



Effectiveness of a provider-focused intervention to improve HPV vaccination rates in boys and girls



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ABSTRACT

Background: HPV vaccination is universally recommended for boys and girls, yet vaccination rates remain low nationwide.

Methods: We conducted a provider-focused intervention that included repeated contacts, education, individualized feedback, and strong quality improvement incentives to raise HPV vaccination rates at two federally qualified community health centers. To estimate the effectiveness of the intervention, rates of initiation of vaccination, and completion of the next needed HPV vaccination (dose 1, 2 or 3) among boys and girls ages 11–21 were compared at baseline and two follow-up periods in two intervention health centers ($n = 4093$ patients) and six control health centers ($n = 9025$ patients). We conducted multivariable logistic regression accounting for clustering by practice.

Results: Girls and boys in intervention practices significantly increased HPV vaccine initiation during the active intervention period relative to control practices (girls OR 1.6, boys OR 11; $p < 0.001$ for both). Boys at intervention practices were also more likely to continue to initiate vaccination during the post-intervention/maintenance period (OR 8.5; $p < 0.01$). Girls and boys at intervention practices were more also likely to complete their next needed HPV vaccination (dose 1, 2 or 3) than those at control practices (girls OR 1.4, boys OR 23; $p < 0.05$ for both). These improvements were sustained for both boys and girls in the post-intervention/maintenance period (girls OR 1.6, boys OR 25; $p < 0.05$ for both).

Conclusions: Provider-focused interventions including repeated contacts, education, individualized feedback, and strong quality improvement incentives have the potential to produce sustained improvements in HPV vaccination rates.

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1. Introduction

HPV causes approximately 33,000 cancers annually in the U.S., [1] and the burden of preventing and treating these cancers exceeds \$7 billion dollars annually [2]. The efficacy of HPV vaccination in reducing cervical, vulvar, vaginal and anal dysplasia and genital warts has been demonstrated in clinical trials [3,4] and post-marketing studies from the U.S. and other countries [5–9]. Yet 2013 U.S. data indicate that only 57% of young women and 35% of young men initiated and 38% of young women and 14% of young men

completed the 3-dose series, and vaccination rates among girls have improved little since 2011 [10–12]. Improving HPV vaccination rates is a priority for the Centers for Disease Control and Prevention [13], the American Academy of Pediatrics [14], and the President's Cancer Panel [15]. Parents are the key HPV vaccine decision-makers, and improving parent-provider communication is widely regarded as the key to raising vaccine initiation rates [16–24], yet many providers feel poorly prepared to address parents' concerns, which can result in weak vaccine recommendations or a failure to broach the topic at all [11,25–27]. Vaccine completion, by contrast, relies more on healthcare systems than personal interactions [28].

Vaccine completion further relies on healthcare and provider practices. Recent findings from the National Immunization

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Survey-Teen (NIS-Teen, 2007–2013) and CDC's national post licensure safety data suggest that had HPV vaccine been administered to adolescent girls born in 2000 during health care visits when they received another vaccine, vaccination coverage for ≥ 1 dose by age 13 years for this cohort could have reached 91.3% during the 2007–2013 period [12].

Many solutions have been proposed to improve vaccination rates, including provider education, provider prompts, and reminder/recall systems [29–32]. A recent analysis of 33 educational interventions to improve HPV vaccination found that none succeeded in improving vaccination rates [33]. Education is thus considered necessary but not sufficient to produce changes in practice. Performance Improvement Continuing Medical Education (PI CME) combines components from two widely used mechanisms to improve provider practice: academic detailing, a method of improving physician adherence to best practice guidelines that involve targeted individualized education and feedback [34], and the Centers for Disease Control and Prevention's Assessment-Feedback-Incentive-eXchange (AFIX) [35] methods for improving vaccine use. In this study, we used a multi-component PI CME intervention to improve HPV vaccination rates. Components of the PI CME included; repeated contacts, focused education, and individualized feedback; we provided the incentive of completing new medical specialty board certification requirements through participation in the PI CME. To determine intervention effectiveness, we compared HPV vaccination rates in two federally qualified health centers receiving our PI CME interventions to six matched controls.

