A Gap Analysis of Syphilis Screening During Pregnancy by Prenatal Care Clinicians

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Abstract

Congenital syphilis (CS) is increasing at an alarming rate in Arizona. The state health department has recommended increased screening to include the third trimester, but providers in individual counties are not following the recommendation. A literature search and appraisal showed increased screening reduces the incidence of CS and presented interventions to increase screening rates. Furthermore, the literature suggests provider education increases screening rates. However, before education could be completed an understanding of providers current knowledge, attitudes, and practice was needed. Using this information, a gap analysis that was completed in an Arizona county ("the County") of syphilis screening during pregnancy by prenatal care clinicians will be presented guided by the Knowledge-Attitude-Practice (KAP) Model and the ACE Star Model of Knowledge Transformation.

Keywords: congenital syphilis, third trimester screening, provider education, ACE Star Model, KAP model

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Syphilis during pregnancy can have detrimental outcomes to the fetus including still birth, perinatal death, premature birth, and developmental disabilities. Congenital syphilis (CS) is caused by the bacteria *Treponema pallidum* that the mother contracts and passes to the fetus. The highest risk for fetal infection or CS at birth is when the mother is in the primary and secondary stage of syphilis (U.S. Department of Health and Human Services [HHS], 2015; Trivedi, Williams, Torrone, & Kidd, 2019). If maternal syphilis is untreated, it causes CS in 80% of cases (Rahman, Hoover, Johnson, & Peterman, 2019; Trivedi et al., 2019). CS is preventable with timely testing and treatment of maternal syphilis with penicillin G at minimum 30 days prior to delivery (HHS, 2015).

Problem Statement

Syphilis has been a curable infection for over 70 years, but it continues to be a national health concern due to rising rates of CS. In 2012, the CS rate was 8.4 cases per 100,000 live births in the United States (US) (Warren, Crammer, Kidd, & Leichliter, 2018). Since then, the rates have continued to climb to a peak 33.1 cases per 100,000 live births in 2018 (CDC, 2018).

Arizona rates of CS are higher than the national average. In 2017, Arizona ranked sixth in the US in rates of CS with a rate of 35.5 per 100,000 live births (CDC, 2018). However, in 2018, Arizona moved up to fourth in the US with a rate of 72.2 per 100,000 live births (CDC, 2019a). In 2019, there were 107 cases of CS in the state of Arizona, with six of those cases resulting fetal or infant death (Arizona Department of Health Services [ADHS], 2020). The ADHS has deemed the state of Arizona in a syphilis outbreak and created an action plan to combat the problem. The goal of the plan is to identify and treat early syphilis cases in order to help decrease the number of [CS] cases. ADHS plans to "[partner] with health agencies statewide to increase awareness for

pregnant women and their partners and educate health care providers on appropriate screening and treatment" (ADHS, 2020, para. 1).

Purpose and Rationale

A project was undertaken to understand the barriers and facilitators that impact provider behaviors in screening and treatment for syphilis among pregnant women. The information obtained from this project will inform the design and implementation of an intervention that will improve provider compliance with state recommended screening protocols for syphilis among pregnant women that will lead to identification of women in need of treatment, and ultimately reduce the incidence of CS.

The purpose of this project was to identify obstetric providers', in the county, current knowledge, attitudes, and practices for the screening and treatment of syphilis in pregnancy to highlight an area of needed improvement for an intervention to be later implemented.

Background and Significance

CS rates in the Unites States are continuing to rise causing local and state level health departments to examine commonalities in the cases and current practices for prevention and commonalities in the cases (Matthias, Rahman, Newman, & Peterman, 2017; Plotzker, Murphy, & Stoley, 2018; Rac et al., 2017; Rahman et al., 2019). On a national scale Kidd, Bowen, Torrone, and Bolan (2018) used data to create a CS prevention cascade. Their results noted that the largest gaps were in prevention services including late or no prenatal care and delayed treatment. Additionally, the researchers identified screening recommendations change from state to state and organization to organization, indicating a need for standardized practices.

When reviewing the literature on CS it is important to look at multiple components that contribute to cases of CS. The first component is common risk factors for CS. Multiple studies

cited late or no prenatal care, high risk maternal behaviors, and delayed treatment of maternal syphilis (Matthias et al., 2017; Rahman et al., 2019, Snow & Coble, 2018; Trivedi et al., 2019). Other studies, examined the most effective interventions to increase screening for maternal syphilis, to provide the women treatment, to intern prevent CS. Though many were identified in the research, the most promising for the county health department were: increased education on the importance of third trimester screening in high risk locations, identification of pregnancy status in all females diagnosed with syphilis, and case review boards (Collier et al., 2011; Matthias et al., 2017; Rahman et al., 2019; Trivedi et al., 2019).

Current Screening Recommendations

Currently the US Preventive Task Force (USPTF) recommends screening early in pregnancy but does not give any recommendation on repeat screenings (2018). The Centers for Disease Control and Prevention and joint guidelines from the American Academy of Pediatrics (AAP) and the American College of Obstetricians and Gynecologists (ACOG) recommend repeat screening at time of delivery, however, this could be too late (AAP & ACOG, 2017; HHS, 2015). Some states who had higher CS case per 100,000 live births have changed their laws to match the CDC recommendations, including Texas, ranked 4th with 44.2 cases per 100,000 live births, and Louisiana, ranked first with 93.4 cases per 100,000 live births (Warren et al., 2018). In Arizona, in 2018, ADHS recommended that providers screen all pregnant women at their first prenatal visit, in the third trimester, and at time of delivery (2020). Arizona's state law previously only required providers to screen patients at the first prenatal visit and did not sanction providers who did not adhere to that mandate (Warren et al., 2018). However, as of January 2019, A.A.C. R9-6-381 requires providers to screen at the first prenatal visit, with repeat screening between 28-32 weeks, and again at birth (CDC, 2019b).

Population

Trivedi et al. (2019) examined national trends in pregnant women with syphilis from 2012-2016. Two common behaviors seen in these women with syphilis were a prior sexually transmitted infection and/ or more than one sexual partner in the past 12 months. Additionally, multiple studies identified late or no prenatal care increased risk for CS (Matthias et al., 2017; Rac et al., 2017; Rahman et al., 2019, Snow & Coble, 2018; Trivedi et al., 2019). A commonality seen in CS cases was infection after the routine first prenatal visit screening; hence, the CDC recommending rescreening women for syphilis in the third trimester (Collier et al., 2011; Matthias et al., 2017; Rac et al., 2017; Warren et al., 2018).

Interventions

Once risk factors for CS are evaluated, the focus of prevention can move to intervention. Because Louisiana has the highest rate of CS nationwide, a review of their intervention practices was informative. Rahman et al. (2019) reviewed the current practices the state of Louisiana had in place to increase surveillance of syphilis in pregnant women to hopefully reduce the number of CS cases, before describing Louisiana's case review board process. A few of the interventions Louisiana has in place include disease intervention specialists (DIS), reporting of pregnancy status of all females who test positive for syphilis, and partner notification. Out of these interventions, the most promising in Louisiana to prevent CS was confirming pregnancy status in all females with syphilis as this could lead to earlier identification of women whose infants would then be at risk for CS.

Though many interventions, including those in Louisiana have been evaluated in the literature, the researcher examined the interventions most promising for the local health department in Arizona. As previously mentioned, a common recommendation is rescreening

women for syphilis in the third trimester, specifically between 28- 32 weeks (ADHS, 2020; Collier et al., 2011; Matthias et al., 2017; Plotzker et al., 2018; Rahman et al., 2019; Trivedi et al., 2019). However, because up until 2019, Arizona's state law did not require repeat testing and does not enforce first trimester testing via legal penalty, it fell to the local and state health departments to educate providers on the recommendation. Three studies examined the effectiveness of third trimester testing to prevent CS (Collier et al., 2011; Matthias et al., 2017; Trivedi et al., 2019). Collier et al. (2011) looked specifically how to increase education on third trimester testing to providers through a local health order to providers in Maricopa County, Arizona. The researchers found some success with the local health order to increase screening, however, some providers when surveyed still reported that they were unaware of the recommendation.

Current Practice

Not all interventions mentioned above are being used. Currently, the local health department has in place partner notification, the use of DIS, who are referred to as clinical disease investigators, and a local health order to test all women in the third trimester (Perez-Velez & García, 2018). Further discussion of the county health departments' practice will be presented later in this report.

