Improving Adolescent Human Papillomavirus Vaccination Rates Through Provider Education

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Abstract

Human papillomavirus (HPV) is a prevalent sexually transmitted infection that affects many adolescents and adults worldwide. The consequences of contracting HPV have proven to be devastating, potentially leading to a variety of life-threatening genitourinary and oral cancers. As such, prevention via vaccination is critical. HPV vaccination is recommended for all adolescents beginning at 11 years of age. Although the immunization has proven to be safe and effective, HPV vaccination rates are substantially below target goals worldwide. A literature review of evidence from the last five years was conducted to examine barriers and facilitators to HPV vaccine uptake. The most commonly cited barriers to vaccination included lack of knowledge about the vaccine and inadequate provider recommendation. Current evidence regarding interventions to increase HPV vaccine uptake reveal that best practices are multi-factorial and should include a combination of provider education and recommendation training. These findings led to the proposal of an evidence-based intervention aimed to increase adolescent HPV vaccination rates. A one-hour educational program was conducted at a local pediatric primary care facility. Five healthcare providers participated in the program, which consisted of a PowerPoint presentation outlining the benefits of HPV vaccination and use of an interactive application from the CDC. The app taught participants how to offer a strong recommendation for the vaccine through active participation. Pre and posttests were administered to determine the providers' intent to vaccinate and vaccination rates were monitored. Analysis of the data collected revealed a statistically significant rise in vaccination rates. These results reveal that provider education can improve recommendation techniques and therefore increase vaccine coverage. Further research is needed to see if one-time education is sustainable.

Keywords: Adolescents, HPV, human papillomavirus, provider education, vaccination

Improving Adolescent HPV Vaccination Rates

Vaccination against human papillomavirus (HPV) is currently recommended by the Centers for Disease Control and Prevention (CDC) and the Advisory Committee on Immunization Practices (ACIP) for both males and females aged 11-26 years (CDC, 2018). Despite numerous clinical trials that led the Food and Drug Administration and CDC to deem the vaccine both safe and effective at preventing genitourinary cancers, HPV vaccination rates are still remarkably lower than all other required adolescent vaccinations. Failing to immunize against HPV as an adolescent can potentially lead to lifelong consequences. A joint statement released by 69 of the National Cancer Institute (NCI) centers refers to low HPV vaccination rates as a serious public health threat (National Institute of Health, 2016).

Background and Significance

Human papillomavirus refers to more than 200 different strains of related viruses that can be spread through sexual contact. It is the most common sexually transmitted infection, affecting more than 79 million Americans (CDC, 2018). While low risk strains of HPV can lead to genital warts, high risk HPV can lead to cervical, anal, oral, penile, or vulvar cancers (NIH, 2018). The HPV vaccine protects against nine different strains, seven of which can potentially lead to cancer (CDC, 2018). There are 33,000 new cases of cervical cancer diagnosed in the United States annually, leading to 4,000 deaths each year. Vaccinating against HPV can prevent 90% of these cases (CDC, 2018).

The HPV vaccine is currently recommended by the CDC and ACIP for all adolescents beginning at 11 years of age, yet in 2017 only 66% of adolescents initiated the vaccine and 49% were up to date, falling significantly short of the *Healthy People 2020* goal of 80% (CDC, 2018). After introduction of the HPV vaccine, HPV related cancers and genital warts decreased by 71%

in adolescents (CDC, 2018). Despite the proven efficacy, only 29.5% of girls and 24.9% of boys complete the series by age 13 (Vollrath, Thul, & Holcombe, 2018).

Internal Evidence

The Director of Professional Practice and the Chief Clinical Services at a local pediatric primary care facility report an office HPV vaccination rate of 13-18%, significantly below state and national levels. A poll of the providers at this location indicates that many do not routinely recommend the vaccine and often offer delayed dosing.

Purpose and Rationale

In 2017, 44% of parents made the decision to not vaccinate their child against HPV (CDC, 2018). This decision may lead to deleterious consequences for them as they grow into adulthood. The purpose of this evidence-based project is to improve provider knowledge regarding the HPV vaccine and intent to vaccinate. These practice changes are anticipated to increase HPV vaccine uptake in adolescents between ages 11-18 years. The inquiry into this clinical problem leads to the PICO question: In pediatric healthcare providers, does an educational class on the HPV vaccine and recommendation techniques versus no educational offering affect overall HPV knowledge and vaccination rates?

Evidence Synthesis

Search Strategy

An extensive review of current literature was performed to answer the PICO question. The databases searched included PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), and Cochrane Library. The databases were searched using a combination of the following terms: adolescents, teenagers, caregivers, parents, health care providers, HPV vaccination, HPV rates, human papillomavirus, education, and recommendation. Boolean and

MeSH terms were added to broaden the search. Initial searches yielded 116 results in PubMed, 84 in CINAHL, and 55 in Cochrane Library. Filters were then applied to include only English language, peer reviewed articles published between 2013 and 2019 with an age limit of 18 years old. This final search yielded 60 results in PubMed, 52 in CINAHL, and 46 in Cochrane Library.

The abstracts of each article were reviewed for quality and relevance. Inclusion criterion included educational interventions aimed at increasing HPV vaccination rates in adolescents. Exclusion criterion included participants older than 18 years old receiving the vaccine and articles published prior to 2013. After critical appraisal of each article, 14 have been chosen based on merit and relevance to the PICO question to be included in the literature review.

