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ORIGINAL PAPER

Success of an EMR-Driven Postpartum Intervention to Improve HPV Vaccination Rates

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Abstract

Human papillomavirus vaccination (HPV) remains low in the United States. The inpatient postpartum setting provides an innovative opportunity to vaccinate eligible patients. This study evaluated two different interventions to improve HPV vaccination rates in hospitalized postpartum patients: a nurse based protocol and an electronic medical record (EMR) postpartum order prompt. This was a comparative intervention study performed in a prospective cohort of postpartum patients at two affiliated County Hospitals. The intervention was conducted over a 6-month period aimed at increasing HPV vaccination rates through a nurse based protocol at one hospital (H-NBP) and an EMR postpartum order prompt at the second hospital (H-EMR). Outcomes measures included vaccine administration, patient refusal, and vaccine wastage. A multiple logistic regression model was used to compare outcomes. At H-NBP, 143 vaccine-eligible patients (74%) were identified of which 44 (32%) received the HPV vaccine, 66 (46%) refused, and 33 (21%) had missed opportunities. At H-EMR, 169 patients (87%) were identified as vaccine-eligible of which 111 (66%) received the HPV4 vaccine, 24 (14%) refused and 34 (20%) had missed opportunities. After adjusting for sociodemographic variables, patients at H-EMR were nearly 6 times more likely than patients at H-NBP to undergo postpartum HPV vaccination (OR 5.865, CI 3.358–10.245, p value < 0.0001). An EMR prompt offers a greater impact on HPV vaccination rates than a nursing protocol. The feasibility and success of inpatient postpartum HPV vaccination interventions as demonstrated in this study provides insights on how to approach vaccination strategies in nontraditional clinical settings.

Keywords Electronic medical record · HPV vaccination · Intervention · Nursing protocol · Postpartum care

Background

HPV has been associated with nearly 30,700 cancers annually in the United States, many of which are preventable [1]. With the introduction of the HPV vaccine aimed at cancer prevention, the Center for Disease Control and Prevention [2] and the President's Cancer Panel [3] have made HPV vaccination an urgent priority in recent years. Therefore, many system, patient and provider based interventions have been proposed and studied to support this initiative.

However, despite over 10 years of efficacy research and various interventions to overcome barriers to HPV vaccine delivery, HPV vaccination rates remain low. According to the 2015 National Health Interview Survey (NHIS), 65.1% of 13–17 year old adolescent women and only 48.5% of women ages 19–26 years nationally initiated the vaccine [4, 5]. Of the adult women, only 6.2% of them received the vaccine at the recommended ages of 11–12 years suggesting a need to promote catch-up vaccination [5]. However, one of the primary barriers has been missed clinical opportunities to recommend and administer the HPV vaccine. According to a recent study at an urban hospital based OB/GYN clinic, young adult women on average had 1.3 missed opportunities per person [6] when seen primarily for postpartum STI screening and contraception visits. Thus, the identification and implementation of

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strategies to to reduce missed opportunities are important to improving HPV vaccination rates.

Electronic medical record alerts and clinical decision support tools have been utilized in the past for various immunizations with mixed results. In a large randomized controlled trial in New York, provider prompts for routine adolescent vaccines (meningococcus, pertussis, HPV and influenza) failed to demonstrate improvement in adolescent immunization rates [7]. In another study, an EMR alert for specifying ACIP recommended dosing intervals succeed in a cohort of female patients as it required the provider to interact with the EMR prompt through acknowledgement of the vaccine status as done, ordered, patient declined, patient discussed or not addressed but initiation rates still were relatively low at 34.9% [8]. The relatively low success in the outpatient setting may be related to barriers such as time constraints limiting HPV vaccine counseling, staff time, supply issues and cost [9].

In contrast to outpatient strategies, inpatient immunization strategies have been successfully implemented for flu and pneumococcal vaccinations and may prove to be efficacious for inpatient HPV vaccination by overcoming systematic barriers found in the outpatient setting such as access and availability [10–14]. Previous studies evaluating inpatient HPV vaccination suggest high acceptance [15–17]. Specifically, in the postpartum population, a relatively high concentration of eligible patients up to age 26 have been identified and high vaccination initiation rates have been demonstrated [16–18]. Additionally, in low income women where outpatient access to care is a significant barrier, a recent paper by Berenson et al. also demonstrated high initiation rates of HPV vaccination in the postpartum setting for low income women from 25.4 to 80.8% [17]. A qualitative assessment of that same program demonstrated that it was highly accepted among providers who demonstrated "pro-vaccine" attitudes as well as viewing the inpatient program as effective in reaching "hard-to-reach" women [18].

Thus, the postpartum cohort represents a potentially high-yield under-vaccinated group of women who are eligible and willing to accept the HPV vaccine and allows an opportunity to compare traditional hospital based interventions with more novel EMR based interventions.