Outcome

In 2014 and 2015, there were zero cases of CS in the county, even though rates of syphilis had increased. Unfortunately, since 2015 the rates of CS are climbing. The county's health department would like to return the number of CS cases to zero. Many cases of CS can be prevented through timely screening and treatment of pregnant women, however, to prevent all cases of CS, all syphilis cases and unintended pregnancy would need to be prevented (Rahman et

al., 2019).

Common Themes in Data

Common themes seen through the data were ways to identify common risk factors for CS and implement viable interventions (Collier et al., 2011; Matthias et al., 2017; Rac et al., 2017; Rahman et al., 2019; Snow & Coble, 2018; Trivedi et al., 2019). The interventions included screening multiple times throughout a woman's pregnancy for syphilis for timely identification and treatment of the woman with syphilis and insuring providers know and adhere to the county recommendations (ADHS, 2020; Collier et al., 2011; Matthias et al., 2017; Plotzker et al., 2018; Rahman et al., 2019; Trivedi et al., 2019). The county has put in place a few of these strategies already, however, not all providers are following the local health order for screening whether to due to lack of knowledge or adherence.

Internal Evidence

The number of cases of both syphilis and CS from 2015-2018 in the county significantly increased. In 2017 and 2018, the county was ranked in the top 100 of all counties in United States (US) with reported cases of primary and secondary syphilis (CDC, 2018; CDC, 2019a). Currently in the county, not all providers are screening patients according to ADHS's recommendations and state law. In September 2018, the Deputy Chief Medical Officer of the county released a letter announcing the county's new recommendation for screening. This recommendation was: all pregnant women are to be screened at the first prenatal visit or other care encounter within a healthcare setting, early in the third trimester, and again at delivery (Perez-Velez & García, 2018). Even with the recommendation from the county, in 2018, the county recorded their highest number of syphilis, and intern CS, cases since 2011. The county health department's manager of Community Health Human Immunodeficiency Virus / Sexually

Transmitted Disease Services stated he believed the increase in number of CS cases was due to lack of education of the updated syphilis screening guidelines (E. Kuhn, personal communication, November, 2018).

Initial PICOT Question

This inquiry has led to the clinically relevant PICOT question, "Does provider education regarding syphilis screening during the third trimester effect screening rates in obstetric clinics over a three-month period?" This led the initial search and syntheses of the evidence.

Search Strategy

Initial databases searched for the literature review included Academic Search Premier, PubMed, and Ovid. Keywords included were: *congenital syphilis, third trimester screening, physicians, public health education, screening, providers, increased screening, social marketing, social awareness, practice patterns, prenatal care,* and *provider education.* The initial search of *congenital syphilis* and *third trimester screening* yielded six results in the Academic Search Premier database, 40 in the PubMed database, and 11 in the Ovid database. Due to the small yield of studies, no limitations where placed on the results. MeSh terms and related articles were examined to expand the keywords. Conclusions from initial studies found led to additional keyword searches for the intervention, specifically *provider education*. Using the terms, *increased screening* and *provider education*, a final yield of nine studies were found in Academic Search Premier, and nine studies in Ovid. The additional term of *prenatal care* had to be added to the PubMed search due to an initial high yield of 525 studies. This addition led to a final yield of 17 studies.

Inclusion criteria included publication in the past five years, examining either increased screening through provider education, or decreased rates of CS due to third trimester screening.

Exclusion criteria included studies written in a non-English language or translated to English, unpublished works, and studies with unclear outcomes. Due to the nature of the studies, level of evidence was not used as an initial exclusion criterion. It was also decided to not include cost analysis studies due to it not being the main focus of the project, three studies were found in all the search databases fitting this description and were excluded.

A secondary search of two additional databases including Science Direct and the Cochrane Library was conducted while critically appraising articles. Science Direct was searched with the keywords: *increased screening* and *provider education*. The initial search yielded 64 results, limitation for the past five years and research articles brought the final results down to 17. Of the 17 studies, two were found to be relevant. The search of the Cochrane Library was conducted with the keywords: *syphilis, pregnancy,* and *prevention*. The search yield six studies. After closer inspection, none of the studies were pertinent to the project.

Critical Appraisal and Synthesis of Evidence

A final 10 articles were chosen and appraised for their quality and strength of evidence through rapid critical appraisals. All of the studies had been completed between 2014-2019. Three of the studies were quality improvement (QI) projects, two were randomized control trials, two were cohort studies, and there was one cross-sectional study, one quasi-experimental study, and one systematic review (SR) (Appendix A). The level of evidence (LOE) was lower, due to the topic of study. The literature included was mainly from the United States (USA) but one study was included from Brazil due to its relevance (Appendix A).

The focus of each study can be broken into two categories. Three studies focused on ways to decrease the number of infants born with CS (Appendix B). The other seven studies focused on ways to increase screening through provider education (Appendix B).

The three studies focused on examining ways to decrease the number of infants born all found that screening at least 40 days prior to delivery decreased the number of CS infants. Two of the studies discussed a rescreening protocol in the third trimester combined with the screening 40 days prior to delivery (Appendix B). Two of the three studies were done for over a year, while the third study did not specify a length due to it being a SR.

The other seven studies examined increased screening through provider education. The two ways the provider education intervention was implemented was through in person education or education on paper (Appendix B). None of the studies looked at paper education alone, this was a secondary option for providers who could not make it to an in-person training or education lecture. All seven studies found increased screening through provider education (Appendix B). One study specifically looked at provider education to increase screening for congenital syphilis (Lazarini et al., 2017). The researchers found an increase in knowledge about CS and an increase in screening for CS after an in person educational session. Three of the seven studies re-assessed screening three months after the education intervention, while another three waited six months (Appendix B). Only one study re-examined screening after a year and this was due to the logistics of multiple providers needing to attend different in person training sessions.

Conclusions from Evidence

Based on the evidence seen in Appendix B, it can be concluded increased screening for maternal syphilis, would lead to increased treatment and intern, decrease the number of CS cases. The best intervention to achieve increased screening is through provider education. The recommendation for increased screening, specifically in the third trimester, matches the recommendation from the state department and the change in state law (ADHS, 2020). Additionally, the intervention of provider education also aligns with the action plan of state

department to “educate health care providers on appropriate screening and treatment” (ADHS, 2020, para. 1). The evidenced suggests that a re-evaluation of screening should be completed three to six months after the implementation of provider education (Appendix B).

Before an effective educational intervention to reduce the number of CS cases in the target county could be implemented, an understanding of the current knowledge, attitudes, and practices of the prenatal care providers was needed. A second search of the literature led to the decision to conduct a gap analysis of the prenatal providers in the Arizona county to understand their knowledge, biases, and current practices for screening pregnant women for syphilis and how the providers believe screening leads to treatment and intern preventions of CS.

Conceptual Framework

A conceptual framework provides a guide for understanding relationships between a project and a desired outcome through an intervention. Interventions based on conceptual frameworks or theoretical models are more likely to succeed and produce desired outcomes (National Cancer Institute, 2005). There are a number of models and theories that can be used to explore the relationships between phenomenon that result in the performance of a desired behavior. These include Affective Events Theory, Change Theory, Diffusion of Innovations, Goal Framing Theory, Health Behavior Goal Model, Problem Behavior Theory, and the Knowledge-Attitude-Practice (K-A-P) model (Davis, Campbell, Hildon, Hobbs, & Michie, 2015). The K-A-P model was chosen to examine the relationship of provider knowledge of the syphilis outbreak to attitudes and practices and the interrelationship of knowledge and attitudes with screening practices during pregnancy for maternal syphilis.

The K-A-P model was originally adapted by Allan Wicker for social psychology from other theories examining relationships between attitudes and behaviors (Schwartz, 1973). It was

further studied by Nancy Schwartz (1973) to determine the exact relationship between knowledge, attitudes, and practices. Four models were statically analyzed before the final model was chosen with attitudes mediating knowledge and practice. The model is depicted showing a relationship between knowledge and attitudes, as well as, attitudes and practice (Appendix C).

The K-A-P model was used to create the survey of providers. The survey contained questions to further understand the providers knowledge about syphilis and CS, their attitudes towards screening for syphilis in pregnant women, and their current practices. The results of the survey were presented to the health department to guide the creation of an educational program for the prenatal care clinicians.

