Promoting Infant and Early Childhood Vaccines in a Refugee Population

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Abstract

Background: Refugee children and children of refugees are at risk for under-immunization. Reminder and recall is an intervention that has been shown to improve vaccination rates, but has not been studied in a refugee-specific population. This quality improvement project was conducted from September-November 2018 at an International Family Medicine Clinic (IFMC) at an academic medical center in Charlottesville, Virginia. The purpose was to pilot a reminder and recall intervention and identify risk factors for delayed immunization for refugee children. ***Methods****:* Charts were reviewed for 441 children under ten years old to identify factors associated with delayed immunization. The 120 children under four years old were screened for the reminder and recall intervention, as older children are prompted to get vaccines by school policies. Parents of children with missing vaccines were contacted with a reminder to make an appointment for vaccination. ***Results:*** Twenty-two children required reminder calls for missing vaccines. By the end of the study, 12 of 22 (54.5%) had appointments scheduled. Foreign-born status, maternal origin country, and number of children per household were among the factors associated with a decreased rate of vaccination on the recommended schedule. Factors associated with improved vaccination rates included use of Women, Infants, Children (a federal nutritional program for low-income families) services, older maternal age at birth, and increased maternal time since immigration. ***Conclusion:*** These results will allow IFMC providers to identify children who are at risk for delayed immunization and provide a basis for a sustainable intervention to improve vaccination rates.

Promoting Infant and Early Childhood Vaccines in a Refugee Population

A refugee is defined as a person who is "unable or unwilling to return to their country of nationality because of persecution or a well-founded fear of persecution due to race, religion, nationality, membership in a particular social group, or political opinion" (Lee et al., 2013, p. 3). The Department of Homeland Security estimates that 75,000 refugees are resettled in the United States (U.S.) each year (Carrico et al., 2015). Of these refugees, 30-40% are children (Berman, Smock, Bair-Merritt, Cochran, & Geltman, 2017).

More than 3.7% of children in the U.S. were born overseas, however, research on their health status and evidence-based guidelines for their care are largely lacking (McBride, 2016). The Centers for Disease Control and Prevention (CDC) approves and publishes the adult and childhood immunization schedules recommended by the Advisory Committee on Immunization Practices (ACIP) for all U.S. residents. For children under 24 months, the recommended vaccines are hepatitis A (HepA); hepatitis B (HepB); diphtheria and tetanus toxoids and acellular pertussis (DTaP); pneumococcal conjugate vaccine (PCV); rotavirus, measles, mumps, rubella (MMR); poliomyelitis (IPV); influenza; varicella; and *Haemophilus influenzae* type B (Hib) (Lee et al, 2013). The schedule for childhood vaccines is summarized in Table 1.

Improving vaccination rates and decreasing the incidence of vaccine-preventable illnesses are included in the Healthy People 2020 goals created by the Office of Disease Prevention and Health Promotion, a branch of the U.S. Department of Health and Human Services. One of these goals is to increase the percentage of children aged 19 to 35 months who receive the recommended doses of DTaP, IPV, MMR, Hib, HepB, HepA, varicella and PCV with a benchmark of 85% completion for each vaccine (Hill, Elam-Evans, Yankey, Singleton, & Kang, 2017).

In 2012, 68.4% of U.S. children age 19-35 months received the recommended number of doses of these vaccines. However, more recent findings indicate that U.S. childhood vaccination rates are exceeding Healthy People 2020 benchmarks. Results from the 2016 National Immunization Survey (NIS) indicated that vaccination rates among children 19-35 months were greater than 90% for IPV, MMR, varicella, and HepB. Rates for up-to-date DTaP, PCV, and Hib vaccinations also exceeded the 85% goal of Healthy People 2020 (Hill et al., 2017).

Completing vaccinations on time in accordance with the CDC-recommended schedule is essential for adequate protection from disease. Timely vaccination often depends on parents attending well-child checks (WCCs) at the intervals recommended by the American Academy of Pediatrics (AAP). Most states require vaccines for school and daycare attendance (including private schools), except in the case of religious or medical exemption (Luman et al., 2005). Because of this requirement, gaps in vaccination tend to close as children enter the four-to-six year-old age range when they start attending school.

Vaccines in the Refugee Population

Some experts point out that complete and timely immunizations are especially important for immigrants, as they are more likely to be exposed to vaccine-preventable diseases due to traveling to or receiving visitors from their country of origin. For example, overseas travel (including migration) has been cited as the most frequent cause of measles cases in the U.S., accounting for 90% of cases in 2008 (Nguyen & Altshuler, 2011). Vaccine-preventable disease outbreaks have occurred in refugee communities in the U.S. In addition, rates of HepB infection are higher in refugee populations compared to the native U.S. population (Carrico et al., 2017). Beyond the immediate public health concerns of these diseases, infectious disease outbreaks have additional negative consequences that include delaying resettlement into the U.S. and the

potential for increased discrimination against refugees (Adachi et al., 2012).

An overview of the U.S. refugee resettlement process is provided in Figure 1. U.S. Department of State regulations require all refugees to receive an overseas medical examination. After refugees arrive in the U.S., they undergo additional health screening to receive a visa for legal permanent residence in the U.S. In Charlottesville, Virginia, the Health Department (HD) conducts this initial domestic screening visit, referred to as the Newcomer Health Assessment. The HD then refers the patients to the International Family Medicine Clinic (IFMC) a local refugee health clinic within the academic health system for additional screening and a source of primary care. The typical screening tests and vaccines provided by the HD and IFMC are summarized in Table 2.

At the first visit to the IFMC, an extensive medical history is taken, screening for certain conditions is performed, and age-appropriate vaccinations are administered as needed based on vaccination records and current guidelines. The HD is able to provide recommended pediatric vaccines with the exception of HepA, which is given at the IFMC. However, most families choose to get all vaccines for their children at the IFMC because they are already attending the clinic for visits with their providers. Of note, the IFMC patient panel also includes children born to refugees, who receive all of their vaccinations at the clinic.

Purpose

This quality improvement (QI) project sought to identify gaps in infant and early childhood vaccines at the IFMC and utilize reminder and recall interventions to improve vaccination rates. The steps of the QI project included:

1. Identification of children who are not up-to-date on vaccines and the demographic factors that may impact immunization completion.

2. Phone notification of parents to inform them of due or overdue vaccines for their child, with a comparison of vaccination rates pre- and post-intervention.

Theoretical Framework

The Donabedian Structure-Process-Outcome (SPO) model was used as a framework for designing the reminder and recall intervention. This model serves to define quality for healthcare and provides a framework for its evaluation. According to this model, quality can be assessed on three levels of care. The structure level describes the care setting including its physical facilities, equipment, and organizational structures for operation. The process level describes what is done for the patient by the care provider as well as the activities of the patients themselves. The outcome level describes how healthcare affects the health status of patients and populations. Knowledge of the structure, process, and outcome factors in a healthcare setting and how these factors relate to each other provides a useful foundation before an assessment of quality can be performed (Donabedian, 1988).

There are numerous patient, provider, and system factors that impact the quality of care for refugee children at the IFMC. The structure and process factors for pediatric care in the refugee population with their expected outcomes are summarized in Table 3. These factors provide insight into how refugee children at the IFMC receive medical care while also revealing opportunities for intervention to improve the vaccination process. Using this model to understand the current state of care and potential barriers to vaccination, a QI project was developed to modify those process factors that exist within the structure of the practice site to improve refugee family adherence to recommended childhood vaccination schedules.

Review of the Literature

To assess the current state of the literature on barriers to timely vaccinations and the impact of parent reminder and recall for routine vaccinations for infants and young children, a review of the literature was conducted. For purposes of this review, "reminder" refers to a notification that a child is due for a particular vaccine or well-child visit. "Recall" refers to communication that the child is now overdue for an immunization or appointment.

Search Methods

The databases used were OVID Medline, Web of Science, CINAHL, and PsychInfo. The search terms "child AND vaccination" were used. Included works were limited to full-text English-language publications of randomized controlled trials (RCTs) and quasi-experimental designs (non-randomized comparison cohort studies) of reminder and recall interventions for routine childhood vaccines conducted between 1993 and 2018. Articles must have addressed telephone communication, postal communication, or both. Studies of reminder and recall for vaccine promotion in adults and children over age 11 were excluded. Due to this age criterion, studies of the human papilloma virus (HPV) vaccine and meningitis vaccines were excluded. Studies that only looked at the influenza vaccine were also excluded, as this was not one of the vaccines included in the chart review. In addition, articles that only looked at e-mail or text message reminders were excluded due to the potential access and patient cost barriers for the IFMC patients related to these communication methods.

A summary of the search procedure is presented in Figure 2. The final 11 studies of reminder and recall interventions reviewed included seven systematic reviews (six of which included a meta-analysis), two RCTs, and two prospective cohort studies. Many additional studies, including several RCTs, were excluded from the final review because they were

included within the systematic reviews. Additional articles from the literature search were reviewed to gather background information that helped to inform the QI project methods.

Background

The generally high rates of vaccination compliance seen in the U.S. population are not consistent across all populations. Refugee children and children of refugee parents are often incompletely immunized or immunized off-schedule, a trend observed in the U.S. and other nations that host refugees. Results from 2000-2003 U.S. National Health Interview Surveys indicated that having a foreign-born mother was associated with a 14% decrease in completion of recommended vaccinations on time compared to having a U.S.-born mother (Buelow & Van Hook, 2008).

A retrospective chart review of 198 refugee children age 18 and younger arriving in Providence, Rhode Island between November 2003 and November 2006 revealed discrepancies between refugee immunization rates and NIS data for vaccinations in U.S.-born children. The results showed that 50% of children 0-35 months were considered up-to-date on all vaccines, which is significantly lower than the Rhode Island and U.S. vaccination rates for this age group (77% and 80%, respectively). A limitation of this study was that it likely underestimated vaccination rates, as only vaccines received in the state of Rhode Island were included and stringent timing criteria were used to define vaccine completeness. In addition, the refugee population in this study included a large proportion of Liberian immigrants, so the findings may not be generalizable to refugee populations in other communities (Watts, Friedman, Vivier, Tompkins, & Alario, 2011).

A Danish study of National Danish Health Service Register data by Moller et al. (2016) indicated that refugee children are 39% less likely to receive the diphtheria, tetanus, pertussis,

and polio vaccine (DTaP-IPV, a combination vaccine that is offered as two separate vaccine in the U.S.) compared to Danish-born children. Refugees were also 15-41% less likely to attend pediatric wellness checks compared to Danish-born children.

A retrospective cohort study of 97,885 Minnesota children aged 36 months or older indicated that children with at least one foreign-born parent were 7-25% less likely to be up-to-date on their immunizations at ages two, six, 18, and 36 months compared to children with two native-born parents (Leeds & Muscoplat, 2017). Another U.S. study using 2010-2012 NIS data from 52,411 children indicated that nativity status of parents was the most significant factor affecting vaccine completion. Foreign-born children had a statistically significant reduction ($p <$ .05) in vaccination rate for DTaP, Hep A, HepB, Hib, PCV, and rotavirus compared to U.S.-born children. These disparities persisted after controlling for income, language, and access to care (adjusted prevalence ratio of 0.39, 95% CI [0.31–0.50]) (Varan et al., 2016).

However, there are inconsistencies in the data regarding disparities in refugee vaccination rates compared to the native-born population. Guttman et al., (2008) examined healthcare records from a database for a cohort of 98,123 children born in Ontario between July 1, 1997 and June 30, 1998 to determine demographic factors that affect up-to-date vaccine status by two years of age. The authors noted that children of immigrant mothers were 15% more likely to be up-to-date than those born to Canadian mothers. Of the children of immigrant mothers, those who were born to refugee mothers were less likely to be up-to-date on vaccines compared to those who had immigrated under different circumstances. However, when the data was adjusted for maternal age, income, and health services characteristics, children of refugee mothers were no less likely to be up-to-date on vaccines than children of other immigrants. A limitation of this study is that it only looked at vaccine completion and not timeliness.

Barriers to Vaccination in the Refugee Population

The disparities in preventive care outcomes for refugee children as described above represent a significant public health concern. Multiple patient and provider barriers are hypothesized to contribute to this gap.

Patient barriers.

Language. The language barriers that most refugees face impact their ability to navigate the health system. For example, language barriers may make it difficult for refugee parents to make medical appointments for their children (Moller et al., 2016). A retrospective study of Medicaid enrollees in Washington State indicated that children of parents who had a preferred language other than English were half as likely as other children to attend all six recommended WCCs in the first year of life. Because many vaccines are given during these WCCs, missing visits can significantly impact timely vaccine completion (Cohen & Cristakis, 2016).

Culture. The cultural backgrounds of refugees influence health-related decision-making. For example, in a Danish study of pediatric vaccinations and health examination visits, Moller et al. (2016) identified informal barriers to refugees accessing a new healthcare system including language barriers, cultural differences in how disease is perceived, and lack of cultural competency of providers. In addition, characteristics of the healthcare system of the country of origin may play a role. In many countries, preventive healthcare for children is not widely available or promoted, so this may not be a priority for newly arrived refugees.

Cultural health beliefs can impact how families perceive the health system in their new country of residence. A study of Laotian refugee parents living in California indicted that the use of traditional Hmong medicine, such as treatment by herbalists and shamans was associated with increased perceived barriers to immunization by parents. Though shamans typically

endorse the use of vaccines, utilizing these healers as a health resource may be associated with mistrust of Western medical care (Baker, Dang, Ly, & Diaz, 2010). Some Southeast Asian cultures believe that white individuals have a different constitution than Asians, which they believe could result in different responses to Western medical therapies. Some of these cultures also believe that an immunization may harm a baby's spirit (Uba, 1992).

A study of Somali refugee parents' decision-making regarding HPV vaccination in teenage girls indicated that ethnic minority patients may be less assertive or verbally expressive compared to white patients, though this may actually result in fewer vaccination refusals compared to the native U.S. population (Dailey & Krieger, 2017).

Income. Household income may impact vaccination completion rates for refugees. NIS data indicate that foreign-born children are more likely to be impoverished and live in low-income neighborhoods compared to their native-born peers (Varan et al., 2016). A study of parent demographic data from the medical records of 1,163 children in Washington and Oregon indicated that children from low-income families were 60-80% less likely to be up-to-date on vaccines compared to children of medium-to-high income families (Bobo, Gale, Thapa, & Wassilak, 1993).

The Baker et al. (2010) study described above indicated that Laotian refugee parents of lower socioeconomic status were more likely to perceive barriers to immunization and less likely to recognize the importance of immunization.

Insurance and access to care. In Virginia, all refugee children meeting income requirements can receive Medicaid until they turn 19 under the Family Access to Medical Insurance Security (FAMIS) plan. This plan covers all childhood vaccines and preventive care.

Due to this policy measure, insurance coverage is typically not a barrier to vaccination for refugee children.

However, even with insurance coverage, immigrants tend to utilize preventive health care services less often. An assessment of NIS data for children 19-35 months indicated that despite similar insurance coverage and availability of healthcare providers, immigrant children were less likely to complete the recommended immunization series on schedule compared to native-born children (Varan et al., 2016). In Canada's universal health care system in which all children and families carry insurance, disparities in vaccination rates for immigrant and non-immigrant children can be minimized or even eliminated, but national vaccination rates for all children are only 65-69%, much less than rates seen in U.S. children (Guttman et al., 2008). These findings suggest that insurance may be necessary but not sufficient for ensuring access to and utilization of primary care services such as vaccination.

Time since immigration. The evidence is mixed for a relationship between length of time in the U.S. and vaccination status. A study of children of urban immigrant mothers in Ontario, Canada indicated that time since immigration has no impact on immunization coverage (Guttman et al., 2008). However, data from the childhood immunization supplement of the 2000-2003 U.S. National Health Interview Surveys indicate that children whose mothers had been in the U.S. for fewer than five years had the lowest vaccination rates of all immigrants and were half as likely to be fully immunized compared to native-born children (Buelow & Van Hook, 2008). Research on immunization rates in refugees who have relocated to Denmark suggests that children in the highest quartile for duration of residency had more than twice the rate of completion of the second MMR vaccine and the DTap-IPV vaccine compared to those in the lowest quartile (Moller, 2016).

Country of origin. The country or region of origin of a family may also impact pediatric vaccine compliance, though specific geographic patterns in outcomes are hard to identify. Leeds and Muscoplat (2017) conducted a retrospective cohort study of foreign-born children in Minnesota and determined that children born to mothers from Western Europe, Canada, Eastern Europe, Asia, and Somalia had lower rates of immunization completion at two, six, 18, and 36 months compared to children of U.S.-born mothers. At the same time, children born to mothers from Central America, South America, the Caribbean, Mexico, and Africa (excluding Somalia) had improved vaccination rates at these ages compared to children of native U.S. mothers.

Guttman et al. (2008) reported conflicting data that Canadian immigrants from Southeastern and Northeastern Asia were more likely to be up-to-date on vaccines by two years of age than those from Central and South America. A retrospective review of vaccination records in Washington State determined that children of Ukrainian-, or Russian-born parents were 4-31% less likely to be fully immunized compared to children of U.S.-born parents. Children of Mexican-born, and Indian-born parents were 3-14% more likely to be fully immunized compared to those of U.S.-born parents (Wolf, Rowhan-Rahbar, Tasslimi, Matheson, & DeBolt, 2016).

The variation in vaccine completion in children with different regions of origin may be related to how similar the health system of the home country is to the country of relocation, which impacts the ease with which a family accesses healthcare services (Moller et al., 2016).

Parental education. The education level of refugee parents has implications for their ability to navigate a new health system and understand health topics such as disease prevention (Moller et al., 2016). The Varan et al. (2016) study using NIS data noted that mothers of foreign-born children were more likely than their U.S. counterparts to have an education level

below high school level. Having a mother with less than a high school education was associated with a decreased rate of timely vaccine completion in this study.

This disparity may be related to the link between lower income and lower education level, rather than a decreased ability to understand health information. A prospective cohort study of mother-infant dyads in a Medicaid-eligible urban population indicated that maternal health literacy was not significantly associated with child vaccination status at three or seven months of age (Pati et al., 2010).