2. Methods

2.1. Setting

Control and intervention practices included the outpatient Pediatric/Adolescent Departments of an urban academic medical center and seven affiliated federally qualified community health centers. Seventy percent of adolescents are from racial and ethnic minority populations, 30% do not speak English as their primary language, and 75% have public insurance (e.g. Medicaid).

2.2. Recruitment of practices

Two of eight community health centers within a single network of inner-city neighborhood health centers were recruited as intervention practices and the remainder served as controls. Selection of the practice for the intervention or control condition was random. Each practice had separate staffs and facilities, so spillover was limited; during the intervention period, none of the intervention components was offered to the control practices. All physicians, nurse practitioners, nurses, physician assistants, and medical assistants at participating practices were eligible to participate in the intervention. Only physicians, nurse practitioners, and physician assistants with their own patient panels were eligible to receive personalized feedback on vaccination rates. As an incentive, physicians were eligible to receive Maintenance of Certification Part IV credits, which fulfilled the requirements for maintaining board certification in pediatrics.

2.3. Intervention

The intervention had four essential components: (1) repeated contacts (i.e. meetings every 4–6 weeks during the project period) to establish trust and accountability and to support providers to make practice-wide changes, (2) focused education on the morbidity and mortality from HPV, vaccine safety, and vaccine efficacy, (3) individualized feedback on vaccination rates relative to the

practice-wide, state, and national rates, and (4) incentives in the form of maintenance of board certification requirements. We now describe these components in detail.

2.3.1. Repeated contacts

Interventions included six to eight sessions conducted over approximately 12 months. Each session was conducted by an HPV physician-educator and administrative staff from the Boston University Continuing Medical Education office during a regular staff meeting, and food was provided.

2.3.2. Focused education

Topics included HPV-related cancers, vaccine efficacy, and safety and use of basic motivational interviewing principles with vaccine-hesitant parents [36]. Educational sessions were designed to change the way providers: (1) viewed the importance of HPV vaccination, (2) framed discussions around HPV vaccines, and (3) responded to parents' initial hesitation toward HPV vaccines.

2.3.3. Individualized feedback:

At each session, providers' and practices' HPV vaccination rates were compared to state and national rates. Participants received individual reports that showed their performance compared to other providers in their practice on HPV vaccination rates by age, gender, and number of doses received. Providers evaluated variations in HPV vaccination rates to create or update their clinical action plans. Participant-driven initiatives to improve systems for series completion were also supported.

2.3.4. Quality improvement incentives

Physicians were eligible to receive Maintenance of Certification Part IV credits, which fulfilled requirements for maintaining board certification in pediatrics. To receive these credits, however, practices as a whole had to demonstrate measurable improvements in HPV vaccination rates.

2.4. Study design

The primary purpose of the intervention was to increase vaccination rates. Therefore, we evaluated study effectiveness at the patient level by comparing vaccination rates of adolescent patients at intervention and control practices using multivariable logistic regression controlling for clustering by practice. Patients included in the assessment of intervention effectiveness included boys and girls aged 11–21 who received primary care in the Pediatric/Adolescent Departments at an intervention or control practice. Receipt of primary care was defined as one or more well visits over the past two years. Patients who previously completed the HPV vaccine series, those who were pregnant during the study period, and those who had received care in both an intervention and control practice were excluded from the analyses (Fig. 1). Those who had previously initiated HPV vaccination were excluded from the analysis of vaccine initiation but not completion of any needed dose.

2.5. Statistical analysis

Initiation of vaccination (receipt of dose 1 only) and of the next needed HPV vaccination (dose 1, 2 or 3) among boys and girls ages 11–21 were compared at baseline and two follow-up periods among two intervention health centers ($n \equiv 4093$ patients) and six control health centers ($n \equiv 9025$ patients). We controlled for the number of adolescents presenting for care at each practice. We chose to evaluate completion of the next needed HPV vaccine dose rather than completion of the entire 3-dose series because several