Methods

Study Design

In November of 2014, two distinct interventions were initiated at two urban county hospitals with tertiary care maternal services to make the HPV4 vaccine available to eligible postpartum patients to promote HPV vaccination uptake as part of each hospital's quality improvement initiative. Institutional Review Board approval was obtained from the Department of Health Services and the site specific IRB for both hospitals for retrospective review of these interventions. The strategies targeting providers were developed under the hypothesis that lack of provider recommendation of the HPV vaccine leads to low vaccination rates in an under-vaccinated population. Formal didactics were presented at both institutions in the form of a provider-attended grand rounds lecture and training sessions for nurses where information regarding the HPV vaccine, national guidelines from the Advisory Committee on Immunization Practices and process-based intervention strategies were reviewed.

The distinct interventions were then introduced, a nurse driven HPV vaccination protocol at one hospital (H-NBP) and an EMR postpartum order set that included a reminder prompt for the HPV vaccine for eligible patients at the other hospital (H-EMR). This intervention strategy provided the opportunity to compare these two distinct interventions and test their efficacy. Since neither site offered the HPV vaccination prior to initiation of these interventions, it was not possible to collect baseline vaccination rates.

All patients age 26 and under who were admitted to the postpartum ward following delivery were included in the study. Vaccine eligibility was determined by patient report cross-referenced with medical records and vaccine registry data were available as part of the nurse's routine screening. Randomization was not performed as the EMR system was designed to be used for all patient care matters and it was deemed unethical for study purposes to not avail the HPV4 vaccine to all eligible patients.

Each institution was responsible for self- monitoring their practices as per their own institutional performance improvement efforts to maintain a more "real world" practice and reduce the risk of introducing a Hawthorne effect of changing providers' behaviors. Periodic feedback was given at 3 and 5 months from the study initiation at H-NBP but not at H-EMR due to administrative practice differences.

Ascertainment of vaccination history and counseling around the HPV vaccine was done by providers as well as nursing staff per their usual care, typically in conjunction with screening for other standard postpartum vaccinations such as Tdap, MMR and influenza. Follow-up vaccination was recommended to be obtained at the scheduled postpartum visit but not tracked given that a significant proportion of follow-up visits occurred with the patient's obstetrician and not in the maternity hospitals.

Outcome Measures and Data Sources

Data were collected on all patients age 26 and under during a 6 month period from November 1, 2014 until April 30, 2015.

Independent predictor variables studied included the following patient demographic characteristics: age, race, ethnicity, extent of prenatal care received (some vs none), where the prenatal care was received (hospital-based clinic vs an outside clinic), insurance status (Medicaid vs non-Medicaid vs none) and language.

Outcome measures consisted of both quantitative and qualitative measures. The primary quantitative outcome was to determine the post-intervention vaccination rates of both institutions by determining the proportion of eligible patients that were correctly identified and vaccinated. Thus, the vaccination compliance rate was defined as the percentage of vaccinated patients over the total number of eligible patients.

Secondary quantitative measures evaluated patients declining the vaccine and missed opportunities among those patients that were vaccine eligible but had not received a vaccine dose. A missed opportunity was defined as any instance where an eligible patient did not receive a dose or did not refuse a dose—reasons included the provider failing to order the vaccine or forgetting to recommend the vaccine, the vaccine being ordered but not administered by the nurse, or the vaccine not being delivered in a timely manner prior to patient discharge. These were identified as process issues that could be improved upon and were addressed in feedback evaluations.

A third quantitative outcome measure aimed at assessing vaccine wastage, the frequency at which patients who were ineligible, based on evidence of series completion as reported in the California Immunization Registry (CAIR) or the patient's immunization records, received a 4th dose of the vaccine. Again, this was identified as a process issue that could be improved upon and was addressed in feedback evaluations to the two hospitals.

Verification of vaccine receipt was obtained from reviewing the medication administration records (MAR), pharmacy orders and immunization records. Eligibility was confirmed using the CAIR registry and cross-referenced with patient verbal reports, hand-carried immunization records ("yellow cards") and provider notes of whether the patient had completed the vaccine series. Inconsistencies such as nurses not logging administered doses in the medical administration and reconciliation reports were reconciled through cross-referencing across other available sources of charting (nursing notes, pharmacy records, and immunization records) to ensure the measures were highly reliable and valid.

Additionally, qualitative evaluation was also performed through a comprehensive review of each patient's medical file to identify reasons for documented refusals, missed opportunities, and any reported side effects from the vaccine administration. Each provider and nursing form was reviewed to maintain high data validity for the qualitative evaluation.