Critical Appraisal

Fourteen studies were chosen to be included in the literature review based on quality, relevance and merit determined by Melnyk and Fineout-Overholt's (2005) rapid critical appraisal. Of the 14 studies selected, 10 were randomized controlled trials, which are considered to be a high-level of evidence. The remaining four studies used surveys and levels of evidence ranged from III to VI (Appendix A). Funding was disclosed for all but two of the studies, with only two being funded by a pharmaceutical company, which could lead to a potential sponsorship bias. Each of the 14 studies took place in an outpatient, primary care setting within the United States and had adequate samples of adolescents aged 9-18 years old. Heterogeneity was observed in the demographics of the sample, with an equal volume of males and females and a wide variety of ethnicities represented (Appendix B).

Intervention methods varied widely amongst each of the studies. Single component and multi-component methods were evaluated, including provider communication classes, web-based videos for parents, and printed fact sheets. Due to the variability, it was difficult to assess which

of these methods would be most beneficial. Despite heterogeneity of the interventions, there was a commonality amongst all. Each of the studies provided education to parents or providers regarding the risks of HPV, the benefits of HPV vaccination, and why it is important to vaccinate at a young age.

While secondary outcomes such as provider comfort level and parent perception were measured in three studies, the main outcome assessed in all but two of the studies was a change in HPV vaccination rates. The measurement tools were homogeneous amongst studies due to the fact that there are limited methods to track HPV vaccination rates. Methods included an online registry, electronic medical records, and self-report through surveys (Appendix A).

Foundation of Evidence

After an exhaustive review of the literature was performed, parental hesitancy was identified in numerous studies as a barrier to HPV vaccination. The greatest report of parental hesitancy (17%) stems from the lack of a recommendation from a medical provider (Holman et al., 2014). Eleven of the fourteen studies examined in this review cite the lack of a strong provider recommendation as the leading cause for parents not accepting the HPV vaccine. Parents frequently reported that their child's medical provider did not recommend the vaccine, with only 58.8% of girls receiving a recommendation and 14.2% of boys (Rahman, Laz, McGrath, & Berenson, 2014). Overall, the HPV vaccine was only strongly recommended by a provider 39% of the time compared to other adolescent vaccines, which were strongly recommended 59% of the time. Receiving a strong recommendation from a provider makes an adolescent five to seven times more likely to receive the vaccine than if receiving no recommendation (Dempsey & O'Leary, 2018; Dempsey et al., 2015; Ylitalo, Lee, & Mehta, 2013). Findings indicate that provider recommendation increases uptake of the HPV vaccine by

creating a positive parental perception of the immunization. That positive attitude is diminished, however, if the vaccine is presented as optional (Dempsey et al., 2015; Underwood et al., 2016).

In a recent survey conducted by Warner et al. (2017), pediatricians had the lowest proportion of knowledge (26.7%) regarding the HPV vaccine out of all specialty providers. Providers are less likely to recommend the HPV immunization if they have little knowledge about the vaccine (Holman et al., 2014). Provider based interventions should aim to increase knowledge and therefore the strength of the recommendation to patients. After one hour of provider education, which entails general HPV knowledge and the correct structure of a strong recommendation, providers are significantly more likely to recommend the HPV vaccine and administer it at minimum dosing intervals (Volrath, Thul, & Holcombe, 2018). A study by Dempsey and O'Leary (2018) found that a strong recommendation results in 89% HPV vaccine acceptance rate, whereas a weak recommendation results in a 71% acceptance rate. Learning to frame a strong recommendation is a mainstay of provider education.

This literature review demonstrates that educational interventions aimed at providers or parents could lead to an increase in overall HPV vaccination rates. The most common intervention analyzed was an HPV education and communication course for providers, which attempted to nullify each of the top parent and provider barriers to vaccination. Findings from this literature review report that provider trainings not only increase HPV vaccination rates, but also significantly improve both parent and provider perceptions of the vaccine.

Conceptual Framework and EBP Model

The conceptual framework used to guide this project was the Health Belief Model (HBM), which attempts to predict an individual's health behaviors by focusing on their attitudes and beliefs towards an illness (Donadiki et al., 2014). In this model, an individual will take a

health related action, such as vaccination, only if they feel as though the illness is a personal threat to them and whether the suggested health behavior is safe, beneficial and effective (Appendix C). Studies indicate that HPV vaccination rates are low due to both provider beliefs that there is a low risk of adolescents contracting HPV and doubts regarding the safety of the vaccine. If providers have doubts or concerns regarding the vaccine, they are less likely to recommend it to their patients. An intervention designed to educate providers about the severity of contracting HPV, the benefits of the vaccine to society, and the safety profile should foster positive attitudes and beliefs towards the vaccine, leading to a strong recommendation. Findings from several studies indicate that provider recommendation increases uptake of the HPV vaccine by creating a positive parental perception of the immunization (Dempsey et al., 2015). That positive parental perception, according to the HBM, will then lead to them taking the health related action of vaccination.

In addition to the HBM, Rosswurm and Larrabee's (1999) model was chosen to guide individuals systematically through the process of developing and implementing an evidence-based practice change (Appendix D). The process begins with assessing the need for change. State and national averages for HPV vaccination rates are markedly below target goals, indicating improvements need to be made in the HPV vaccination process. Next, potential interventions must be identified and recent evidence synthesized to support the intervention based on feasibility, benefits, and risk. Provider education and communication training has been supported by recent evidence to be a potential low cost intervention that significantly improves vaccination rates. Once the intervention is identified, the practice change can then be designed, where outcomes and resources are identified and the practice change is implemented and

evaluated. If positive outcomes are achieved, the practice change can be integrated and maintained in practice (Appendix D) (Rosswurm & Larrabee, 1999).

Methods

Ethical Considerations

University Institutional Review Board (IRB) approval was obtained prior to project implementation. Physical data (surveys) were de-identified by assigning unique coded numbers to individuals and were stored in a locked file cabinet. Electronic data was also de-identified and stored on an encrypted, password-protected computer. All information will be deleted at the completion of the project.

