Addressing Low Vaccination in a Free Clinic

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Abstract

Project Title: Addressing Low Vaccination in a Free Clinic

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Background: Vaccination is an effective public health tool; however, immunization rates are low in American adults, with disparities existing for Hispanics compared to non-Hispanic Caucasians, uninsured individuals, undocumented immigrants, and low-income individuals (Lu et al., 2014; Lu et al., 2015; Williams et al., 2016). Consequently, 42,000 adults still die each year in the United States (US) from vaccine-preventable diseases, and nine billion dollars are spent on associated healthcare costs and lost productivity (ADHS, 2015; Wilson et al., 2019). To improve adult vaccination rates, the National Vaccine Advisory Committee recommends the Standards for Adult Immunization Practices, including regular assessment, recommendation, delivery or referral, and documentation during follow-up on vaccination (Orenstein et al., 2014; CDC, 2016).

Local problem: A free clinic in Arizona serving uninsured, undocumented Latin American immigrants had low vaccination rates and a deficiency in vaccination documentation in electronic medical records.

Methods: An evidence-based quality improvement project was conducted to address low vaccination rates and provider practices using a multi-component intervention. The effect and usage were evaluated through chart audits and pre- post-intervention surveys.

Interventions: A vaccination questionnaire was administered at all in-person primary care visits. Brief educational videos were provided to providers and office staff before the intervention addressing the questionnaire's use, purpose, and goals. Adult immunization schedule printouts were made available in all patient rooms and provider charting areas. Additionally, a resource sheet on local free immunization programs was created for providers and patients.

Results: The intervention's effect was unable to be determined due to a breakdown in the protocol after the second week of implementation. However, 92% of completed questionnaires reviewed indicated the patient needed one or more vaccination. Sixty-five percent of electronic medical records reviewed had no vaccination documentation historically for assessment, recommendation, referral, follow-up, or scanned vaccination records. No charts reviewed had these areas documented regularly.

Conclusion: Vaccination rates and the Standards of Adult Immunization Practices are low at the free clinic. Further quality improvement measures are indicated addressing barriers present.

Keywords: Adult, Vaccine, Immunization, Uninsured, Undocumented Immigrant

Addressing Low Vaccination in a Free Clinic

Immunization plays a vital role in the public health of Americans. With the help of current vaccinations, the average American lifespan increased more than 30 years, and mortality from vaccine-preventable diseases (VPD) decreased 14 fold (United States Department of Health and Human Services [HHS], 2010). Adult vaccination rates are low in general, with disparities seen in certain racial and ethnic groups, including Hispanics, compared to non-Hispanic Caucasians, uninsured individuals, those with low incomes, foreign-born persons, noncitizens, and undocumented immigrants (Lu et al., 2014; Lu et al., 2015; Williams et al., 2016). Many evidence-based interventions are available to increase vaccination rates; thus, it is essential to support clinics with low adult immunization rates in implementing measures to protect their patient population.

Problem Statement

Each year in the US, 42,000 adults still die from VPD (Arizona Department of Health Services [ADHS], 2015). Additionally, VPD healthcare costs and lost productivity are estimated at 9 billion dollars per year (Wilson et al., 2019). From 2017 to 2018, VPD trends in Arizona showed an increase in influenza, tetanus, hepatitis A, varicella, Streptococcus pneumoniae, and hepatitis B (ADHS, 2018). These diseases pose a substantial morbidity and mortality threat to unvaccinated adults (Ndiaye et al., 2005). Both healthy adults and those with chronic health issues are recommended to have scheduled vaccinations based on age, medical problems, risk factors, and prior vaccination (Williams et al., 2017). Vaccination is crucial for individuals with high-risk comorbidities such as type 2 diabetes, which increases the risk of serious illness, hospitalization, or death from VPD (Centers for Disease Control and Prevention [CDC], 2017). In addition to the health risks, the cost of medical care for VPD can be financially devastating,

especially for persons with low incomes or no health insurance. For example, one case of Pneumococcal bacteremia can cost a 50-64 year old individual $32,204 in medical bills (McLaughlin et al., 2015).

Adult immunization rates remain low even though many national campaigns aim to improve adult vaccination uptake (Healthy People 2020, 2013; Orenstein et al., 2014). The barriers to achieving vaccination may be multifactorial. Falcone et al. (2019) suggest a lack of insurance to be a significant barrier, along with fear of needles or side effects, distrust of the health system, misinformation, price, and lack of transportation. Immigrant persons may enter nations with inadequate immunization due to a lack of preventative services exacerbated by the circumstances that led to their immigration (Martinez et al., 2015).

Further, foreign-born adults, both citizens and noncitizens, experience cultural, linguistic, and other barriers to accessing preventive services (Lu et al., 2014). Regardless of citizenship, all foreign-born persons are eligible for US public health vaccination programs (Gómez & O'Leary, 2019). Noncitizens may not utilize these services due to lack of eligibility awareness or limited funding of health department programs for immigrant vaccination (Lu et al., 2014).

According to the National Vaccine Advisory Committee (NVAC), general barriers to adult vaccination may include a lack of knowledge of both patients and providers that healthy and high-risk adults need vaccinations, management of acute and chronic medical issues may take priority over preventative care, high out of pocket costs for uninsured adults may make vaccines unaffordable, many patients see multiple providers which complicates coordination of care and reduces the likelihood of routine vaccination assessment and provision (Orenstein et al., 2014). To ensure adult patients are vaccinated, NVAC recommends all health care providers follow the Standards for Adult Immunization Practices (SAIP). These standards include

assessing patient vaccination status at every visit, providing a strong recommendation for needed vaccines, administering or referring patients to a vaccinating provider when indicated, and following up with patients to ensure vaccines were received (Orenstein et al., 2014; CDC, 2016).

Purpose and Rationale

It is the purpose of this evidence-based project to reinforce the importance of practicing SAIP and evaluate interventions for improving vaccination rates in the clinic setting.

The topic of low vaccination rates was selected due to the prevalence of the problem in American adults in general, the significant disparities in vaccination coverage in specific underserved populations, and the importance of immunization for adult health, especially for those with high-risk comorbidities.

Background and Significance

National and Statewide Data

The CDC (2019) recommends scheduled vaccination for all adults unless contraindicated. However, low vaccination rates are seen low in American and Arizonan adults. The following are examples of Healthy People 2020 (2013) adult vaccination target levels: 90% of adults 65 years and older and 60% of high-risk adults age 18-64 should be vaccinated for pneumococcal disease. In comparison, in 2018, Arizonan adults had vaccination rates of 74% for those 65 and older and 30% for high-risk adults 18-64 years old for pneumococcal disease (Kaiser Family Foundation [KFF], 2020). In Hispanic Arizonan adults, 64.8% of those 65 and older and 26.4% of high-risk adults age 18-64 were vaccinated for pneumococcal disease (KFF, 2020). Nationally, 9.8% of uninsured adults aged 18-64 at high risk were vaccinated for pneumococcal disease in 2012 (Lu et al., 2015). Foreign-born persons are less likely to be vaccinated for pneumococcal disease over the age of 65, tetanus over 18, Tdap over 18, and HPV for women

18-26 (Lu et al., 2014). Mexico specifically has a different vaccination schedule than the US, resulting in lower coverage throughout the lifespan for high-risk individuals at certain ages (Lu et al., 2014).

Those who are uninsured are more likely to have low vaccination and increased barriers to preventative medical care (Lu et al., 2015). In Arizona, 15.4% or 631,300 Arizonans 19-64 years old are uninsured. When looking at low-income adults under 200% of the federal poverty level, 24.2% or 290,200 Arizonans 19-64 years old are uninsured. 19.4% or 405,000 Hispanic Arizonans were uninsured in 2019 (KFF, 2020). Approximately two-thirds of undocumented Latin American immigrants are uninsured, and Latinos, in general, are twice as likely to be uninsured as non-Hispanic Whites (Philbin et al., 2018). Noncitizens are more likely to be uninsured when compared to US citizens, and undocumented immigrants are at the highest risk, with 45% of the population uninsured (KFF, 2019). The US population in 2017 consisted of 22 million noncitizens (KFF, 2019). Pew Research Center (2019) estimates that in 2016, 275,000 undocumented immigrants resided in Arizona, with 78% estimated to be Latin American immigrants from Mexico. Noncitizens are more likely to have limited access to private coverage from employers as they tend to work in industries that do not offer employer-sponsored health insurance. Low wages further increase vaccination and medical access barriers due to unaffordability (KFF, 2019).

Multi-component interventions may increase vaccination rates across adult populations (Falcone, 2019; Ndiaye et al., 2005; Community Preventive Services Task Force [CPSTF], 2017); however, research specific to vaccination uptake in the previously discussed disparity groups is limited. Increasing vaccination coverage of high-risk adults is possible through system, provider, and patient-based interventions that incorporate increased access and reduced

vaccination costs (Williams et al., 2016; Ndiaye et al., 2005; CPSTF, 2017). Studies investigating single interventions are limited, but evidence of improvement exists for multifactorial interventions (Falcone, 2019; Ndiaye et al., 2005; CPSTF, 2017).