Vaccine refusal. Vaccine refusal is uncommon in the refugee population. A qualitative study of immigrant and refugee mothers of children under eight years old revealed that mothers typically trust the advice of their healthcare provider when making decisions about vaccination, regardless of prior knowledge or experience (Kowal, Jardine, & Bubela, 2015). Similarly, Guttman et al. (2008) described a high level of acceptability of vaccination recommendations among immigrants. When refusal does occur, it is often culture-specific. Focus groups conducted by the Washington State Department of Health indicated Russian and Ukrainian immigrants may refuse vaccines due to suspicion of the health system from previous experience with a corrupt medical system as well as media coverage of adverse vaccination events. These focus groups also indicated that Somali immigrants are more likely to believe that measles-containing vaccines cause autism, resulting in refusal of the MMR vaccine. (Wolf et al., 2016).

Other factors. Additional factors may impact refugee access to care and vaccine completion. Exposure to violence is common among refugees and has been shown to negatively predict health outcomes (Jamil et al., 2015). A review of domestic health screening reports of refugees in Kentucky from 2013-2015 showed that 29.2% of refugees reported witnessing or experiencing torture (Carrico et al., 2017). Exposure to trauma or violence in the country of

origin or during the immigration process may impact a family's priorities for health and ability to seek out care (Moller et al., 2016).

Participation in the Women, Infants, and Children program (WIC), a federally subsidized nutritional program may also impact vaccination status (Fu et al., 2012). Utilization of WIC services during pregnancy was associated with increased vaccination rates at two, six, 18, and 36 months in the Leeds and Muscoplat (2017) study of immigrants in Minnesota. WIC provides resources and education that promote vaccine utilization. A systematic review of strategies to improve immunization rates indicated that WIC is associated with improved childhood vaccination rates (Shefer et al., 1999).

Provider and system barriers. One provider factor that may result in decreased vaccination rates is a failure to screen for or provide vaccinations at acute visits. Foreign-born families may be more likely to visit their primary care provider (PCP) exclusively for acute care needs and may miss their regular health maintenance visits (Nguyen & Altshuler, 2011). The time allotted for these visits and the acute concerns of parents may limit the ability of a provider to address vaccination. Some providers may be hesitant to vaccinate a child during a minor illness; however, per national guidelines it is generally safe to do so. Severe or acute illness is a contraindication to vaccination, but vaccinations can be given when symptoms begin to resolve (Daley et al., 2004).

Provider self-report data of vaccination practices indicate that deferral of vaccines occurs with more conservative criteria than that which is recommended by the AAP and the ACIP, which can result in later-than-optimal immunization (Hughart et al., 1998). Provider continuity is also important in keeping immunizations up-to-date, which can be difficult to achieve in the

high-volume clinics where refugees are typically served in the U.S. and Canada (Guttman et al., 2008).

System barriers include the complexity of vaccination catch-up schedules as well as difficulty obtaining accurate records of vaccination prior to immigration. A review of Minnesota Refugee Health Assessment Forms, which are brought to the domestic health assessment visit and includes vaccination history and dates, showed that the majority of refugees lacked vaccination documentation (Lifson, Thai, & Hang, 2001). At the IFMC, patients often face barriers of missed work and difficulty accessing the clinic using public transportation which may discourage them from making appointments.

Summary of Findings on Reminder and Recall Interventions

The 11 included studies in the review of literature of reminder and recall are summarized in Table 4 and were conducted in a number of different countries and settings. The methods used for reminder and recall included telephone calls, postal reminders, or a combination. Children were chosen to receive a reminder intervention based on missing vaccinations and in some cases, WCCs as well. The primary outcome of interest in each of these studies was vaccination completion.

The seven systematic reviews involving telephone and/or postal reminder and recall for childhood vaccines generally demonstrated effectiveness of these interventions for improving vaccination rates or primary care visit attendance with varying degrees of certainty related to the heterogeneity of the study populations and methods. The two RCTs and two non-randomized studies also indicated reminder and recall interventions are effective at improving vaccination rates, though some methodological issues, described in Table 4, may have affected the findings.

Some of the articles also reported results for the significant secondary outcome of cost-effectiveness. Lieu et al. (1998) determined that letters followed by automated telephone reminders were more effective and more cost-effective for increasing immunization rates than either intervention alone. In an RCT of an enhanced reminder and recall program using combined postal and telephone reminders, Sahni, Banes and Boom (2017) demonstrated that despite the cost of adding an intervention, reminder and recall has the potential to generate revenue for a practice. Importantly, none of the studies of postal and telephone reminders and recall for vaccinations reported any adverse events.

One significant gap in the literature is that none of the studies specifically evaluated reminder and recall interventions for a refugee-specific population. However, there were promising results in groups that share characteristics with the refugee population. Studies of low-income, Medicaid-insured, and minority patients were included in the literature review and showed that reminder and recall can improve vaccination rates in vulnerable populations. For example, Daley et al. (2004) demonstrated in an RCT that reminder and recall combined with a QI initiative to address barriers to immunizations doubled vaccination rates in Medicaid-insured children aged 7-18 months after initial implementation. However, the baseline immunization rates for these clinics were less than 25% prior to the intervention. A before-and-after trial of a QI project at six centers serving a low-income minority population in Washington, D.C. resulted in improved rates of under 24-month vaccinations by 14% (Fu et al., 2012).

Implications of Literature Review

The evidence summarized above indicates that reminder and recall interventions via phone or postal communication regarding immunization status of young children are efficacious, cost-effective, and safe for patients. This evidence is already incorporated in national guidelines

for pediatric primary care. The National Vaccine Advisory Committee publishes recommendations for child and adolescent immunization practice in collaboration with the CDC and the AAP (Centers for Disease Control and Prevention, 2017). The guideline includes recommendations for increasing vaccine availability, tracking vaccine completion, and helping families comply with recommendations. The guideline also recommends that providers in all practice settings should utilize reminder and recall systems for pediatric vaccines. The ACIP also publishes practice guidelines for vaccination, which include strategies to improve coverage such as parent reminder and recall and frequent assessment of vaccination status.

In addition to effectiveness, the literature supports the feasibility and acceptability of reminder and recall interventions in practice. A non-randomized study of 44 primary care practices in Wandsworth, England indicated that practitioners who adopted a reminder and recall intervention found it to be useful and easily implemented by clinic staff (Atchison, Zvoc, & Balakrishnan, 2013). An additional advantage is that reminder and recall can engage patient populations who are easily lost to follow-up (Posadzki et al., 2016).

Despite the evidence showing efficacy and acceptability, utilization rates of reminder and recall are low. A survey of 1,200 U.S. private pediatrics practices and public health clinics revealed that overall utilization of reminder and recall is low. In private practice, only 16% of providers report routinely using reminder and recall, and only 38% regularly conduct assessments of immunization status. The utilization rates are higher for public clinics, with 51% using reminder and recall and 85% conducting routine assessments of immunization status (Tierney et al., 2003).

Barriers to utilizing reminder and recall in practice reported by providers include lack of time, personnel, and funding to conduct records reviews and contact parents (Tierney et al.,

2003; Dombkowski et al., 2012). Provider surveys indicate that other barriers include a lack of confidence in the reliability of vaccination data on which to base interventions, lack of staff knowledge on using the immunization information systems, and lack of reliable contact information for parents (Perriera et al., 2012). An assessment of implementation of reminder and recall in 11 Colorado (CO) pediatric practices indicated that unawareness of baseline vaccination gaps might be a barrier to initial implementation, while unrealistic expectations for parent response times may be a barrier to sustaining the intervention (Saville et al., 2016). In an RCT of children 5-17 months in an outpatient clinic in Colorado, Kempe et al. (2001) noted that while parents may have been agreeable to seeing their provider after they were contacted, they may not have made or attended an appointment.

Implications for QI Project

Regular review of immunization records and having a champion leading efforts to increase vaccinations improve the likelihood of successful adoption of reminder and recall (Tierney et al., 2003). The practice of regular immunization record review is also recommended in the guidelines (Centers for Disease Control and Prevention, 2017). This supports the role of an advanced practice nurse (APRN) or other healthcare provider in identifying gaps and contacting families with reminders.

Though the literature on reminder and recall in the refugee community is lacking, the amount of evidence showing effectiveness in a variety of populations and communities suggests that it could be an effective intervention in the IFMC population (Harvey, Reissland, & Mason, 2015; Jacobson Vann, Jacobson, Coyne-Beasley, Asafu-Adjei, & Szilagyi, 2018; Williams, Woodward, Majeed, & Saxena, 2011; Crocker-Buque, Edelstein, & Mounier-Jack, 2017). Based on the review of the literature, this QI project used ten years of historical data to identify gaps in

vaccination completion in IFMC patients and associated risk factors for under-immunization. The project also utilized reminder and recall interventions in an effort to improve vaccination rates.

Methods

Though there is significant evidence supporting the use of phone and postal methods for reminder and recall for due and overdue childhood vaccines, the effectiveness of these interventions has not been studied in a refugee-specific population. A QI project was implemented and evaluated with two specific aims:

1. To determine the effectiveness of a reminder and recall on infant and early childhood vaccination rates in a clinic serving a refugee population.
2. To assess vaccine completion in the clinic population and identify risk factors for insufficient vaccination

Definition of Terms

CHiP: Children's Health Improvement Program. A community-based health organization in central Virginia founded in 1991 that provides home visits to vulnerable families with children under seven years old by registered nurses and family support workers with certifications in parental education. This is distinct from the Children's Health Insurance Program, a program that helps provide insurance for children who are ineligible for Medicaid due to income requirements (Jefferson Area Children's Health Improvement Program, 2013).

Clinic database: Records of basic demographic data (such as date of birth, country of origin, immigration status) for the IFMC patient population used to track outcomes for this population.

Parental country of origin: Country from which the child's mother (or father if he is primary caregiver) originally immigrated. Many refugees spent time in refugee camps or lived temporarily in other countries prior to arriving in the U.S., and may have even been born in these camps, but the country designation is used in an effort to look at patterns related to cultural background.

Provider: One of the licensed PCPs caring for refugee children at the practice site. At the time of QI implementation this includes attending physicians, resident physicians, and nurse practitioners, and may include physician assistants if staffing changes occur. These providers have completed specialized training in managing this patient population.

Refugee: A person of foreign nationality who applies for entrance to the U.S. due to fear of persecution in their country of origin (United States Citizenship & Immigration Services, 2017). For purposes of this project, the term "refugee" refers to any immigrant to the U.S. with refugee, asylum seeker, or SIV status. Asylum seekers are a category of immigrant, which differ from refugees in that they apply for asylum while already residing in the U.S. (Chai, Davies-Cole, & Cookson, 2013). Special Immigrant Visas (SIV) are another type of immigrant status granted to Afghan and Iraqi individuals who are employed by or on behalf of the U.S. government or served as translators for the U. S. Armed Forces (Lee et al., 2013). SIVs and asylum seekers are not subject to the same overseas medical exams and immunization requirements as refugees.

Reminder and recall: Notification that a child is due or overdue for a particular vaccine or well-child check.

Specialist: During chart review, children were screened for involvement of a specialist in their care. The child must have had two or more visits with a provider from the specialty to be

considered having a specialist involved in their care, as occasionally children are referred for a specific concern and do not require further follow-up.

Trauma: Experience of violence or witness to violent situations by the child or family in the country of origin, during the immigration process, or after resettlement. This information is obtained from the social history documentation in the EMR (electronic medical record), which is typically documented by the provider at the initial IFMC visit.

Up-to-date: This refers to receiving a vaccine during the age window recommended by the ACIP. For purposes of this project, foreign-born children were considered up-to-date if they had caught up on recommended vaccines within 12 months of arrival in the U.S. This is based on the work of Watts et al., (2011) which recommended at least 12 months after the initial clinic visit to complete the necessary vaccines. The authors used 15 months as a goal for vaccine completion, due to delays in establishing a PCP upon arrival. A more conservative 12-month window was chosen in this case as some of the U.S. arrival dates in the clinic database and EMR were approximated and may have actually reflected the date of the initial screening for HD referral.

Virginia Immunization Information System (VIIS): The statewide vaccination registry for children and adults that is designed to include all vaccinations received in Virginia, regardless of setting.

Well-child check (WCC): Preventive pediatric visits recommended by the AAP. The recommended schedule is that visits take place in the first week of life, ages 1, 2, 4, 6, 9, 12, 15, 18, 24, 30, and 36 months of age, then annually until age 21. The goals of each visit vary by age and specific patient needs, but the visits always include growth and developmental surveillance, health screening, and review of vaccinations.

WIC: Women, Infants, and Children. A federally subsidized nutritional support and parental education program for pregnant and breastfeeding women and children up to five years of age who meet income requirements and are considered nutritionally at-risk (United States Department of Agriculture, 2018).

Setting

The QI project was conducted at the IFMC, which is included within a family medicine practice at an academic health system in Charlottesville, Virginia from September 2018 to November 2018. The clinic serves over 3,500 patients in the Charlottesville area who immigrate from a wide range of countries including, but not limited to, Afghanistan, Burma (now Myanmar), Bhutan, the Democratic Republic of the Congo, Somalia, Sudan, Togo, Liberia, Russia, Iraq, and Syria. The study population included 328 refugee children and children of refugee parents served by the IFMC and born between September 30, 2008 and September 30, 2018.

From the group of 328 children, the 120 children who were under 48 months were screened for vaccine completion and the need for reminder and recall. Forty-eight months was chosen as a cutoff because as children approach four years old, they are eligible for the four to six year-old vaccinations that are required for school entry, which means they have a strong independent motivator to complete recommended vaccinations. The September 30 deadline was chosen because this is the date used by Charlottesville area schools as a cut-off for kindergarten enrollment and therefore stratifies children into different age cohorts based on anticipated kindergarten start date.

Protection of Human Subjects

The project was conducted with approval and oversight by the University of Virginia Institutional Review Board for Health Sciences Research (IRB-HSR). Sensitive patient demographic data was secured on a server and de-identified prior to entry into a spreadsheet for data analysis. The requirement of informed consent was waived by the IRB-HSR, as calling patients with reminders was already an established and expected process within the IFMC. A copy of the IRB-HSR approval letter is found in Appendix A.

Immersion in Clinic Culture

Developing a comprehensive plan that included understanding of multiple aspects of patient care at the IFMC and the refugee experience required collaboration from multiple parties engaged in caring for this community. This included discussions with individuals within the IFMC and the Department of Family Medicine, collaboration from partners at the institutional level of the health system, and assistance from community and state organizations involved in refugee care. These levels of involvement (summarized in Figure 3) helped to inform the Structure, Process, Outcome model used in developing the reminder and recall system and determining which risk factors to address.

While assessing the structures, processes, and outcomes affecting the quality of refugee care, insights on barriers to timely vaccination of children at the IFMC were collected from representatives from these various stakeholders. This information was compiled and organized into a fish-bone diagram, shown in Figure 4.

Data collection

Using medical record numbers obtained from the IFMC patient database, the EMR was used to collect demographic data on clinic patients born between September 30, 2008 and September 30, 2018. A summary of the demographic information collected from the EMR is

summarized in Table 5. This information was used to identify potential risk factors or protective factors for immunization status. The patient's medical history was screened for potential contraindications to vaccines, such as allergies to vaccine components or immunocompromised status.

The EMR and VIIS were used to assess completion of all recommended pre-school vaccines at six-month intervals from age 12 to 36 months, with two notable exceptions. The influenza vaccine was excluded due to its annual schedule and wide commercial availability, which create difficulty in tracking compliance. The rotavirus vaccine was excluded because the window for receiving this vaccine is very short and it is not possible to get a catch-up vaccine after the window has passed (Centers for Disease Control and Prevention, 2017). The expected vaccines for each age category used to determine up-to-date status are summarized in Table 6. A documented immunity to varicella or Hepatitis B was considered a complete immunization.

The two HepA vaccines were also evaluated separately to see if a child had completed each vaccine and whether or not this was done on time per the ACIP schedule. The HD does not provide these vaccines, so children must receive them at the IFMC. Additionally, though two HepA vaccines are recommended by the ACIP for children over 12 months of age, they are not required for enrollment in Virginia public schools. Therefore, the HepA vaccines are reflective of the clinic's adherence to recommended preventive care measures beyond the minimum requirements to attend school.

Reminder and recall intervention

IFMC patients born after September 30, 2014 who were not up-to-date on vaccines for their age were identified. Their records were checked for an upcoming appointment. If an appointment was scheduled that was not listed as a WCC, the provider for the upcoming visit

was sent a message through the EMR to notify them to address missing vaccinations at that time. Those who did not have upcoming appointments were targeted for the reminder and recall intervention.

Using contact information from the EMR, a clinic volunteer who provides regular appointment reminders for the practice site called parents to notify them of overdue vaccines for their child and encourage them to call the clinic to schedule a nurse visit or WCC. Calls to non-English-speaking parents were made using phone-based interpretation services. Two attempts were made to speak with the family or leave a voicemail. After two unsuccessful attempts occurring one to two weeks apart, the child's PCP was notified that the child will likely need vaccines at a future appointment.

The patients' records were followed for eight weeks after the first round of phone calls to determine if the necessary appointment was made and if the family attended the appointment. For the reminder and recall intervention, a scheduled appointment was considered a successful outcome, as the time frame allowed for the study limited the ability to track vaccine completion.

If an appointment was made for a nurse visit, the child's PCP was notified so that they can order the necessary vaccines. Field notes were collected with observations on the process and its outcomes along with any barriers encountered.

Data Analysis

Statistical analysis was performed using SPSS version 25.0. Binomial logistic regression was used to determine the risk of incomplete vaccinations for each demographic factor at each age category, expressed as an odds ratio with a 95% confidence interval and significance level of $p < .05$. The risk of late and non-completion compared to on-time completion of HepA1 and 2

for each demographic factor was assessed using multinomial logistic regression. The risks were expressed as odds ratios with a 95% confidence interval with $p < .05$.

To compare the rates of immunization before and after the reminder and recall intervention, a binomial test of proportions was performed with a level of significance of $p < .05$. Because the entire eligible population of clinic patients was included in data collection and analysis and no sampling was done, a power analysis was not performed.