Population and Setting

Five healthcare providers (nurse practitioners and physicians) were eligible to participate in this evidence-based project. Inclusion criteria included being a healthcare provider employed by the project site and having an interaction with adolescents who were eligible for the HPV vaccine. Participants were excluded if they did not provide direct care to patients or if they did not attend the staff meeting where the intervention was presented. The project was conducted in a pediatric primary care facility located in Mesa, Arizona. The clinic provides services such as well child exams, sick visits, and immunization encounters for children from birth to age 18 years.

Procedure

The Director of Professional Practice for the organization was contacted regarding potential participation in the project. Upon agreement of participation, the project director contacted the clinic manager to arrange a date and time for the intervention that was convenient for potential participants. In July of 2019, the project site champion identified eligible

participants. The project director distributed a recruitment letter to the potential participants prior to the start of the intervention. The recruitment letter described the evidence-based project and also served as the consent form. By choosing to stay and take part in the intervention, individuals consented to be an active participant in the project. An eight-point questionnaire along with a demographic data form was then distributed to eligible participants. Each participant had 10 minutes to complete the questionnaire. After all questionnaires were completed, a one-hour educational course regarding HPV and the HPV vaccine commenced. Led by the project director, 30 minutes were dedicated to providing a PowerPoint presentation regarding the risks of HPV, the benefits of the vaccine, and tips for providing a strong, assumptive recommendation. During the final 30 minutes, an interactive video from the CDC and American Academy of Pediatrics was shown. The web-based app (*Same Day, Same Way*) is an interactive video about how to give a strong recommendation for the HPV vaccine. The app simulated typical parent-provider interactions that take place during adolescent visits and allowed the providers to choose how they would recommend the vaccine and answer frequently asked questions. Based on their responses, the virtual patient and parent would make a decision to either accept or decline the vaccine. Feedback was then given to participants about how to better frame their recommendations. Immediately following the hour-long educational intervention, a post-survey was distributed for participants to complete. A final post-survey was hand-delivered to the participants three months post intervention.

Data Collection and Outcome Measures

The primary outcome measured was overall HPV vaccination rates, while secondary outcomes included provider knowledge and intent to vaccinate. The Clinical Services Director pulled vaccination rates monthly from the electronic medical record. Administration rates were

pulled both collectively for the clinic and individually by provider. Intent to vaccinate was measured using a modified *Determinants of Intent to Vaccinate (DIVA)* survey. This 56-item questionnaire is intended to assess provider commitment to vaccination and knowledge regarding the vaccine. The questions are grouped into six different domains: (a) 'properties of the vaccine', (b) 'disease characteristics/benefits', (c) 'information about the vaccine', (d) 'practical aspects', (e) 'adaptation', and (f)'primary care provider's experience' (Martinez et al., 2016). Prescribing providers are asked questions within each of these domains and must choose from four possible responses on a scale between 1= "*totally disagree*", 2= "*somewhat disagree*", 3= "*somewhat agree*" and 4= "*totally agree*". Of the 56 questions in the original questionnaire, eight were chosen for the modified version due to time constraints of the participants. The *DIVA* tool was found to be a valid and reliable instrument to assess provider intent to vaccinate, with a Cronbach's alpha of 0.85. A Delphi panel also concluded that the *DIVA* questionnaire could be utilized as a stand-alone tool in assessing provider commitment to vaccinate against HPV, finding good internal consistency and reliability (Martinez et al., 2016).

Budget and Funding

The intervention for this project was cost-effective with minimal out-of-pocket expenses. The majority of the budget plan (Appendix E) was allocated to printed copies of the pre and post surveys, which are not necessary for project implementation. There was also the potential for the associated cost of paying the providers' salary or loss of patient revenue if the education was provided at any time other than the lunch hour. This project was implemented during the lunch hour, so while there was no loss of revenue, a meal was provided. There were no grants awarded for this project. The student provided all funding.

Results

Five providers returned completed surveys to the project director (*N*=5). Answers provided were converted to a Likert scale and given a score. A Wilcoxon Signed Rank Test was conducted to compare the average scores for provider intent to vaccinate pre-intervention versus post-intervention. Scores could not be analyzed due to constant variables, indicating there was no difference in provider intent to vaccinate pre-intervention compared to post-intervention.

Vaccination rates for the clinic, and per provider, were pulled for five months prior to intervention and five months post intervention. A repeated measures of analysis of variance (ANOVA) was conducted to determine if there were any significant differences in individual provider vaccination rates between the months before the intervention and the months after. The results were examined based on an alpha of 0.05. The main effect for the within-subjects factor was not significant ($F(4, 16) = 1.96$, $p = .200$), indicating that vaccination rates pre-intervention and post-intervention were similar. A two proportions z-test was also conducted to determine whether there was a significant difference between the proportion of total eligible adolescents (*N*=2,096) who accepted the vaccine pre-intervention and the proportion of total eligible adolescents (*N*=2,428) who accepted the vaccine post-intervention. The result of the two proportions z-test was statistically significant based on an alpha of 0.05 ($z = -5.12$, $p = <.001$) indicating that the proportion of children accepting the vaccine pre-intervention was significantly lower than children accepting the vaccine post-intervention. These results are consistent with the literature in that increasing provider knowledge and the strength of their recommendation leads to increased vaccine uptake.

Potential Impact

Implementing a provider-based educational training on HPV will lead to practitioners having increased knowledge regarding the benefits of the vaccine and will increase their comfort

and confidence in delivering a stronger and more timely recommendation to parents. This recommendation will in turn empower parents with knowledge of the importance of vaccinating, leading to increased vaccine uptake. Significantly improving HPV vaccination rates will ultimately lead to a decreased incidence of HPV related genitourinary cancers, thus creating better health outcomes for our population.