The HHS 2010 National Vaccine Plan (2010) reports having a consistent supply of vaccines in provider sites can improve vaccine uptake by increasing access to immunization. In a longitudinal analysis of influenza vaccination behaviors in adults, Maurer (2016) suggests that increased access to vaccination through offering and delivering immunizations at each health visit may improve uptake in low socioeconomic status groups. Referral to offsite clinics for immunization is recommended by the CDC (2016) when clinics do not have vaccinations available onsite. However, this places additional barriers to access such as lack of transportation, distrust of the health system, unaffordability, etc., that may be difficult to overcome for individuals of low socioeconomic status (Ndiaye et al., 2005; Falcone et al., 2019).

Internal Evidence

A 501(c)(3) non-profit medical clinic located in Southwest US provides free healthcare services to the surrounding uninsured community. Providers report many patients at this clinic are undocumented Latin American immigrants, although citizenship is not tracked. The population served has a high rate of type 2 diabetes among other chronic illnesses that warrant scheduled vaccination uptake to decrease potential complications, hospitalization, and death from VPDs. The clinic has a gap in service of onsite vaccination availability. Offsite referral to public health centers is made to patients in need of immunization. Immunization rates are not formally tracked; however, clinic providers report low vaccination uptake, which they attribute to increased barriers experienced with offsite referrals. Reported barriers perceived by clinic staff include lack of transportation, difficulty getting time off work, and domestic priorities. Based on

an electronic medical record (EMR) audit, it was unclear if clinic providers followed SAIP with routine assessment, recommendation, referral, and follow-up on patient immunization. More than seventy percent of charts audited had a lack of any vaccination documentation.

PICO Question

This inquiry led to the clinically relevant PICO question, "in uninsured undocumented Latino immigrants, does free onsite immunization availability compared to referral to an offsite clinic affect immunization rates?"

Search Strategy

An exhaustive search of the evidence was conducted using the following electronic reference libraries: PubMed, CINAHL, and Cochrane Database of Systematic Reviews. The initial search was performed using the following keywords: immunization, vaccination uptake, intervention, uninsured, undocumented immigrant, Latin American, onsite, referral, adult. However, limited research was available for onsite vaccination compared to offsite referral, uninsured, undocumented immigrant, or the Latin American demographic within the past five years. The final search strategy was performed using the following keywords: immunization, vaccination, uptake, intervention, uninsured, immigrant, adult. References of relevant articles were reviewed by hand searching for pertinent articles (e.g., reviews). Inclusion criteria were limited to peer-reviewed publications in English from 2015 until 2020. Randomized trials, cohort studies, systematic reviews, and metanalyses were included. Articles focusing on adult vaccination uptake were limited, so participant eligibility included all ages. Eligible interventions included those that an outpatient clinic, pharmacy, or healthcare encounter location implemented to improve vaccination rates. Outcome measures included vaccination rates and missed opportunities for vaccination.

PubMed

PubMed search combinations included "Immunization OR Vaccination AND Intervention AND Uptake OR Coverage OR Rates." Limits of 5 years, clinical trial, and review were added for a final yield of 493 studies. Articles were narrowed down by a review of titles followed by abstracts with a final yield of 14 studies. Additional search combinations using "Uninsured OR Immigrant" led to one result reviewed for appropriateness with a yield of zero studies.

CINAHL

CINAHL search combinations included "Immunization OR Vaccination AND Intervention AND Uptake OR Coverage OR Rates." The initial yield was 578. The addition of Systematic Review OR Meta-analysis OR Randomized Control Trial led to 120 articles. Titles followed by abstracts were reviewed for appropriateness with a yield of 14 studies. The addition of "AND Uninsured" to the initial search led to 12 articles reviewed for appropriateness with a yield of zero studies. The addition of "AND Immigrant" to the initial search led to 14 articles that were then reviewed for appropriateness with a yield of zero studies.

Cochrane Database of Systematic Reviews

Cochrane Database of Systematic Reviews search combinations included "Immunization OR Vaccination AND Intervention AND Uptake OR Coverage OR Rates." The initial yield was 21 Cochrane Reviews and 590 trials. The limit of 5 years was placed with a yield of 14 Cochrane Reviews and 465 clinical trials. Titles followed by abstracts were reviewed for appropriateness with a yield of 18 studies. The addition of "AND Uninsured" to the initial search led to 11 articles that were reviewed for appropriateness with a yield of 0 studies. The addition of "AND

Immigrant" to the initial search led to 5 articles reviewed for appropriateness with a yield of 0 studies.

Critical Appraisal and Synthesis of Evidence

Ten studies were selected for review. Six of the studies included were systematic reviews, two were randomized control trials, and two were randomized cluster control trials (see Appendix A, Table A1). The level of evidence of each study was evaluated through Melnyk and Fineout-Overholt's (2011) rapid critical appraisal. All of the studies included had moderate to high-quality evidence. All studies reported funding sources, and limited bias was detected. Most studies measured vaccination uptake, vaccination percentage, vaccination percentage point increase, or missed vaccination opportunities. Ages of study participants ranged from 0-99, with six studies focused primarily on a pediatric population (see Appendix A, Table A2). Settings were diverse, ranging from clinics to college campuses to pharmacy locations. All studies had adequate sample sizes. Most articles included data from US studies, while four articles included studies conducted in other countries.

Due to the diversity of independent variables of interest, there was significant heterogeneity across all studies. A wide range of unique interventions was included; therefore, it is difficult to determine the precise intervention with the strongest evidence. Dependent variables were relatively consistent with most studies assessing vaccination uptake, vaccination percentage point change, vaccination series initiation, and series completion. However, the vaccinations assessed were different between each article, with six studies including HPV vaccination in the investigation. Most systematic reviews utilized confidence intervals and odds ratios or relative risk ratios. The studies' reliability and validity are difficult to determine based on the heterogeneity of interventions and mixed results (see Appendix A, Table A2).

There was a broad range of interventions that may improve vaccination uptake based on the evidence reviewed. The most consistent evidence was for multi-component complex interventions that target different categories of interventions (see Appendix A, Table A2). Evidence supports strong provider recommendation, provider reminders, provider and patient education, provider audit and feedback, provider tip sheets, patient recall/reminders, enhancing access to vaccination, among other interventions (see Appendix A, Table A2). Many of the interventions correlated with increasing vaccination uptake are specific to the site and demographic served and may not be widely applicable.

It was difficult to locate evidence from the past five years that onsite vaccination compared to referral offsite improved vaccination rates, especially in the target population of uninsured, undocumented Latin American immigrants. However, evidence exists that onsite vaccination uptake is higher when vaccines are recommended and provided at the same visit (CDC, 2012). At the time of project design and implementation, the DNP project site had substantial barriers to an onsite vaccination program, including lack of funding, inadequate administrative staff hours, barriers inherent in a volunteer-run clinic, providers uncomfortable with adult vaccination schedules, and COVID-19 pandemic practice changes. Additionally, COVID-19 pandemic restrictions lead to human subject protections implemented by Arizona State University (ASU) Institutional Review Board (IRB), limiting the design of the DNP project to a virtual implementation. For these reasons, a multi-component intervention that could be implemented by the DNP student virtually was chosen to address low vaccination rates and support SAIP without bringing vaccines onsite.

A multi-component intervention was designed and implemented based on the evidence in the literature and the barriers present at the DNP project clinic. The intervention included a

vaccination questionnaire. The questionnaire acted as a provider reminder tool, educated patients and providers on vaccination indications, increased client demand for vaccinations through increased frequency of vaccination conversations at the clinic, and acted as a system/provider-based tool by changing provider workflow. Additionally, the intervention included a brief provider and office staff education on the questionnaire and background information. A resource sheet summarizing local free immunization program information was created for providers and patients to help decrease barriers to obtaining offsite referrals. Finally, CDC immunization schedule printouts were included in all patient rooms and provider charting areas to act as a physician tip sheet. The multi-component intervention was selected for its low cost and emphasis on the recommendations of the CDC and NVAC to follow SAIP (CDC, 2016). The questionnaire was specifically designed to assess the history and risk factors for the thirteen most commonly needed adult vaccinations. The vaccines included in the questionnaire were determined by the medical director's preference due to his knowledge of vaccination needs at the clinic.

Theoretical Model and Implementation Framework

Social-Ecological Model

The theoretical model used to promote understanding of the evidence and underpin this project is the Social Ecological Model (McLeroy et al., 1988). This model guides the development of successful programs by helping detect factors that affect behavior (McLeroy et al., 1988). This model spurs users to consider the individual and how they interact with their surrounding system by looking at the five influence levels (individual, interpersonal, organizational, community, and public policy). The individual level encompasses an individual's knowledge and skills. The interpersonal level comprises an individual's relationships with other individuals. The organizational level includes an organization's reach and influence over the

individual. The community level encompasses all organizations in a community and how they can work together towards a common goal. Public policy includes governing bodies that influence a goal. The Social-Ecological Model emphasizes that healthy change is more likely when the environment promotes said change (McLeroy et al., 1988).

This theoretical framework informed the project's content and structure by focusing the quality improvement implementation on fostering an environment conducive to improved provider vaccination practices. The intervention was chosen for its ability to influence all five levels of the Social-Ecological Model (McLeroy et al., 1988). The questionnaire, provider education, resource sheets, and CDC ACIP printouts affect the individual level by acting as a provider reminder, educating both provider and patient, and encouraging dialog between the provider and patient on vaccinations. On an organizational level, the intervention is system-based, changing the process of patient visits and alerting providers and staff to a crucial need of vaccinations in the population served. The community is affected as more conversations are being had with individuals of the community, leading to a ripple effect of improving knowledge and enhancing demand. Finally, public policy was considered in the intervention design, wherein CDC and NVAC recommendations to follow SAIP were used as an interventional target.