Implementation Framework

An implementation framework provides a road map for project development and execution. The ACE Star Model of Knowledge Transformation is an implementation framework that was developed to guide the process of applying evidence to practice change in a simplified manner (Stevens, 2013). The model is depicted as a five-point star with a ring connecting the stages to highlight the five steps of the evidence-based practice process (Appendix D). The steps include discovery, evidence summary, translation into guidelines, practice integration, and process, outcome evaluation (Stevens, 2013). The progression is fluid, allowing for a constant revaluation and future change to take place as the evidence changes and improves. Because evidence around best practices for screening for CS can and does change, this model was selected so that the process can restart as new evidence emerges.

The first two points of the star, discovery of research and evidence summary, were completed. The results of those steps were discussed in the synthesis of current evidence where it was found that provider education can increase screening practices. The next step of the model is

to translate the evaluated and summarized literature into practice change. As evidence was summarized, it became clear there was a need for a gap analysis to determine provider current knowledge before education could be implemented, this led to an additional search which produced KAP model. The third point of the star, translation into guidelines was the creation of survey using KAP model. The fourth point, practice integration, and fifth point, process outcome evaluation, was the implementation of survey and analysis of data with recommendations to health department, respectively.

Methods

The purpose of this project was to identify gaps in the current practices of prenatal care clinicians in comparison to practices recommended by researchers and clinical experts, and in the screening of pregnant women for syphilis to intervene with treatment to prevent CS. Because the county health department does not have legal jurisdiction over prenatal providers in the county, the goal of the health department with this project was to identify providers' current knowledge, attitudes, and practices surrounding syphilis in pregnancy. The data collected will used to inform the county health department about the areas related to the detection and management of syphilis in pregnancy about which prenatal care clinicians need more information. It is hoped that this knowledge will lead to an effective intervention with clinicians that will ultimately decrease the number of CS cases through increasing maternal treatment.

Project Description

A recruitment email was sent out to prenatal care clinicians in the county via an email from the communication division of the health department. The health department provided a list of names of obstetric practices in the county to invite to complete the survey but did not include the provider names or email contact information. The project manager created a list of obstetric

providers in the county and their email addresses. The health department's community relation specialist reviewed the list for completeness and was responsible for sending messages. The inclusion criterion was obstetric providers in the county providing prenatal care to pregnant women. The exclusion was any other healthcare providers in the county.

The initial email was sent via the health department with an introduction of the project and an invitation to participate letter along with a link for the survey. One week and two weeks after the initial email, a follow up email was sent with a reminder of the deadline and the link for the survey. The survey was estimated to take no more than five minutes for the participants to complete. The survey contained questions to further understand the providers knowledge about syphilis and CS, their attitudes towards screening for syphilis in pregnant women, and their current practices. Survey responses and analyses of results were generated in aggregate form. Analysis was conducted using the Intellectus software.

Instrumentation.

The survey was focused on four domains: demographics, knowledge, attitudes, and practices. The questions were adapted from previously studied K-A-P surveys completed in women's health settings (Dvalishvili et al., 2016; Park, Amey, Creegan, Barandas, & Bauer, 2010; Power & Schulkin, 2017; Rodrigues & Domingues, 2017; Shirreffs, Lee, Henry, Golden, & Stekler, 2012) and from a previously completed screening in another Arizona county (Collier et al., 2011). Demographics included the participant's credential and type of practice setting, e.g. federally qualified health center or private practice. The survey included four knowledge questions asked as true/ false statements, four Likert scale statements/ questions to evaluate attitudes, and four multiple choice questions about clinicians' practices (Appendix F). The questionnaire was reviewed by a women's health specialist and graduate program faculty

member, a board certified WHNP and a PhD prepared, NIH funded nurse researcher with extensive experience in health outcomes research, and a women's health specialist for face and content validity. The health department community relations senior staffer also reviewed the survey for content validity.

Timeline.

The timeline for the project was based on the implementation framework, The ACE Star Model of Knowledge Transformation. The Discovery Research stage took place between January 2019 and July 2019, this was the initial search phase where it was found provider education can increase screening practices. Evidence Summary took place between March 2019 and July 2019. From July 2019 to October 2019, the survey instrument was created using the KAP model. The implementation of the survey occurred in January 2020. The evidence from the survey was summarized, evaluated for statistical significance, and recommendations were formed between January 2020 and May 2020.

Budget

The total cost of the project to the health department was $1,605.80 (Appendix E). The only expense was of the time two of the health departments employees worked on the project. Due to the health department already having survey monkey, the cost of the program was not included in the overall cost. Otherwise the project was no cost due to donated time from the project manager and project mentor. No outside funding was received.

Ethical Considerations and Human Subject Protection

The project was reviewed by Arizona State University's Intuitional Review Board and was deemed exempt pursuant to Federal Regulations 45CFR46.

Results

Of the 117 prenatal care clinicians in the county, the health department had emails of 105 individuals (Figure F1). Of the 105 emails sent, 99 were delivered with six returned undelivered. The response rate was low. Only 7% of the contacted prenatal care clinicians completed the of the survey. 100% of the respondents were physicians (Table F1). No certified nurse midwives (CNMs), midwives, nurse practitioners (NPs), or physician assistants (PAs) responded. 71% of the physicians worked in private practice. 29% selected other and reported working in an academic center.

Knowledge Results

It was apparent that the respondents were aware that the state of Arizona was in a syphilis outbreak and that Arizona Health Care Cost Containment System (AHCCCS) covered three screenings of syphilis in pregnancy with 100% responding true to both of these knowledge questions (Table F2). Knowledge in the state law requiring three screenings for syphilis, question two, was low with 57% of respondents answering either false or do not know. Finally, knowledge on reporting requirements was mixed. Seventy-one percent (71%) of participants acknowledged that they knew the reporting requirement, while 29% responded that they did not know.

Attitude Results

Attitudes among the respondents were unanimous when it came to screening for syphilis in pregnancy to reduce the incidence of CS with 100% strongly agreeing to the statement (Table F3). Results were mixed on if third trimester screening is necessary in low risk individuals. One respondent reported believing that it was not necessary to screen low risk individuals while 29% were neutral on the statement.

The most cited barrier to screening and management of syphilis in pregnancy was late onset of prenatal care by patient (Table F4). This was followed by patient nonadherence to treatment and appointments. Respondents did not report clinical barriers, quired in questions five through eight. Only 14% of respondents agreed with the statement that delay in test results was a clinical barrier and that there was a lack of locations for referral for treatment. The rest of the respondents were neutral, disagreed, or strongly disagreed.

Practice Results

All the physicians reported using either rapid plasma regain (RPR) or venereal disease research laboratory (VDRL) to screen for syphilis (Table F5). Though only 14% reported using the traditional screening algorithm, from the report of screening with an RPR or VDRL test, it can be assumed that 100% of the participants used this algorithm. All respondents reported screening three times in pregnancy, at the first prenatal visit, at the time of the glucose tolerance test (GTT), and again at delivery. Treatment of patients was reported equally between in office and referral to the county health department. Finally, 86% of respondents reported that the perinatal providers in their practice identified women who needed syphilis screening with 14% responding that the medical assistant was the one to identify patients.

Project Impact

The project highlighted gaps in some aspects of the knowledge, attitudes, and practices of prenatal care providers in the county. This information can be used to create targeted education for the providers on screening for syphilis in pregnancy. With targeted education the hope would be to decrease the number of CS cases that occur in the county.

Additionally, the project provided the health department with a template for future assessments of apparent lapses in adherence to the standard of care. Previously when a problem

arose in the county, the local health department would send out information based on what the health department staff believed the problem to be. This project has provided the health department with the K-A-P survey model that can be used for future problems. The health department also now has a list of obstetric providers with email contact information.

The knowledge gained from this project can be applied by other health departments. By showing the areas of lack of knowledge, as well as the current attitudes and practices of providers in the county in regard to screening for syphilis in pregnancy, other health departments who are also experiencing an outbreak of syphilis and, as a result, CS, can query their own providers using a similar survey. Furthermore, the state health department can gain statistical information to help with the syphilis outbreak currently happening in the state of Arizona.

