement changes within a practice with the potential of improving operational flow and optimizing patient care. As such, all staff members should be encouraged to engage and participate in QI initiatives.^{37–39} Programs that combine education regarding the quality improvement process with a targeted focus on any area of interest has the potential for applicability of these methods in primary care offices.

There are several limitations to the generalizability of this study. This QI initiative involved a limited number of practices in AAP NY Chapter 1. These practices were mostly large, private practices serving largely suburban communities; therefore, practices of varying sizes and patient demographics may have different results from a similarly designed QI project. Providers from these practices volunteered to participate in this program, leading to potential site selection bias. Balanced measures were obtained by a single subjective composite practice-wide survey, which did not address objective data or individual perceptions. To address these possibilities, we are currently expanding this QI program to pediatric practices across New York State in a variety of outpatient pediatric settings. Furthermore, due to study design for this QI program, it is difficult to assess the influence of time and the correlation of subjects across the cycles.

Here, we show that a QI program that includes teaching of essential QI principles, and provides examples of workflow-focused strategies resulted in increases in HPV vaccine series

initiation and completion rates among children aged 11–12 years well above the goal of 10%, even when replicated with a second group of practices. Key concepts to the success of this program include the basic quality improvement education, providing strategies to deliver a strong provider vaccine recommendation, reviewing system changes to facilitate vaccination, and engagement of the all office staff in the effort, all potentially generalizable to optimize patient care and workflow efficiency in a busy primary care practice.

Abbreviations

HPV	human papillomavirus
QI	quality improvement
AAP	American Academy of Pediatrics
MOC	Maintenance of Certification
PDSA	Plan-Do-Study-Act
QIDA	Quality Improvement Data Aggregator

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