ACE Star Model of Knowledge Transformation

The framework chosen to guide this project was the ACE Star Model of Knowledge Transformation (Stevens, 2004). This framework helps guide quality improvement through the translation and application of evidence to practice. The model is broken down into five points of a star, highlighting the process steps. The steps are discovery, evidence summary, translation into guidelines, practice integration, and process outcome evaluation (Stevens, 2004). This model

was selected due to its cyclical flow, allowing for initial evaluation, intervention, reevaluation, and further quality improvement based on outcomes or evidence changes.

The first two sections of the model, the discovery of research and evidence summary, were completed through an exhaustive literature review and evidence summary. Translation of evidence was achieved by planning the DNP project guided by evidence found in the literature review, translated to the DNP project site's specific needs. The SAIP (Orenstein et al., 2014) was identified as a potential point of emphasis for the project site based on its recommendation from the CDC, NVAC, and Immunization Action Coalition (IAC) for improving vaccination rates. Practice integration was implemented by promoting practice change through brief educational videos for providers and clinic staff on the adult vaccination questionnaire and related practice process. Practice change was also championed onsite by the office manager and medical director and virtually by the DNP student. Process outcome evaluation was assessed through statistical analysis of pre-and post-intervention provider surveys and chart audits for patients who had onsite primary care visits during the study period.

Methods

The evidence-based project was developed based on the literature review described previously. This project included a vaccination questionnaire implemented at a free clinic in the Southwest US, brief provider and staff training, resource sheet on local free immunization clinics, and CDC ACIP Guideline printouts in all patient rooms and provider charting areas. The IRB of ASU approved this project through expedited review. Ethical considerations included updating the clinic's HIPPA privacy statement to include wording on using and disclosing health information to third parties for research or similar purposes. Providers were recruited through an email with a link to a pre-intervention survey hosted on Qualtrics. Implied consent messaging

was included at the beginning of the survey, wherein providers consented to participation in the DNP project by completing the survey. Additionally, participating providers were notified of risks and their right to opt out of the project at any time. All patient and participant information was de-identified and stored in a password-protected personal computer.

The populations included in this project were paid primary care providers at the free clinic, including Medical Doctors, Doctors of Osteopathic Medicine, or Nurse Practitioners. The project was implemented in a free clinic serving uninsured Spanish-speaking patients presenting for in-person primary care visits. These patients were not directly involved as participants; however, de-identified information from patient charts was reviewed post-intervention to assess the vaccination questionnaire's use and effect.

Participants were recruited by an email sent out to current medical providers at the free clinic on December 28th, 2020, by the office manager. This email contained links to brief educational videos and a link to a pre-intervention survey for participating providers. The survey included an implied consent form at the start of the survey followed by questions about provider vaccination practices and opinions on barriers to adult immunization at the clinic. Surveys were password-protected, de-identified using a provider-selected four-digit pin, and accessible only through a private link. Education related to the vaccination questionnaire implementation and practice process change was presented using a recorded PowerPoint voice-over hosted on a YouTube private channel with a private link. Front office staff and nursing staff were educated on the vaccination questionnaire implementation in the same method in a separate video sent out via email using a private link.

The vaccination questionnaire was created based on the public document produced by the IAC (2020) titled *Which Vaccines Do I Need Today?* The primary author modified the IAC's

questionnaire based on feedback from the medical director related to which vaccines to include, reading level, and style. The document was modified to be below a 6th-grade reading level and translated into Spanish. Reading level was verified through Microsoft Word's algorithm testing using Flesch-Kincaid Grade Level Readability Formula. The free clinic printed the vaccination questionnaire in both English and Spanish for implementation.

The questionnaire was implemented starting January 4th, 2021, for six weeks ending February 12th, 2021. The questionnaire was to be given to every patient presenting for an in-person primary care visit to fill out in the lobby before their clinic visit. Completed questionnaires were to be collected by front office staff and placed in front of the patient's paper chart. Paper charts were oriented towards the wall, so no patient health information was visible in the hallway. Providers were to review patient responses and request vaccination records from the patient if not already in the patient's EMR. If vaccination was needed, providers were encouraged to recommend immunization and refer patients to a vaccinating provider using the free clinic's standard referral process. Providers were to chart a note about vaccination assessment, recommendation, and referral into the EMR. Vaccination questionnaires were to be collected and given to the medical director for appropriate scanning into the EMR then disposed of in a medical record shredding bin.

After the first week of the intervention, the clinic contacted the primary author to discuss barriers to implementation and request changes to the vaccination questionnaire. The questionnaire was decreased from four to two pages and formatted to have Spanish on the front and English on the back. It was modified to cover fewer vaccinations, reducing from assessing 13 vaccinations to the four most commonly indicated vaccinations in the clinic's population, including Influenza, Pneumovax 23, Prevnar 13, and Hepatitis B. The questionnaire was also

numbered by line so that providers could see the translation from a specific line if needed. ASU's IRB approved this revision.

Following the six-week intervention, a post-implementation provider survey was sent via email link to providers. This survey contained the same content as the pre-intervention survey and had the same implied consent attached to the questionnaire beginning. Surveys were password-protected, de-identified using a provider-selected four-digit pin, and accessible only through a private link. The data analysis plan included descriptive statistics using Intellectus software.

Post-intervention chart audits were conducted one week following the intervention period to assess change in vaccination practices before and after the intervention. Patient charts (n=41) were reviewed utilizing randomized sampling techniques. Charts were randomly selected by choosing every fourth patient who presented for an in-person primary care visit during the study period. The chart audit included the following data: type of provider, patient age, primary language, questionnaire use, vaccination assessment during study period, recommendation during study period, referral during study period, assessment historically, recommendation historically, referral historically, and vaccination documentation scanned into the EMR historically. Data was planned to be analyzed using Chi-Squared Test of Independence, Multinomial Logistic Regression, and Descriptive Statistics in Intellectus software.

This project's budget relied mainly on the in-kind donation of time for preparation, delivery, and analysis (see Appendix c, Figure 1). The free clinic donated printing, paper, and staples for the intervention and in-kind donation of provider time when participating in the intervention. Because of the minimal cost, no funding was needed.

Results

One provider participated in the pre-intervention survey, and another participated in the post-intervention survey. Due to this low response, analysis past descriptive statistics could not be performed. Both providers were Medical Doctors with 20-30 years of experience, one female and one male. Both providers indicated that they assessed, recommended, referred, and followed up on vaccinations “sometimes.” Both indicated that they “somewhat agree” that a vaccination questionnaire would improve how often they assessed, recommended, referred, and followed up on vaccination with patients. Both providers indicated varying levels from "agree" to "strongly agree" that adult patients have issues obtaining offsite vaccination referrals, are unaware of vaccines they need, don't know where to get vaccines, and are willing to get recommended vaccines. Both providers agreed that patients could not afford vaccines, are unable to complete vaccine referrals due to barriers inherent in offsite referrals, and are wary of obtaining vaccines offsite due to distrust of unfamiliar health services.

Chart audits were conducted on every fourth in-person primary care patient visit during the study period from 1/4/2021 – 2/12/2021 for a total of 45 charts. Four chart audits were discarded due to the seemingly random selection of answers on the questionnaire that did not line up with subsequent answers or patient history. The final number of charts audited was forty-one (n=41). Through discussion with the office manager and medical director of the clinic, it was found that the clinic changed the protocol after two weeks into the intervention. The questionnaire was given to patients to fill out; it was collected but was not given to providers for review. Analysis on the significance of the questionnaire's effect on vaccination assessment, recommendation, and referral could not be assessed because of the deviation from protocol. Data analysis from the first two weeks, where full intervention protocol was followed, was impossible due to an incomplete data set.

Patients filled out questionnaires during the entire six-week study period. However, after the second week, completed questionnaires were not given to providers for review. The chart audit revealed 70% of patients audited filled questionnaires during the study period. Of the questionnaires audited, 92% indicated that vaccination was due. About 65% of charts reviewed had no vaccination documentation historically, including assessment, recommendation, referral, or scanned records. Only 2% of EMRs had scanned vaccination records of any kind, and 0% had vaccination assessment, recommendation, referral, or follow-up regularly documented as recommended in SAIP.

The clinical significance of this project includes the illumination of the need for further quality improvement. Data collected from the vaccination questionnaires indicated a substantial need for vaccination in this clinic's patient population. Additionally, chart audits revealed the lack of SAIP, including low rates of assessment, recommendation, referral, follow-up, and scanned vaccination documentation.

Due to the DNP project intervention, clinic leadership expressed interest in pursuing further quality improvement and system-based interventions to increase vaccination rates. Based on conversations with clinic providers, the medical director, and the office manager, the intervention increased patient interest in and awareness of the need for adult vaccinations. Providers expressed more understanding of the lack of regular vaccination practices and documentation and the need for immunizations in the patient population.