Project Sustainability

The one-hour educational course provided during this evidence-based project can be easily replicated at other pediatric primary care facilities throughout the organization. The materials used were electronic and tailored to train any type of pediatric provider. As such, the course could be effortlessly sent to and implemented at other pediatric facilities. The site would need an individual who is trained in using the course materials to facilitate the class as well as time allotted to provide the education. There would be no additional cost to the organization.

Discussion

Summary and Conclusions

Low HPV vaccination rates in Arizona and the United States indicate the need for an evidence-based intervention aimed at increasing immunization uptake. This project demonstrates that provider education intended to strengthen recommendation techniques can successfully improve overall vaccination rates. While survey results of this project indicate that provider intent to vaccinate did not improve, this is likely due to the fact that individual intent was already at peak potential pre-intervention. This conclusion was reached as providers had high pre-intervention scores with no room for improvement post-intervention. This suggests that providers were already intending to vaccinate all adolescents, yet their current practice was not sufficient

to promote vaccination. By implementing a provider education course, techniques were given on how to improve vaccine recommendations and therefore uptake.

Vaccination rates did improve post-intervention for each individual provider. Though this is clinically significant, given the small sample size of five providers, rates were not statistically significant. Additional data was also analyzed, using a larger sample size of total adolescents eligible for the vaccine. The proportion of eligible adolescents that accepted the vaccine post-intervention was significantly higher than the proportion of eligible adolescents that accepted the vaccine prior to the intervention. These results are consistent with suggestions from the literature in that increasing provider knowledge and the strength of their recommendation leads to increased vaccine uptake.

Limitations and Barriers

There were several limitations and barriers noted throughout this project. The barriers that were encountered included reluctance from two providers to participate and time constraints. There were significant challenges in pulling vaccination rates for the office without including the rates for the non-participating providers. This initially led to the possibility of skewed data and falsely low vaccination rates. However, upon further evaluation, an alternative method for extracting vaccination rates was developed to alleviate that potential issue. The participating providers also voiced concern that they had limited time to properly discuss the HPV vaccine given their short ten-minute appointment windows. Furthermore, an additional limitation of the project was the inability of the electronic medical record to separate administration of the first dose versus subsequent doses of the HPV vaccine. Separating this data would have allowed for the opportunity to determine if series initiation or series completion was of greater concern for the facility.

Recommendations

Office vaccination rates began to decline two months after the education was provided. This would seemingly indicate that continuing education is needed to reinforce recommendation techniques and the importance of HPV vaccination. It is recommended that similar education be provided to all medical staff in direct contact with adolescent patients on a quarterly basis to continually improve vaccine uptake.

The educational course provided during this project was implemented just prior to the start of school, which is typically when a large influx of patients are seen by their primary care provider for back-to-school needs. Given the decline of vaccination rates over time post-intervention, and the timing of the delivery of the intervention, future studies are needed to determine if provider education courses about HPV vaccination are equally successful in improving vaccination rates at different time periods throughout the year.

Conclusion

Human papillomavirus vaccination rates in adolescents are significantly below target goals, creating missed opportunities for reducing cancer cases. The lack of a recommendation from a medical provider is a driving factor that limits vaccination. Attempting to improve HPV vaccination rates amongst adolescents is a daunting task, especially considering it is a worldwide issue. Utilizing knowledge gained from the literature, an evidence-based intervention was developed in an effort to improve vaccine uptake. Through implementation of a provider education course in which techniques were given on how to provide a strong recommendation, HPV vaccination rates improved significantly. These findings indicate that educational interventions, system changes, and improved provider recommendation could lead to an increase in overall HPV vaccination rates and therefore a decrease in HPV related cancer deaths.

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Appendix A

Table 1

Evaluation Table

Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Brewer et al. (2017). Announcements versus conversations to improve HPV vaccination coverage: A randomized trial. **Country:** USA **Funding:** Pfizer & National Cancer Institute **Bias:** Sponsorship Bias	Inferred Theory of Planned Behavior	RCT (3 & 6 month FU) **Purpose:** To determine if announcement or conversation training lead to larger increases in HPV vax coverage	**N=** 30 (clinics) **n=** 10 (CG) **n=**10 (IV1) **n=**10 (IV2) **Pt type:** Vax prescribing providers A: 11-12- 31% 13-17- 69% **Setting:** Primary care clinic serving 11-12yo's **Exclusions:** prior QI to increase HPV vax rates w/i last	**IV1-** 1 hr provider announcement training **IV2-** 1 hr provider conversation training **DV-** Change in HPV vax initiation between baseline & 6 months post **Definition-** announcement- 1) due for 3 vax 2) HPV middle of vax stated 3)state you will vax	Online vax registry	Power analysis ITT Fisher's exact ANOVA Poisson regression	**IV1-** 3 month: IG difference from CG- 5.1% p=.003 6 month: IG difference from CG- 5.4% p=.02 **IV2-** 3 month: IG difference from CG- 2% p=.10 6 month: IG difference from CG- 2% p=.24	**LOE: II** **Strengths:** randomized, standardized intervention, low attrition, large sample **Weaknesses:** unknown providers adherence to intervention **Conclusions:** Brief provider announcement training increases HPV vax rates, conversation training does not **Feasibility:** Low cost and resources