Discussion

The responses of the survey showed the knowledge, attitudes, and practices of a small subset of providers in the county. Due to the limited number of responses to the survey, the results of the study cannot be used to conclude the overall knowledge and practices of all prenatal care clinicians in the county. With that said, it can be concluded that there is a lack of knowledge around the reverse sequence screening algorithm.

With many women with syphilis being asymptomatic, it is important to have a reliable testing algorithm that does not leave loose ends. Currently, there is not one fixed protocol for the screening of syphilis (Thomas, Catlin, & Stacey, 2020). There are two common algorithms, the traditional and reverse screening (Appendix G) The traditional screening algorithm was the first algorithm that came out. The reserve screening algorithm came about with the introduction of automated enzyme immunoassay (EIA) and the chemiluminescent immunoassay (CLIA) treponemal tests. In a direct comparison of the two screening algorithms, the reverse sequence

screening algorithm "yielded significantly higher total screening positives (1.0% vs. 0.7%, p=0.01, Chi-square analysis), true positive rates (0.7% vs. 0.4%, p=0.002), and overall proportion of patients treated per patients screened (0.5% vs. 0.2%, p=0.002)" (Dunseth, Ford, & Krasowski, p. 56, 2017). Speaking with health department clinician and support staff, anecdotally, they stated there was a lack of understanding regarding the use of the reverse screening algorithm. This is an area of knowledge a tailored education program can focus on for prenatal care clinicians in the county.

The survey did highlight, at least of the respondents, there is not a lack of testing. 100% of the respondents stated they screened three time during pregnancy. With this information, an educational program focused on screening three times during pregnancy would not be beneficial. Furthermore, the original hypothesis of the health department, lack of provider knowledge on frequency of testing, was incorrect. Knowledge is needed for how to test, not frequency of testing.

Limitations

The biggest limitation was the lack of responses by participants. Due to the low number of responses and lack of representation by other disciplines who were included in the survey distribution, the practices between providers types and practice types were unable to be compared. Additionally, five of the physicians worked for private practices and only two worked in an academic practice.

The lack of responses could have been due to the use of email communication. In a similar study done by Rodrigues and Domingues (2018) in Brazil, the researchers contacted their respondents in person during their work hours. Additionally, the time frame of their project was longer. The researchers contacted 516 respondents over five months; in this project the project

director contacted 99 individuals via email over three weeks. Park et al. (2010) completed an online survey and emailed the link to respondents, however, they first mailed an introductory letter to prospective participants. The online survey was open for two months and one reminder email was sent. Additionally, there were incentives of candy and entry into a raffle for a $200 for clinics that high level of participants. The researchers had 268 individuals complete their survey.

Though the health department did not have the extra money to do incentives, a mailed letter and/ or a personal visit could have improved response rate. Saleh and Bista (2017) searched for factors that improve survey response rates. The researchers found that the interests of the participants, the structure of the survey, and communication methods all were important to receiving higher response rates. With so many aspects interworking together to achieve responses, there is room for the health department to improve for future surveys.

Perspective bias on the part of the respondents could have changed how the participants responded to the query. Also, the respondents were not asked what they thought the problem was. One physician who completed the survey left the following response at the end of the survey:

> "questions in this survey are biased toward blaming the patient when there are so many barriers to patients getting into care, especially if there is ambivalence regarding the pregnancy or if the pregnancy was initially undesired. State support of Crisis Pregnancy Centers that are unlicensed and are not actual providers of any health care (such as STI testing and treatment) is part of this problem."

This comment highlights the how the providers may have felt like their perspective are not valued and that it is their lack of knowledge or attitudes that need intervention.

Another limitation of the gap analysis was that the literature review and intervention were based on an assumption that a knowledge deficit was responsible for the lack of adherence to the screening. The K-A-P survey showed otherwise. The providers who responded (a very small number of prospective participants) were screening as recommended.

Recommendations

In future research, the health department should consider a mailed introductory letter or visit from the key investigator to the clinics to improve response rates. Additionally, the health department should keep an up to date list of providers with contact information including emails, as well as, addresses. Additional investigation is needed to fully understand the barriers and facilitators to screening for syphilis in pregnancy to gain the perspectives of the clinicians in the county. In a future gap analysis, an alternative PICO question, "Among prenatal care providers (P), what factors facilitate (I) or inhibit (C) adherence to CDC recommended screening for syphilis in women during pregnancy (O)?" would ground the direction of the project in data based foundation for lack of education and provider attitudes as major contributors to failure screen for syphilis. With this PICO question, the survey to assess K-A-P would be clearly justified and not solely based on an assumption as this project was. Once they have this data, they may find that in fact there is a need for education, or they may find that there are other issues that need to be addressed. However, based on the responses from clinicians who did participate, the health department should create a targeted education for providers focused on the benefit of the reverse sequence screening algorithm.

Conclusion

K-A-P surveys are helpful in identifying areas of knowledge deficits and barrier providers see in care. Even with provider education, case counts of CS may not decrease, yet

prenatal care clinicians may be able to identify more cases of maternal syphilis with reverse sequence screening. The current gap analysis highlighted areas of needed improvement within the health department and provided a format for investigating the factors that are driving future outbreaks with the K-A-P survey. The intervention may be more likely to effectively guide the intervention to address the root cause or causes of health problems in the community.

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Appendix A

Table 1

Evaluation Table of Studies

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Biswas et al. (2018) Characteristics associated with delivery of an infant with congenital syphilis and missed opportunities for prevention-California, 2012-2014 **Country:** USA	Inferred to be HBM	Cohort Study **Purpose:** Identify differentiating characteristics in GS cases with and without CS infants.	**n=** 427 **Age group=** 15-45 **Gender:** female **Participants:** 263 GS cases without CS infants 164 GS cases with CS infant **Setting:** California, between	**IV:** Characteristics of GS cases **DV:** CS cases **Definitions:** Characteristics examined-demographics, prenatal care, testing, treatment	Information was obtained from California Department of Public Health surveillance record	Chi-squared or Fisher exact test (if counts <5)	**DV:** 29% of CS mothers were screened < 40 days before delivery compared to 0% of non-CS mothers, All non-CS mothers were tested at least 40 days before delivery	**LOE:** IV **Strengths:** large number of cases examined, characteristics identified as causes for CS **Weaknesses:** Lower level evidence, stillbirths not included, **Conclusions:** Study does prove that timing of

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Funding: None noted **Bias:** None noted			03/12/2012-12/31/2014 **Exclusion:** none-live births, **Attrition:** NA					screening before delivery does decrease risk of CS **Feasibility:** Screening at least 40 days before delivery is feasible
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Busch et al., (2018) Primary care provider knowledge and practice patterns regarding childhood obesity **Country:** USA	Inferred to be HBM	Quality Improvement **Purpose:** Improve the management of pediatric obesity through provider education intervention	**n=** 50 charts reviewed **Participants:** providers were majority family medicine NP's and physicians, include pediatric NPs and physicians who saw patients between the ages of 5-18,	**IV:** Educational program for providers **DV:** Increased rates of screening and referrals for childhood obesity **Definitions:** Educational intervention-presented in	Chart review 3 months post intervention	Frequency	**DV:** Referral rate increased from 6% to 16%, lab test screening increased from 14% to 26%, Billing for obesity dropped from 28% to 14% Coding dropped from 28% to 24%	**LOE:** V **Strengths:** Increased screening and referral after education, **Weaknesses:** Small chart review, decreased billing and coding, statistics for significance were not run

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Funding: None noted **Bias:** None disclosed			Charts reviewed were for patients with BMI at or above 85th percentile, appointment type was well child or sports physical **Setting:** Free standing primary care clinic in midwestern town **Exclusion:** Visits that were not comprehensive visits **Attrition:** 0%	person and shared through meeting minutes Chart review looked at sex, age, BMI, specialty of provider, medical training, completion of billing codes, discussion of BMI status, frequency of referral and lab tests ordered			Discussion of weight status stayed the same at 7%	**Conclusions:** Due to the goal being to increase screening and not coding or billing, it is realistic to include this study **Feasibility:** An intervention that can be done through minutes is more likely feasible than an in person intervention
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice

Key: **APN-** advance practice nurse; **BMI-** body mass index; **CDC-** Centers for Disease Control and Prevention; **CS-** congenital syphilis; **CT-** chlamydia; **DV-**dependent variable; **EHR-** electronic health record; **GC-** gonorrhea; **GS-** gestational syphilis; **HBM-** health belief model; **HIV-** human immunodeficiency virus; **IV-** independent variable; **LOE-** level of evidence; **M-** mean; **N-**number of studies; **n-** number of participants; **NA-** not applicable; **OB/GYN-** obstetrician and gynecologist; **p-** alpha value; **PPD-** postpartum depression; **PDSA-** plan do study act model; **RCT-** randomized control trial; **STD-** sexually transmitted diseases; **USA-** United States of America; **<-** less than

Clevesey et al. (2019) A project to improve postpartum depression screening practices among providers in a community women's health clinic **Country:** USA **Funding:** None declared **Bias:** None declared	PDSA	Quality Improvement **Purpose:** Improve healthcare provider knowledge concerning PPD and increase screening	**n= 6** **Participants:** 3 OB/GYN physicians, 3 APN's, average experience level of 10.7 years **Setting:** Local community women's clinic in the southwestern USA with 6 providers, implemented over 3 months **Exclusion:** All providers in the practice were included **Attrition:** 0%	**IV:** Educational intervention **DV1:** Increased knowledge regarding PPD screening and services **DV2:** Increased screening rates of PPD **Definitions:** Educational intervention- 1-hour in-service	Affordable Care Act Preventive PPD Screening Clinical Practice Questionnaire Chart reviews with Agency for Healthcare Research and Quality Chart Audit tool	Frequencies Chi-squared	**DV1:** Awareness increased from 16.7-50% to 83.3-100% on different topics related to PPD **DV2:** Screening documentation increased from 56% to 92.7% ($p < 0.5$)	**LOE:** V **Strengths:** Increased screening with significant p value. **Weaknesses:** Small sample size, assessed self-reported knowledge **Conclusions:** Educational interventions can increase screening rates **Feasibility:** An in-person in-service may not be feasible, but an educational intervention is.
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/

Key: **APN**- advance practice nurse; **BMI**- body mass index; **CDC**- Centers for Disease Control and Prevention; **CS**- congenital syphilis; **CT**- chlamydia; **DV**-dependent variable; **EHR**- electronic health record; **GC**- gonorrhea; **GS**- gestational syphilis; **HBM**- health belief model; **HIV**- human immunodeficiency virus; **IV**- independent variable; **LOE**- level of evidence; **M**- mean; **N**-number of studies; **n**- number of participants; **NA**- not applicable; **OB/GYN**- obstetrician and gynecologist; **p**- alpha value; **PPD**- postpartum depression; **PDSA**- plan do study act model; **RCT**- randomized control trial; **STD**- sexually transmitted diseases; **USA**- United States of America; **<**- less than

								application to practice
Dignan et al., (2014) Effectiveness of a primary care practice intervention for increasing colorectal cancer screening in Appalachian Kentucky **Country:** USA **Funding:** National Cancer Institute at the National Institutes of Health **Bias:** None declared	Inferred to be HBM	Randomized control trial **Purpose:** increase colorectal cancer screening by providing an intervention to primary health providers in Appalachian Kentucky	**n=** 66 practices early intervention group= 33 delayed intervention group= 33 **n=** 3844 charts reviewed in baseline, 3751 charts reviewed in 6 month follow up **Practices:** 52 were family practice, 10 were internal medicine, 4 were both 37 were group practices, 20 had 2-4 providers, 17 had more than 5 providers **Setting:** Appalachian Kentucky	**IV:** Educational intervention through academic detailing **DV:** Increased screening for colorectal cancer **Definitions:** Academic detailing- provider education through personal contact	Medical record reviews	Logistic regression using generalized estimating equation Two-tailed t-test	**DV:** Providers recommending a colonoscopy went up 15.7% after education in early intervention group compared to 2.4% in delayed intervention. (p= .01)	**LOE:** II **Strengths:** LOE, sample size, p value **Weaknesses:** Results showed increase in recommendation for screening not completion, this was an in-person education intervention **Conclusions:** Strong study showing education increases patient's being advised to be screened **Feasibility:** An in person educational intervention may not be

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			Exclusion: Practices in operation < 1 year, practices closing in next 2 years, practices not seeing patients on regular basis Patient's charts with irritable bowel syndrome, colon cancer, or rectal bleeding **Attrition:** NA					plausible but an educational intervention in general could be
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Kelly et al., (2014) Evaluation of a partnership between primary and	Inferred HBM	RCT **Purpose:** Increase comprehensive STD testing in general practices	**n=** 12 general practices **Participants:** in 6 month period 293 patients were	**IV:** Provider education and resource pack **DV:** Increased screening for STDs	Laboratory testing Chart review	Frequencies	**DV:** Before intervention total number of patients tested was	**LOE:** II **Strengths:** HIV data significant, LOE,

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secondary care providing an accessible Level 1 sexual health service in the community **Country:** Ireland **Funding:** Health and Social Care division of the Public Health Agency for Northern Ireland. **Bias:** None noted			seen, 48% between the ages of 16-25, 27% men, **Setting**: general practices in Ireland with high population density **Exclusion:** Not discussed **Attrition:** None	**Definitions:** STDs- screened for were CT, GC, syphilis, HIV Provider education and resource pack- included formal training day from one provider and nurse from practice, education of all staff, completion of modules			31%; (30/97) after - 40% (52/131) (p = 0.2) Patients that had an HIV test increased from 5/104 (4.8%) test in January 2012 to 61/144 (42.4%) tests in October 2012, (p<0.001).	**Weaknesses:** Nonsignificant data for overall testing, pilot study **Conclusions:** Extensive education was completed, increased in certain screening was seen thus showing education can increase STD screening including syphilis **Feasibility:** this level of education is not feasible for this project, but a reduced version is
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/

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								application to practice
Lazarini et al. (2017) Educational intervention in primary care for the prevention of congenital syphilis **Country:** Brazil **Funding:** None noted **Bias:** None noted	Inferred to be HBM	Quasi-experimental study **Purpose:** Evaluate efficiency of educational intervention of primary care providers in Brazil and its impact on CS rates	**n=** 102 before workshop, **n=** 85 after workshop **Age (M):** 38 years **Gender:** female= 78/102 **Participants:** Health professionals working in primary care or in maternal and child services **Setting:** Municipality of Lodrina, Parana from October 2013- December 2015 **Exclusion:** Non health care workers, those not working in primary care or	**IV:** Educational intervention **DV1:** number of successes **DV2:** Incidence and mortality of CS **Definitions:** Educational intervention- include information on prevention, diagnosis, and treatment of GS and CS Successes- correctly answered questions on questionnaire GS- syphilis contracted during pregnancy	Questionnaire where answers were supported from training Incidence and mortality of CS from the system for notifiable diseases and Mortality Information System	McNemar test (for correlated frequencies)	**DV1: number of successes** Before – 53% After- 74.3% P < 0.001 **DV2: Incidence and mortality of CS** Transmission Rate 2012- 81.6% 2013- 75% 2014- 33.7% 2015- 40.2% Fetal Deaths 2012- 4 2013- 5 2014- 5 2015- 5	**LOE:** III **Strengths:** Non-invasive intervention, modest attrition rate **Weaknesses:** Lack of control group, small sample size **Conclusions:** Education interventions can help when there is a lack of knowledge in providers about CS **Feasibility:** Recommended to start education due to effectiveness

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			maternal and child services **Attrition:** 17%	Transmission- the transmission of syphilis from mother to child				
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Matthias et al., (2017) Effectiveness of prenatal screening and treatment to prevent congenital syphilis, Louisiana and Florida, 2013-2014 **Country:** USA	Inferred to be HBM	Cross-sectional study **Purpose:** Evaluate the effects of current screening for the prevention of CS in two different states with high number of cases of CS	**n=** 710 (syphilis infections in pregnant women) **n=** 155 CS cases **Characteristics of pregnant women with syphilis:** 68% African American 32% were foreign born women	**IV1:** Screening in first or second trimester for syphilis **IV2:** Re-screening in third trimester for syphilis **IV3:** First screen for syphilis in third trimester **DV:** Number of cases of CS **Definitions:**	CS diagnosis criteria	Frequencies	**IV1- DV:** Prevented 470 CS cases **IV2- DV:** Prevented 30 CS cases **IV3- DV:** Prevented 55 CS cases	**LOE:** IV **Strengths:** Shows preventions in high risk area for CS, large number of cases **Weaknesses:** LOE, potential for missing data, frequencies being the only data analysis conducted