The DNP project site can sustain the intervention through using questionnaires in yearly primary care visits that allow for additional time to assess preventative care services. Clinic leadership did not feel the questionnaire was sustainable when given to every patient presenting for a primary care visit due to the amount of time needed to review the questionnaire with

patients. However, to decrease missed opportunities for vaccination and reduce barriers to access in this population, the results indicate the need for onsite vaccination, a nursing-led immunization program, implementing standing orders, EMR reminders, and patient reminder/recall systems. Additionally, discussion with free clinics in the area with successful programs and similar patient populations was planned to formulate a sustainable future vaccination program.

Discussion

Summary

The DNP project's purpose was to assess the impact of a multi-component intervention on vaccination assessment, recommendation, and referral with the ultimate goal of improving low immunization rates. The design of this quality improvement project was informed by a literature review and the recommendations of the CDC and NVAC to champion SAIP to improve adult vaccination rates in the clinic setting. The multi-component intervention included a change of workflow and protocol, brief provider and staff education, patient questionnaire-provider reminder tool, printouts of vaccination schedules, and free vaccination resource sheets. The intervention was implemented for six weeks starting January 2021. After week one, the questionnaire was revised, and after week two, providers did not follow the workflow protocol. Random chart audit of patients presenting for in-person primary care visits during the study period looked at the variables of assessment, recommendation, and referral documented during the intervention period and historical documentation of all of the above and scanned vaccination records. The analysis included descriptive statistics in Intellectus statistical software. Analysis of the intervention’s effect was not possible due to protocol break down after the second week of implementation and incomplete data set from the first two weeks of implementation. Results

indicate the need for one or more vaccinations in 92% of completed questionnaires reviewed and the need for improved vaccination practices based on a lack of regular vaccination documentation in all EMRs reviewed.

Limitations and Barriers

The project site had unique barriers to implementing quality improvement measures addressing vaccination uptake. The clinic was funded by in-kind donations and government grants leading to a lack of available funds for quality improvement measures. Limited funding necessitated an intervention with low-cost or grant funding. This barrier prevented EMR software improvement measures that would create the ability to track vaccination and generate provider reminders. Administrative staff hours were also unavailable for support of project measures, resulting from the lack of funding. This barrier led to the restriction of any intervention that needed administrative hours to manage tasks or compliance. One example is the Vaccines for Adults (VFA) program, a government-funded program through the ADHS (2015) providing free vaccination to uninsured adults. Additionally, the clinic was comprised of mostly volunteer staff with a few paid core staff members. This led to high staff turnover throughout the day and from day to day, leading to difficulty in training and consistency with new or complex processes.

The COVID-19 pandemic caused many barriers to successful implementation. Due to ASU IRB regulations, all human subject research was conducted virtually. This led to barriers inherent in a virtual implementation of an evidence-based project. Without an in-person presence, it was challenging to ensure providers and office staff were fully trained, the project remained visible, and protocols were followed. This likely contributed to the breakdown of protocol after the second week of the intervention. The clinic also had many practice changes

during and before the six-week implementation. Government mandates on social distancing, masking, etc., were put in place. In-office providers decreased due to COVID-19 mitigation restrictions, and many patient visits transitioned from in-person to telemedicine. Due to the practice changes and the threat of COVID-19 illness, many in-person visits were focused on acute and chronic medical conditions, taking priority over preventative care.

Barriers to implementation of the questionnaire came to light during the first two weeks of implementation. Reading comprehension and literacy of the patient population was lower than expected. This led to the need for verbal interpretation from a medical interpreter or provider. The process of oral interpretation caused an unsustainable visit length. Providers who were not fluent in Spanish had difficulty utilizing a separate Spanish and English questionnaire when interpreting patient responses. These barriers likely led to frustration and change in how the questionnaire was used at the clinic. Additionally, different dialects led to miscommunication and confusion, increasing interpretation time. In some cases, patients were filling out boxes on the questionnaire randomly. When asked if they had the medical indications selected, patients stated they did not, and they chose the boxes at random because they could not read or understand the form.

Other Literature

The findings in this project are congruent with other evidence-based studies (Lu et al., 2015; Lu et al., 2014; Williams et al., 2016) showing vaccination disparities in uninsured, undocumented immigrant populations. Substantial barriers led to the breakdown of the protocol in this project, and therefore the intervention was not successful. Similar evidence-based multi-component interventions were successful (see Appendix A, Table A2). However, these were

completed in population groups and settings, so results may not be translatable to the DNP project site.

Recommendations

This DNP project's findings emphasize the need for further quality improvement addressing clinic-specific barriers to increase vaccination uptake. Implementation of a nurse-run vaccination program with onsite immunization availability to decrease missed vaccination opportunities should be considered. This program would include nurse assessment of vaccination status and standing order protocols. Nurse ownership of the vaccination program may alleviate provider assessment time that played a role in the breakdown of sustainability of the vaccination questionnaire-provider reminder tool. Provider reminders through EMR alerts would likely decrease provider preparation time for assessment and SAIP, leading to improved vaccination practices, decreased missed opportunities for vaccination, and increased vaccination rates. Patient reminder/recall systems utilizing postcards may increase community demand and educate patients on their need for vaccination. Additional research is needed in the patient population as evidence for improving vaccination rates in low-income, uninsured, undocumented Latin American immigrant adults is lacking.

Conclusions

Adult vaccination in the US is low compared to Healthy People 2020 targets. Disparities exist in uninsured, low income, noncitizens, undocumented immigrants, foreign-born persons, and Hispanic or Latinx persons, further indicating the importance of improving vaccination uptake in these adult populations. Research on improving vaccination rates in the demographics served in the clinic is limited, leading to implications for further research. Many evidence-based solutions exist for increasing vaccination rates in the clinic setting, and as such, it is vital to

pursue quality improvement measures. Although the multi-component intervention utilized in the DNP project was not sustainable at the time implemented, the results illuminated the need for further quality improvement to increase adult immunization and vaccination practices.

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Appendix A

Evaluation and Synthesis Tables

Table A1

Evaluation Table

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Crocker-Buque et al. (2016) Interventions to reduce inequalities in vaccine uptake in children and adolescents aged <19 years: A systematic review. **Funding:** The National Institute for Health Research Health Protection	Donabedian's Model	**Design:** SR of RCTs, QE, RCS **Purpose:** Update the 2009 NICE systematic review, focusing and refining recommendations on effective interventions to decrease vaccine	**N:** 41 Age: 0-19 **DS:** MEDLINE, Embase, ASSIA, The Campbell Collaboration, CINAHL, The Cochrane Database of Systematic Reviews, Eppi Centre, Eric, and PsychINFO **Inclusion Criteria:** RCTs, QEs, ecological and observational studies; pediatric from birth to 19	**IV1:** multi-component complex interventions **IV2:** patient-focused reminder/recall systems **IV3:** outreach programs **IV4:** prompts for HCW **IV5:** Computer-based interventions **DV1:** vaccination uptake Childhood vaccinations **DV2**: adolescent vaccinations **DV3**: seasonal vaccinations 0-19y.o.	Checklist designed for RCT and NRCTs assessing: 1. external validity 2, internal validity 3. power of study	Data abstraction form Studies descriptively analyzed. Checklist assessing quality of reporting, external validity, internal validity, power of study.	**Multi-component complex interventions –** Increase VU, particularly in urban, ethnically diverse, low-income, or deprived population. **Patient-focused reminder/recall systems** increase VU,	**LOE:** I **Strengths:** studies mainly from the USA, with some from the UK, Canada, and Australia. **Weaknesses:** No Meta-analysis performed**.** **N**o consideration of vaccine hesitancy. Most interventions did not specifically target inequalities but instead delivered interventions in low-uptake populations. **Conclusions:** locally designed, multi-component interventions have the strongest evidence of increasing vaccine uptake in urban, ethnically diverse, low-income, or deprived populations. Some proof of text

Key: **Key: ANOVA**- analysis of variance; **CG**- control group; **CHICOS:** Combatting HPV Infections and CancerS; **CI** – confidence interval; **DS –** databases searched; **DV**-dependent variable; **EG** – experimental group; **EMR** – Electronic Medical Record; **GRADE** – Grades of Recommendation, Assessment, Development and Evaluation Working Group approach to evidence assessment; **HCW** – Health care worker; **HPV** - human papillomavirus vaccine; **IV**- independent variable; **MA-** meta-analyses; **MANOVA**-multivariate analysis of variance; **MD** – mean difference; **mn**- months; **N**-number of studies (if SR) or participants in study; **n**- number of participants (if SR) or number of participants in subset; **PCV** - pneumococcal conjugate vaccine; PP – Percentage point; **PPSV -** 23-valent pneumococcal polysaccharide vaccine**; QE –** Quasi-experimental**; RCT** – randomized control trial; **RCCT** – Randomized Cluster Control Trial; **SR-** systematic review; **Tdap -** tetanus, diphtheria and pertussis vaccine; **USA** – United States of America; **UTD** – up to date; **VU** – vaccine uptake; **VR** – vaccination rate; **wk**- weeks; **y.o.** – years-old; α - Cronbach's alpha value

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Research Unit in Immunization at the London School of Hygiene and Tropical Medicine in partnership with Public Health England **Bias:** none detected **Country:** USA, United Kingdom, Canada, Australia		uptake inequalities in high-income countries.	y.o. in Organization for Economic Cooperation and Development countries; Primary care level interventions aimed at increasing vaccine uptake with outcomes reported in specific population groups; English language;				especially in adolescent **Prompts for HCW:** one study increased initiation rates (35% vs. 21.3%) in African American pts. One study found no increase in VU. **Computer-based interventions** do not increase VU	messaging reminder systems in adolescents. Some evidence for interventions that increase in intensity for non-responders. **Feasibility/applicability to pt. population:** multi-component locally designed interventions are designed for a specific context and population, so may not be transferable to other settings. Population of all studies included was pediatric and therefore may not be applicable to adult populations. Also site has limited resources and volunteer staff.