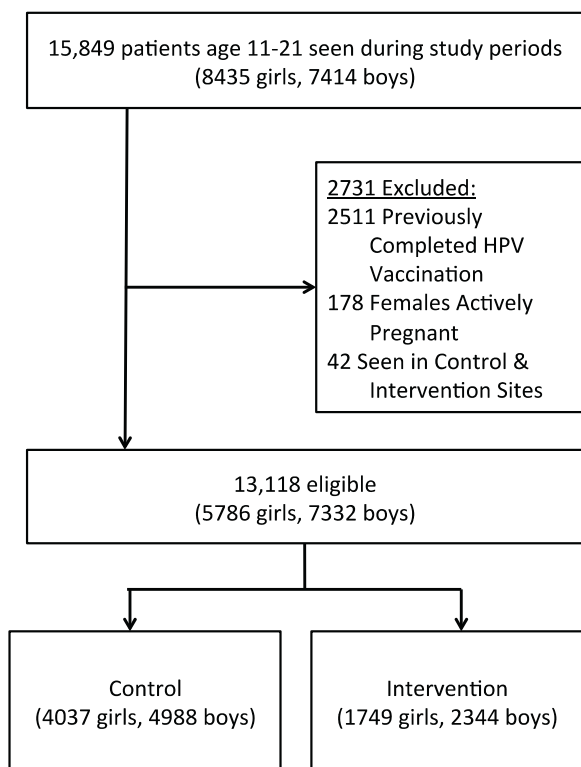


Fig. 1. Subject eligibility at intervention and control practices.

providers indicated that current systems did not permit scheduling of the six-month dose and thus many intentionally completed the series at the next annual visit. Therefore, we felt that completion of the next indicated dose, rather than completion of the entire series, was a more appropriate outcome for the study period.

We compared the odds of vaccination at intervention and control practices during each of the four 6-month study periods (Table 1).

2.5.1. Pre-intervention

At baseline, we reviewed electronic medical record data for the 6-month period prior to the first contact with the practice to determine vaccination rates.

Table 1

Timeline of study periods and intervention sessions.

| Study time period | Intervention step |
|---------------------------------------|---|
| Pre-intervention | 6-month period prior to the first contact with the practices |
| Transition | Session 1 Feedback of initial baseline data Session 2 Education on HPV-related cancers, vaccine efficacy and safety Session 3 Motivational interviewing |
| Active | Session 4 Creation of individualized action plans for each clinical site Session 5 1st feedback on follow-up data and action plan review Session 6 2nd feedback on follow-up data and action plan review Session 7 3rd feedback on follow-up data and action plan review Session 8 Final feedback on follow-up data and action plan review |
| Post-intervention/maintenance: | 6-month period following the final feedback session and assignment of credits to participating providers |

2.5.2. Transition

We provided baseline data to individual providers and provided educational sessions on HPV and HPV vaccine.

2.5.3. Active

Providers created their own action plans via practice consensus to increase HPV vaccinations among eligible boys and girls and were given regular feedback of their behaviors for six months after implementation of their action plans.

2.5.4. Post-intervention/maintenance

Six months after our last contact with the practice, we re-evaluated vaccination rates to determine whether improvements were sustained.

We used multivariable logistic regression, controlling for clustering by practice. We included the following co-variables: patient age, race/ethnicity, insurance status, number of visits during the study period (as a marker of number of opportunities), whether the patient had a preventive care visit during the time period (vs. a problem visit only), receipt of meningococcal or tetanus vaccines (as an indicator of vaccine acceptance), and history of sexually transmitted infections or pregnancy. The Boston University Medical Campus Institutional Review Board approved this study. All analyses were performed using Stata Version 10.1.

3. Results

3.1. Baseline vaccination rates

Analysis of vaccination rates prior to the intervention indicated that 68% of girls and 9.4% of boys 11–21 years old had initiated vaccination and 42% of girls and 1% of boys had completed the 3-dose series at all practices (data not shown). Initiation rates did not differ significantly between intervention and control practices for females (~68%), though boys were more likely to have initiated HPV vaccination at control practices (13.5%) compared with intervention practices (1.3%). Adolescents who had not completed the HPV vaccine series were included in subsequent analyses to determine the effects of the intervention on vaccination outcomes (Table 2)

3.2. Intervention effect on vaccine initiation

A total of 3961 girls and 6910 boys who had never received HPV vaccination were included in the analysis of HPV vaccine initiation. Due to significant gender differences in vaccination rates during the