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Funding: None noted **Bias:** None declared			83% screened in first 2 trimesters **Setting:** Syphilis cases in pregnant females from 2013-2014 in Louisiana and Florida **Exclusion:** though not excluded, some still births may not have been included **Attrition:** NA	CS diagnosis criteria 1 or more of following: - laboratory confirmation - stillbirth - signs and symptoms of CS - abnormal long bone x-ray - abnormal cerebral spinal fluid				**Conclusions:** Early screening is the most effective method for preventing CS, re-screening in third trimester does play roll in areas with high rates of CS **Feasibility:** Recommended to re-screen in third trimester in areas with high rates of CS
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Myers et al., (2017)	Theory of Planned Behavior	Quality Improvement	**n=** 530 **Age (M):** < 25 years of age	**IV:** Education to providers on screening for STDs	Screening rates	Frequencies	**DV:** Screening increased from 3% to 65.85% after education	**LOE:** V **Strengths:** large sample size,

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Improving STD screening rates on a university campus **Country:** USA **Funding:** None noted **Bias:** None indicated		**Purpose:** To determine if provider education on CDC guidelines for STD testing improved screening rates for CT and GC	**Gender:** not mentioned **Participants:** patients 25 years of age or younger seen at clinic, sexually active **Setting:** Health clinic on private residential university campus **Exclusion:** individuals 26 years and older, not sexually active, individuals tested in last year for CT or GC, repeat appointment within 3 months of implementation **Attrition:** 118 students refused STD testing	**DV:** Increased screening rates **Definitions:** Screening rates - determined off CPT codes in EHR for test ordered (CT and GC)				significant results **Weaknesses:** LOE, no control group, not as generalizable due to setting, demographics not discussed **Conclusions:** Provider education can increase screening **Feasibility:** Education is feasible to implement and is low risk.

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			after being offered by provider					
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Plotzker et al., (2018) Congenital syphilis prevention: Strategies, evidence, and future direction **Country:** USA **Funding:** None declared **Bias:** None noted	Inferred to be HBM	Systematic review **Purpose:** Review promising interventions for prevention of CS	**N=** 24 articles for prenatal syphilis screening **Articles:** prenatal syphilis screening strategies- 18 articles looked at screening in 1st and/ or 3rd trimester, 6 articles looked at point of care testing **Exclusion:** None discussed	**IV1:** Universal first prenatal visit screening **IV2:** Re-screening high risk pregnancies in 3rd trimester and at delivery **IV3:** Alternative screening methods **DV:** number of CS cases **Definitions:**	Literature reviews, chart reviews,	Frequencies	**DV for IV1:** All 10 studies showed early disease detection decreases CS **DV for IV2:** in 1 article rescreening detected 5% of CS cases which led to prevention/ treatment of 30 CS cases, **DV for IV3:** results varied from study to study but in high	**LOE:** I **Strengths:** looked at a couple different strategies to prevent CS, high level of evidence **Weaknesses:** Quality of literature reviewed, lack of statistical discussion, lack of consensus between articles on who is high risk and needs repeat screening

Key: **APN-** advance practice nurse; **BMI-** body mass index; **CDC-** Centers for Disease Control and Prevention; **CS-** congenital syphilis; **CT-** chlamydia; **DV**-dependent variable; **EHR-** electronic health record; **GC-** gonorrhea; **GS**- gestational syphilis; **HBM-** health belief model; **HIV-** human immunodeficiency virus; **IV**- independent variable; **LOE-** level of evidence; **M-** mean; **N**-number of studies; **n**- number of participants; **NA**- not applicable; **OB/GYN-** obstetrician and gynecologist; **p**- alpha value; **PPD-** postpartum depression; **PDSA**- plan do study act model; **RCT-** randomized control trial; **STD-** sexually transmitted diseases; **USA-** United States of America; **<-** less than

				Universal first prenatal visit screening- screening all pregnant women at first prenatal visit High risk pregnancies- not strictly defined by all studies but included diagnosis of other STD, illicit drug use, sex exchange workers, living in poverty Point of care testing- testing on site			prevalence areas can be effective	**Conclusions:** Screening is the most effective route to prevent CS **Feasibility:** Repeat screening is feasible
Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/

Key: **APN**- advance practice nurse; **BMI**- body mass index; **CDC**- Centers for Disease Control and Prevention; **CS**- congenital syphilis; **CT**- chlamydia; **DV**-dependent variable; **EHR**- electronic health record; **GC**- gonorrhea; **GS**- gestational syphilis; **HBM**- health belief model; **HIV**- human immunodeficiency virus; **IV**- independent variable; **LOE**- level of evidence; **M**- mean; **N**-number of studies; **n**- number of participants; **NA**- not applicable; **OB/GYN**- obstetrician and gynecologist; **p**- alpha value; **PPD**- postpartum depression; **PDSA**- plan do study act model; **RCT**- randomized control trial; **STD**- sexually transmitted diseases; **USA**- United States of America; **<**- less than

								application to practice
Wood et al., (2019) Effectiveness of a quality improvement intervention to improve rates of routine *chlamydia trachomatis* screening in female adolescents seeking primary preventive care **Country:** USA **Funding:** National Institute of Mental Health and the Children's Hospital of Philadelphia Research	Lean Six Sigma and PDSA	Cohort study **Purpose:** Increase screening rates of CT in adolescent females	**n=** 1550 visits **Participants:** Female adolescents aged 15-19 years. **Setting:** Urban primary care site providing adolescent primary and confidential sexual health care, 12 attending physicians and 2 APNs. **Exclusion:** Not discussed **Attrition:** NA	**IV:** Multiphase intervention **DV:** Screening rates **Definitions:** Intervention included staff education on screening guidelines, local prevalence, complications of infection, current, screening ratees, then process mapping occurred, and a protocol for screening was designed and implemented based on where gaps	Laboratory testing Chart reviews	Frequencies Chi-squared	**DV:** Pre-intervention screening 312/757 (41.2%) Post intervention, screening 397/793 (50.0%) (95% confidence interval, 28.6%-71.5%; P < .001).	**LOE:** IV **Strengths:** Statistically significant increase in screening, **Weaknesses:** LOE, intervention was expanded beyond education **Conclusions:** the education given on screening to the providers and staff covered important information for screening that would need to be covered also in a project to increase CS screening

Key: **APN**- advance practice nurse; **BMI**- body mass index; **CDC**- Centers for Disease Control and Prevention; **CS**- congenital syphilis; **CT**- chlamydia; **DV**-dependent variable; **EHR**- electronic health record; **GC**- gonorrhea; **GS**- gestational syphilis; **HBM**- health belief model; **HIV**- human immunodeficiency virus; **IV**- independent variable; **LOE**- level of evidence; **M**- mean; **N**-number of studies; **n**- number of participants; **NA**- not applicable; **OB/GYN**- obstetrician and gynecologist; **p**- alpha value; **PPD**- postpartum depression; **PDSA**- plan do study act model; **RCT**- randomized control trial; **STD**- sexually transmitted diseases; **USA**- United States of America; **<-** less than

Institute K23 Readiness Award **Bias:** None disclosed				were identified				**Feasibility:** The education could be implemented with information of screening with lab work already being completed

Key: **APN**- advance practice nurse; **BMI**- body mass index; **CDC**- Centers for Disease Control and Prevention; **CS**- congenital syphilis; **CT**- chlamydia; **DV**-dependent variable; **EHR**- electronic health record; **GC**- gonorrhea; **GS**- gestational syphilis; **HBM**- health belief model; **HIV**- human immunodeficiency virus; **IV**- independent variable; **LOE**- level of evidence; **M**- mean; **N**-number of studies; **n**- number of participants; **NA**- not applicable; **OB/GYN**- obstetrician and gynecologist; **p**- alpha value; **PPD**- postpartum depression; **PDSA**- plan do study act model; **RCT**- randomized control trial; **STD**- sexually transmitted diseases; **USA**- United States of America; **<-** less than