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			6 months, <100 11-12 yo patients **Attrition:** 3% (clinic closed)	Conversation- 1) introduce 3 vax needed 2)place HPV in middle of list 3)discuss health benefits, ask if questions				
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Dempsey et al. (2019). Effect of a health care professional communication training intervention on adolescent Human Papillomavirus vaccination. **Country:** USA **Funding:** Not disclosed **Bias:** None	Precaution-adoption process model	RCT CSS **Purpose:** To determine if multimodal provider intervention would increase HPV vax rates	N= 43,132 n=21,892 (CG) n= 21,240 (IG) **Pt type:** Adolescents 9yo or older presenting for care A: Median-12.6yo S: f- 50.3% m-49.7% R: c-54.9% b-4.5% his- 12.4% o-7.9%	**IV:** 5 component-HPV fact sheet, parent ed website, images of HPV diseases, decision aid for HPV vax, 2.5 hr provider communication training **DV1:** Change over time between IG and CG in initiating HPV series	EMR Online vax registry Surveys	ITT Generalized linear mixed model Intercept-only model Descriptive statistics	**DV1:** **CG:** 1.8% **IV:** 11.3% p<.001 OR= 1.46 **DV2:** **CG:** -5.5% **IG:** -0.9% OR=1.56 **DV3:** 72-90% used communication techniques (most frequently used). 91% likely to continue to use.	**LOE:** II **Strengths:** heterogeneity of treatment effects analysis, randomized, large sample size **Weaknesses:** small geographic area not generalizable, long term FU not assessed **Conclusion:** Substantial and sustained increase in HPV vax initiation after multicomponent provider intervention. Provider communication ed used most frequently

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			Setting: PCO w/ at least 400 active adolescent patients **Exclusions:** Less than 9 yo, not eligible for HPV vax **Attrition:** None (electronic monitoring)	**DV2:** Completion of HPV vax series **DV3:** intervention sustainability				and reported easiest to use **Feasibility:** Multicomponent utilizes more resources that individual interventions, may be difficult to sustain over long period of time
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Dempsey et al. (2019). Parent report of provider HPV vaccine communication strategies used during a randomized, controlled trial of provider communication intervention. **Country:** USA **Funding:** CDC	Inferred Theory of Planned Behavior	RCT CSS **Purpose:** To assess secondary, parent reported outcomes of a provider communication intervention aimed at improving adolescent HPV vax	**N=** 342 **n=** 162 (CG) **n=** 180 (IG) **Pt type:** Parents of young adolescents seen at participating PCO A: <13=59% 13-14=41% S: f=50% m=50% R:	**IV:** 2.5 hour provider communication training teaching strong, presumptive techniques **DV1:** Parents report of provider rec style **DV2:** Parents HPV vax perception	Surveys	Chi-square Fishers Exact Descriptive Statistics	**DV1:** **CG=**36% **IG**=68% P<.001 **DV2:** **CG=**28% **IG=**55% P<.001 **DV3:** **CG=**45% **IG=**63% P=.003	**LOE:** II **Strengths:** randomized, non-invasive, validated data analysis tools **Weaknesses:** self-report, potential recall bias, unvaried demographic population, poor attrition rate **Conclusion:** Giving a strong, presumptive rec improves parent

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Bias: Recall (d/t attrition rate)			C=77% B=4% O=19% **Setting:** PCO in Denver, CO. **Exclusions:** ineligible to receive HPV vax, not between the ages of 11-17 years **Attrition:** 53% d/t invalid addresses or no response	**DV3:** Adolescent HPV vax receipt				attitude and acceptance of HPV vax **Feasibility:** Recommended d/t low cost, time effective approach
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables & Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Dixon et al. (2019). An educational intervention to improve HPV vaccination: A cluster randomized trial. **Country:** USA **Funding:** Merck-	Theory of Planned Behavior	RCT- cluster **Purpose:** Test the effect of digital HPV vax educational intervention delivered during a clinic visit	**N=**1596 **n=**1059 (CG) **n=** 537 (IG) **Pt type:** Parents of adolescents 11 to 17 yo who were unvaccinated or partially vaccinated. A: 11-12 -57.4% 13-14 -25.6%	**IV:** HPV digital educational video **DV:** HPV vax uptake **Definitions:** Vax uptake: change in vax status as a result of a clinic visit	CHICA Theo	Chi squared test *t-tests* ITT GEEs	**DV:** **IG:**78% **CG:**52.8% OR=3.07 with 95% CI p=.003	**LOE:** II **Strengths:** non-invasive, low attrition rate, randomization **Weaknesses:** unblinded, clustering in single urban health system, dichotomous variable **Conclusion:** Video presented to parents

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Regenstrief Program. **Bias:** Sponsorship Bias			15-17-17% S: F-45.3% M-54.7% R: B- 54.5% C-8.8% O-36.7% **Setting:** Eskenazi pediatric health clinics **Exclusions:** parents of children who were fully vaccinated, not able to read English language **Attrition:** None (able to track vax status in state registry)					on risks and benefits of HPV triples the odds of HPV vax uptake **Feasibility**: Recommended due to ease of administration, potential lack of resource (tablets)
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Krantz et al. (2017). Increasing HPV vaccination coverage	Inferred Health Belief Model	QI **Purpose:** To increase rate of HPV series	**N=**105 **Pt type:** Medical providers serving adolescents	**IV:** 15 minute provider education w/ HPV facts & framing of rec	Online vax registry	Fisher's exact Clopper-Pearson exact method	**DV:** Preintervention-50.9% Post-intervention-61.7%	**LOE:** V **Strengths:** validated analysis tools, completion of series