Table 2

Demographic characteristics of adolescents aged 11–21.

| Demographics of study population (N = 13118) | | | |
|--|--------------------------------|----------------------------|---------|
| | Non-intervention (n = 9025) | Intervention (n = 4093) | P value |
| Sex | | | |
| Girls | 4037 (44.7) | 1749 (42.7) | 0.033 |
| Boys | 4988 (55.3) | 2344 (57.3) | |
| Age | | | |
| <15 | 4825 (53.5) | 2318 (56.6) | 0.001 |
| ≥15 | 4200 (46.5) | 1775 (43.4) | |
| Race | | | |
| White | 906 (10.0) | 183 (4.5) | 0.000 |
| Black | 4614 (51.1) | 1579 (38.6) | |
| Hispanic | 1285 (14.2) | 374 (9.1) | |
| Asian | 129 (1.4) | 424 (10.4) | |
| Other | 2091 (23.2) | 1533 (37.5) | |
| Primary language | | | |
| English | 5725 (63.4) | 2270 (55.5) | 0.000 |
| Non-English | 3300 (36.6) | 1823 (44.5) | |
| Subsidized insurance | 4838 (53.6) | 2531 (61.8) | 0.000 |

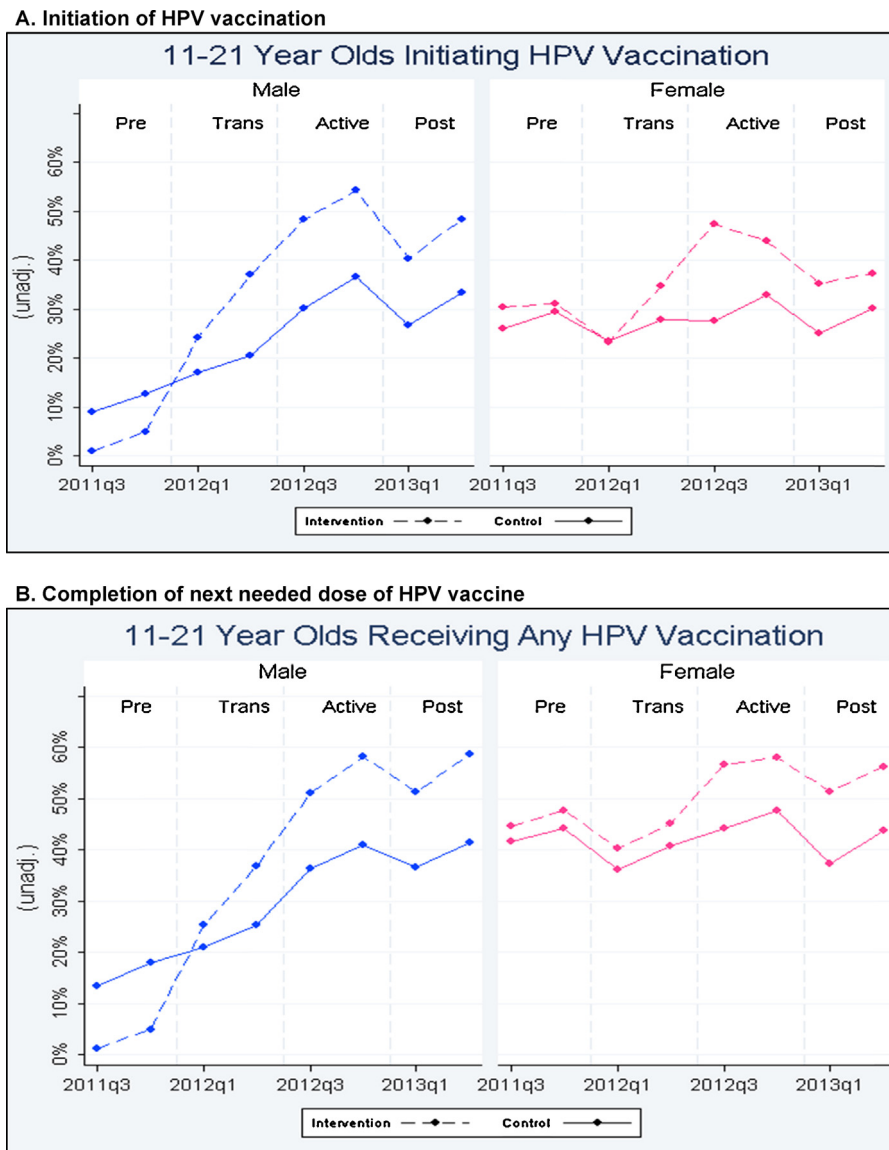


Fig. 2. Proportion of 11–21 year old (a) initiating and (b) completing the next needed HPV vaccination (dose 1, 2 or 3) by time period at intervention and control sites. (A) Initiation of HPV vaccination. (B) Completion of next needed dose of HPV vaccine

pre-intervention period, boys and girls were analyzed separately. In the pre-intervention and transition periods, the odds of vaccine naïve girls initiating vaccination were similar at control and intervention practices. During the active period, girls at intervention practices were more likely to initiate HPV vaccination than those at control practices (OR 1.6 95% CI 1.1–2.2), but though rates at intervention practices remained higher than baseline, differences between intervention and control practices did not remain significant in the post-intervention period. For vaccine-naïve boys, the odds of initiating HPV vaccination were similar at intervention and control practices in the pre-intervention period. The odds of vaccine initiation among boys at intervention compared to control practices rose to 11 (95% CI 6.9–18) in the transition period, 11 (95% CI 6.9–17) in the active period, and remained elevated at 8.5 (95% CI 5.2–14) in the post-intervention period (Tables 2 and 3; Fig. 2A).

3.3. Intervention effect on completion of the next needed HPV vaccine dose

The odds of a girl completing the next needed HPV vaccine dose (dose 1, 2, or 3) at intervention and control practices were similar