Results

Sample Selection

The initial search of the clinic database resulted in a list of 441 children under ten years old. Of these, 36 children were excluded because they left the practice before they reached 24 months of age, and therefore did not have the opportunity to complete the recommended early childhood vaccinations on time. Seventy-two more were excluded because they established care after age five, meaning school entry served as an impetus for vaccine catch-up rather than clinic practice. Five patients were excluded because their birthdates had been entered incorrectly into the database so they did not meet inclusion criteria. This left a final sample of 328 children whose medical records were assessed for risk factors for insufficient vaccination completion. Of these remaining children, 120 were under four years old and therefore eligible to receive the reminder and recall intervention if they were found to be missing vaccines. The patient selection process is summarized in Figure 5. The demographic characteristics of the final sample are summarized in Table 7.

Risk Factor Identification Results

Vaccination rates by age.

The initial data review found that no children had documentation of a contraindication to any of the recommended vaccines or parental refusal of a vaccine.

The results of the analysis of predictive factors for vaccine completion are summarized in Table 9. Foreign-born refugee children were less likely to be up-to-date on all vaccines for their age compared to U.S-born children of refugees with $p < .05$ at ages 24 months (*OR* = .25, 95% CI [.15, .42]), 30 months (*OR* = .16, 95% CI [.09, .28]), and 36 months (*OR* = .09, 95% CI [.05, .17]).

Maternal country of origin was a significant negative predictor of vaccine completion. Countries of origin associated with decreased rates of childhood vaccine completion were the Democratic Republic of the Congo, Afghanistan, Iraq, Syria, and Russia. The odds ratios and confidence intervals for these findings are summarized in Table 9.

The number of WCCs a child missed per year as an IFMC patient was associated with decreased vaccination completion at 12, 18, and 24 months. For each missed WCC per year, vaccination completion rates decreased 66-78%.

Children with a documented preferred language of Arabic were less likely to have completed all recommended vaccines at 30 months (*OR* = .24, 95% CI [.07, .90]) and 36 months (*OR* = .22, 95% CI [.05, .89]). A preferred language of Swahili was associated with decreased rates of vaccine completion at 12 months (*OR* = .20, 95% CI [.04, .98]) and 24 months (*OR* = .20, 95% CI [.04, .97]). Children with a documented language preference of English and those with an English speaker living in the home did not have significant differences in vaccination completion compared to their peers.

Increased number of children per household was associated with a significant decrease in vaccination completion at 18 months. With each additional child in his family, a child is 17% less likely to be up-to-date on vaccines at age 18 months.

Utilization of WIC services was among the protective factors for vaccination and was associated with increased vaccination completion at 18 months (*OR* = 1.88, 95% CI [1.13, 3.13]), 24 months (*OR* = 1.82, 95% CI [1.10, 3.02], 30 months (*OR* = 2.07, 95% CI [1.24, 3.45]), and 36 months (*OR* = 2.56, 95% CI [1.49, 4.38]).

The number of years since immigration for the child's mother was positively associated with vaccine completion. For each year of maternal residency in the U.S., children's vaccination completion rates at 24, 30, and 36 months increased 12-14%. Older maternal age at birth of the child was also associated with improved vaccine completion. The likelihood a child is fully vaccinated at 24, 30, and 36 months increased 5-8% for each year of maternal age.

Hepatitis A vaccines.

Demographic factors associated with completion of HepA1 and HepA2 were also evaluated. These results are summarized in Table 10. Missed WCCs was a significant risk factor for missing the HepA1 vaccine or receiving it late. For each missed WCC per year as an IFMC patient, a child was over five times more likely to be missing the HepA1 vaccine (*OR* = 5.52 95% CI [1.99, 15.26]) and almost three times more likely to receive the HepA1 vaccine late (*OR*= 2.91 95% CI [1.15, 7.35]), compared to receiving the vaccine on time. Similarly, utilizing the clinic more frequently for sick visits than well visits was associated with an increased risk of not receiving the HepA2 vaccine (*OR* = 2.37, 95% CI [1.10, 5.11]).

Involvement of a registered nurse care coordinator (RNCC) in a child's care was associated with a greater than two-fold risk of receiving the HepA1 vaccine late rather than on

time (*OR* = 2.30, 95% CI [1.10, 4.81]. Involvement of the RNCC was also associated with a greater than two-fold risk of missing the HepA2 vaccine compared to completing it on time (*OR* = 2.3, 95% CI [1.17, 4.70]).

For those families who did not have a documented preferred language of English, utilizing a professional interpreter (in person or via phone service) for the majority of visits was associated with increased rates of missing HepA1 (*OR* = 3.40, 95% CI [1.04, 11.19]), while having a family member interpret for the visit was not a statistically significant factor in HepA1 completion. Many parents declined interpretation services as they have some proficiency in English, despite what is documented as a preferred language in the EMR. Those who declined interpretation for the majority of clinic visits had children who were almost ten times more likely to receive HepA1 late rather than on schedule (*OR* = 9.85, 95% CI [1.15, 84.80].

Foreign-born children were more likely to be missing HepA2 (*OR* = 4.38 95% CI [2.01, 9.55]) or receive it late (*OR* = 4.34, 95% CI [2.34, 8.05]) compared to receiving the vaccine on time. In regards to specific geographic patterns of origin, parental origin from the Middle East were 11 times more likely to complete the HepA1 vaccine on time rather than miss it (*OR* = 0.09, 95% CI [0.01, 0.76]). Children with parents from the Middle East were also nearly three times more likely to receive the HepA2 vaccine on time rather than late (*OR* = 0.35, 95% CI [0.14, 0.87]).

The use of WIC services was associated with an 11 times greater likelihood of receiving HepA1 on time rather than late (*OR* = 0.09, 95% CI [0.01, 0.72]). Receiving WIC services was also associated with more than twice the likelihood of receiving HepA2 on time rather than receiving it late (*OR* = 0.44, 95% CI [0.24, 0.80]) or missing the vaccine (*OR* = 0.46, 95% CI

[0.22, 0.96]). Utilization of CHiP services were associated with a 4.5-fold increase in on-time HepA1 vaccination compared to late vaccination (*OR* = 0.22, 95% CI [0.50, 0.99]).

Older maternal age at birth was associated with increased likelihood of on-time HepA2 vaccination compared to late vaccination. For each additional year of age for the mother at birth of the child, the child was 7% more likely to receive the vaccine on-time instead of late.

Increased proportion of sick visits to WCCs and follow-ups was also associated with an increased risk of missing the vaccine compared to timely completion (*OR* = 2.37, 95% CI [1.10, 5.11]).

Reminder and Recall Results

At the end of the data collection window, 12 of the 22 (54%) children who required a reminder phone call had appointments for vaccination catch-up in the next 60 days. Before the reminder and recall intervention, 98 of 120 (81.6%) children under four years old were caught up on the ACIP-recommended vaccines for their age or had appointments scheduled in the next 60 days during which they could be caught up. After the intervention, 110 of 120 (91.7%) children had received the missing vaccines or had appointments to do so within the next 60 days. Using the binomial test of proportions, there was a statistically significant improvement in the proportion of children with completed vaccines or vaccination appointments after implementation of the reminder and recall intervention ($p = .02$).

Discussion

Vaccination Completion

Missed WCCs were a significant factor affecting vaccine completion for IFMC children at all age intervals and for completion of HepA1. This correlation was not unexpected since the recommended vaccine schedule is correlated with the recommended WCC schedule. This is

also consistent with previous reviews of pediatric vaccination rates in refugee populations, such as the Watts et al. (2011) review of NIS data that indicated that regular follow-up with a PCP is associated with an increased likelihood of vaccine completion.

Foreign-born children were less likely to be caught up for their age compared to U.S.-born children and less likely to complete the HepA series on time. This is reflective of the different vaccination practices seen in the children's country of origin, and may be related to delays in acclimatization to the U.S. health system.

Language barriers have been shown in prior studies to affect utilization of preventive care (Cohen & Cristakis, 2006; Guttman et al., 2008). A preferred language of Swahili or Arabic had a significant impact on vaccination rates compared to those who speak other languages. However, since having an English speaker in the home was not a significant factor in vaccine completion, these findings are likely more reflective of difference in vaccination completion based on country of origin, rather than language barriers.

It was unexpected that for families with a documented language preference other than English, using professional interpretation services for the majority of visits was associated with an increased risk of not receiving HepA1 or receiving it late when compared to not using an interpreter or using a family member to interpret. This may be related to disparities in interpreter competency as well as differences in regional dialects that may result in sub-optimal translation of medical information (Partida, 2007). However, this finding is more likely affected by confounding variables. Education level or time since immigration may impact how easily a parent learns English. A future analysis of interpreter use and vaccine outcomes could control for these factors. In addition, the preferred language in the child's medical record typically reflects that of the mother, but many mothers have an English-speaking husband who they may

bring to their child's appointment. This could also confound the results because the "preferred language" for the visit would actually be English, rather than the language documented in the EMR.

A review of vaccination data from Maryland children indicated that having three or more children in the household was associated with a decreased likelihood of completing vaccinations on time (Hughart et al., 1998). This is consistent with the finding that increased number of children per household is associated with decreased vaccination completion at 18 months. This likely reflects the challenges associated with attending preventive care appointments for multiple children, especially for working parents.

Parental country and region of origin were associated with differences in vaccination completion. This is consistent with the findings of Leeds and Muscoplat's (2017) assessment of Minnesota immigrant children. However, the regions evaluated in the Minnesota study were distinct from those evaluated in this project, which is reflective of the differences in immigrant populations between the two communities.

The use of WIC services was associated with increased rates of timely HepA1 and 2 vaccination. This association may be related to a family's likelihood to utilize available community services and is consistent with findings of prior studies (Leeds & Muscoplat, 2017; (Shefer et al., 1999).

Similarly, the use of CHiP services was associated with increased rates of on-schedule HepA1 vaccination. Home visits from nurses and caseworkers through CHiP include vaccination education and reminders to schedule well-child checks. Vaccination-focused home visits such as those provided by CHiP have been shown to be an effective intervention to improve immunization rates (Shefer et al., 1999). CHiP workers also communicate frequently

with the RNCC, who can provide additional insights to IFMC staff regarding which families may be at-risk of suboptimal preventive care and may require more education and follow-up.

Involvement of the RNCC was associated with late HepA1 vaccination and non-completion of the HepA2 vaccine. This was surprising given that the RNCC is a resource for education and communication for families. This decrease in timely vaccination may reflect the fact that families followed by the RNCC are often the most at-risk of poor follow-up and decreased adherence to recommended health-related activities.

The literature shows that increased maternal time in the U.S. is associated with increased vaccination completion (Baker, Dang, Ly, & Diaz, 2010; Buelow & Van Hook, 2008). This was the case in this assessment of the IFMC population as well. However, Guttman et al., (2008) found that maternal time since immigration was not a significant factor in vaccine completion, though the study was not specific to refugees.

Maternal age was positively associated with vaccination completion among IFMC pediatric patients. This is consistent with a systematic review of factors associated with delayed vaccination that showed older maternal age was associated with increased rates of timely vaccine completion (Tauil, Sato, & Waldman, 2016). Additionally, for Canadian refugees, a child with a mother under age 19 had a 38% decreased likelihood of being fully vaccinated for his age (Guttman et al., 2008).

Exposure to trauma or violence by a family member was not associated with vaccine completion in this population. Documentation of trauma exposure varied between which provider attended the visit and how the question was phrased. A standardized definition of trauma may help to more accurately assess the impact of these experiences on health outcomes.

Reminder and Recall Intervention

The reminder and recall intervention resulted in statistically significant improvement in vaccination rates, which has clinical implications for child and population health in the central Virginia community. In addition, it resulted in a vaccination completion rate for the clinic population of 91.7%, which is in excess of the Healthy People 2020 population goal of 85%.

The amount of impact observed from the reminder and recall intervention in the clinic is similar to that seen in the literature. A resident-led QI project implemented reminder and recall at two clinics in Salt Lake City, Utah and showed statistically significant increases at the two clinics from 79.6% to 89.6% and 75.1% and 92.1% respectively (Jones, Spain, Wright, & Gren, 2015). A systematic review of strategies to increase childhood vaccine uptake in the United Kingdom reported a median increase in vaccine completion of 11% from five studies of reminder and recall resulted in a median increased (Williams, Woodward, Majeed, & Saxena, 2011). In a systematic review of reminder and recall methods, five studies of telephone reminders were associated with a composite 4% increase in immunizations (Harvey, Reissland, & Mason, 2015). Another systematic review of 60 studies showed a median 8% increase in vaccinations after implementation of reminder and recall (Shefer et al., 1999).

Differences in the degree of effect of this reminder and recall intervention from that shown in other studies may be reflective of the small sample size or the already high rate of vaccine completion in the population who was subject to the intervention. It is possible that calls from a volunteer have a smaller impact on parents' decisions regarding preventive care for their child compared to contact from the child's provider or a clinic nurse. However, the use of a volunteer may increase the feasibility of reminder and recall.

Strengths and Weaknesses of the Design

The reminder and recall intervention had a strong basis in the literature. Additionally, this QI project addressed multiple patient and provider barriers to vaccinations found in the literature and from discussions with IFMC staff.

The intervention utilized a before-and-after design with no randomization of clients to the intervention. This design was intended to maximize the number of patients who received the intervention.

The limited time frame allowed for the study made it difficult to track the recipients of the reminder and recall intervention for appointment attendance and vaccine completion. Prior to initiating the reminder and recall, there was concern that there might not be enough appointment availability to accommodate the increased demand for vaccines and well child checks. However, due to the low volume of children requiring vaccination catch-up, parents were able to get WCC appointments for their child within two months of the scheduling call and a nurse visit within one month.

Data Availability

One limitation is that a child's name or birthdate was occasionally entered into VIIS did not match the name entered into the clinic EMR, which created difficulty in determining vaccination status. This occurred in 11 children's records of the final sample of 328. This error is more likely to occur in a refugee population as errors in recorded birth dates and name spellings can be common during the immigration process. The naming conventions and calendars of other cultures may differ from U.S. tradition, which may create difficulty in transferring data to U.S. records. There were also disparities between VIIS and EMR records. Twenty-three percent of the children had some form of disparity in patient identification and which vaccines were recorded in each system. This figure does not include cases of minor date

discrepancies between the EMR and VIIS vaccination record. In addition, seven children had two different VIIS entries where staff had been documenting vaccinations. Documentation issues like these create delays in assessing vaccine completion and may contribute to missed or late vaccines.

Other issues with data entry include potential for the immigration status of the child or parent to be coded incorrectly due to providers using incorrect terminology in their documentation. There is potential for mislabeling a clinic patient as “refugee”, when they may actually be an “asylum seeker” or “SIV”. This designation is not relevant to clinical care, but it limits the ability to draw conclusions based on demographics.

There were also limitations related to how the patient information was initially entered into the database. Until 2016, the information was entered into the database manually, which has some potential for transcription error. When the patients from the database were reviewed, several entries had birthdates that were not listed correctly and were outside of the inclusion criteria for the analysis. Since then, the database has received information automatically from the EMR, but this requires the provider to enter pertinent information correctly during a refugee visit. There are inconsistencies among providers in which patients get entered into the database. Some providers do not include the children of refugees as part of the refugee clinic panel, resulting in a potential omission of a significant part of the true clinic population from the database.

There were cases of incorrect or outdated parent contact information in the EMR, which delayed or prevented successful parent contact from occurring. The volunteer making calls also faced challenges related to families lacking voicemail capability and parents not being available during the hours that calls were made. A nurse or office receptionist may be more efficient in

this role as they have more familiarity with navigating the EMR to contact patients and can put in a telephone encounter note so other clinic staff can easily see what contacts have been made. These staff members also have the ability to make appointments for patients, while the volunteer had to provide directions to the patients to make an appointment through an additional phone call.

In addition, there were cases when it appeared that the preferred language listed in the patient vital information was not updated properly. Frequently upon reading encounter notes, the language used in the visit did not match what was listed in the chart. For example, Dari might be listed as the preferred language, but the past few visits had all been conducted in English. This may have impacted results related to language and interpretation preferences.

Potential for Bias

There is some potential for bias related to the availability of data. Children born in the U.S. were typically born in the same hospital system as the IFMC and therefore more data were readily available on the child's history. This may have skewed the data toward higher vaccine completion rates for U.S.-born children. Additionally, it was easier to obtain information on the patient's mother if the child was born in the U.S., as her records are linked from the birth hospital encounter. There were challenges obtaining complete information on the mothers of many of the foreign-born children. This was especially challenging since the surnames of parents and children in the refugee population frequently do not match.

Information on past medical history for foreign-born children was somewhat limited. While refugees are required to have certain health and vaccination records for immigration, more detailed medical history information may be lost in the immigration process, particularly for refugees who flee from countries with limited public health resources (Lifson, Thai, & Hang,

2001). Special Immigrant Visa immigrants, who comprise an estimated 21.6% of the IFMC patients in this study, do not have to complete the same overseas health screening and immunization requirements as refugees, which makes assessing health history and vaccine completion more challenging for these patients.

Generalizability

The findings of this QI project may not be generalizable to other settings. The practice setting is fairly specific as a designated refugee care facility and affiliate of a large academic medical center in a small city in central Virginia. The resettlement patterns of refugees result in distinct cultures at each refugee relocation city, so what is effective in families from the cultures that predominate the population for this clinic may not be applicable to other areas of the country. In addition, the small number of subjects receiving the reminder and recall limits the ability to draw meaningful conclusions about the effectiveness of the intervention.

Clinical Practice Implications

This project applied the evidence-based practice of reminder and recall for vaccinations to a novel population in an effort to address healthcare disparities. It required significant inter-professional collaboration to coordinate the reminder and recalls and to complete the provider educational intervention. Additionally, by utilizing existing processes within the practice site, this project has the potential to create a sustainable way to reduce the number of children within the IFMC who are behind on vaccines.

The reminder and recall intervention also presents an opportunity for patient education. For example, one of the parents who received a reminder call stated that he did not need to make an appointment for a two year-old WCC since his child is turning three years old soon, even though the child was behind on vaccines as well as recommended developmental screening. The

clinic volunteer was not able to provide any detailed clinical information in her role as a hospital volunteer, but a registered nurse could use this as an education opportunity.