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Das et al. (2016) Systematic review and meta-analysis of interventions to improve access and coverage of adolescent immunizations. **Funding:** Bill and Melinda Gates Foundation **Bias:** none detected **Country:** USA, China, Australia, Denmark, England, Canada	Donabedian's Model	**Design:** SR of RCTs, quasi-randomized trials, and 16 before-after studies **Purpose:** Evaluate the effectiveness of potential interventions for adolescent health and well-being	**N:** 23 Age: 11-19 **DS:** The Cochrane Library, Medline, PubMed, Popline, LILACS, CINAHL, EMBASE, World Bank's JOLIS search engine, CAB Abstracts, British Library for Development Studies at IDS, the World Health Organization regional databases, Google, and Google Scholar. **Inclusion Criteria:** interventions targeted at	**IV1:** Vaccination requirement in School **IV2:** Clinic Staff Training **IV3:** Reminders **IV4:** National Permissive Recommendation **DV:** VR/VU	Vaccination coverage, VU, vaccine initiation, incidence of certain vaccine-preventable diseases	95% CI Tau^2 Z = 4.93 (P<0.00001) Chi ^2 df I^2	**IV1:** increase VU; Tau^2= 0.19, Chi^2 = 527.86, df=6 (P < 0.00001) I^2 = 99%, test for overall effect Z= 3.90 (P <0.0001) **IV2:** non-significant Tau^2= 0.11, Chi^2 = 16.97, df=1 (P < 0.00001) I^2 = 94%, test for overall effect Z= 1.10 (P= 0.27) **IV3:** Increase VU; Tau^2= 0.00, Chi^2 = 3.77, df=3 (P= 0.29) I^2 =	**LOE:** I **Strengths:** **Weaknesses:** quality of evidence of studies included **Conclusions:** Implementing vaccination requirement in school, sending reminders, and national permissive recommendation for adolescent vaccination has the potential to improve immunization uptake **Feasibility/applicability to pt. population:** requirement in school not applicable of feasible for adults. Barriers to Clinic staff training, reminders include resources and volunteer staff.

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
			improving vaccinations in youth and adolescents **Exclusion Criteria:** efficacy of vaccine preparations, assessing changes in antibody titers, or various modes of delivering vaccines without control or baseline data.				20%, test for overall effect Z= 7.33 (P<0.0001) **IV4:** Increase VU; test for overall effect Z= 3.33(P= 0.0009)	
Dempsey et al. (2019) A randomized, controlled, pragmatic trial of an iPad-based, tailored messaging intervention to	Donabedian's Model	**Design:** RCT **Purpose:** seasonal influenza vaccine is recommended and funded for	**N:** 1,294 age: 9-26 Latino 18-26 and Latino parents of 9-17 85% Hispanic Low income	**IV1:** CHICOS tailored messaging **IV2:** Usual care **IV3:** Untailored messaging **DV1:** Receipt of any needed dose of HPV vaccine	Baseline and post-intervention Intention to treat Percentage VR	pair-wise (2-way) analyses 3-way analyses Bhapkar's tests of	No statistically significant differences between any two study arms in any of the vaccination uptake measures in the	**LOE:** I **Strengths:** Population of Latino, low income, **underserved** **Weaknesses:** Many patients removed from the study due to lack of information in the EMR. high levels of positive vaccination attitudes of study

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
increase human papillomavirus vaccination among Latinos **Funding:** Patient-Centered Outcomes Research Institute **Bias:** moderate. sampling bias towards positive HPV attitudes. Possible social desirability confounder. No blinding. Selective outcome reporting. **Country:** USA		groups at higher risk of serious infection, but uptake is suboptimal	Medically underserved 5 family practice clinics in Colorado **Inclusion Criteria:** 9-26 y.o. patient who had not completed HPV vaccination, consent signed. **Exclusion:** age <9 or >3=26 y.o. Already completed vaccine series at time of enrollment. Could not be matched to record. **Attrition:** 489	**DV2:** Initiation of the series; Started at 0 doses **DV3:** Initiation but not completion: started at 0 doses **DV4:** Completion of the vaccine series: anyone **DV5:** Completion of the series: start 1–2 doses **DV6:** Completion of the series: start 0 doses CHICOS: Combatting HPV Infections and CancerS: an intervention developed specifically for the Latino population and created with		marginal homogeneity Odds Ratio, 95% CI	intention to treat analysis	participants could have diminished the statistical power of the study. Per intervention: young adult (49%) and parent (72%) designated Very Likely to receive the vaccine at that visit. This increased to 60% and 77%, post-intervention survey. When very likely and somewhat likely were combined >90% **Conclusions:** no evidence that exposure to CHICOS, a tailored educational intervention about HPV vaccination for Latinos, lead to significant increases in HPV vaccine utilization compared to an Untailored intervention or Usual Care. Vaccination intention did not match up to vaccination behavior.

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
				significant community and end-user input.				**Feasibility/applicability to pt. population:** Results not statistically significant.
Jaca et al., (2018) A systematic review of strategies for reducing missed opportunities for vaccination. **Funding:** Stellenbosch University, the South African Medical Research Council, and the National Research Foundation of South Africa.	Donabedian's Model	**Design:** SR of RCT, RCCT, Cohort Studies. **Purpose:** assess effects of interventions for reducing Missed opportunities for vaccination (MOV).	**N:** 6 **n:** 92,525 age: 0-adult **DS:** PubMed, Scopus, and the Cochrane Central Register of Controlled Trials **Inclusion Criteria:** RCT, RCCT, Cohort studies with individuals eligible for vaccinations, caregivers of individuals eligible for vaccinations, or HCW who provide	**IV1:** provider prompts and tracking using lay health workers **IV2:** systematic verification of immunization history and chocolate bars labeled, "immunize on time" **IV3:** screen and vaccinate at all visits and remove legal guardian signatures **IV4:** parent education and case management	Rate of MOVs and vaccination coverage, as defined by the authors of included studies	RR with 95% CI. GRADE tool	**Patient education** (RR 1.92, 95% CI 1.38–2.68) ↓MOV ↑VU **Patient tracking using community HCW** (RR 1.18, 95% CI 1.11–1.25) ↑VU **Patient tracking and provider prompts** (RR 1.24, 95% CI 1.18– 1.31)	**LOE:** I **Strengths:** studies from USA, **Weaknesses:** level of bias of studies included **Conclusions:** patient education, patient tracking, outreach sessions, and provider prompts reduce missed opportunities for vaccination and improve vaccination coverage. **Feasibility/applicability to pt. population:** feasible and applicable

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Bias: High risk of bias reported from studies included in SR. **Country:** U.S.			immunizations. Interventions leading HCW to check immunization history and giving vaccines, targeting patients, providers, or healthcare system. **Attrition** 654 (0.007%)	**IV5:** provider education and one on one coaching **IV6:** Education, electronic prompts, and feedback **DV1:** rate of MOV **DV2**: uptake of vaccines **MOV:** occur when persons eligible for vaccination visit a health facility and do not get the vaccines they need.			↑VU	
Niccolai & Hansen (2015) Practice- and community-based interventions to increase human papillomavirus	Donabedian's Model	**Design:** SR of **Purpose:** To systematically review the literature	**N:**14 **n:** age: 0-18 y.o. **DS:** PubMed, Web of Science, and MEDLINE **Inclusion Criteria:** United	**IV1:** reminder and recall **IV2:** physician-focused interventions (eg, audit and feedback) **IV3:** school-based programs	VR VU PP	Descriptive statistics	**IV1: (**telephone calls, mailed letters, text messages, and/or outreach visits) 7/7 significant increases in at	**LOE:** I **Strengths:** **Weaknesses:** both randomized and nonrandomized designs. Variable quality of studies included

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vaccine coverage: A systematic review. **Funding:** National Institutes of Health **Bias:** none detected **Country:** USA		on the effectiveness of interventions conducted at the practice or community level to increase uptake of HPV vaccines in the United States.	States, focused on adolescents 18 years and younger, reported an outcome of actual HPV VR, and comparison group. **Exclusion:** Studies that examined only intentions or attitudes, only included young adults 18 years and older, were development or feasibility studies, or were only published as conference abstracts were excluded.	**IV4:** social marketing **DV:** VR/VU			least one HPV vaccination outcome. **IV2:** physician-focused - mixed results **IV3:** not applicable to PICOT **IV4:** social marketing – posters and brochures in local retail establishments, a web-site, a hotline, public service announcements, a continuing medical education	**Conclusions:** Most practice- and community-based interventions significantly increased HPV vaccination rates using varied approaches across diverse populations. **Feasibility/applicability to pt. population:** site has resource issues and volunteer staff. Physician-focused reminders may be feasible.