during the pre-intervention and transition phases (Table 4; Fig. 2B). During the active and post-intervention periods, girls at intervention practices were more likely to complete the next needed HPV vaccination HPV vaccine dose than those at control practices (active period OR 1.4 95% CI 1.0–2.0; post-period 1.6, 95% CI 1.1–2.2 $p < 0.05$ for both). Boys at intervention practices were also more likely to complete the next needed HPV vaccination than those at control practices (transition period OR 20, 95% CI 12–34; active period OR 23, 95% CI 15–37; post period OR 25, 95% CI 15–40). Of note, state-funded HPV vaccine for males became available during the transition period, resulting in a dramatic increase in male vaccination at both intervention and control practices.

3.3.1.1. Additional factors correlated with vaccine receipt

Other variables associated with increased odds of vaccination (initiation of series or completion of the next needed HPV vaccination) differed for boys and girls. For girls, associated variables included age ≤ 15 (initiation only), Hispanic race (Asian for completion doses only), non-English speaking, receipt of other vaccines, having more clinic visits, well child visits, and subsidized insurance (initiation only). For boys, associated variables included age ≥ 15 ,

Table 3
Factors associated with initiation of HPV vaccine.

| | Female | | Male | |
|--|------------------|----|----------------|----|
| | OR (95% CI) | | OR (95% CI) | |
| Age | | | | |
| <15 | Ref | * | Ref | ** |
| ≥15 | 0.86 (0.74–0.99) | | 1.6 (1.4–1.9) | |
| Race/ethnicity: | | | | |
| White | Ref | | Ref | |
| Black | 1.1 (0.85–1.5) | | 1.2 (0.9–1.6) | |
| Hispanic | 1.4 (1.1–1.9) | * | 1.3 (0.97–1.9) | |
| Asian | 1.2 (0.78–1.7) | | 1.5 (1.0–2.3) | |
| Primary language non-English | 1.24 (1.1–1.4) | ** | 1.1 (0.92–1.2) | |
| History of: | | | | |
| Meningococcal vaccine | 0.79 (0.66–0.96) | * | 1.2 (0.97–1.5) | |
| Tdap vaccine | 1.3 (1.1–1.6) | ** | 1.8 (1.4–2.2) | ** |
| Sexually transmitted Infection | 1.1 (0.88–1.4) | | 1.5 (1.2–1.8) | ** |
| Prior pregnancy | 0.97 (0.59–1.6) | | | |
| Had a well child visit during study period | 4.8 (4.2–5.6) | ** | 7.0 (5.7–8.5) | ** |
| >1 visit at clinic during study period | 1.8 (1.6–2.0) | ** | 1.5 (1.3–1.7) | ** |
| Subsidized insurance | 1.3 (1.1–1.4) | ** | 1.2 (1.1–1.4) | ** |
| Census tract: | | | | |
| Median income (Thousand \$) | 1.0 (0.99–1.0) | | 1.0 (1.0–1.0) | |
| % <High school education | 1.0 (0.99–1.0) | | 1.0 (1.0–1.0) | |
| % Minority population | 1.2 (0.89–1.7) | | 1.0 (0.76–1.4) | |
| Intervention site (vs. control) | | | | |
| Transition period | 1.0 (0.70–1.5) | | 11 (6.9–18) | ** |
| Active period | 1.6 (1.1–2.2) | ** | 11 (6.9–17) | ** |
| Post-Intervention period | 1.1 (0.78–1.6) | | 8.5 (5.2–14) | ** |