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through provider-based interventions. **Country:** USA **Funding:** None **Bias:** None		competition after provider education	S: f- 41% m- 59% R: B- 74% His- 1% O-25% **Setting:** PCO w/ predominantly low income patients **Exclusion:** Not between the ages of 13-17, not an active patient in vax registry **Attrition:** None (electronic monitoring)	**DV:** HPV vax series competition rates **Definition:** Series completion- receive all recommended doses			p<.05	rather than single dose **Weaknesses:** no control group, minimal variability in demographics **Conclusions:** Provider based interventions increase HPV series completion rates **Feasibility:** Low cost, limited resources
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Kumar et al. (2019). A brief provider training video improves comfort with recommending	Inferred Health Belief Model	Descriptive-questionnaire **Purpose:** Assess efficacy & feasibility of provider training	**N**=96 **Pt type:** pediatric providers Physicians-52%	**IV:** Video w/ didactic teaching outline HPV disease & vax **DV:** Provider comfort w/	Questionnaire (baseline & post-test)	Likert-scale McNemar test	Unacceptable to delay: Baseline- 50% Post- 71% p<.01	**LOE: VI** **Strengths:** inexpensive, validated IV & questionnaire

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the human papillomavirus vaccine. **Country:** USA **Funding:** American Academy of Pediatrics **Bias:** None		video about HPV vax	Residents- 6.3% NP/PA-23.9% **Setting:** 4 Pediatric PCOs **Exclusions:** Not a peds provider **Attrition:** 11%	counseling on HPV			Counseling for rationale: Baseline- 49% Post- 79% p<.01 Making a strong rec: Baseline- 68% Post- 84% p<.01	**Weaknesses:** convenience sampling, self-report, did not assess vax rates **Conclusion:** training video significantly improves provider comfort in counseling on vax & strong rec. **Feasibility:** Recommended d/t low cost, minimal resources & self-reported improvement in counseling
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Malo et al. (2018). Why is announcement training more effective than conversation training for introducing HPV vaccination? A theory based investigation.	Theory of Planned Behavior	RCT CSS **Purpose:** To assess the impact of announcement and conversation communication training on HPV vax coverage.	**N=**83 **n=**47 (CG) **n=**36 (IG) **Pt type:** Vax prescribing clinicians serving adolescents age 11-17 years. S:	**IV:** 1 hr provider education course teaching the EASE approach for HPV rec **DV1:** provider's HPV vax attitudes	Validated pre and post training surveys	Paired t-tests Independent sample *t-tests* ANOVA	**DV1:** **CG:** M=4.4 **IV:** M= 4.7 $p < .001$ $d = .62$ **DV2:** **CG:**3.5 **IV:**4.1 p<.001	**LOE:** II **Strengths:** no attrition, randomization, validated measurement tools **Weaknesses:** short follow-up, self-report, possible social desirability

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			f= 69% m=31% Years of practice: >10 yrs: 66% **Setting:** pediatric PCO providing HPV vax to adolescents **Exclusions:** <100 11-12 yo patients, no pediatric provider to order HPV vax **Attrition=** 0%	**DV2:** subjective norms about HPV vax **DV3:** self-efficacy to rec HPV vax **DV4:** time spent discussing vax			*d*=.90 **DV3:** **CG:**4.1 **IG: 4**4.6 p<.001 *d*=.89 **DV4:** **CG:**3.8 min **IG**:3.2 min p=.01 *d*=.28	**Country:** USA **Funding:** Grants from Pfizer & National Cancer Institute **Bias:** None **Conclusion:** After a 1 hr HPV rec training course, providers report delivering rec that is stronger, timelier, more urgent and more consistent than pre-training. **Feasibility:** Recommended due to low cost and minimal time commitment
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
McLean et al. (2017). Improving human papillomavirus vaccine use in an integrated health system: Impact of a provider and	Inferred Theory of Planned Behavior	Pre- & post-test (1yr post) Quasi-experimental **Purpose:** To evaluate the effectiveness of a multicomponent provider intervention in	**N=**24, 658 **n=**16,041 (IG) **n=**8,617 (CG) **Pt type:** Medical provider for adolescents 11-17 yo A:	**IV:** Multi-component-provider training, quarterly feedback of vax rates, patient reminder	EMR vax registry	GEE	**DV:** 11-12 yo: **CG pre IV:** 31.9% **CG post IV:** 44.5% **IG pre IV:** 40.6% **IG post IV:** 59.3%	**LOE: III** **Strengths:** No attrition, long FU period **Weaknesses:** multi-component so increases cannot be attributed to one item,

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staff intervention. **Country:** USA **Funding:** CDC **Bias:** None		changing HPV vax coverage	11-12- 28% 13-15-44% 16-17-28% S: F- 49% **Setting:** Medical offices that serve a large number of adolescents in regional health care system in WI **Exclusions:** Not between the ages of 11-18yo **Attrition-** 0% (electronically followed)	**DV:** Change in HPV vax coverage			p=.002 13-17yo: **CG pre IV:** 48.4% **CG post IV:** 55.4% **IG pre IV:** 53% **IG post IV:** 61.7% p=.001	pediatric providers higher in IV group **Conclusion:** multi-faceted approach targeting providers and parents increases HPV vax rates **Feasibility:** Components such as provider training low cost and few resources, however patient recall is not cost effective and utilizes many resources
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Perkins et al. (2015). Effectiveness of a provider focused intervention to improve HPV vaccination rates in boys and girls.	Inferred Theory of Planned Behavior	RCT **Purpose:** Evaluate the effectiveness of multi-component provider-based intervention in increasing HPV vax	**N=**13,118 **n=** 9025 (CG) **n=**4093 **Pt type:** Physicians, NPs, PAs of adolescents, adolescents 11-21yr	**IV:** repeated contact, focused education on HPV vax, individualized feedback on vax rates, incentives **DV:** HPV vax rates	EMR (pre IV, active, 6 month FU)	LR	**Active phase:** **DV:** f: OR- 1.6 95% CI m: OR- 11 95% CI **6 month post:**	**LOE: II** **Strengths:** low attrition rate, randomized, diverse demographics **Weaknesses:** state funded vax for boys,