χ^2 test, Fisher exact test and *t* test were used when appropriate to examine the difference between effect of intervention (pre vs post), and intervention methods. A multivariable logistic regression model was constructed to examine the association between vaccination rates of eligible patients and intervention method. Among the variables yielding p values smaller than 0.1 in univariate association tests, ethnicity, language, and prenatal care were identified as covariates possibly affecting the association between outcome and intervention methods; and hence they were included in the multiple logistic regression model. Analyses were performed in SAS 9.4 (SAS Institute, Cary NC). *p* values less than 0.05 were considered statistically significant.

Results

Characteristics of Eligible Patients

A total of 387 patients met eligibility criteria of age 26 years or younger at H-NBP and H-EMR. The clinical and demographic characteristics of the study cohort are displayed in Table 1. The majority of the women were of Hispanic descent at both institutions with a significantly higher proportion of Hispanic patients at H-NBP (78.6% vs 59.5% *p* value < 0.0001). Similarly, there were significant language differences with more women at H-EMR speaking English (96.9% vs 74%, *p* value < 0.0001). The majority of patients at both institutions received prenatal care (94% and 97%) with a significantly higher percentage of patients at H-EMR receiving hospital-based prenatal care (70.3% vs 50.5%, *p* value: < 0.0001).

Intervention Effect on Inpatient HPV Vaccination

Table 2 displays the overall effectiveness of interventions to promote postpartum HPV vaccination based on percentages of eligible patients who received the vaccine, refused the vaccine and the frequency of missed opportunities.

At H-NBP, 143 patients (143/195; or 74% of all the postpartum patients aged 26 and under) were identified as HPV vaccine eligible of which 44 (32%) received the HPV4 vaccine, 66 (46%) refused, and 33 (21%) were missed opportunities.

At H-EMR, 169 patients (169/195; or 87% of all the postpartum patients aged 26 and under) were identified as vaccine eligible of which 111 (66%) received the HPV4 vaccine, 24 (14%) refused and 34 (20%) were missed opportunities. The difference in vaccine receipt among eligible patients at the two hospitals were statistically significant with a 66% vaccination rate at H-EMR vs a 32% rate at H-NBP (*p* value < 0.0001).

Table 1 Comparison of patient demographic and prenatal care practices for postpartum patients age 26 years or younger at H-NBP and H-EMR

	H-NBP (n = 192)	H-EMR (n = 195)	Significance
Age (med years, range)	22 (13–26)	23 (15–26)	NS
Race/ethnicity			
Black	15 (7.8%)	42 (21.5%)	0.003
Hispanic	151 (78.6%)	116 (59.5%)	
Non-Hispanic white	11 (5.7%)	17 (8.7%)	
Language			
English	142 (74%)	188 (96.9%)	< 0.001
Spanish	46 (24%)	6 (3.1%)	
Other	3 (1%)	1 (0%)	
Insurance			
Medi-Cal	186 (96.9%)	173 (88.7%)	0.002
Prenatal care site (PNC)			
At hospital-based clinic	97 (50.5%)	137 (70.3%)	< 0.001
At outside clinic	89 (46.4%)	47(24.1%)	
Scant/no PNC	6 (3.1%)	11 (5.6%)	

Table 2 Outcomes for vaccine delivery in postpartum patients age 26 or younger at H-NBP and H-EMR

	H-NBP (n = 192)	H-EMR (n = 195)	Significance
Prior HPV vaccine completion	49 (26%)	26 (13%)	0.003
Postpartum HPV vaccine eligible	143 (74%)	169 (87%)	
Received pp Vaccine	44 (32%)	111 (66%)	< 0.001
Declined pp Vaccine	66 (46%)	24 (14%)	
Missed opportunity	33 (21%)	34 (20%)	
Vaccine wastage	2 (1.4%)	7 (4%)	0.007

Additionally, there were higher rates of vaccine refusal at H-NBP (46% vs 14%, p value < 0.0001). There was no difference in missed opportunities with both institutions accounting for similar proportions (20% vs 21%). After adjusting for ethnicity, language, insurance status, and prenatal care site, H-EMR patients were almost 6 times more likely to get HPV vaccine postpartum (OR 5.865; 95% CI 3.358, 10.245) compared to H-NBP patients.

To address the issue of vaccine wastage, Table 2 summarizes of the number of ineligible patients that were identified upon study review as having documentation of completing the HPV vaccine series in the past, who incorrectly received a subsequent dose of the HPV4 vaccine during the intervention study period resulting in vaccine wastage. There was a significantly higher proportion of patients who received an ineligible dose at H-EMR compared to H-NBP (27% vs 4%, p value 0.007).

Qualitative Factors for Inpatient HPV Vaccination Non-receipt

Reasons for patients declining vaccination were documented for 8/66 (12.1%) patients in H-NBP and 7/24 (29.2%) patients in H-EMR. Reasons included patient wanting to defer decision to later visit, wanting to verify vaccine documentation from home, or wanting to think more about receiving the vaccine. The number of cases where a reason was documented explaining a missed opportunity represents a small proportion of all missed opportunities: 2/33 (6.1%) for H-NBP and 18/34 (52.9%) for H-EMR. Most commonly identified reasons included lack of provider order or nurse not administering vaccine despite order present.