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							webinar, tip sheets for physicians, and a website increase VR	
Regan et al. (2017) Randomized Controlled Trial of Text Message Reminders for Increasing Influenza Vaccination. **Funding:** Department of Health Western Australia **Bias:** none detected **Country:** Australia	Diffusion of Innovations theory	**Design:** RCT **Purpose:** seasonal influenza vaccine is recommended and funded for groups at higher risk of serious infection, but uptake is suboptimal	**N:**12,354 age: Nine practices in the Perth metropolitan area and 1 rural practice **Inclusion:** high-risk group for severe influenza infection, had a mobile telephone number on file with the practice, had previously consented to contact by SMS with their general practitioner, and had not received a seasonal influenza vaccine before the	**IV1:** vaccination reminder by text message reminding of eligibility for free influenza vaccine **DV:** Vaccination initiation and percentage point VR	Intention to treat analysis VC VR Percent	$\chi 2$ statistics Log-binomial regression models Wilcoxon rank sums	39% relative increase VR text reminder (RR=1.39; 95% CI, 1.26-1.54)	**LOE:** I **Strengths:** all patients included high risk group **Weaknesses:** All participant included qualified for free influenza vaccination through a government-funded program. Only those with a mobile phone number on record were included. **Conclusions:** Text reminders modestly effective in increasing influenza immunization rate. **Feasibility/applicability to pt. population:** feasible however may not be applicable due to onsite availability of vaccination needed. If vaccines were available onsite, it would be applicable.

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
			date when the SMS reminder was sent **Criteria:** **Attrition**					
Rodriguez et al. (2019). Human papillomavirus vaccine interventions in the u.s.: A systematic review and meta-analysis **Funding:** National Center for Advancing Translational Sciences, NIH. The Cancer Prevention Research Institute of Texas.	Health belief model?	**Design:** SR of RCT, QE, cohort **Purpose**: perform a SR and meta-analysis to assess the effectiveness of intervention strategies aimed at increasing HPV vaccine initiation and	**N: 17** n: 68,623 Age: 9-26 y.o. **DS:** CINAHL, OVID, and Web of Science) **Inclusion Criteria:** assessed vaccine outcomes for 9−26 years recommended to receive the HPV vaccine. reported HPV vaccine initiation or completion rates after intervention. included an intervention strategy	**IV1:** Behavioral **IV2:** Environmental **IV3:** Informational **IV4:** Combined **DV1:** HPV initiation **DV2:**HPV completion **Behavioral interventions -** target decision support (e.g., message framing, peer or expert education video, evidence-based pamphlet) and use healthcare system alerts or patient	VU HPV initiation and completion	meta-analysis, the RR and 95% CIs I2 and the Cochran Q statistic Funnel plots and Egger test	**IV1:** behavioral (RIE=2.04, 95% CI=1.36, 3.06) effective initiation. effectively increased completion by 68% (RIE=1.68, 95% CI=1.25, 2.27). **IV3:**informational strategies (RIE=1.92, 95% CI=1.27, 2.91) were effective for	**LOE:** I **Strengths: i**ncluded all intervention types (behavioral, environmental, informational, and combined). Only USA studies. **Weaknesses:** findings limited; studies limited. Most studies focused on females. Heterogeneity of methods and results. Most studies didn't include race or ethnicity. **Conclusions:** Findings of this review support behavioral and informational interventions for HPV vaccine initiation and behavioral interventions for completion.

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Bias: none detected **Country:** USA		completion among U.S. children, adolescents, and young adults aged 9−26 years.	(behavioral, environmental, or informational) and a comparison group. Only peer-reviewed articles with post-intervention rates were included. **Exclusion Criteria:** (1) duplicated in the literature, (2) non-English articles, (3) conducted outside the U.S., (4) focused on intent to vaccinate, (5) without a vaccine strategy or complete evaluation of the HPV vaccine intervention (no post-intervention HPV vaccination	prompts (i.e., text messages, email, mailed correspondence, and phone calls). **Environmental strategy -** changes the social environment to facilitate vaccination (e.g., via decreased financial barriers [no cost/reduced cost vouchers] or novel vaccination sites [e.g., schools]). **Informational strategy** -increased awareness and knowledge of HPV, HPV-related disease, or the HPV vaccine, but it does not specifically target decision			HPV vaccine initiation.	**Feasibility/applicability to pt. population:** feasible and applicable however barriers exist with volunteer clinic staff and resources.

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			rate), (6) not primary (7) abstract-only articles	making or influence social environment.				
Thomas & Lorenzetti (2018) Interventions to increase influenza vaccination rates of those 60 years and older in the community **Funding:** government health organizations (n = 33), foundations (n = 9), organizations that provided healthcare	Donabedian's Model	**Design:** SR of RCTs, RCTs **Purpose:** no Cochrane Review assessing interventions to increase influenza vaccination in older people in the community	**N:** 61 n: 1,055,337 Age: >60 y.o. **DS:** CENTRAL, MEDLINE, CINAHL, Embase, ERIC, World Health Organization (WHO) International Clinical Trials Registry Platform clinicaltrials.gov **Inclusion Criteria:** interventions to increase influenza with recording of influenza	**IV1:** increasing community demand **IV2:** enhance access to vaccination services **IV3:** provider- or system-level interventions **IV4:** societal interventions **DV:** Influenza VU	VR/VU	GRADE Review Manager 5 for treatment effects odds ratios for dichotomous outcomes meta-analyses where the treatments, participants, and the underlying clinical question were sufficiently	**IV1:** **a.** reminder postcard: 11/17 trials 95% CI was above unity, increased VR **b.** 95% CI of 12/16 trials above unity, increased VR c. Health risk appraisal - 95% CI above unity 4/4, increased VR	**LOE:** I **Strengths:** Many typed of interventions included. Large N and n. adult population **Weaknesses:** few studies prior to 2002-2004 (SARS epidemic), also time period could affect strength of studies included. Only focuses on influenza. **Conclusions:** many interventions increase VR. Access to immunization alone may not increase VR as much as multimodal intervention. **Feasibility/applicability to pt. population:** portions of results could be feasible and applicable to the site. The site has issues

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services in the studies (n = 3), and a pharmaceutical company offering free vaccines (n = 1). Fifteen studies did not report study funding sources. **Bias:** low to moderate risk of studies included reported by authors **Country:** USA (n = 36), Canada (n = 7), Australia (n = 4), the UK (n = 4), Spain (n = 3), and one each in Denmark, Germany, Hong			vaccination status either through clinic records or billing data, or local or national vaccination registers. **Exclusion Criteria:** studies without a case definition, retrospective designs based only on individual recall of disease, or studies comparing different types of vaccines or different schedules or doses without a control group			similar for pooling Chi2 examine heterogeneity between studies I2 statistic to assess variability in estimates of effect due to heterogeneity. I2 statistic	d. client education by nurses +vaccination vs. client education by nurses alone; intervention group increased 23.8% and declined in the education- only group by 2.1% (P = 0.001). The OR was 152.95 (95% CI 9.39 to 2490.67; P = 0.001. **IV2:** **a.** two studies of home visits (OR 1.30, 95%	with resources and volunteer staff that would need to be navigated.

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Kong, Israel, New Zealand, Puerto Rico, and Switzerland							CI 1.05 to 1.61); b. two studies of free vaccine compared to a user pays model (OR 2.36, 95% CI 1.98 to 2.82, P < 0.001). Free vaccine to no intervention - OR of 7.80 (95% CI 4.97 to 12.24; P < 0.001) and OR of 4.03 (95% CI 3.25 to 4.99; P < 0.001 IV3: successful - reminding physicians to vaccinate all patients compared to	

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							reminding approximately half of the patients; posters in clinics presenting vaccination rates and encouraging competition between doctors; and chart review and benchmarking to the rates achieved by the top 10% of physicians. Not effective: not effective were: letters to GPs upon discharge from hospital; posters	

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							plus postcards versus posters alone; educational reminders; academic detailing and peer comparisons compared to mailed educational materials; educational outreach plus feedback to teams versus written feedback; and increasing staff vaccination rates IV 4: societal level not	

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							relevant to PICOT	
Zimmerman et al., (2017) Using the 4 pillars™ practice transformation program to increase adolescent human papillomavirus, meningococcal, tetanus-diphtheria-pertussis and influenza vaccination **Funding:** Merck Sharpe & Dohme Corp	Diffusion of Innovations theory	**Design:** Randomized control cluster trial **Purpose:** To report the results of an intervention using the 4 PillarsTM Practice Transformation Program to increase adolescent	**N:** 9473 **Setting**: Primary care family medicine and pediatric practices **Sample Demographics:** 11-13 y.o. 42.3%; females 49.6%; non-white race 31.7%, commercial insurance 61.6%; **Inclusion Criteria:** adolescent practice of at least 50 patients, estimated vaccination rates	**IV:** 4 Pillars™ Program, provider education, and 1on1 coaching of immunization champion **DV1:** VR HPV initiation **DV2:** VR HPV completion **DV3:** VR meningococcal **DV4:** VR Tdap **DV5:** VR influenza **4 Pillars™ Program:** Pillar 1 – Convenient vaccination services; Pillar 2 –	VR and PP changes in vaccination post-intervention	Descriptive statistics Paired t-test, one way pre-post differences in influenza vaccination rates, cumulative HPV initiation, HPV completion, meningococcal and Tdap vaccination rates.	↑17.1 PP (P < 0.001) for HPV series initiation (range = 10.7–24.4 PP). ↑16.6 PP (range = 9.4–21.4 PP) for meningococcal vaccine ↑14.6 PP (range = 10.7–20.9 PP) for Tdap vaccine (P < 0.001 for pre-	**LOE:** I **Strengths:** intervention shown to be effective in adults based on parent study. Large number of participants. Participating practices all part of same health system using single EMR improved consistency of reporting and data collection. **Weaknesses:** pre-post study design. Single geographic region may limit generalizability. Patient population 11-17 y.o. at baseline and one year older post-intervention and HPV vaccination increased with age.