Appendix B

Table 1

Synthesis Table of Studies

	Studies	Biswas et al.	Busch et al.	Clevesey et al.	Dignan et al.	Kelly et al.	Lazarini et al.	Matthias et al.	Myers et al.	Plotzker et al.	Wood et al.
Basics	Year	2018	2018	2019	2014	2014	2017	2017	2017	2018	2019
	LOE	IV	V	V	II	II	III	IV	V	I	IV
	Design	CS	QI	QI	RCT	RCT	QE	CSS	QI	SR	CS
	Length	>2yrs	3 mo	3mo	6 mo	6 mo	>2yrs	1 yr	3 mo	NA	1.5yrs
Interventions	Screening >40 days before delivery	X						X		X	
	Re-Screen 3rd trimester							X		X	
	Education In-Person		X	X	X	X	X		X		X
	Education on Paper		X	X		X			X		X
Results	# N-CS	↑					↑	↑		↑	
	Screening		↑	↑	↑	↑	↑		↑		↑

Key- ↑- increased; CS- cohort study; CSS- cross sectional study; LOE- level of evidence; MO- months; NA- not applicable; N-CS- Non congenital syphilis infant; QE-quasi-experimental study; QI- quality improvement; RCT- randomized control trial; SR- systematic review; YRS- years

Appendix C

Conceptual Framework Model

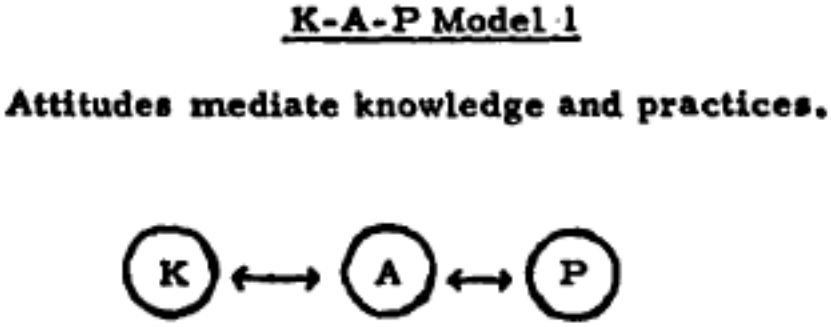

Figure 1: Knowledge-Attitudes-Practice Model. (Schwartz, 1973)

Appendix D

Implementation Framework

Figure 1: ACE STAR Model of Knowledge Transformation. (Stevens, 2013)

Key- ↑- increased; CS- cohort study; CSS- cross sectional study; LOE- level of evidence; MO- months; NA- not applicable; N-CS- Non congenital syphilis infant; QE-quasi-experimental study; QI- quality improvement; RCT- randomized control trial; SR- systematic review; YRS- years

Appendix E

Budget

Category	Activity	Projected	Cost to Site	No Cost to Site
Direct Costs	Project Manager-DNP student Kinley Brownsberger	$15.87 (hourly wage based on $33K annual salary average for intern) x 400 hours		$6,348
	Project Mentor-Dr. Link	$65/ hour x 2 hours per week for 10 months		$5, 200
	Obstetric providers (completing survey)	$80/ hour x 30 minutes x 200 providers		$8,000
	Emerson Kuhn-Program Manager of Community Health HIV/STD Services	$37.02 (hourly wage based on $77K annual salary average for healthcare programing manager) x 20 hours	$740.40	
	Caitlin Jensen-Community Relations Specialist	$43.27 (hourly wage based on $90K annual salary average for marketing manager) x 20 hours	$865.40	
Indirect Cost	Survey Monkey Premier	Annually for one-member use	($1,188)*	
Funding	Health department money allotted to sexually transmitted disease surveillance	$122,000**		
Potential Cost Savings	Prevented Cases***	**$15,390.84**		
		Total Project Cost	**$ 1,605.80**	$19,548

* The cost of survey monkey was not included in the overall cost to the health department because currently the system is used by the whole health department and was not an extra expense for the project.

**The health department does not have a separate allotment of funds for congenital syphilis but receives a lump sum of grant money for sexually transmitted disease surveillance. Part of this money is available for use during the project.

*** The prevented cases cost savings was calculated by determining the costs of CS cases and the cost of CS related intrauterine fetal demise (IUFD) cases for the state of Arizona based on the number of cases in 2018 (Arizona Department of Health Services, 2018). Then the cost to screen all pregnant women in Arizona was based on number of births in 2017, the most current data, and the cost to treat all the cases was calculated. Cost savings for the state of Arizona was determined by subtracting the cost of the cases from the cost to screen and treat. To determine the Pima County specific savings the percent of state births that occurred in the county was multiplied by the total state savings. Information for cost of a congenital syphilis case, IUFD case, treatment, and lab test was obtained from researchers Albright, Emerson, Werner, & Hughes (2015). See below:

i. Cost of cases of CS in Arizona = # of congenital syphilis cases in AZ 2018 (51) x cost to treat living CS babies ($12,610) = $643,110

ii. Cost of IUFD CS cases in Arizona = # of IUFD cases due to syphilis in AZ 2018 (10) x cost of IUFD ($4675) = $46,7500

iii. Cost to test in Arizona= # of AZ births in 2017 (81,664) x cost of RPR ($7) = $571,648

iv. What would have been the cost to treat in Arizona= # of CS cases in AZ 2018 both living and passed (61) x cost of treatment ($55) = $3,355

v. What the cost savings would have been for all of AZ = [cost of cases of CS ($643,110) + cost of IUFD CS cases ($46,750) = 689,860] - [cost to test ($571, 648) + cost to treat ($3,355) = $575,003] = $114,857

vi. Potential Pima County savings= Percent of state births (13.4%) x total state savings ($114,857) = $15,390.84

Appendix F

Results Figures and Tables

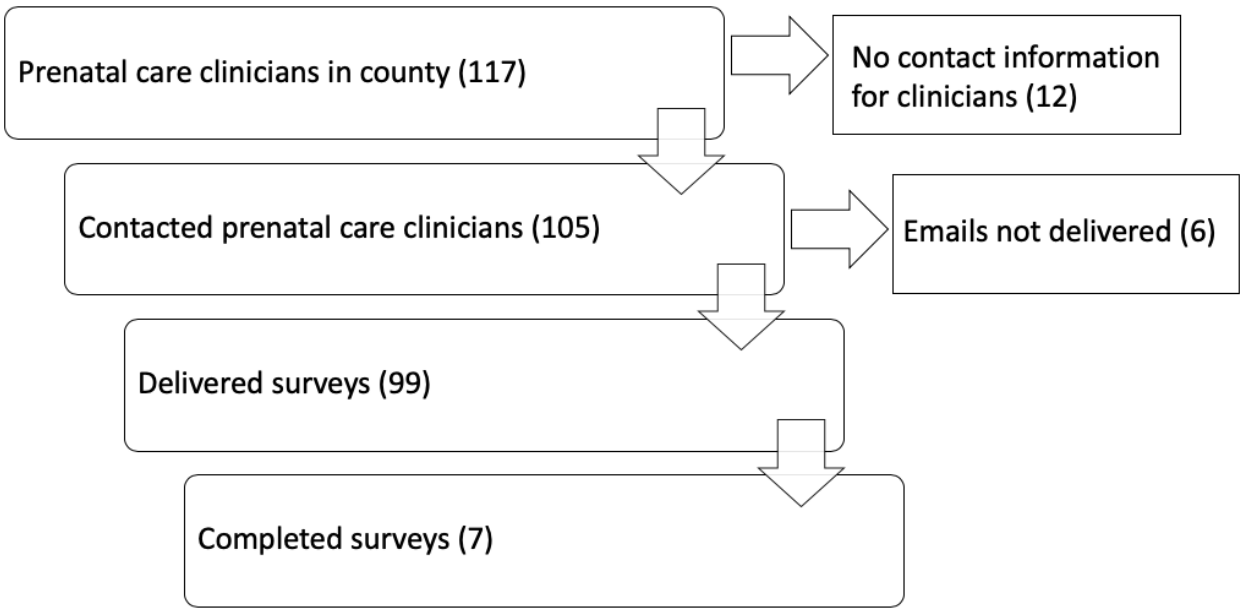

Figure F1. Flowchart of surveys.

Table F1

Characteristics of Participants

Demographics		*n*	%
1. Credentials			
	Certified Nurse Midwife	0	0
	Physician	7	100
	Midwife	0	0
	Nurse Practitioner	0	0
	Physician Assistant	0	0
2. Practice			
	Private	5	71
	Federally Qualified Health Center	0	0
	Other	2	29

Note. Due to rounding errors, percentages may not equal 100%.