One provider factor that may result in decreased vaccination rates is a failure to address vaccination at acute visits, as recommended by the ACIP (Centers for Disease Control and Prevention, 2017). This is reflected in the fact that a higher proportion of sick visits to well visits was associated with an increased rate of non-completion of HepA2 compared to timely completion. The strong correlation between missed WCCs and decreased vaccine completion also indicates that the clinic population would benefit from increased attention to vaccination status at acute visits. In fact, six of the 22 children (27%) who required reminder calls for missing vaccines had attended recent sick visits at the clinic, which are missed opportunities to address vaccination. Time allotted for appointments may be a limiting factor to allowing providers to address vaccines in the same visit, but the effort to screen and discuss vaccines can be a collaborative and systematic approach between nurses and providers to maximize efficiency.

Implications for Future Research

The involvement of a developmental pediatrics specialist was not a significant factor associated with vaccination rates. A child had to attend more than one visit to be counted as seeing developmental pediatrics, but many more children in the clinic population were referred to this specialist. It would be useful to see if there is a correlation among those children who were referred to developmental pediatrics and vaccination completion. In addition, examining demographic factors among children who are referred to developmental pediatrics may provide more information on who is at risk for developmental delays. In refugees, there are many potential reasons for positive screening results for developmental delays that could be explored.

These may include challenges adapting to a new environment; missed opportunities for timely developmental screening at WCCs; exposure to trauma or violence; or epidemiological factors related to their countries of origin, such as infectious disease, poor prenatal care, or exposure to toxins such as lead.

Income information was not readily available in the EMR, but examining this data in the IFMC population may identify additional trends affecting vaccine completion for refugees. A study by Moller et al., (2016) found that those refugees in the highest two quartiles for family income were 27-59% more likely to have complete vaccines than those in the bottom quartile (Moller et al., 2016).

Parental income and employment information was also not consistently available in the EMR to allow for determination of the effect of these factors on vaccinations for children. It is possible that children with parents who work may have lower rates of timely vaccination completion because of added barriers attending appointments. At the same time, having employed parents may improve vaccination rates as research shows that employment is associated with improved health outcomes for refugees (Wood et al., 2018). This may be related to improved feelings of self-worth and self-efficacy that come with finding employment. Employment may also be associated with an improved ability to navigate U.S. society, which may translate to increased utilization of preventive healthcare.

Provider continuity has been cited as a factor affecting timely vaccination completion (Guttman et al., 2008). Many providers at the IFMC reported that continuity of providers in the practice was poor. This was supported by the chart review, as children frequently visited with multiple providers and did not have a consistent PCP throughout their childhood. This is in part

because of the high volume of patients for the clinic, as well as the fact that the clinic is part of an academic medical center with residents rotating through every three years.

A similar reminder and recall intervention could be applied to other preventive care activities for refugee patients such as cancer screening or for adult vaccinations. The literature supports using reminder and recall for non-vaccine health maintenance activities, though the intervention has not been studied specifically in refugees. An RCT at a clinic in Rochester, New York serving low-income patients indicated that multimodal reminder and recall including a personal or automated phone call increased rates of colorectal cancer screening compared to usual care or letters alone (Fiscella et al., 2010; Fortuna et al., 2013).

Implementation of the evidence-based reminder and recall intervention for improving vaccinations is an example of the type of coordinated care that is consistent with the patient-centered medical home (PCMH) model of care endorsed by the American Academy of Pediatrics and the American Academy of Family Physicians. The University of Louisville publicized its own version of the PCMH, the refugee-centered medical home. Using this model, they strongly endorsed partnerships with community stakeholders and even utilized the local resettlement agency to host immunization clinics. At these clinics, they are able to vaccinate up to 150 refugees in a single session (Bosson et al., 2017). A similar event could be established in the central Virginia area through existing partnerships with the local resettlement agency and the affiliated school of nursing. The resettlement agency could help publicize the event to the refugee community. At the same time, student volunteers could help provide vaccines and education on the importance of WCC attendance.

Products of the Scholarly Practice Project

As a result of this work, a practice guide was developed for clinic staff to continue to monitor refugee children's vaccines and address gaps through reminder and recall. This document is shown in Figure 6 and was provided to clinic staff as a means of creating sustainable change in the management of pediatric preventive care.

An abstract for this project was accepted as a poster presentation at the North American Refugee Health Conference in Toronto, Ontario, Canada on June 14-16, 2019. This abstract is included in Appendix B. An abstract was also submitted for consideration for poster presentation at the Virginia Association of Doctors of Nursing Practice Annual Meeting July 12-13, 2019 in Winchester, VA.

A manuscript of this QI project was submitted for publication into the *Journal of Immigrant and Minority Health.* This manuscript is included in Appendix C.

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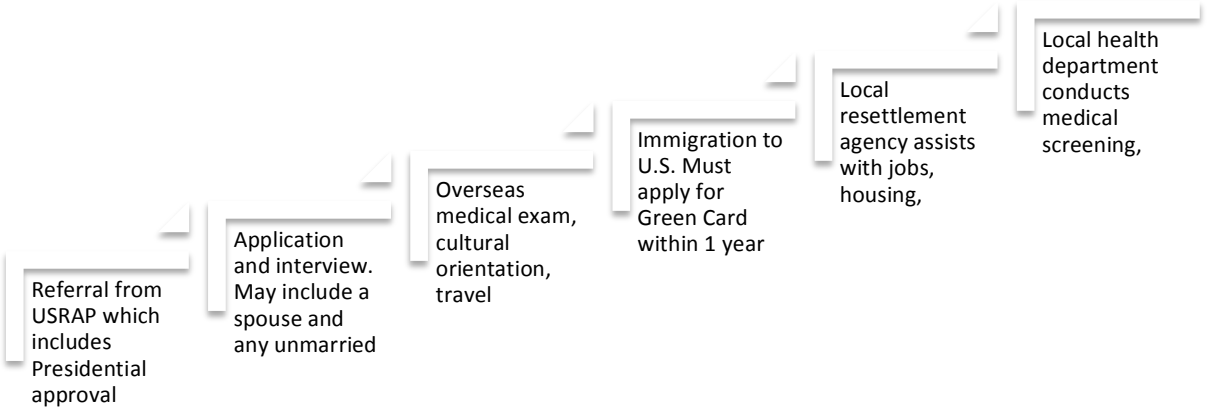

Figure 1. Overview of the process of refugee settlement in the United States. USRAP = United States Refugee Admission Program. From *Refugees* by the United States Citizenship and Immigration Services. Published 2017 by the United States Department of Homeland Security.

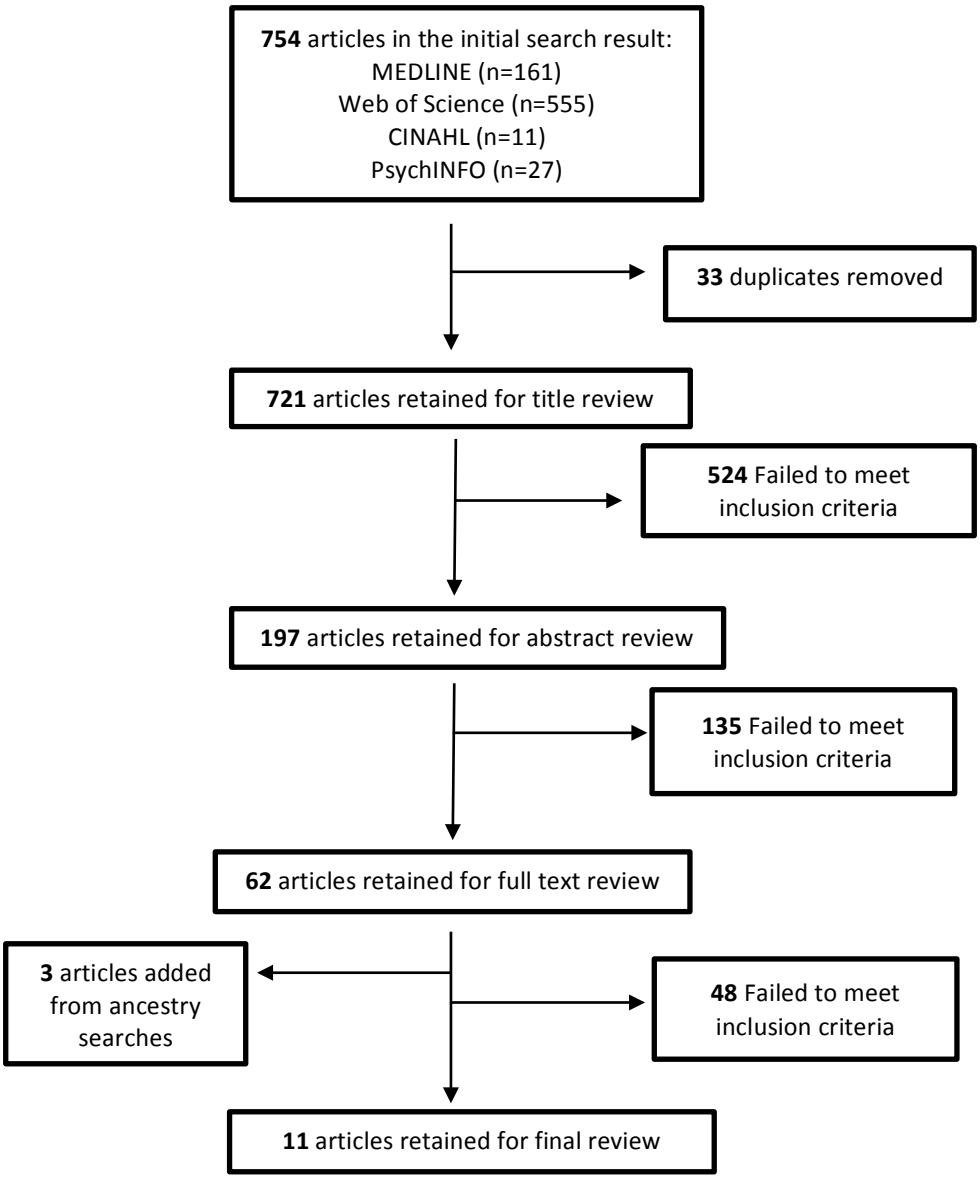

Figure 2. Summary of literature search procedure.

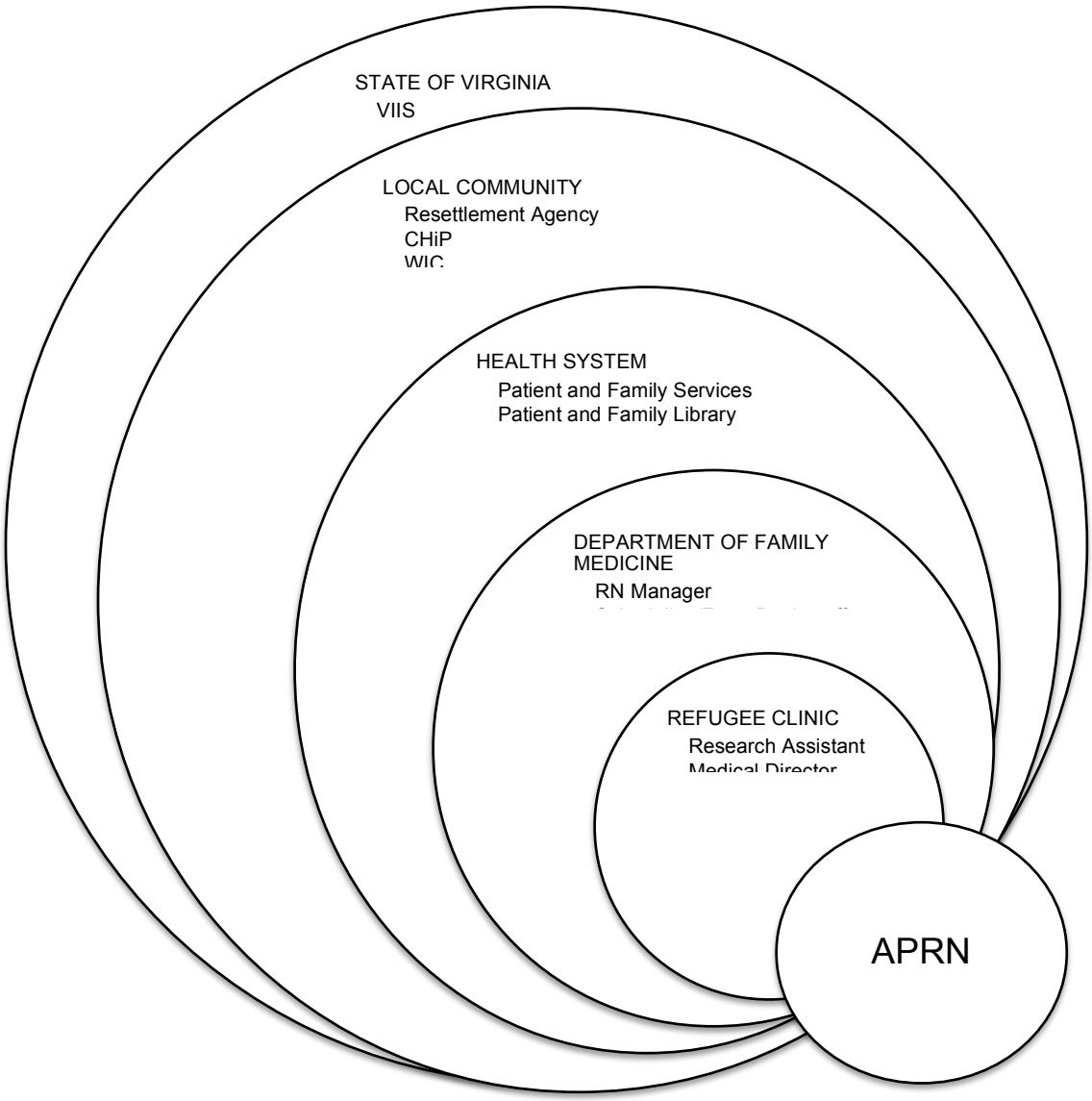

Figure 4. Visual representation of the levels of interactions and collaboration used to inform this project and its findings. APRN = advanced practice registered nurse; RN = registered nurse; RNCC = registered nurse care coordinator; VIIS = Virginia Immunization Information System; CHiP = Children's Health Improvement Program; WIC = Women, Infants & Children.

[a]Providers include the Department of Family Medicine attending physicians, resident physicians, and nurse practitioners.

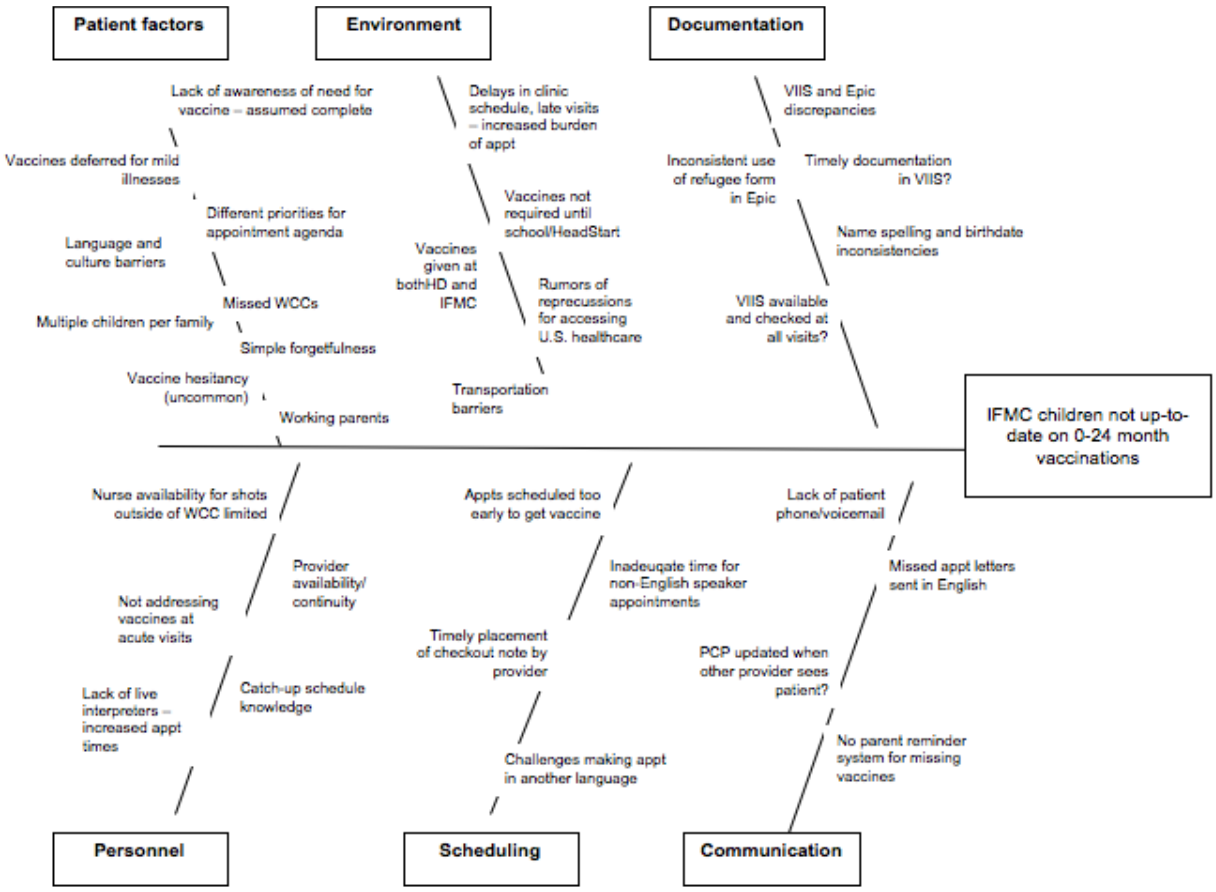

Figure 3. Fish-bone diagram summarizing hypothesized reasons for delayed vaccinations among pediatric patients at the International Family Medicine Clinic. This was created through discussions with stakeholders in care for refugee families in the community including the medical director, nurse manager, RN case manager, pharmacist, three nurse practitioners, a medical resident, and representatives from the community including the health department, local school system, local resettlement agency, and CHiP. CHiP = Children's Health Improvement Program; VIIS = Virginia Immunization Information System; WIC = Women, Infants & Children; WCC = well-child check; PCP = primary care provider; HD = Health Department.