* $p < 0.05$.
** $p < 0.01$.

Hispanic or Asian race (completion doses only), receipt of other vaccines, history of sexually transmitted infection, having more clinic visits, and well child visits, and subsidized insurance (initiation only). Home residence location (census tract) did not correlate with vaccine initiation or receipt of a needed dose (Tables 3 and 4).

4. Discussion

Given the recent findings on the importance of providers offering the HPV vaccine at every opportunity, this study demonstrates the ability of a provider-centered multi-component PI CME intervention to create sustained improvement in HPV vaccination rates. All practices improved over time, especially for boys, but intervention practices demonstrated improvements beyond those seen in control practices. The elements that contributed to the success of this PI CME intervention included: (1) repeated contacts to establish trust and accountability while supporting providers to make practice-wide changes, (2) focused education on the morbidity and mortality from HPV, vaccine safety, and vaccine efficacy, (3) individualized feedback of vaccination rates and opportunity for discussion on why rates differed between providers, and (4) quality improvement incentives in the form of maintenance of board certification requirements to motivate demonstrable behavior change.

Changing healthcare provider behavior is difficult [39,40], and many previous educational efforts failed [33]. Discussions with participating providers indicated that an important element of the intervention's success was targeted education followed by practice-specific development of their own targeted actions plans. Action plans created at the two intervention practices included: (1)

Table 4
Factors associated with completion of any needed dose of HPV vaccine.

| | Female0065 | | Male | |
|--|------------------|----|-----------------|----|
| | OR (95% CI) | | OR (95% CI) | |
| Age | | | | |
| <15 | Ref | | Ref | ** |
| ≥15 | 0.96 (0.82–1.1) | | 1.6 (1.4–1.9) | |
| Race/ethnicity: | | | | |
| White | Ref | | Ref | |
| Black | 1.2 (0.85–1.6) | | 1.3 (0.91–1.8) | |
| Hispanic | 1.7 (1.2–2.5) | ** | 1.5 (1.1–2.2) | * |
| Asian | 1.7 (1.0–2.7) | * | 1.8 (1.2–2.9) | ** |
| Primary language non-English | 1.3 (1.1–1.5) | ** | 1.1 (0.96–1.3) | |
| History of: | | | | |
| Meningococcal vaccine | 2.0 (1.6–2.5) | ** | 1.8 (1.4–2.2) | ** |
| Tdap vaccine | 1.9 (1.6–2.3) | ** | 1.9 (1.5–2.4) | ** |
| Sexually transmitted infection | 1.2 (1.0–1.5) | | 1.4 (1.2–1.7) | ** |
| Prior pregnancy | 0.53 (0.34–0.85) | * | | |
| Had a well child visit during study period | 6.0 (5.1–6.9) | ** | 6.3 (5.4–7.4) | ** |
| >1 visit at clinic during study period | 2.0 (1.7–2.2) | ** | 1.6 (1.4–1.8) | ** |
| Subsidized insurance | 1.2 (1.1–1.4) | | 1.1 (0.98–1.3) | |
| Census tract: | | | | |
| Median income (Thousand \$) | 1.0 (0.99–1.0) | | 1.0 (1.0–1.0) | |
| % <High school education | 1.0 (0.99–1.0) | | 1.0 (1.0–1.0) | |
| % Minority population | 1.0 (0.73–1.5) | | 0.99 (0.71–1.4) | |
| Intervention site (vs. control) | | | | |
| Transition period | 0.99 (0.69–1.4) | | 20 (12–34) | ** |
| Active period | 1.4 (1.0–2.0) | * | 23 (15–37) | ** |
| Post-intervention period | 1.6 (1.1–2.2) | * | 25 (15–40) | ** |