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
And National Institutes of Health **Bias:** none recognized. **Country:** USA		vaccinations.	for at least one adolescent vaccine (HPV, Tdap, meningococcal, influenza) less than national goals (80%) and a willingness to make office changes to increase vaccination rates	Communication with patients about the importance of immunization and the availability of vaccines; Pillar 3 – Enhanced office systems to facilitate immunization; Pillar 4 – Motivation through an office Immunization Champion		ANOVA to compare the changes in HPV vaccination rates between age groups Generalized estimating equation (GEE) modeling	post differences) Average influenza vaccination rates did not differ from pre- (40.6%) to post intervention (42.9%; 2.3 PP difference).	**Conclusions:** healthcare settings are an important venue for improving vaccination rates. Clinically and statistically significant improvements in HPV initiation and completion, meningococcal, and Tdap vaccinations. **Feasibility/Applicability to pt. population:** feasible and applicable
Zimmerman et al. (2017) Using the 4 pillars practice transformation program to increase pneumococcal immunizations for older adults: A cluster-	Diffusion of Innovations theory	Design: RCCT, pre-post study Purpose:	N= 18,107 Year 1 n= 13 Year 2 n= 12 25 primary care practices ≥65 y.o. Mean 74.2 y.o 60.7% women 16.5% non-white	IV: Toolkit, provider education, and one-on-one coaching of practice-based immunization champions. DV: PPSV rate and PP change DV2: PCV rate and PP change	PPSV rate and PP change PCV rate and PP change	Descriptive analysis Chi-square tests for differences in cumulative VR at different time points.	Intervention and control groups significantly higher PPSV VR average increases 6.5–8.7 PP ($P<0.01$). Intervention not related to higher	**LOE:** I **Strengths:** randomized design, the large number and diversity of patients, diverse practice settings, two intervention years of vaccination reporting. **Weaknesses:** year 1 EMR difficulties lead to delayed feedback. Intervention transference may have occurred leading to intervention and

Key: **Key: ANOVA**- analysis of variance; **CG**- control group; **CHICOS:** Combatting HPV Infections and CancerS; **CI** – confidence interval; **DS –** databases searched; **DV**- dependent variable; **EG** – experimental group; **EMR** – Electronic Medical Record; **GRADE** – Grades of Recommendation, Assessment, Development and Evaluation Working Group approach to evidence assessment; **HCW** – Health care worker; **HPV** - human papillomavirus vaccine; **IV**- independent variable; **MA-** meta-analyses; **MANOVA**- multivariate analysis of variance; **MD** – mean difference; **mn**- months; **MOV** – issed opportunity to vaccinate **N**-number of studies (if SR) or participants in study; **n**- number of participants (if SR) or number of participants in subset; **PCV** - pneumococcal conjugate vaccine; PP – Percentage point; **PPSV -** 23-valent pneumococcal polysaccharide vaccine**; QE –** Quasi-experimental**; RCT** – randomized control trial; **RCCT** – Randomized Cluster Control Trial; **SR-** systematic review; **Tdap -** tetanus, diphtheria and pertussis vaccine; **USA** – United States of America; **UTD** – up to date; **VU** – vaccine uptake; **VR** – vaccination rate; **VC** - Vaccination completion; **wk**- weeks; **y.o.** – years-old; α - Cronbach's alpha value

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
randomized trial. **Funding:** CDC grant, NIHHS grant USA **Bias:** none identified			15.7% were Hispanic. **Inclusion:** Practices at least 100 pts >18 y.o., baseline VR less than 50% and willingness to make changes to change VU, Attrition n=1			Cox proportional hazard models with the robust sandwich estimate Year 1 and 2. Two-sided tests was with type I error (alpha) equal to 0.05 year 2	likelihood of PPSV vaccination. Younger pts more likely to receive PPSV ($p<0.001$) White, non-Hispanic more likely to receive PPSV Year 2 pre-post study, the likelihood of PPSV and PCV vaccination was significantly higher in the active intervention sites than the maintenance sites in Pittsburgh, but not in Houston.	control group increase in VR. CDC changed guidelines in year 2 leading to provider confusion, **Conclusions:** PPSC and PCV VR increased in >65y.o. intervention and control. In large safety net practices, no significant increase. **Feasibility/Applicability to pt. population:** feasible and applicable.

Key: **Key: ANOVA**- analysis of variance; **CG**- control group; **CHICOS:** Combatting HPV Infections and CancerS; **CI** – confidence interval; **DS –** databases searched; **DV**- dependent variable; **EG** – experimental group; **EMR** – Electronic Medical Record; **GRADE** – Grades of Recommendation, Assessment, Development and Evaluation Working Group approach to evidence assessment; **HCW** – Health care worker; **HPV** - human papillomavirus vaccine; **IV**- independent variable; **MA-** meta-analyses; **MANOVA**- multivariate analysis of variance; **MD** – mean difference; **mn**- months; **MOV** – issed opportunity to vaccinate **N**-number of studies (if SR) or participants in study; **n**- number of participants (if SR) or number of participants in subset; **PCV** - pneumococcal conjugate vaccine; PP – Percentage point; **PPSV -** 23-valent pneumococcal polysaccharide vaccine**; QE –** Quasi-experimental**; RCT** – randomized control trial; **RCCT** – Randomized Cluster Control Trial; **SR-** systematic review; **Tdap -** tetanus, diphtheria and pertussis vaccine; **USA** – United States of America; **UTD** – up to date; **VU** – vaccine uptake; **VR** – vaccination rate; **VC** - Vaccination completion; **wk**- weeks; **y.o.** – years-old; α - Cronbach's alpha value

Table A2

Synthesis Table

Author	Crocker-Buque et al.	Das et al.	Dempsey et al.	Jaca et al.	Niccolai & Hansen	Regan et al.	Rodriguez et al.	Thomas & Lorenzetti	Zimmerman et al.	Zimmerman et al.
Year	*2016*	*2016*	*2019*	*2018*	*2015*	*2017*	*2019*	*2018*	*2017*	*2017*
Design	*SR*	*SR*	*RCT*	*SR*	*SR*	*RCT*	*SR*	*SR*	*RCCT*	*RCCT*
LOE	*I*	*I*	*I*	*I*	*I*	*I*	*I*	*I*	*II*	*II*
n= ***N=***	*41*	*23*	*1,294*	*92,525* *6*	*14*	*12,354*	*68,623* *17*	*1,055,377* *61*	*9473*	*13* *18,107*
Ages	*0-19*	*11-19*	*9-26*	*0-99*	*0-18*	*0-99*	*9-26*	*>60*	*11-13*	*>65*
Latino			*x*							
Low-income	*x*		*x*							
Interventions										
MCCI	↑			↑	↑		↑	↑	↑	↑
PRR	M	↑		↑	↑	↑	M	↑		
Enhancing access							NC	↑	↑	↑
Prompts for HCW	↑/NC			↑						
System based								↑	↑	↑
Vaccine Champion								↑	↑	↑
Provider reminders								↑		
HCW Training		NS								
Patient Education				↑			M	↑	↑	↑
Provider Education					↑			M	↑	↑
Patient Tracking				↑						
Physician Audit/feedback					M			M		
Physician tip sheets					↑					
4 Pillars Program									↑	↑
CHICOS			NS							
CBI	NC									
Poster reminder								NC		
Free vaccination								↑		

Key: CBI – Computer-based intervention; **CHICOS:** Combatting HPV Infections and CancerS; **Hib** - Haemophilus influenza b vaccine; **IPV** - Inactivated polio vaccine; **M** – Mixed Results; **MCCI** – Multi-component complex intervention; **Men4 -** quadrivalent meningitis vaccine and relevant boosters; **MenB** - meningitis B vaccine; **MenC -** meningitis C vaccine; **MMR -** measles, mumps and rubella vaccine; **NC** – No Change; **NS** – nonsignificant; **ORP** – Outreach program; **PCV -** Pneumococcal conjugate vaccine; **PPSV** - Pneumococcal polysaccharide vaccine; **PRR** -Patient recall/reminder **RCT** – randomized control trial; **RCCT** – Randomized Cluster Control Trial; **SR-** systematic review; **TDaP** - tetanus, diphtheria and pertussis vaccine; **VU** – Vaccine Uptake