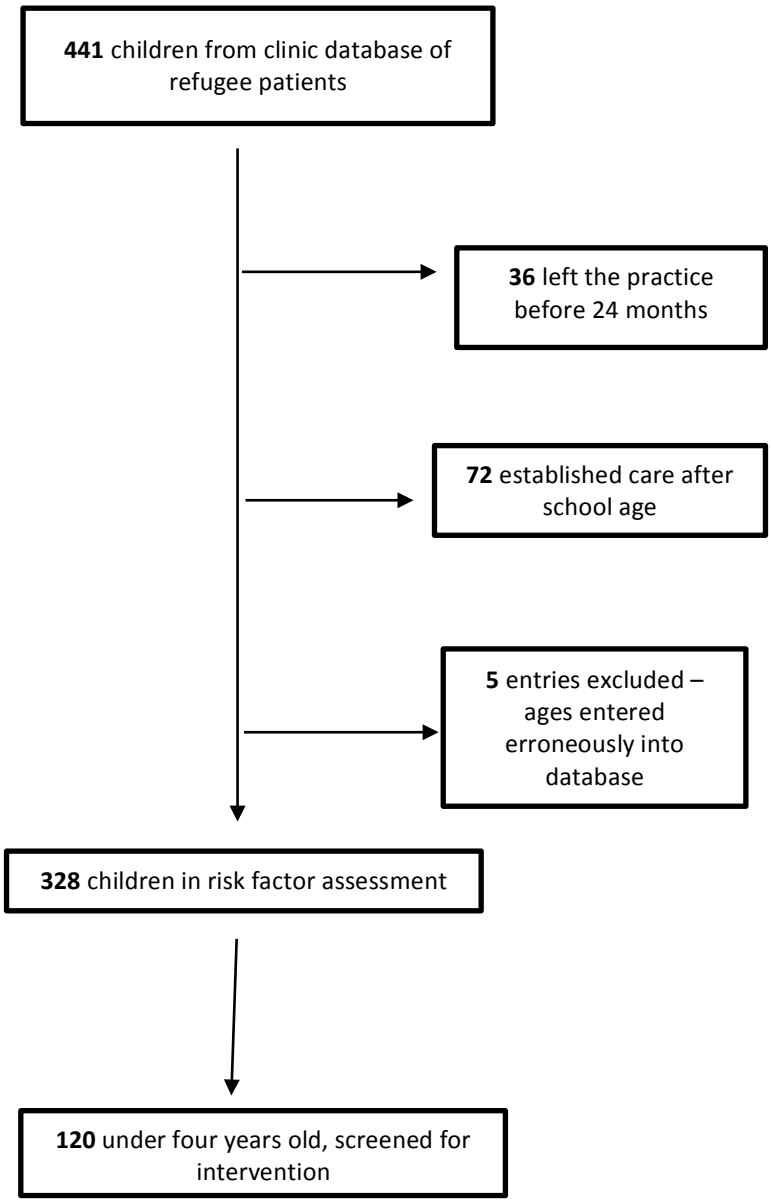

Figure 5. Summary of patient screening process from initial population obtained from clinic database.

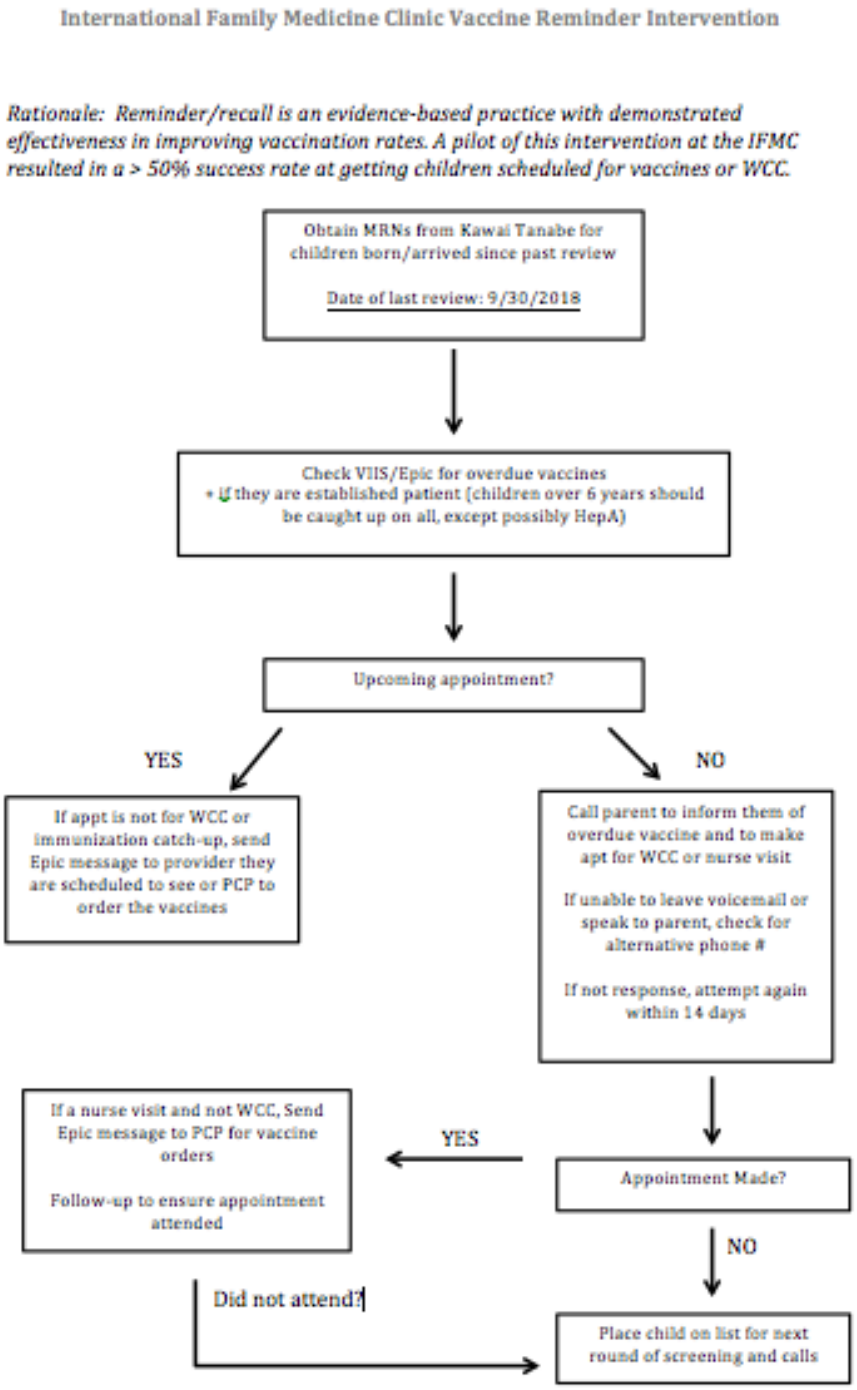

Figure 6. Diagram of process for IFMC nursing staff to continue reminder and recall intervention. IFMC = International Family Medicine Clinic; VIIS = Virginia Immunization Information Syste ; Epic = EMR provider used by the clinic; HepA = Hepatitis A vaccine; WCC= well-child check; PCP = primary care provider.

Table 1.

Recommended Early Childhood Vaccines: Schedule and Contraindications

Vaccine	Dose #1	Dose #2	Dose #3	Dose #4	Contraindications/Precautions
HepB	Birth	1-2 months	6-18 months (2-4 months after dose 2; 4 months ideal)		- Prior anaphylaxis to HepB vaccine - Baker's yeast allergy - Birth weight < 2000 g for newborn dose
Rotavirus (Rotarix or Rotateq)	6 weeks - 14 weeks, 6 days	4-6 months (≥4 weeks after Dose #1)	6-8 months (Rotateq, (≥4 weeks after Dose #2)		- Dose #1 cannot be given after 14 wks, 6 days of age - No doses can be given after 8 months - Rotarix – avoid in latex allergy - History of intussusception - SCID; Consult expert before vaccinating for other immunodeficiencies
DTaP	2 months	4 months (≥4 weeks after Dose #1)	6 months (≥4 weeks after Dose #1)	15-18 months (≥6 months after dose #3)[a]	- Severe allergic reaction to component or prior DTaP vaccine
Hib (3- or 4-dose series)	2 months	4 months (≥4 weeks between each dose)	6 months (4-dose series 12-15 months (3-dose series)	12-15 months (4-dose series)	- Severe allergic reaction to component or prior Hib-containing vaccine
PCV13	2 months	4 months	6 months	12-15 months [b]	- Severe allergic reaction to component or prior PCV13 dose
IPV	2 months	4 months (≥4 weeks after Dose #1)	6-18 months (≥4 weeks after Dose #2)	4-6 years[c] (≥6 months after Dose #3)[c]	- Prior anaphylaxis to IPV vaccine, streptomycin, neomycin, or polymyxin B

MMR	12-15 months	4-6 years[c]	- History of anaphylactic reaction to neomycin - Severe allergy to any vaccine component - Immunosuppression - Blood product transfusion within 11 months - Thrombocytopenia – weigh risks/benefits - TST must be performed prior to vaccine, may suppress reactivity of the test
Varicella	12-15 months	4-6 years[c] (≥3 months after Dose #1)	- Severe allergy to any vaccine component - Immunosuppression - Blood product transfusion within 11 months - Personal/family history of seizures
HepA	≥ 12 months	≥ 6 months after Dose #1	- Severe allergic reaction to component or prior HepA vaccine

Note. HepB = Hepatitis B; DTaP = diphtheria and tetanus toxoids and acellular pertussis; Hib = *Haemophilus influenzae* type B ; PCV13 = pneumococcal conjugate vaccine; IPV = poliomyelitis vaccine; MMR = measles, mumps, rubella; TST = tuberculin skin test; HepA = Hepatits A. From *Epidemiology and Prevention of Vaccine-Preventable Diseases* (13th ed.) by the Centers for Disease Control and Prevention, J. Hamborsky, A. Kroger, and S. Wolfe (Eds.). Copyright 2015 by the Washington, D.C. Public Health Foundation. (2015).

[a]This vaccine completes primary series, a fifth booster dose given at age 4-6 years

[b]Vaccine is considered a booster, primary series is complete after Dose #3.

[c]Primary series for MMR, varicella, and IPV are completed in the 4-6 year-old age range, outside of the target population of 0-24 months that are the focus population of this project.

Table 2.

Initial Refugee Assessment and Immunization for Children under 11 Years Old

Intervention Type	Specific Tests and Vaccines
Diagnostic Tests performed by Health Department	- Hgb (fingerstick) - TST - Urinalysis (dipstick)
Diagnostic Tests completed at IFMC (venipuncture)	- Venipuncture: serum lead level, basic metabolic panel, HIV, HBsAg, HepC antibody (if piercings or tattoos), Syphilis RPR (if risk factors) - Stool Ova & Parasite (if symptoms) - Chest X-ray if positive TST - If Hgb low at HD: CBC, hemoglobin electrophoresis, & iron studies - +Any other labs indicated by history & physical
Recommended pediatric vaccines given by Health Department	- HepB - Hib - MMR - Pneumococcal - Rotavirus - DTaP - Polio - Varicella
Recommended pediatric vaccines given by IFMC	- HepA - Influenza (during flu season)

Note. Hgb = hemoglobin; TST = tuberculin skin test; IFMC = International Family Medicine Clinic; HIV = human immunodeficiency virus; HBsAg = hepatitis B surface antigen; RPR = rapid plasma regain; CBC = complete blood count; HepC = hepatitis C; HepB = hepatitis B; Hib = *Haemophilus influenzae* type B; MMR = measles, mumps, rubella; DTaP = tetanus and diphtheria toxoids and acellular pertussis. From *Newcomer Health (Refugee) Program* by the Virginia Department of Health. Published 2018.

Table 3.

Donabedian Framework: Refugee Care for Children in Charlottesville, Virginia

	Structure	Process	Outcome
Establishing Care	U.S. State Department/ Department of Homeland Security	- Enforces immigration laws - Reviews applications - Performs security screening - Performs overseas Medical Exam	- Refugee family legally immigrates to U.S., screened for serious public health concerns that would prevent migration to U.S.
	Local resettlement NGO	- Orients refugees to new home - Provides assistance with housing, employment, school enrollment - Secures appointments at HD and enrolls patient in clinic	- Refugees initially established for resettlement in U.S. - A point of contact is available for questions related to resettlement
	State of Virginia	- Provides Medicaid entitlement to all refugee children under 19 years old - All eligible to receive insurance through FAMIS under this entitlement if income requirements met - VA Vaccines for Children assists for those that are above income requirement for FAMIS	-Reduces or eliminates financial barriers to health care for children
	Health Department	- Conducts initial refugee health exam within 45 days of arrival - Reviews health records from home country, including vaccines, if available, and faxes records to IFMC - Offers the recommended early childhood vaccines, excluding HepA	- Initial health screening completed

	IFMC provider	- Reviews records from HD - Obtains full medical and social history and performs complete physical exam - Orders follow-up tests based on requirements and patient condition - Offers the recommended early childhood vaccines, excluding HepA	- Refugee has a primary source of care and access to services from affiliated health system for preventive care and management of medical conditions.
Health Maintenance Visits	AAP CDC	-Provides guidelines for WCC in U.S. - Establishes recommended vaccine schedule in U.S. - Lead screening guidelines	- Children receive age-appropriate wellness assessments with screening of growth and development - Prevents infectious disease - Protects children from lead poisoning
	VIIS	- Provides a record of all vaccinations given in VA, regardless of location	- Clinic staff determine which vaccines are needed
	Practice site provider	- Follows AAP and CDC guidelines for wellness visit - Address concerns - Refers to specialists as needed - Patient and family education	- Children receive care that is evidence-based from U.S.-based governmental agencies and professional organizations
	Practice site front desk staff	- Schedules appointments - Volunteer sends out appointment reminders weekly	- Appointments are scheduled at appropriate time with appropriate provider
	Practice site nursing/ medical assistant staff	- Prints out VIIS sheet at each pediatric visit for provider to review - Administers the vaccines - Clinic hours available to receive vaccines at a nurse visit if they were not given during WCC - Documents vaccines in medical record and VIIS	- Immunizations are given safely and documented appropriately
	Local resettlement NGO	- Provides language services for appointments as available	- Communication between clinic staff and family is facilitated by a trained professional

	Academic health system patient services	- Provides language services when resettlement agency staff unavailable, occasionally live interpreter, typically using Cyracom phone services	
	Practice site nurse case manager	- Communicates with resettlement agency and local schools on vaccine progress and other pertinent issues. - Refers to community services as needed - Assists high risk families with nutrition, appointments, managing health conditions - Provides additional patient education	- Families have an additional resource to assist them with managing their health and navigating U.S. society
Community Support	Local resettlement NGO	- Sends initial refugee vaccination records to schools	- Families have a liaison communicating with the school system on their behalf
	CHiP	- Provides nurse and caseworker visits families at home for at risk children under seven years old - Review vaccine records and provide teaching on vaccines	- Families have a resource to encourage well-child care and a presence in the home to assist them with their children's health
	Local school system	- Publish policies that require child to get vaccines and to submit a provider-completed health form prior to enrollment	- Infectious disease transmission is reduced. - Schools have documentation that children are healthy enough for school activities
	WIC	- Assists low-income mothers and young children with nutrition and wellness who are "nutritional risks" - Monitors vaccine coverage of participants	- Families have a source of education on numerous wellness topics including vaccines

Note. U.S. = United States; NGO = non-governmental organization; IFMC = International Family Medicine Clinic; FAMIS = Family Access to Medical Insurance Security; HepA = Hepatitis A; AAP = American Academy of Pediatrics; WCC = Well-Child Check; CDC = Centers for Disease Control and Prevention; VIIS = Virginia Immunization Information System; VA = state of Virginia; CHiP

= Children's Health Improvement Program; WIC = Women, Infants & Children. Information obtained from Centers for Disease Control and Prevention (2013), International Rescue Committee (2018), Jefferson Area Children's Health Improvement Program (2013), United States Citizenship & Immigration Services. (2017), and United States Department of Agriculture (2018).

Table 4.