* $p < 0.05$.
** $p < 0.01$.

strongly recommending HPV vaccination with Tdap and meningococcal vaccinations at 11- and 12-year-old well child visits, (2) presenting HPV as a cancer prevention vaccine, (3) checking vaccinations at every visit and using problem visits to vaccinate, and (4) practice-wide reminder systems including posters for patients and reminder cards for providers. Motivated by the intervention, each practice also took additional steps to improve completion that went beyond the minimum improvements necessary to receive maintenance of board certification credits. Practice 1 obtained additional funding to hire an HPV vaccine navigator to help with recalling patients. Practice 2 activated a completion system that utilized a school-based health center that served many of their patients.

Changes to the continuing medical education and Maintenance of Certification (MOC) processes that focus on improving quality of care incentivize and promote physician involvement. PI CME interventions leverage these incentives and also create sustained changes in provider behavior by utilizing evidence-based educational techniques including needs assessment to motivate change, interactive learning with case discussions or hands-on sessions, repeated contacts, and outcomes assessments [43]. PI CME can simultaneously address education deficits, communication challenges, and systems issues because it is tailored to the needs of each practice, and also is attractive to providers because it fulfills maintenance of board certification requirements.

5. Strengths and limitations

This study compared the effects of the PI CME intervention in two intervention and six control practices. Because all practices

use the same electronic medical record system, we were able to accurately capture vaccination rates for all adolescents receiving care in intervention and control practices, as well as to systematically assess for confounding. We conducted the study using existing quality improvement processes, staff, and resources in federally qualified community health centers serving diverse, low-income populations, enhancing the generalizability of the findings. We modeled improvements over 6-month study periods, and due to the inclusion of a limited number of practices, were not able to adjust for differences in time trajectories in the intervention and control sites. The dramatic improvements in HPV vaccination rates for boys were catalyzed by the availability of state-funded HPV vaccine for boys during the transition period, making the effects of the intervention difficult to distinguish from the effects of increased vaccine availability. Odds ratios of ten or higher in vaccination rates [in boys] are likely an artifact of timing. Expressed in absolute terms, the difference in rates is approximately 20%. Notwithstanding, HPV vaccination rates for boys did improve more quickly and reached higher levels at intervention than at control practices.

6. Future directions

For an intervention to make a sizable impact, it must be disseminated widely. This intervention was intensive, requiring several interactions with the participants and regular data analysis, and it was also used to provide CME/CNE and Part IV credit to participants. The intensity of the training may be the reason that providers were motivated to make some improvements in practice. The repeated contacts increased participant enthusiasm for making changes in practice and established trust. While external resources were used to implement these interventions, practices with data reporting capabilities from electronic health records and project management support could run this model using on site IT resources and a local Quality Improvement manager or physician champion to keep clinicians on task, design and provide education, and analyze and feedback data to providers. As more practice systems incorporate Quality Improvement and patient safety initiatives and staff, they will have the onsite capacity to implement these kinds of programs. A larger scale research study could explore the facilitators and barriers to disseminating this type of intervention in a broader range of practice settings, including online.

7. Conclusions

To date, provider-focused education interventions to improve HPV vaccination rates have demonstrated limited impact [33]. We describe a highly effective PI CME intervention that combined repeated contacts, education, individualized feedback, and strong quality improvement incentives to increase both initiation and completion dosing of the HPV vaccine series among male and female adolescents. By blending multi-component continuing medical education with routine data collection using the EMR, and leveraging requirements for maintaining board certification, this model has the potential for widespread adoption. Using this model, busy providers can implement durable practice changes to increase HPV vaccination rates.

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