Table F2

Knowledge of Syphilis in Arizona State

Knowledge criteria		*n*	%
1. The state of Arizona is in a syphilis outbreak.			
	True	7	100
	False	0	0
	Do not know	0	0
2. The state law requires three screenings of syphilis in pregnancy			
	True	3	43
	False	3	43
	Do not know	1	14
3. All syphilis cases must be reported to the local health department in 5 business days.			
	True	5	71
	False	0	0
	Do not know	2	29
4. AHCCCS covers three screenings of syphilis in pregnancy			
	True	7	100
	False	0	0
	Do not know	0	0

Note. Due to rounding errors, percentages may not equal 100%.
AHCCCS- Arizona Health Care Cost Containment System

Table F3

Attitudes of Providers

Attitudes		*n*	%
1. Third trimester screening for syphilis is not necessary in my patients who are low risk.			
	Strongly Agree	0	0
	Agree	1	14
	Neutral	2	29
	Disagree	1	14
	Strongly Disagree	3	43
2. Screening for syphilis during pregnancy can reduce the incidence of congenital syphilis.			
	Strongly Agree	7	100
	Agree	0	0
	Neutral	0	0
	Disagree	0	0
	Strongly Disagree	0	0

Note. Due to rounding errors, percentages may not equal 100%.

Table F4

Attitudes of Barriers in the Management of Syphilis During Pregnancy

Barrier Types			*n*	%
Screening and Management				
	1. Late onset of prenatal care by patient			
		Strongly Agree	2	29
		Agree	5	71
		Neutral	0	0
		Disagree	0	0
		Strongly Disagree	0	0
	2. Patient nonadherence to testing			
		Strongly Agree	0	0
		Agree	3	43
		Neutral	1	14
		Disagree	1	14
		Strongly Disagree	2	29
	3. Patient nonadherence to treatment			
		Strongly Agree	1	14
		Agree	4	57
		Neutral	2	29
		Disagree	0	0
		Strongly Disagree	0	0
	4. Patient nonattendance of appointments			
		Strongly Agree	1	14
		Agree	4	57
		Neutral	2	29
		Disagree	0	0
		Strongly Disagree	0	0
Clinical				
	5. Delay in test results			
		Strongly Agree	0	0
		Agree	1	14
		Neutral	1	14
		Disagree	4	57
		Strongly Disagree	1	14

Barrier Types			*n*	%
	6. Cost of screening to the clinic			
		Strongly Agree	0	0
		Agree	0	0
		Neutral	1	14
		Disagree	4	57
		Strongly Disagree	2	29
	7. Time spent counseling patients			
		Strongly Agree	0	0
		Agree	0	0
		Neutral	1	14
		Disagree	4	57
		Strongly Disagree	2	29
	8. Lack of locations for referral for treatment			
		Strongly Agree	0	0
		Agree	1	14
		Neutral	1	14
		Disagree	3	43
		Strongly Disagree	2	29

Note. Due to rounding errors, percentages may not equal 100%.

Table F5

Practices in the Management of Syphilis During Pregnancy

Practice		*n*	%
1. At what time(s) during pregnancy, in general, do you test pregnant women for syphilis?			
	Frist prenatal visit	7	100
	Second trimester	0	0
	Third trimester	1	14
	At time of glucose tolerance test	7	100
	At delivery	7	100
2. Which screening do you use to screen for syphilis?			
	RPR	6	86
	VDRL	1	14
	TP-PA	0	0
	EIA	0	0
	Traditional Screening Algorithm	1	14
	Reverse Sequencing Screening Algorithm	0	0
	Other	0	0
3. Where are your patients treated for syphilis (pregnant or non-pregnant)?			
	In office	5	71
	Refer to county health department	5	71
	Other	0	0
4. Who identifies pregnant women in need of syphilis screening in your practice?			
	RN with standing orders	0	0
	Prenatal provider	6	86
	Medical assistant	1	14
	Other	1	14

Note. Due to rounding errors, percentages may not equal 100%.
All questions with multiple possible answer.
EIA- enzyme-linked immunosorbent assays; RN- registered nurse; RPR- rapid plasma regain; TP-PA- *T. pallidum* particle agglutination; VDRL- venereal disease research laboratory

Appendix G

Screening Algorithms for Syphilis

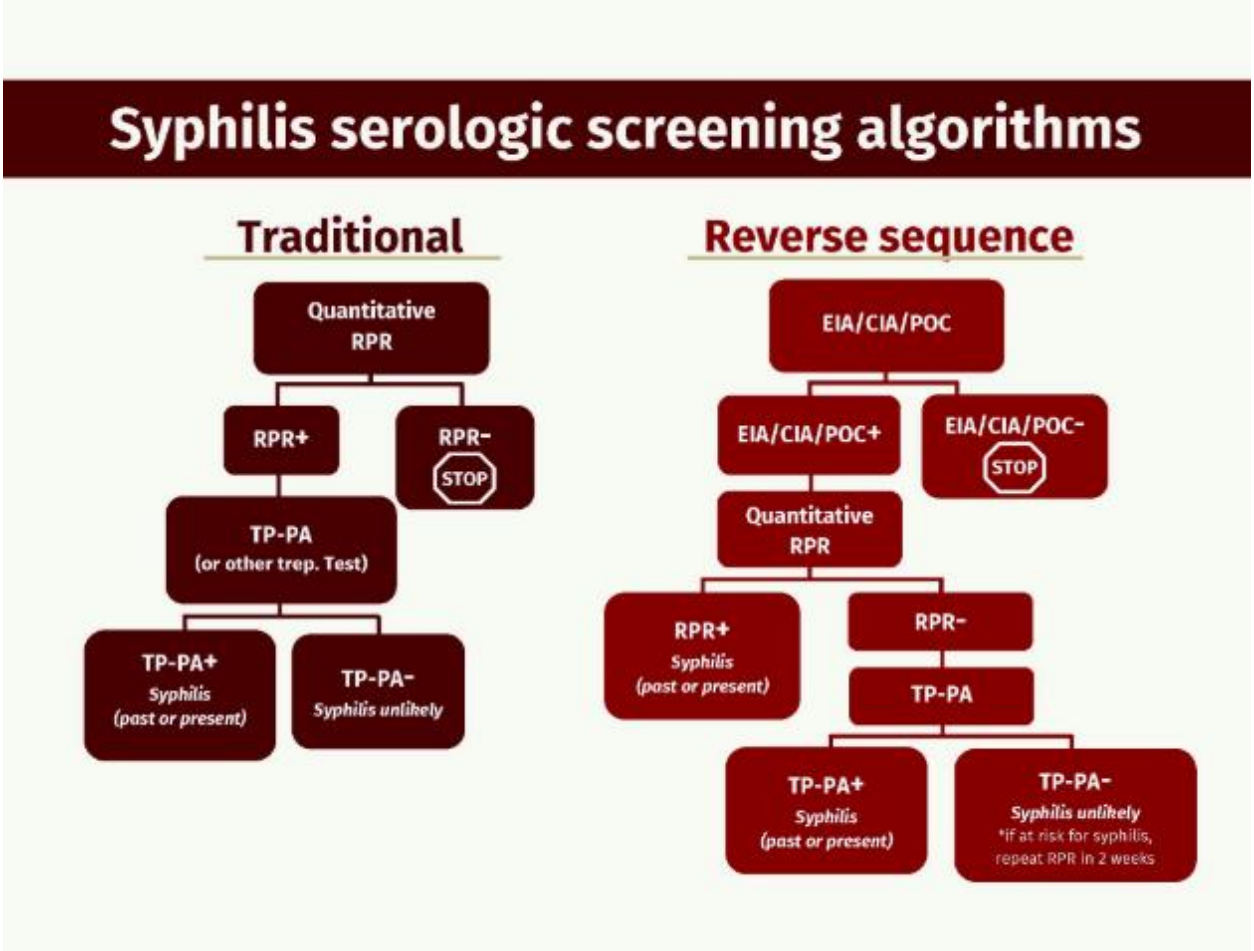

Figure 1. Traditional v Reserve sequence screening algorithms for syphilis. (ADHS, 2020)