Literature Review Summary on the Effectiveness of Reminder and recall Interventions on Rates of Recommended Childhood Vaccines

First Author, Year	Subjects and Setting	Design/ Level of Evidence	Methods	Outcomes and Limitations
Atchison et al., 2013	Children 0-5 years overdue for routine immunizations at primary care clinics in Wandsworth, England	Comparison Cohort Level 3	Compared childhood vaccine uptake with a guideline-directed call/recall system for overdue childhood immunizations compared to standard of care	Statistically significant increase in uptake for DTaP/IPV/Hib, MMR, and the pre-school DTaP/IPV booster in intervention group ($p < .05$). Non-significant improvement in PCV and Hib/MenC[a] boosters, which still has clinical significance. Limitations: - not randomized, high risk of bias - Control group was self-selected and much smaller (12 vs 32 clinics) - number of children not reported (percentages for outcomes generated by computer software)
Crocker-Buque et al., 2017	Children < 11 years and adolescents 11-19 years old. *n* = 41 total studies included, including 18 on reminder/	Systematic Review Level 1	Review of interventions for reducing inequalities in vaccine adherence Databases searched: MEDLINE, Embase, ASSIA, The Campbell Collaboration, CINAHL, The Cochrane Database of Systematic Reviews, Eppi Centre, Eric, & PsychINFO for studies	Findings: Though some heterogeneity present, most studies indicated effectiveness of reminder and recall at improving vaccination rates in children < 11. Few studies addressed inequalities for any of the interventions evaluated. Limitations: No meta-analysis conducted on

	recall		published between 2008 and 2015	findings
Hambidge et al., 2004	Infants at 11 clinics born July 1, 1998 – June 30, 1999 at Denver Health Medical Center.	RCT Level 2	Intervention: 4 clinics randomized to immunization arm with intensive reminder and recall for vaccines and AFIX[b] teaching intervention to clinic staff (mean 258 children per clinic, range 65-697) 3 clinics randomized to WCV arm with intensive reminder and recall for WCVs & AFIX intervention to clinic staff (mean 158 children per clinic, range 45-273) Control: 4 clinics randomized to control group receiving no intervention (mean 290 children per clinic, range 72-718)	Neither the Immunization or WCV arms had statistically significant improvement in WCVs or immunization up-to-date rates, though some increase was seen which has clinical significance Limitations: - randomization of clinics, not patients - high degree of baseline variability between groups including baseline vaccination rate - 20% loss to follow-up
Harvey et al., 2015	*n* = 28 studies included in meta-analysis of parents of children ≤ 5 years old, including 24 RCTs	Systematic Review with Meta-Analysis Level 1	Databases searched: MEDLINE, EMBASE, EMBAR, CINAHL and PsychINFO 6 separate meta-analyses performed for different interventions Cochrane methodology used	11 studies of postal reminder efficacy, high rate of heterogeneity, random effects model showed improvement in vaccine uptake by 9.9% (95% CI 0.045-0.152, p< .001) 5 studies of telephone reminder efficacy. Fixed effects model showed 4% increase in vaccine uptake (95% CI 0.006-0.073 p= 0.019) 4 studies assessed combined postal and phone reminders. Random effects model indicated 11.3% improvement in vaccine uptake (95% CI 0.033-0.193, p< .006)

				Limitations: - strategies may be outdated in age of cell phones - reasons for heterogeneity not explained, may be differences in intervention methods to explain differences in effectiveness
Jacobson Vann et al., 2018	*n* = 75 studies of non-hospitalized children and adults including 70 RCTs	Systematic Review with Meta-Analysis Level 1	Databases searched: CENTRAL, MEDLINE, Embase and CINAHL to January 2017. Search also included grey literature and trial registers to January 2017 Cochrane review methodology applied	In 21 trials with 31,099 combined subjects, patient-focused reminder or recall appear to increase childhood immunizations, RR = 1.22, 95% CI (1.15-1.29) with high certainty of the evidence
Jones et al., 2015	*n* = 457 children under age 3 years recruited from clinics associated with academic medical centers in Salt Lake City, Utah.	Prospective Cohort Level 3	Outreach intervention to parents of under-vaccinated children involving letter, followed by telephone reminders. Compared baseline vaccination rates with rates 3 months post-intervention. Also conducted cost analysis to determine break-even point for this QI initiative.	Primary outcome: Up-to-date immunization rates increased from 79.6% to 89.6% and 75.1% to 92.1% at the two clinics ($p < .01$ for both) Secondary outcome: Determined that 36 immunizations were required to financially break even with QI project Limitations: - no control group used - revenue figures may not be generalizable to other settings

Posadzki et al., 2016	Total *n* = 41 studies of preventive healthcare, *n* = 5 studies of immunizations in children.	Systematic Review with Meta-Analysis Level 1	Databases searched: Cochrane Central Register of Controlled Trials; MEDLINE; Embase; PsycINFO; CINAHL; Global Health; WHOLIS; LILACS; Web of Science; and ASSIA); three grey literature sources (Dissertation Abstracts, Index to Theses, Australasian Digital Theses); two trial registries (www.controlled-trials.com; www.clinicaltrials.gov) for papers published between 1980 and June 2015. Looked at automated telephone communication systems for preventive healthcare and long-term care management	Telephone reminders likely increase vaccination in children RR 1.25 (95% CI 1.18-1.32) compared with no calls, letters, or usual care with moderate certainty evidence. Limitations: Unclear age criteria for studies involving children vs. adolescents
Sahni et al. (2017)	*n* = 1,892 children age 19-35 months due or overdue for vaccines from 9 pediatrics practices in the Houston, Texas area	RCT Level 2	Participants randomized to standard or enhanced reminder and recall and followed for six weeks. The standard group received one notification by mail, the intervention group received up to three notifications including phone reminders.	Outcomes: Enhanced group had a 9.9% increase in appointments made compared to the standard group ($p < .001$). Both reminder and recall groups found to generate over $20,000 in additional revenue after subtracting costs. The enhanced intervention group had only a slight increase in revenue compared to the standard. Limitations: - no control group receiving no reminders - some self-selection bias from the

				practices that chose to participate
Shefer et al., 1999	*n* = 197 studies in a review of population-based interventions for vaccinations	Systematic Review with Meta-Analysis Level 1	Databases searched: Medline, Embase, Psychlit, CAB Health, and Sociological Abstracts	60 studies of reminder and recall by phone or mail. 42 of 60 had execution rated good or fair, & suitability that was greatest or moderate Median vaccine coverage difference of 12% seen with phone reminders, mail reminders or both interventions
Szilagyi et al., 2000	*n* = 41 studies of vaccines in children and adults	Systematic Review with Meta-Analysis Level 1	Databases searched: MEDLINE, Embase, ASSIA, The Campbell Collaboration, CINAHL, The Cochrane Database of Systematic Reviews, Eppi Centre, Eric and PsychINFO Cochrane Review methodology used	Findings: Reminder and recall effective at improving routine childhood vaccination rates in 12 of 15 studies with OR 4.5 (95% CI 2.10-8.60). Reminder and recall most effective in academic settings
Williams et al., 2011	*n* = 46 studies of children 6 weeks-11 years old in developed countries, including 26 RCTs	Systematic Review with Meta-Analysis Level 1	Databases searched: MEDLINE, EMBASE, PsycInfo, Cochrane & OpenSIGL to June 2010 Search also included ancestry search and grey literature.	Twenty-two included papers reported on 41 interventions of reminders and recalls with phone, mail, or both. 34% of the interventions had statistically significant increases in vaccination rates ($p < .05$). Using Down and Black's quality scoring framework, average quality of these studies was high. Overall, 11% median point change of vaccine completion.

Notes. n = number of subjects (children or studies) in the population used for analysis; DTaP = diphtheria tetanus toxoids & acellular pertussis; IPV = poliomyelitis vaccine; Hib = *Haemophilus influenzae* type B; MMR = measles, mumps,& rubella; , PCV= pneumococcal conjugate vaccine; MenC = meningitis conjugate vaccine; AFIX = Assess, Feedback, Incentives, Exchange; WCV = well-child visit; RCT = randomized controlled trial; CI = confidence interval; QI = quality improvement; RR = risk ratio; OR = odds ratio.

[a]The meningitis conjugate vaccine was discontinued in the United Kingdom in 2016

[b]A CDC-sponsored quality improvement program to support Vaccines for Children providers.

Table 5.

Complete List of Demographic Data Collected from the Electronic Medical Record

Child's Record	Primary Caregiver's Record
Gender	Age at birth of child
Immigration status	Immigration status
Country of origin	Country of origin
Country of exit	Country of exit
Insurance	Highest level of education completed
Time in the U.S. (if born abroad)	Time in the U.S.
Experience of trauma	Experience of trauma
Preferred language	
English speaker(s) in the home	
Interpreter used	
Number of children per household	
Preschool attendance	
Primary caregiver during the day	
Proportion of sick visits to well visits	
Emergency department visits	
Hospitalizations (since birth)	
NICU admission at birth	
Missed WCCs	
Number of specialists involved in care	
Developmental Pediatric specialist involved in care	
Use of WIC services	
Use of CHiP services	
Involvement of RNCC	

Note. NICU = Neonatal Intensive Care Unit; WCC = Well child check; WIC = Women, Infants & Children; CHiP = Children's Health Improvement Program; RNCC = registered nurse care coordinator.

[a]Only includes visits to the emergency department that is connected to the same hospital as the IFMC. Any other emergency visits would not be shown in the EMR

[b]Only includes visits to specialists that are connected to the same hospital as the IFMC. Any other emergency visits would not be shown in the EMR. Two or more visits were required for a specialist to be considered involved in the child's care.

Table 6.

Criteria Used to Determine 'Up-to-Date' Vaccination Status at 12, 18, 24, 30, and 36 Months of Age

Vaccines	Number of doses at 12 months	Number of doses at 18 months	Number of doses at 24, 30, and 36 months
Hepatitis B	3	3	3
Diphtheria & tetanus toxoids & acellular pertussis	3	4	4
Haemophilus influenzae type B	3	4	4
Pneumococcal conjugate vaccine	3	4	4
Poliomyelitis	2	2	3
Measles, mumps, & rubella		1	1
Varicella		1	1
Hepatitis A		1	2

Table 7.

Demographic Characteristics of Children under Age Ten in the International Family Medicine Clinic

Characteristic	U.S.-born children of refugees (*n* = 152)	Refugee children (*n* = 176)	Total (*n* = 328)
Age in years			
Mean (*S.D*)	3.78 (*2.406*)	6.10 (*2.325*)	5.03 (*2.628*)
Gender			
Male (%)	82 (53.9)	87 (49.4)	169 (51.5)
Female (%)	70 (46.1)	89 (50.6)	159 (48.5)
Parent Country of Origin			
Afghanistan (%)	41 (27.0)	76 (43.2)	117 (35.7)
Iraq (%)	15 (9.9)	22 (12.5)	37 (11.3)
Bhutan/Nepal (%)	39 (25.7)	28 (15.9)	67 (20.4)
DRC (%)	11 (7.2)	12 (6.8)	23 (7.0)
Burma/Myanmar (%)	17 (11.2)	15 (8.5)	32 (9.8)
Syria (%)	0 (0.0)	13 (7.4)	13 (4.0)
Russia (%)	5 (3.3)	0 (0.0)	5 (1.5)
Somalia (%)	12 (7.9)	3 (1.7)	15 (4.6)
Iran (%)	2 (1.3)	2 (1.1)	4 (1.2)
Togo (%)	2 (1.3)	1 (0.6)	3 (0.9)
Colombia (%)	0 (0.0)	2 (1.1)	2 (0.6)
Ethiopia (%)	2 (1.3)	0 (0.0)	2 (0.6)
State of Palestine (%)	1 (0.7)	1 (0.0)	2 (0.6)
Tibet (%)	2 (1.3)	0 (0.0)	2 (0.6)
Other[a]	3 (2.1)	1 (0.6)	3 (0.9)
Mother status			
Refugee	124 (81.6)	122 (69.3)	246 (75)

SIV	17 (11.2)	54 (30.7)	71 (21.6)
Immigrant	7 (4.6)	0 (0.0)	7 (2.1)
Asylum Seeker	1 (0.7)	0 (0.0)	1 (0.3)
Missing	3 (2.0)	0 (0.0)	3 (0.9)
Insurance			
Medicaid (%)	141 (92.8)	171 (97.2)	312 (95.1)
Private Insurance (%)	7 (4.6)	0 (0.0)	7 (2.1)
Medicaid + period with Private Insurance (%)	2 (1.3)	1 (0.6)	3 (0.9)
Medicaid with period of no insurance (%)	2 (1.3)	3 (1.7)	5 (1.5)
Missing (%)	0 (0.0)	1 (0.6)	1 (0.3)
Preferred Language[b]			
English (%)	36 (23.7)	9 (5.1)	45 (13.7)
Dari (%)	24 (15.8)	51 (29)	75 (22.9)
Pashto (%)	7 (4.6)	19 (10.8)	26 (7.9)
Nepali (%)	37 (24.3)	27 (15.3)	64 (19.5)
Arabic (%)	12 (7.9)	35 (19.9)	47 (14.3)
Karen (%)	12 (8.6)	2 (1.1)	15 (4.6)
Swahili (%)	5 (3.3)	12 (6.8)	17 (5.2)
Burmese (%)	4 (2.6)	10 (5.7)	14 (4.3)
Farsi/Persian (%)	4 (2.6)	2 (1.1)	6 (1.8)
Somali/Mai-Mai (%)	3 (2.0)	2 (1.1)	5 (1.5)
Other/Unknown[c] (%)	7 (4.6)	7 (4.0)	14 (4.3)

Note. N = number of subjects; S.D. = standard deviation; DRC = Democratic Republic of the Congo; SIV = Special Immigrant Visa.

[a]Other countries included Liberia, Gambia, Pakistan, and Hong Kong (one child from each of these).

[b]Preferred language is based on electronic medical record documentation.

[c]Other languages included Spanish, Russian, Tibetan, Urdu, Krahn, Kirundi, and Ewe.

Table 8.

Linear Regression Analysis of the Impact of Demographic Factors on Vaccine Completion for International Family Medicine Clinic Patients Expressed as Odds Ratios (OR) and Confidence Intervals (CI)

	12 Months *n* = 144		18 Months *n* = 122		24 Months *n* = 112		30 Months *n* = 111		36 Months *n* = 111	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Missed WCCs/year [a]	0.34*	[0.14, 0.80]	0.22*	[0.10, 0.52]	0.28*	[0.10, 0.76]	0.44	[0.18, 1.09]	0.92	[0.39, 2.21]
Foreign- Born	0.46	[0.20, 1.04]	0.56	[0.34, 0.91]	0.25*	[0.15, 0.42]	0.16*	[0.09, 0.28]	0.09*	[0.05, 0.17]
Maternal time in U.S. (years)	0.99	[0.90, 1.10]	1.02	[0.96, 1.10]	1.14*	[1.05, 1.22]	1.12*	[1.03, 1.20]	1.13*	[1.05, 1.23]
Maternal Country of Origin [b]										
Afghanistan	[c]		0.43	[0.13, 1.47]	0.20*	[0.06, 0.69]	0.14*	[0.03, 0.69]	0.11*	[0.01, 0.92]
Iraq	[c]		0.30	[0.08, 1.14]	0.17*	[0.04, 0.68]	0.11*	[0.02, 0.58]	0.08*	[0.01, 0.70]
Bhutan/ Nepal	[c]		1.12	[0.31, 4.11]	0.58	[0.16, 2.12]	0.28	[0.06, 1.38]	0.16	[0.02, 1.36]
DRC	[c]		0.15*	[0.03, 0.73]	0.13*	[0.03, 0.64]	0.09*	[0.02, 0.55]	0.06*	[0.01, 0.61]
Burma (Myanmar)	[c]		0.69	[0.17, 2.74]	0.51	[0.13, 2.02]	0.27	[0.05, 1.46]	0.20	[0.02, 1.81]
Syria	[c]		1.33	[0.24, 7.56]	0.13*	[0.02, 0.77]	0.08*	[0.01, 0.55]	0.06*	[0.01, 0.59]
Russia	[c]		0.27	[0.03, 2.25]	0.11	[0.01, 1.34]	0.05*	[0.00, 0.65]	0.06*	[0.00, 0.92]
Other [d]	[c]		0.80	[0.18, 3.65]	0.70	[0.15, 3.17]	0.36	[0.06, 2.19]	0.18	[0.02, 1.76]

Preferred Language[e]										
English	[c]		0.59	[0.16, 2.11]	0.94	[0.27, 3.29]	0.45	[0.12, 1.75]	0.67	[0.15, 2.97]
Dari	[c]		0.68	[0.20, 2.29]	0.46	[0.14, 1.51]	0.34	[0.09, 1.20]	0.27	[0.07, 1.08]
Pashto	[c]		0.69	[0.17, 2.92]	0.39	[0.09, 1.67]	0.36	[0.08, 1.59]	0.50	[0.10, 2.52]
Nepali	[c]		1.44	[0.42, 5.02]	1.22	[0.37, 3.98]	0.57	[0.16, 2.07]	0.46	[0.11, 1.86]
Arabic	[c]		0.69	[0.20, 2.37]	0.41	[0.12, 1.39]	0.24*	[0.07, 0.90]	0.22*	[0.05, 0.89]
Swahili	[c]		0.20*	[0.04, 0.98]	0.36	[0.07, 1.72]	0.20	[0.04, 0.97]	0.21	[0.04, 1.07]
Burmese	[c]		0.89	[0.19, 4.24]	0.86	[0.19, 3.89]	0.34	[0.07, 0.90]	0.38	[0.07, 2.13]
Farsi/ Persian	[c]		0.37	[0.05, 3.02]	1.00	[0.11, 9.23]	0.40	[0.04, 3.90]	0.27	[0.03, 2.83]
Other[f]	[c]		1.11	[0.26, 4.82]	1.25	[0.31, 5.07]	0.80	[0.18, 3.65]	0.71	[0.14, 3.66]
Mother age at birth	1.02	[0.95, 1.10]	1.03	[0.98, 1.07]	1.05*	[1.01, 1.10]	1.07*	[1.02, 1.13]	1.08*	[1.02, 1.13]
Children per household	0.90	[0.71, 1.15]	0.83*	[0.70, 0.99]	1.01	[0.85, 1.21]	1.07	[0.89, 1.27]	1.07	[0.89, 1.28]
WIC services	1.65	[0.71, 3.84]	1.88*	[1.13, 3.13]	1.82*	[1.10, 3.02]	2.07*	[1.24, 3.45]	2.56*	[1.49, 4.38]

Note. *n* = number of children in analysis; OR = odds ratio; CI = confidence interval; WCC = well-child check; DRC = Democratic Republic of the Congo; WIC = Women, Infants & Children. Non-significant variables were maternal education level, interpreter used for visit (if English not listed as preferred language in EMR), presence of English speaker in the home, number of specialists involved in care, developmental pediatrics specialist involved in care, proportion of sick visits to well visits, emergency department visits per

year, hospitalizations per year, use of CHIP services, involvement of a registered nurse care coordinator, and experience of trauma by child or family member.

*$p < .05$

[a]Number of missed well-child check per year receiving care at the International Family Medicine Clinic.

[b]Due to colinearity, the country Somalia was excluded from the final regression results.

[c]Due to small number of cases, odds ratio estimates were too high to be reliable.

[d]Refers to less-commonly represented countries: Iran (*n*=4), Togo (*n*=3), Colombia (*n*=2), Ethiopia (*n*=2),, Palestine(*n*=2), Tibet (*n*=1), Liberia (*n*=1), Gambia(*n*=1), Pakistan (*n*=1), Hong Kong (*n*=1).

[e]Due to colinearity, the language Karenni was excluded from the final regression results.

[f]Refers to the less commonly represented languages: Somali/MaiMai (*n*=5), Kirundi (*n*=3), French (*n*=2), Spanish (*n*=2), Russian (*n*=2), Mandarin (*n*=1), Urdu (*n*=1), Tibetan (*n*=1), Krahn (*n*=1), and Ewe (*n*=1).

Table 10.