Discussion

Our findings suggest that a high percentage of the Los Angeles County postpartum patients age 26 and under are unvaccinated or under-vaccinated for HPV. This result is consistent with other studies that demonstrate low vaccine compliance among ethnic minorities in underserved population [12–15]. Our data further suggest that an EMR prompt in the postpartum order set is a simple and effective way to promote HPV vaccination in the inpatient setting.

Recently, several studies have assessed interventions in the *outpatient* setting to increase HPV vaccinations. One study on the effectiveness of an EMR prompt in the postpartum outpatient visit demonstrated a significant increase from 1.2 to 26.5% in HPV vaccination [19]. Similarly, multimodal interventions including an electronic decision support tool and standing HPV vaccination order-sets showed

an increase in vaccine rates from 7.1 to 23.7% in a general OBGYN outpatient setting [20].

Our study is the first to evaluate EMR prompt usage in the *inpatient* postpartum setting which demonstrates a significantly higher success rate in increasing HPV vaccination rates to 66%, which is far higher than rates previously reported rates in the outpatient setting.

Previous studies demonstrated that the postpartum patient population had a high degree of acceptance of the HPV vaccine with acceptance rates as high as 95–97% [12, 15, 18, 21]. In contrast, the proportion of eligible candidates who refuse the HPV vaccine in our current study was high, with 46% of the H-NBP cohort and 14% of the H-EMR cohort refusing vaccination respectively. This difference may arise because patient survey studies are biased by selection of patients willing to participate in the survey and so cannot effectively evaluate for the degree to which patients refuse to participate. Thus, patient refusal rates may in fact be higher than previously thought in the postpartum cohort and considerations can be made in how to better overcome the refusal rate with prenatal counseling, increasing knowledge, and specification of the type of provider making the recommendation.

Qualitative analysis of charts demonstrated common issues for patients declining the vaccine as well as missed opportunities. Similar challenges with miscommunication between providers and issues with care coordination have been identified in other postpartum settings with the HPV vaccine [18]. Recognition of these challenges permit for future opportunities to intervene. Prenatal counseling may reduce hesitation and delays among eligible postpartum patients. Missed opportunities may be reduced by improving process flow such that the vaccine is ordered and available long before discharge planning is undertaken.

Study Limitations

Given the pragmatic, quasi-experimental design, there are limitations to our study. First, the documentation practices differed between the two institutions—paper charting vs EMR. To overcome this limitation, at both institutions, documentation in the primary expected places (MAR, immunization records) were cross referenced with order-set and descriptive notes to ensure enhanced validity of the data collected.

A second limitation relates to the learning component associated with adopting a new EMR system as well as developing proficiency in counseling patients effectively about the HPV vaccine by a broad pool of nurses and providers when these practices had not been employed routinely before the interventions. As nurses and providers gain experience in these two areas, their ability to implement the interventions more efficaciously and consistently is affected. In the statistical analysis, the time interaction evaluated through conjoint analysis (not shown) was noted to be not significant. The differences in practice patterns between the two institutions may also introduce a bias by cluster sampling given there may be a difference in the provider and nurse attitudes that could have contributed to how providers and nurses recommended the HPV vaccine.

Future Interventions

For the inpatient intervention to have a significant impact, it must be widely disseminated. The results from the current study are encouraging as it was applied in a "real world" setting to a high need inpatient population. Larger scale studies exploring HPV vaccines in other inpatient settings may help identify opportunities to increase rates as well as identify unique system and provider barriers to inpatient vaccination both for the HPV vaccine but other priority vaccines as well.

Conclusion

Interventions to increase HPV vaccination among the postpartum population create a unique opportunity in the inpatient setting to help women receive their recommended HPV vaccination. In the current era where the EMR is readily adopted into standard practice, an integrated EMR prompt offers a more effective solution to increasing HPV vaccination in the inpatient postpartum setting over nursing protocols. The high initiation rates inpatient suggest reduction in barriers previously reported in the outpatient settings [9].

The feasibility and success of inpatient postpartum HPV vaccination as demonstrated in this study may provide insights about how to approach HPV vaccination in other clinical settings such as specialty outpatient clinics, urgent care, or other inpatient wards. Particularly, given the expanded FDA approval for the HPV vaccination age extension to 45 years of age [22], determining alternate clinical settings for HPV vaccine intervention could provide significant expanded access to a previously unvaccinated population. Through implementation of programs in these non-traditional venues we may achieve higher rates of HPV vaccinated individuals.

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Compliance with Ethical Standards

Conflict of interest Park has received consultant fee from Merck which produces the Gardasil vaccine.

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