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Country: USA **Funding:** American Cancer Society **Bias:** None			A: <15 yr=54% >15yr=46% S: f= 44% m= 56% R: C= 8% B= 47% O= 45% **Setting:** Pediatric PCO & community health center **Exclusion:** HPV vax completion, pregnancy **Attrition:** 0% (electronic tracking)	**Definitions:** repeated contact: HPV education at staff meeting every 6-8 weeks			f: OR-1.6 95% CI m: OR-8.5 95% CI p<.05	limited number of practices **Conclusions:** multi-component provider intervention increases HPV vax in boys & girls **Feasibility:** Repeated contact time consuming, many resources needed for multicomponent IV
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables and Definitions**	**Measurement**	**Data Analysis**	**Study Findings**	**Decision for Use**
Sanderson et al. (2017). Pragmatic trial of an intervention to increase human papillomavirus	Social Ecological Model	Clustered, pragmatic non-RCT **Purpose:** Evaluate the effectiveness of provider-focused	**N=** 269 **n=** 167 (CG) **n=** 194 (IG) **Pt type:** B or Hisp adolescents who had	**IV1:** educational video/flyer & 1 hr provider training & rec	Parent Questionnaire (pre & post, 12 month FU)	Chi-square ITT LR	**IV1:** **CG:**32.9% **IG:** 45.4% RR= 1.38 95% CI	**LOE: III** **Strengths:** non-invasive, pragmatic trial

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vaccine in safety-net clinics. **Country:** USA **Funding:** NIH **Bias:** None	and patient-focused intervention strategies aimed at increasing HPV vax rates among AA's and Hisp.	received no HPV vax A: 9-12-60% 13-15- 23% 16-18- 17% S: f- 50% m- 50% R: AA- 90% Hisp- 10% **Setting:** PCO for low income **Exclusions:** not AA or Hisp, not adolescent, received HPV vax **Attrition:** 27% (IG), 38% (CG) d/t refusal	**IV2:** Provider training & rec alone **DV:** Receipt of HPV vax	**IV2:** RR: 4.08 95% CI	**Weaknesses:** non-randomized, narrow demographic range **Conclusion:** Provider recommendation had 4x increased HPV vax rate, video/flyer did not. Parent report video/flyer was helpful **Feasibility:** Recommended d/t low cost and non-invasive

Key: A- age, **ANOVA**- analysis of variance, **B**-black, **C**- Caucasian, **CDC**- Centers for Disease Control and Prevention, **CG**-control group, **CHICA**- child health improvement through computer automation, **CI**- confidence interval, **CSS**- cross-sectional survey, ***d***- Cohen's d, **DV**- dependent variable, **DV1**-dependent variable 1, **DV2**- dependent variable 2, **DV3**- dependent variable 3, **DV4**- dependent variable 4 **EASE**- elicit, acknowledge, share, explain, **ed**- education, **f**-female, **EMR**- electronic medical record, **FU**- follow up, **GEE**- generalized estimating equation, **His**- Hispanic, **HPV**- human papillomavirus, **hr**- hour, **IG**- intervention group, **ITT**- intention to treat, **IV**- independent variable, **IV1**- independent variable 1, **IV2**-independent variable 2, **LR**- logistic regression, **M**- mean, **m**-male, **min**- minutes, **N**-sample (population), **n**-sample size (studies), **NP**- nurse practitioner, **O**- other, **OR**- odds ratio, **PA**- physician assistant, **PCO**- primary care office, **QI**- quality improvement, **R**- race, **RR**- relative risk, **RCT**- randomized control trial, **rec**- recommendation, **S**- gender, **vax**- vaccine/vaccinated, **yo**- years old

Appendix B

Table 2

Synthesis Table

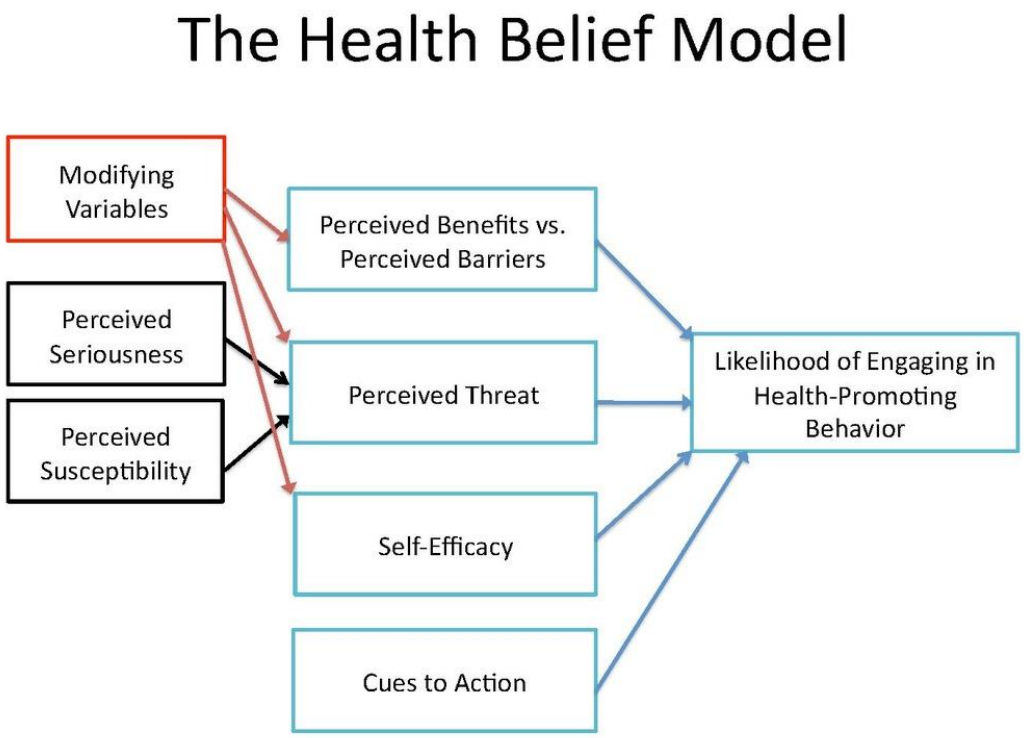
	Brewer	Dempsey	Dempsey	Dixon	Krantz	Kumar	Malo	McLean	Perkins	Sanderson
Year	2017	2019	2019	2019	2017	2019	2018	2017	2015	2017
Design	RCT	RCT/CSS	RCT/CSS	RCT	QI	DS	RCT/CSS	QE	RCT	NRCT
LOE	II	II	II	II	V	VI	II	III	II	III
Study Characteristics										
Demographics										
Age Range (yo)	11-17	9-18	9-14	11-17	13-17		11-17	11-17	11-21	9-18y
Female %		50.3	50	45.3	41		69	49	44	50
Caucasian %		54.9	77	8.8	25				8	0
Setting										
USA	X	X	X	X	X	X	X	X	X	X
PCO	X	X	X	X	X	X	X	X	X	X
Sample	30(clinics)	43,132	342	1596	105	96	83	24, 658	13,118	269
Measurement Tools										
EMR	X	X							X	
Registry		X		X	X			X		
Survey		X	X			X	X			X
Interventions										
Provider Training (SIV)	X		X		X	X	X			
Provider Training (MIV)		X						X	X	
Parent Education				X						
Parent & Provider Education										X
Outcomes										
Change in HPV vax rates	⬆	⬆	⬆	⬆	⬆			⬆	⬆	⬆
Provider Perception						⬆	⬆			
Parent Perception			⬆							