Odds Ratios (OR) and Confidence Intervals (CI) for Multinomial Logistic Regression Analysis Predicting Hepatitis Vaccine Completion from Demographic Factors

	Hepatitis A1 N = 298				Hepatitis A2 N = 271			
	Missing[a] vs. On-time[b]		Late[c] vs. On-time		Missing vs On-time		Late vs. On-time	
Patient Factors	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Missed WCCs[d]	5.52*	[1.99, 15.26]	2.91*	[1.15, 7.35]	2.52	[0.87, 7.29]	2.33	[0.94, 5.81]
Foreign-Born	0.93	[0.35, 2.48]	1.65	[0.77, 3.54]	4.38*	[2.01, 9.55]	4.34*	[2.34, 8.05]
Parental Region of Origin[e]								
Middle East	0.09*	[0.01, 0.76]	0.99	[0.32, 3.07]	0.88	[0.26, 2.98]	0.35*	[0.14, 0.87]
W Africa	[f]		0.59	[0.06 5.99]	[f]		1.33	[0.14, 13.03]
E Africa	0.18	[0.02, 1.80]	1.43	[0.35, 5.82]	1.21	[0.33,4.41]	1.17	[0.39, 3.52]
Southwest Asia	0.34	[0.38, 2.96]	1.35	[0.50, 3.62]	0.46	[0.19, 1.11]	0.62	[0.28, 1.35]
SE Asia	[f]		1.28	[0.31, 5.24]	[f]		1.00	[0.35, 2.89]
S America	[f]		[f]		[f]		[f]	
Russia	[f]		0.22	[0.03, 1.54]	[f]		0.22	[0.03, 1.48]
Maternal age at birth	1.01	[0.92, 1.10]	0.98	[0.91, 1.04]	0.97	[0.90, 1.03]	0.93*	[0.88, 0.98]
Interpreter Use								
Professional[h]	3.40*	[1.04, 11.19]	1.73	[0.67, 4.45]	0.40	[0.08, 1.72]	0.93	[0.39, 2.22]
Family	1.67	[0.41, 6.80]	3.11	[0.74,13.15]	0.30	[0.06, 1.65]	0.86	[0.29, 2.57]

Not Used	[f]		9.85*	[1.15, 84.80]	0.48	[0.09, 2.66]	2.17	[0.66, 7.16]
Proportion sick visits[i]	1.47	[0.51, 4.17]	1.11	[0.45, 2.72]	2.37*	[1.10, 5.11]	1.41	[0.67, 2.96]
WIC services	0.09*	[0.01, 0.72]	0.65	[0.30, 1.43]	0.46*	[0.22, 0.96]	0.44*	[0.24, 0.80]
CHiP	0.22*	[0.50, 0.99]	0.53	[0.23, 1.23]	0.97	[0.48, 1.98]	1.10	‘[0.63, 1.95]
RN CC Involved	0.52	[0.17, 1.65]	2.30*	[1.10, 4.81]	2.33*	[1.17, 4.70]	1.23	[0.70, 2.17]

Note. N = number of children in analysis; OR = odds ratio; CI = confidence interval; WCC = Well child check; ME = Middle East; WIC = Women, Infants & Children; CHiP = Children’s Health Improvement Program; RNCC = registered nurse care coordinator. Non-significant variables were country of origin, maternal time in the U.S., maternal education level, hospitalizations and emergency department visits under age five, presence of English speaker in the home, number of specialists involved in care, developmental pediatrics specialist involved in care, number of children per household, and experience of trauma by child or family member.

*$p < .05$.

[a] “Missing” refers to children who have never completed the vaccine.

[b] “On-time” refers to children who received the vaccines at the ages recommended by the Advisory Committee on Immunization Practices (ACIP) at the Centers for Disease Control and Prevention.

[c] “Late” refers to children who received the vaccines but after the recommended ACIP-recommended age.

[d] [a]WCCs = missed well-child check per year receiving care at the clinic

[e]Due to colinearity, the category of Central Asia for region of origin was excluded. This included children from Afghanistan and Pakistan.

[f]Due to small number of cases, odds ratio estimates were too high to be reliable.

[g]Preferred language is based on electronic medical record documentation.

[h]Certified interpreters include hospital employees, trained volunteers from the local resettlement agency, and interpreters utilized via a phone-based interpretation service provided by the medical center.

[i]Number of sick visits to the clinic per year relative to well checks and follow-ups, before age five.

Appendix A

Institutional Review Board Approval Letter

ASSURANCE FORM
University of Virginia
Institutional Review Board for Health Sciences Research
HIPAA Privacy Board

IRB - HSR # 21010

Event:	Type:	Sponsor(s):
Approval New Protocol - Expedited	Protocol	Sponsor Protocol #:
		Principal Investigator: Kathryn Reid, MSN, RN

Title: Evaluating and Promoting Infant and Early Childhood Vaccination in a Refugee Population

Assurance: Federal Wide Assurance (FWA)#: 00006183 **IRB#00000447**

Certification of IRB Review:
The IRB-HSR/HIPAA Privacy Board abides by 21CFR50, 21CFR56, 45CFR46, 45CFR160, 45CFR164, 32CFR219 and ICH guidelines as compatible with FDA and DHHS regulations. This activity has been reviewed in accordance with these regulations.

Event Date: 09/24/18
Protocol Expiration Date: 09/23/19
Number of Subjects: 431
HSR Protocol Version Date: 09/18/18

UVA Site Only
IRB Application Date: 09/18/18
Data Security Plan Date: 09/18/18

Current Status: Open to enrollment

Consent Version Dates:

Committee Members (did not vote):

Comments: The IRB determined the protocol met the criteria for approval per the federal regulations and was approved.
It is open to enrollment.

The purpose of this study is to determine which demographic and social factors affect early childhood vaccination rates in a panel of pediatric refugee patients.

The study will involve a retrospective chart review of children born on or after 9/30/2008 who have had a visit in the International Family Medicine Clinic from 9/30/2008 to 9/30/2018.

There is no outside sponsor for this study.

N= 431 Ages= birth to 10 years of age

This study is not regulated by the FDA as it does not involve research on a drug, biologic or device.

No additional committee approvals are required

No compensation

UVA

REGULATORY INFORMATION:

The IRB determined this protocol met the criteria of minimal risk.

Protocol Expedited by Category #5: Research involving materials (data, documents, records or specimens) that have been collected solely for non-research purposes (such as medical treatment and/or diagnosis).

This protocol has been granted a Waiver of Consent to identify potential subjects via 45CFR46.116.

This protocol has been granted a waiver of consent under 45CFR46.116 for the main study.

This protocol has been granted a waiver of HIPAA authorization under 45CFR 164.512(i)(2) for the main study.

The following HIPAA identifiers will be collected: Name, MRN, elements of date.

The minimum necessary PHI to be collected includes: Vaccinations, encounters with or use of care coordinator, visits and appointments, hospitalizations, presence of any medical condition or allergy that would contraindicate vaccines.

Subjects may not be contacted by any method (email, phone, in person etc.) to obtain more information for this study without additional IRB-HSR approval.

No identifiable health information will be taken or shared outside of the UVa HIPAA covered entity.

PLEASE REMEMBER:
* If an outside sponsor is providing funding or supplies, you must contact the SOM Grants and Contracts Office/ OSP regarding the need for a contract and letter of indemnification. If it is determined that either of these documents is required, participants cannot be enrolled until these documents are complete.
* You must notify the IRB of any new personnel working on the protocol PRIOR to them beginning work.
* You must obtain IRB approval prior to implementing any changes to the approved protocol or consent form except in an emergency, if necessary to safeguard the well-being of currently enrolled subjects.
* If you are obtaining consent from subjects, prisoners are not allowed to be enrolled in this study unless the IRB-HSR previously approved the enrollment of prisoners. If one of your subjects becomes a prisoner after they are enrolled in the protocol you must notify the IRB immediately.
* You must notify the IRB-HSR office within 30 days of the closure of this study.
* Continuation of this study past the expiration date requires re-approval by the IRB-HSR.

The IRB-HSR official noted below certifies that the information provided above is correct and that, as required, future reviews will be performed and certification will be provided.

Name: Amy E. Blackman, MSN, RN, CCRC **Title:** Member, Institutional Review Board for Health Sciences Research **Phone:** 434-924-9634 **Fax:** 434-924-2932	**Name and Address of Institution:** IRB for Health Sciences Research University of Virginia, PO Box 800483 Charlottesville, VA 22908 **OR** IRB for Health Sciences Research

Appendix B

Abstract for Poster Presentation Accepted to the North American Refugee Health Conference

Contact:

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Theme: Vaccination

Format: Oral Presentation

Target Audience: Family Physicians/Primary Care Practitioners

Title Promoting Infant and Early Childhood Vaccines in a Refugee Population

Key words: refugee, vaccination, pediatric

Background and Purpose/Objectives: Refugee children and children of refugees are at risk for under-immunization compared to their peers. Reminder and recall has been shown to improve vaccination rates, but has not been studied in a refugee-specific population. This study was conducted from August-November 2018 at an international family medicine clinic at an academic medical center in Charlottesville, Virginia. The purpose was to pilot a reminder/recall intervention and identify risk factors for delayed immunization for refugee children.

Methodology: Charts were reviewed for 441 children under ten years old in the clinic database to identify factors associated with delayed immunization. The children age 0-48 months were screened for vaccine completion, as older children are prompted to get vaccines by school policies. Parents of insufficiently vaccinated children were contacted using a phone-based interpretation service.

Results/Impact/Outcomes: Of the 131 preschool-aged children, 22 met inclusion criteria for reminder intervention as current clients of the clinic with missing vaccines and no upcoming appointment. By the end of the study window, 12 of 22 children had appointments scheduled.

Factors associated with delayed vaccines included being foreign-born, increased number of children per household, increased missed well-child checks per year and maternal country of origin. Factors associated with improved vaccination rates included use of Women, Infants, Children (a federal nutritional program for low-income families), older maternal age at birth, and increased maternal time since immigration.

Conclusions/Discussion: These results will allow clinic providers to identify children at risk for delayed immunization and provide a basis for a sustainable intervention to improve vaccination rates.

Target Level of Experience: Beginner

Appendix C

Manuscript Submission to the *Journal of Immigrant and Minority Health*

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April 22, 2019

Dear Dr. Sana Loue,

We wish to submit an original research article entitled "Promoting Infant and Early Childhood Vaccines in a Refugee Population for consideration by the *Journal of Immigrant and Minority Health.* We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

Ms. Spriggs served as first author who implemented the methods, collected data, and prepared the manuscript. Dr. Lovegrove served as a statistical consultant. Ms. Tanabe, Dr, Thompson, and Dr. Hauck served in developing the methods and revising and reviewing content. Each author has reviewed the manuscript and approves its submission. None of the authors have conflicts of interest to disclose.

In this paper, we present findings from a chart review of 328 children of refugee families and risk factors for under-immunization. We piloted a reminder and recall intervention for those children who were overdue for vaccines. The results that indicate reminder and recall can be effectively implemented in a refugee-specific clinic population to improve infant and early childhood vaccinations.

This work is significant because of the public health concerns associated with the rise of vaccine-preventable illnesses in recent years as well as the increased need for pediatric providers to be familiar with the health needs of international patients.

We believe that this manuscript is appropriate for publication by the *Journal of Immigrant and Minority Health* because it has implications for primary care practitioners in the field of refugee health and provides evidence that reminder and recall can help improve health maintenance activities among refugees.

Please address all correspondence concerning this manuscript to me at sms3ef@virginia.edu. Thank you for your time and consideration.

Sincerely,
Sarah Margaret Spriggs, MS, FNP-C

Promoting Infant and Early Childhood Vaccines in a Refugee Population

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Suggested running head: Promoting Vaccination in a Refugee Population

Abstract

Background: Children of refugees are at risk for under-immunization compared to their peers. Reminder and recall has been shown to improve vaccination rates, but has not been studied in refugees. This study was conducted at an International Family Medicine Clinic in Charlottesville, Virginia to determine risk factors for delayed vaccination and use reminder and recall to increase vaccinations. ***Methods****:* Medical records of 328 children were evaluated for factors affecting immunization. Parents of children with missing vaccines were contacted to make an appointment for vaccination. ***Results:*** Twelve of 22 (54.5%) children who received the reminder intervention had appointments scheduled. Foreign-born status, number of children per household, missed well-child checks, maternal country of origin, use of federal nutrition support, older maternal age, and increased maternal time since immigration had a statistically significant impact on vaccination rates. ***Conclusion:*** These findings have the potential to assist clinic staff with immunization practice.

Key Words:

refugee, vaccination, pediatric, reminder

BACKGROUND

Refugee children and children of refugee parents are often incompletely immunized compared to their peers. A retrospective study of 97,885 Minnesota children indicated that children with at least one foreign-born parent were 7-25% less likely to be up-to-date on immunizations at ages two, six, 18, and 36 months compared to children with two native-born parents (1). Data from the 2010-2012 United States (U.S.) National Immunization Survey (NIS) indicated that foreign-born children were less likely to receive routine childhood vaccines compared to native-born children. These disparities persisted after controlling for income, language, and access to care (adjusted prevalence ratio of 0.39, 95% CI [0.31–0.50]) (2).

Barriers to Vaccination in the Refugee Population

The disparities in vaccination rates for refugee children are a public health concern. Multiple patient and provider barriers are hypothesized to contribute to this gap.

Patient barriers.

Language. A retrospective study of Medicaid enrollees in Washington State indicated that children of parents with a primary language other than English were half as likely as their peers to attend all six recommended well-child checks (WCCs) in the first year of life. Vaccines are typically given during WCCs, so missing these visits impacts timely vaccination (3).

Income. National Immunization Survey responses indicate that foreign-born children are more likely to be impoverished compared to their native-born peers (2). A review of medical records of 1,163 children in Washington and Oregon indicated that children from low-income families were 60-80% less likely to be up-to-date on vaccines compared to children from medium-to-high income families (4).

Time since immigration. In a study of Danish refugee children, a longer duration of residence in Denmark is positively correlated with completion of recommended vaccines. Children in the highest quartile for duration of residence were more than twice as likely to have completed vaccines compared to those in the lowest quartile (5). U.S. National Health Interview Survey results indicated that children whose mothers had been in the U.S. for fewer than five years were at highest risk of being behind on vaccines compared to children of U.S.-born mothers (*OR* = .505) (6).

Country of origin. A retrospective study in Minnesota determined that children born to mothers from Western Europe, Canada, Eastern Europe, Asia, and Somalia had lower rates of immunization completion at two, six, 18, and 36 months compared to children of U.S.-born mothers. At the same time, children of mothers from Central America, South America, the Caribbean, Mexico, and Africa (excluding Somalia) had increased vaccination completion rates at these ages compared to those with U.S.-born parents (1).

A review of vaccination records in Washington State determined that children of Ukrainian- or Russian-born parents were 4-31% less likely to be fully immunized compared to children of U.S.-born parents. Children of Mexican- and Indian-born parents were 3-14% more likely to be fully immunized compared to children with U.S.-born parents (7).

Other factors. Exposure to trauma or violence before or during the immigration process has been hypothesized to affect a family's utilization of health services (5).

Participation in the Women, Infants, and Children program (WIC), a federal nutrition program for low-income families, has been shown to increase childhood vaccination rates. WIC promotes vaccine completion by providing education and support to families (8).

Provider and system barriers. Foreign-born families may visit their primary care provider (PCP) exclusively for acute needs and miss wellness visits (9). Some providers may be hesitant to vaccinate a child at an acute visit; however, per national guidelines it is generally safe to vaccinate during minor illness (10). Inappropriate deferral can result in delayed immunization (12).

Other barriers include the complexity of vaccination catch-up schedules and access barriers such as missed work time and transportation difficulties.

Reminder and Recall

Reminder and recall is an intervention used to promote vaccination. It involves contacting parents to inform them of due or overdue vaccines for their children, typically via phone or postal communication. Multiple systematic reviews have been conducted on reminder and recall for pediatric vaccine completion and indicate that the intervention is efficacious at improving vaccination rates, cost-effective, and safe (14, 15, 16, 17).

Reminder and recall is a strategy to engage patient populations who are easily lost to follow-up, such as refugees and is incorporated into national practice guidelines for vaccinations (18, 19).

One significant gap found in the literature review is that none of the studies of reminder and recall interventions were specific to a refugee population. There were promising results in groups that share characteristics with refugees including low-income, Medicaid-insured, and minority patients. Daley, et al. (10) demonstrated in an RCT that reminder and recall combined with a QI initiative doubled immunization rates in Medicaid-insured children aged 7-18 months after initial implementation. However, the immunization rates for these clinics were less than 25% prior to the intervention. Fu et al. (2012) performed a QI project implementing reminder

and recall at six centers serving low-income minority patients in Washington, D.C. resulted in a 14% improvement in rates of under 24-month vaccinations (11).

THEORETICAL FRAMEWORK

The Donabedian Structure-Process-Outcome (SPO) model was used to establish a framework for the reminder and recall intervention and a guide for determining which factors to assess during data collection. The SPO model serves to define healthcare quality and provides a framework for its evaluation. Knowledge of the structure, process, and outcome factors in a care setting and how these factors relate to each other provides a useful foundation before an assessment of quality can be performed (20).

Through clinic observations and discussions with staff, the SPO model cultivated understanding of the current state of pediatric preventive care and barriers to vaccines in a refugee clinic.

METHODS

Setting

The study was conducted from September 2018 to November 2018 at the International Family Medicine Clinic (IFMC) within a family medicine practice at an academic health system in Charlottesville, Virginia. The clinic serves over 3,500 refugee and immigrant patients in the greater Charlottesville area from a wide range of countries including, but not limited to, Afghanistan, Nepal, Iraq, Syria, and Burma (now Myanmar).

Protection of human subjects

This study was conducted with approval and oversight by the University of Virginia Institutional Review Board for Health Sciences Research (IRB-HSR).

Data collection

Demographic data for patients born between September 30, 2008 and September 30, 2018 was collected from the electronic medical record (EMR). Potential risk factors and protective factors for vaccine completion were identified. Additionally, the medical history was screened for contraindications to vaccines.