Author	Crocker-Buque et al.	Das et al.	Dempsey et al.	Jaca et al.	Niccolai & Hansen	Regan et al.	Rodriguez et al.	Thomas & Lorenzetti	Zimmerman et al.	Zimmerman et al.
Vaccines evaluated										
Hib	*x*									
HPV	*x*	*x*	*x*	*x*	*x*		*x*		*x*	
Influenza	*x*			*x*		*x*		*x*	*x*	
IPV				*x*						
Men4	*x*								*x*	
MenB	*x*									
MenC	*x*									
MMR	*x*	*x*		*x*						
PCV	*x*									*x*
PPSV										*x*
TDaP	*x*	*x*							*x*	
VZV	*x*									
Dependent Variables										
VU	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
Initiation of series			*x*			*x*	*x*			
Partial series			*x*							
Series completion			*x*			*x*	*x*			
Measurement										
OR(95% CI)	*x*		*x*		*x*			*x*		
RR(95% CI)		*x*		*x*		*x*	*x*			
Incidence of VPD		*x*								
Country										
US	*x*	*x*	*x*	*x*	*x*		*x*	*x*	*x*	*x*
UK	*x*	*x*						*x*		
Canada	*x*	*x*				*x*		*x*		
Australia	*x*	*x*						*x*		
China		*x*								
Denmark		*x*						*x*		
other								*x*		

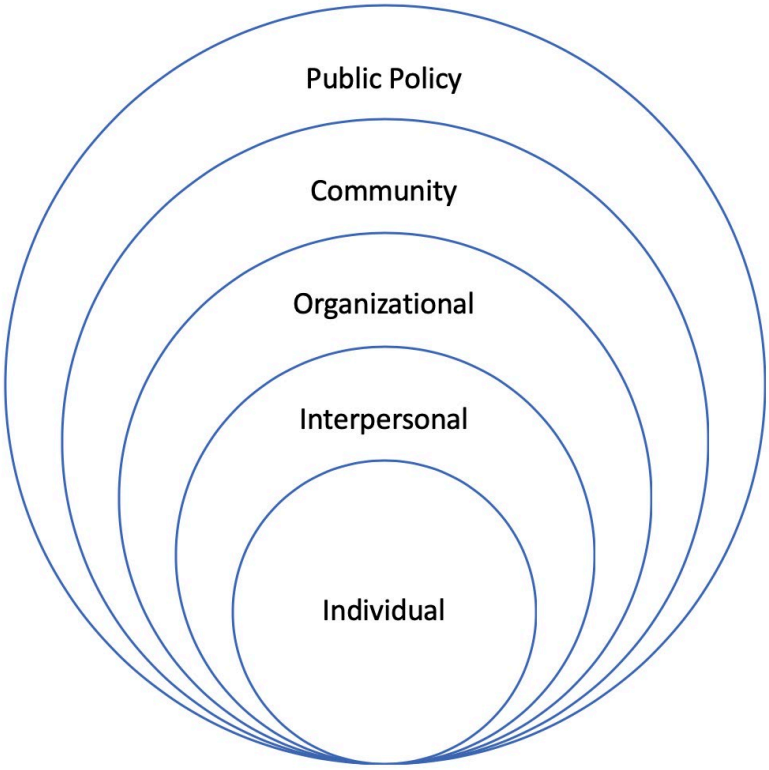
Key: CBI – Computer-based intervention; **CHICOS:** Combatting HPV Infections and CancerS; **Hib** - Haemophilus influenza b vaccine; **IPV** - Inactivated polio vaccine; **M** – Mixed Results; **MCCI** – Multi-component complex intervention; **MCCI HF** - Multi-component complex intervention targeting health facility (education, prompts, and audit and feedback); **Men4 -** quadrivalent meningitis vaccine and relevant boosters; **MenB** - meningitis B vaccine; **MenC -** meningitis C vaccine; **MMR -** measles, mumps and rubella vaccine; **NC** – No Change; **NS** – nonsignificant; **ORP** – Outreach program; **PCV -** Pneumococcal conjugate vaccine; **PPSV** - Pneumococcal polysaccharide vaccine; **PRR** -Patient recall/reminder **RCT** – randomized control trial; **RCCT** – Randomized Cluster Control Trial; **SR-** systematic review; **TDaP** - tetanus, diphtheria and pertussis vaccine; **VU** – Vaccine Uptake; **VZV** - varicella-zoster vaccine

Appendix B

Models and Frameworks

Figure 1

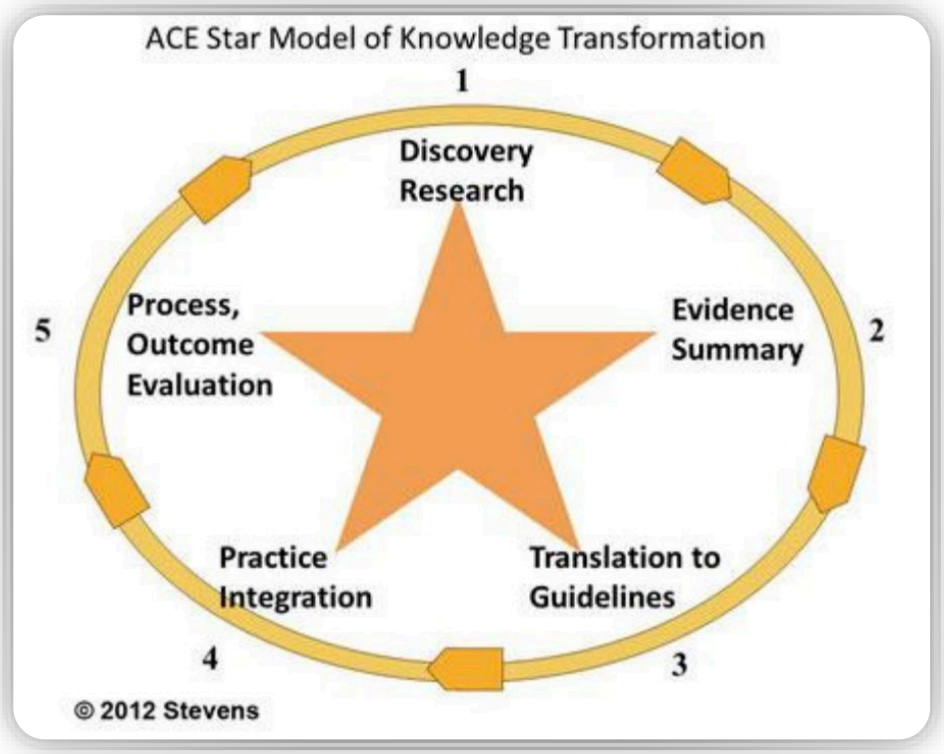
Social-Ecological Model



(Adapted from McLeroy et al., 1988)

Figure 2

ACE Star Model of Knowledge Transformation



(Stevens, 2004)

Appendix C

Figure 1

Budget

Phase	Activities	Cost	In-Kind Support	Subtotal	Total
Preparation	Design educational PPT Presentation for providers $40/hr x 5 hr		$200 volunteered time		
	Design pre-and post- provider PPT survey on education provided $40/hr x 4 hr		$160 volunteered time		
	Design patient vaccination assessment tool for provider use $40/hr x 4 hr		$160 volunteered time		
	Design virtual provider survey on provider vaccination behaviors, barriers, and attitudes toward SAIP $40/hr x 4 hr		$160 volunteered time	**$0**	
Delivery	Deliver virtual provider utilization survey on SAIP via email and Qualtrics (free) $40/hr x 1 hr		$40 volunteered time		
	Deliver virtual PPT presentation with pre and post-survey using Zoom (free) $40/hr x 2 hr		$80 volunteered time		
	Deliver Patient vaccination assessment tool and utilization survey via email $40/hr x 1 hr		$40 volunteered time		
	Volunteer provider time to complete education and surveys $100/hr x 1 hr x 30 providers		$3000 volunteered time	**$0**	
Evaluation	Statistical consultation with ASU Statistics Department tutoring staff (free)				
	Review and analysis of results $40/hr x 10hrs		$400 volunteered time	**$0**	**$0**
Potential Funding	In-kind support		**$3840 total volunteered time**		

Potential Revenue / Savings	**Decreased Vaccine-Preventable Diseases (VPD)** • Influenza (50-64yr) (65+yr) • Pneumococcal bacteremia (50-64yr) (65-74yr) (75-84yr) (85+yr) • Pneumococcal Meningitis medical cost per case (50-64yr) (65-74yr) (75-84yr) • Non-bacteremic pneumococcal pneumonia (Outpatient) (50-64yr) (65-74yr) (75-84yr) (85+yr) • Herpes Zoster (50-59yr) (60-69yr) (70-79yr) (80+yr) • Pertussis (50-64yr) (65+yr)	**Medical cost per case of VPD** ($1280) ($1867) ($32,204) ($27,883) ($24,433) ($19,911) ($35,188) ($37,199) ($32,957) ($585) ($667) ($729) ($801) ($1079) ($1817) ($2537) ($2537) ($432) ($432) (McLaughlin et al., 2015)			

Budget Justification:

All operations will be virtual and completed on the student's personal computer. Personal computer was purchased previously for other purposes and will be utilized during this project at no additional cost.

1. Preparation:
    a. PPT and Microsoft Word have already been purchased for other purposes and will be utilized during this project at no additional cost.
    b. No office supplies (paper, pens, printing) will be utilized during this project.
2. Delivery:
    a. Participating providers volunteer their time at the project site, and therefore they will volunteer their time to complete the virtual surveys and learning on their own time at $0/hr
3. Potential Revenue/Savings based on the medical cost per case of vaccine-preventable disease prevention