Key: CSS= Cross Sectional Survey, **DS**= Descriptive Survey, **EMR**= Electronic Medical Record, **LOE**= Level of Evidence, **MIV**= Multicomponent Intervention, **NRRCT**= Non-randomized controlled trial, **PCO**= Primary Care Office, **QE**= Quasi-experimental, **QI**= Quality Improvement, **RCT**= Randomized Controlled Trial, **SIV**= Single Intervention, ⬆ = significantly increased

Appendix C

Figure 1

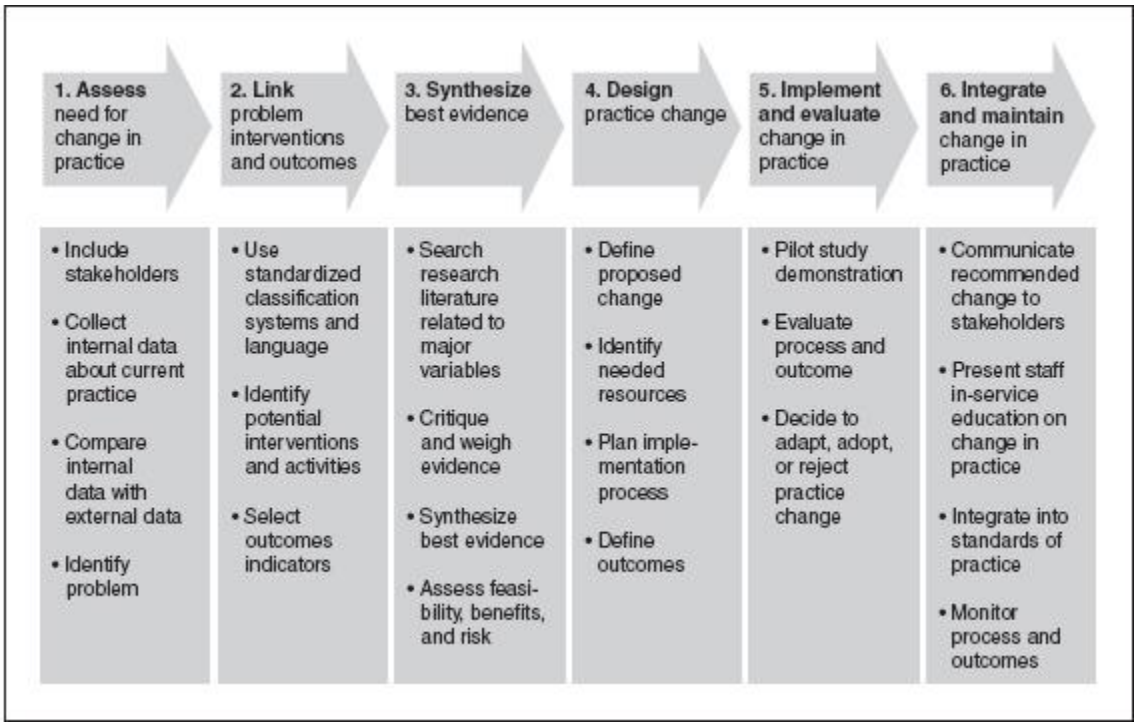
The Health Belief Model



Appendix D

Figure 2

Rosswurm & Larrabee's Model for EBP Change



Appendix E

Table 3

Budget Plan

Phase	Activities	Cost	subtotal	Total
Educational Class	Design and print educational handouts (15 total x $.10/page)	$1.50		
	Laptop to stream educational app*	$0		
	Educational app	$0		
	HDMI cable to connect laptop to television	$10		
	Television to project images larger*	$0		
	Design and print pre and post intervention surveys (30 total x $.10/page)	$3.00		
	Meeting room space for 1 hour*	$0		
	Electricity and air conditioning in meeting space*	$50		
	Pay 15 providers for 1 hour of their time ($65/hr)*	$0		
	Lunch for 15 people	$200	$264.50	
Data Collection	Intellectus	$75		
	3 month post intervention surveys (15x $.10 each)	$1.50	$75.50	$340.00