The EMR and state immunization registry were used to assess completion of all recommended pre-school vaccines at six-month intervals from age 12 to 36 months. Exceptions were the annual influenza vaccine and the rotavirus vaccine, which has a limited window during which it can be given with no opportunity for catch-up once this window has passed (18). Foreign-born children were considered up-to-date if they had caught up on recommended vaccines within 12 months of arrival in the U.S

Reminder and Recall Intervention

IFMC patients born after September 30, 2014 (age four years and younger) who had not received all recommended vaccines for their age were identified. Children older than four approach the age of school entry, which serves as a strong independent motivator to increase vaccine completion and catch-up, and therefore were presumed not to require additional prompting to complete vaccines. Records were checked for upcoming appointments for children under four with missing vaccines

The 22 children who did not have appointments received the intervention. A volunteer called their parents to notify them of overdue vaccines. She instructed them to schedule the appropriate appointment for vaccination. Calls to non-English speakers were facilitated by professional phone-based interpretation services. After two unsuccessful attempts to speak to the parents or leave a voicemail, the child's PCP was notified that the child will likely need vaccines at a future appointment.

The EMR was followed to determine if an appointment was made and if the family attended the appointment.

MEASURES

Up-to-date status was based on the vaccine schedule recommended by the Advisory Committee on Immunization Practices. The expected vaccines at 12, 18, 24, 30, and 36 months used to determine up-to-date status are summarized in Table 1. A documented immunity to varicella or Hepatitis B was considered a complete immunization.

For the reminder and recall intervention, a scheduled appointment was considered a successful outcome, as the time frame allowed for the study limited the ability to track vaccine completion.

ANALYSIS

Statistical analysis was performed using SPSS version 25.0. Binomial logistic regression was used to determine the risk of incomplete vaccinations for each demographic factor at each age category, expressed as an odds ratio with a 95% confidence interval and significance level of $p < .05$. To compare rates of immunization before and after the reminder and recall intervention, a binomial test of proportions was used with $p < .05$.

Participants

The initial search of the clinic database obtained a list of 441 children born between September 30, 2008 and September 30, 2018. Of these, 113 children were excluded because they left the practice before 24 months of age or established care at age five years or older, an age when school serves as the main motivator vaccine completion. Five more were excluded due to data entry errors in the patient's birthdate. Medical records were reviewed for the remaining

sample of 328 children for risk factors for insufficient vaccination completion. Demographic characteristics of the final sample are summarized in Table 2.

Of the remaining children, 120 of them were under four years old and therefore eligible to be screened to receive the reminder and recall intervention. The patient selection process is summarized in Figure 1.

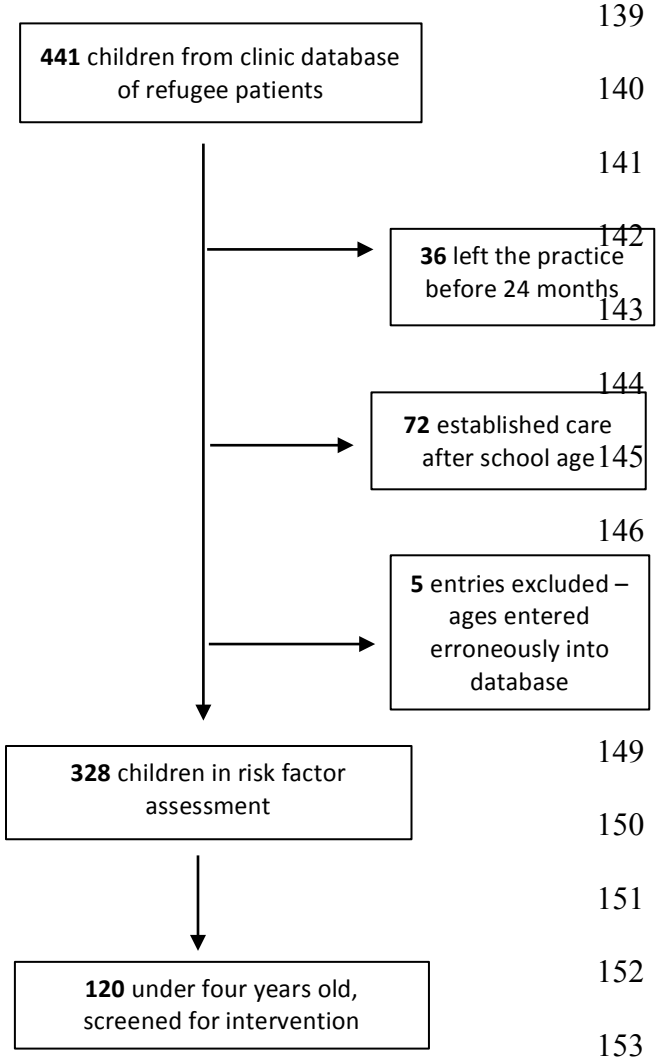

Figure 1. Summary of patient screening process from initial population obtained from clinic database.

RESULTS

Risk Factor Identification

The initial data review found that no children had documentation of a contraindication to any of the recommended vaccines or parental refusal of a vaccine.

The results of the analysis of predictive factors for vaccine completion are summarized in Table 3. Foreign-born children were less likely to be up-to-date for their age compared to U.S-born children at ages 24 months (*OR* = .25, 95% CI [.15, .42]), 30 months (*OR* = .16, 95% CI [.09, .28]), and 36 months (*OR* = .09, 95% CI [.05, .17]).

The number of WCCs a child missed per year was associated with decreased vaccination rates at 12, 18, and 24 months. For each missed WCC per year as an IFMC patient, vaccination rates decreased 66-78%.

Maternal origin country was a predictor of vaccine completion. Countries of origin associated with significantly decreased rates of childhood vaccine completion were the Democratic Republic of the Congo, Afghanistan, Iraq, Syria, and Russia. The odds ratios and confidence intervals for these findings are found in Table 3.

Children with a documented preferred language of Arabic were less likely to be fully vaccinated at 30 months (*OR* = .24, 95% CI [.07, .90]) and 36 months (*OR* = .22, 95% CI [.05, .89]). A preferred language of Swahili was associated with decreased vaccination rates at 12 months (*OR* = .20, 95% CI [.04, .98]) and 24 months (*OR* = .20, 95% CI [.04, .97]).

Increased number of children per household was associated with a significant decrease in vaccination completion rates at 18 months. With each additional child in his family, a child is 17% less likely to be up-to-date on vaccines at age 18 months.

Utilization of WIC services was among the protective factors for vaccination and was associated with increased vaccination completion at 18 months (*OR* = 1.88, 95% CI [1.13, 3.13]), 24 months (*OR* = 1.82, 95% CI [1.10, 3.02], 30 months (*OR* = 2.07, 95% CI [1.24, 3.45]), and 36 months (*OR* = 2.56, 95% CI [1.49, 4.38]).

The number of years since immigration for the child's mother was positively associated with vaccine completion. For each year of maternal residency in the U.S., children's vaccination completion rates at 24, 30, and 36 months increased 12-14%.

Older maternal age at birth of the child was also associated with improved vaccine completion. For each additional year of maternal age, a child's immunization completion at 24, 30, and 36 months increased 5-8%.

Reminder and Recall Results

At the end of the data collection window, 12 of the 22 (54%) children who required a reminder phone call had appointments for vaccination catch-up in the next 60 days. Before the reminder and recall intervention, 98 of 120 (81.6%) children under four years old were caught up on the ACIP-recommended vaccines for their age or had appointments scheduled in the next 60 days during which they could be caught up. After the intervention, 110 of 120 (91.7%) children had received the missing vaccines or had appointments to do so within the next 60 days. Using the binomial test of proportions, there was a statistically significant improvement in the proportion of children with completed vaccines or vaccination appointments after the reminder and recall intervention was implemented ($p = .02$).

DISCUSSION

Vaccination Completion

Language barriers have been shown to affect utilization of preventive care (3, 21). Having a preferred language of Swahili or Arabic had a significant impact on vaccination rates compared other preferred languages. However, since having an English speaker in the home was not a significant factor in vaccine completion, these findings are likely more reflective of difference in vaccination completion based on country of origin, rather than language barriers.

Parental country of origin was associated with variation in vaccination completion. This is consistent with the findings of a review of vaccine records in Minnesota immigrants, though there were differences in which countries were associated with decreased vaccination rates (1).

This is likely reflective of the differences in the demographic makeup of the refugee populations in each community.

Exposure to trauma or violence by the child or a family member was not associated with vaccine completion in this population. Documentation of trauma exposure varied based on which provider attended the visit and how the question was phrased. A standardized definition of trauma may allow for a more accurate assessment of the impact of such experiences on health outcomes.

One provider factor that may negatively affect vaccination rates is a failure to address vaccinations at acute visits (10, 14). Six of the 22 IFMC children (27%) who required reminder calls for missing vaccines attended recent sick visits at the clinic within the last two months, which represent missed opportunities to address vaccination.

Reminder and Recall Intervention

The reminder and recall intervention resulted in a statistically significant improvement in vaccination rates of 12%. This amount of improvement is similar to that of other studies. In a systematic review of reminder and recall methods, five studies of telephone reminders were associated with a composite 4% increase in immunizations (14). Another systematic review showed a median 8% increase in vaccinations after implementation of reminder interventions (8).

Differences in the degree of effect of this reminder and recall intervention may be reflective of the small sample size or the high baseline rate of vaccine completion in the IFMC population. Calls from a volunteer may have a smaller impact on parents' decisions for their child's care compared to contact from the child's provider or a nurse. However, the use of a volunteer likely increases the feasibility of the intervention.

Strengths and Weaknesses of the Design

Reminder and recall has a strong basis in the literature. The study addressed multiple hypothesized barriers to vaccinations from the literature and observations of clinic practice.

The intervention utilized a before-and-after design with no randomization of clients to the intervention. This design was intended to maximize the number of patients who received the intervention when working with a small starting population.

The limited time frame allowed for the study made it difficult to track appointment attendance and vaccine completion.

Data Availability

There were cases of incorrect or outdated parent contact information in the EMR, which delayed or prevented successful parent contact. The volunteer making reminder calls also faced obstacles such as parental unavailability during clinic hours and parental lack of voicemail capability.

There was more demographic information and medical history available for U.S.-born children compared to foreign-born children. The U.S.-born children were usually born in the hospital system that contains the IFMC, which meant more information on child and mother was readily available in the child's medical record. This continuity of care likely contributed to the finding of higher vaccine completion rates for U.S.-born children. While refugees are required to have certain health and vaccination records for immigration, more detailed medical history information may be lost in the immigration process, particularly for refugees who flee from countries with limited public health resources (13). However, Special Immigrant Visa immigrants, who comprise 21.6% of the IFMC patients in this study, do not have the same

overseas health screening and immunization requirements as refugees, which makes evaluating health history and vaccine completion challenging.

Generalizability

The findings of this QI project may not be generalizable to other settings. The resettlement patterns of refugees result in a distinct composition of cultures at each refugee relocation city, so what is effective in families from the cultures that predominate the IFMC population may not be applicable to other communities. The small size of the intervention group may also limit the ability to draw conclusions about effectiveness.

New Contribution to the Literature

This assessment reveals factors that may affect immunization completion in refugee children. Though the findings may not be generalizable to other refugee populations, it contributes to the body of work on factors affecting utilization of preventive care among refugees.

Reminder and recall has been demonstrated to improve vaccination rates in a variety of settings, but has not been studied in a refugee population. This project indicates that this intervention could be effective in improving pediatric vaccination rates and parental engagement for refugees.

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Table 1.

Criteria Used to Determine 'Up-to-Date' Vaccination Status at 12, 18, 24, 30, and 36 Months of Age

Vaccines	Number of doses at 12 months	Number of doses at 18 months	Number of doses at 24, 30, and 36 months
Hepatitis B	3	3	3
Diphtheria & tetanus toxoids & acellular pertussis	3	4	4
Haemophilus influenzae type B	3	4	4
Pneumococcal conjugate vaccine	3	4	4
Poliomyelitis	2	2	3
Measles, mumps, & rubella		1	1
Varicella		1	1
Hepatitis A		1	2

Table 2.

Demographic Characteristics of Children under Age Ten in the International Family Medicine Clinic

Characteristic	U.S.-born children of refugees (*n* = 152)	Refugee children (*n* = 176)	Total (*n* = 328)
Age in years			
Mean (*S.D*)	3.78 (*2.41*)	6.10 (*2.33*)	5.03 (*2.63*)
Gender			
Male (%)	82 (53.9)	87 (49.4)	169 (51.5)
Female (%)	70 (46.1)	89 (50.6)	159 (48.5)
Parent Country of Origin			
Afghanistan (%)	41 (27.0)	76 (43.2)	117 (35.7)
Iraq (%)	15 (9.9)	22 (12.5)	37 (11.3)
Bhutan/Nepal (%)	39 (25.7)	28 (15.9)	67 (20.4)
DRC (%)	11 (7.2)	12 (6.8)	23 (7.0)
Burma/Myanmar (%)	17 (11.2)	15 (8.5)	32 (9.8)
Syria (%)	0 (0.0)	13 (7.4)	13 (4.0)
Russia (%)	5 (3.3)	0 (0.0)	5 (1.5)
Somalia (%)	12 (7.9)	3 (1.7)	15 (4.6)
Iran (%)	2 (1.3)	2 (1.1)	4 (1.2)
Togo (%)	2 (1.3)	1 (0.6)	3 (0.9)
Colombia (%)	0 (0.0)	2 (1.1)	2 (0.6)
Ethiopia (%)	2 (1.3)	0 (0.0)	2 (0.6)
State of Palestine (%)	1 (0.7)	1 (0.0)	2 (0.6)
Tibet (%)	2 (1.3)	0 (0.0)	2 (0.6)
Other[a]	3 (2.1)	1 (0.6)	3 (0.9)
Mother status			

Refugee	124 (81.6)	122 (69.3)	246 (75)
SIV	17 (11.2)	54 (30.7)	71 (21.6)
Immigrant	7 (4.6)	0 (0.0)	7 (2.1)
Asylum Seeker	1 (0.7)	0 (0.0)	1 (0.3)
Missing	3 (2.0)	0 (0.0)	3 (0.9)
Insurance			
Medicaid (%)	141 (92.8)	171 (97.2)	312 (95.1)
Private Insurance (%)	7 (4.6)	0 (0.0)	7 (2.1)
Medicaid + period with Private Insurance (%)	2 (1.3)	1 (0.6)	3 (0.9)
Medicaid with period of no insurance (%)	2 (1.3)	3 (1.7)	5 (1.5)
Missing (%)	0 (0.0)	1 (0.6)	1 (0.3)
Preferred Language[b]			
English (%)	36 (23.7)	9 (5.1)	45 (13.7)
Dari (%)	24 (15.8)	51 (29)	75 (22.9)
Pashto (%)	7 (4.6)	19 (10.8)	26 (7.9)
Nepali (%)	37 (24.3)	27 (15.3)	64 (19.5)
Arabic (%)	12 (7.9)	35 (19.9)	47 (14.3)
Karen (%)	12 (8.6)	2 (1.1)	15 (4.6)
Swahili (%)	5 (3.3)	12 (6.8)	17 (5.2)
Burmese (%)	4 (2.6)	10 (5.7)	14 (4.3)
Farsi/Persian (%)	4 (2.6)	2 (1.1)	6 (1.8)
Somali/Mai-Mai (%)	3 (2.0)	2 (1.1)	5 (1.5)
Other/Unknown[c] (%)	7 (4.6)	7 (4.0)	14 (4.3)

Note. N = number of subjects; S.D. = standard deviation; DRC = Democratic Republic of the Congo; SIV = Special Immigrant Visa.

[a]Other countries included Liberia, Gambia, Pakistan, and Hong Kong (one child from each of these).

[b]Preferred language is based on electronic medical record documentation.

[c]Other languages included Spanish

Table 3.

Linear Regression Analysis of the Impact of Demographic Factors on Vaccine Completion for International Family Medicine Clinic Patients Expressed as Odds Ratios (OR) and Confidence Intervals (CI)

	12 Months *n* = 144		18 Months *n* = 122		24 Months *n* = 112		30 Months *n* = 111		36 Months *n* = 111	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Missed WCCs/year [a]	0.34*	[0.14, 0.80]	0.22*	[0.10, 0.52]	0.28*	[0.10, 0.76]	0.44	[0.18, 1.09]	0.92	[0.39, 2.21]
Foreign- Born	0.46	[0.20, 1.04]	0.56	[0.34, 0.91]	0.25*	[0.15, 0.42]	0.16*	[0.09, 0.28]	0.09*	[0.05, 0.17]
Maternal time in U.S. (years)	0.99	[0.90, 1.10]	1.02	[0.96, 1.10]	1.14*	[1.05, 1.22]	1.12*	[1.03, 1.20]	1.13*	[1.05, 1.23]
Maternal Country of Origin [b]										
Afghanistan	[c]		0.43	[0.13, 1.47]	0.20*	[0.06, 0.69]	0.14*	[0.03, 0.69]	0.11*	[0.01, 0.92]
Iraq	[c]		0.30	[0.08, 1.14]	0.17*	[0.04, 0.68]	0.11*	[0.02, 0.58]	0.08*	[0.01, 0.70]
Bhutan/ Nepal	[c]		1.12	[0.31, 4.11]	0.58	[0.16, 2.12]	0.28	[0.06, 1.38]	0.16	[0.02, 1.36]
DRC	[c]		0.15*	[0.03, 0.73]	0.13*	[0.03, 0.64]	0.09*	[0.02, 0.55]	0.06*	[0.01, 0.61]
Burma (Myanmar)	[c]		0.69	[0.17, 2.74]	0.51	[0.13, 2.02]	0.27	[0.05, 1.46]	0.20	[0.02, 1.81]
Syria	[c]		1.33	[0.24, 7.56]	0.13*	[0.02, 0.77]	0.08*	[0.01, 0.55]	0.06*	[0.01, 0.59]
Russia	[c]		0.27	[0.03, 2.25]	0.11	[0.01, 1.34]	0.05*	[0.00, 0.65]	0.06*	[0.00, 0.92]
Other [d]	[c]		0.80	[0.18, 3.65]	0.70	[0.15, 3.17]	0.36	[0.06, 2.19]	0.18	[0.02, 1.76]

Preferred Language[e]										
English	[c]		0.59	[0.16, 2.11]	0.94	[0.27, 3.29]	0.45	[0.12, 1.75]	0.67	[0.15, 2.97]
Dari	[c]		0.68	[0.20, 2.29]	0.46	[0.14, 1.51]	0.34	[0.09, 1.20]	0.27	[0.07, 1.08]
Pashto	[c]		0.69	[0.17, 2.92]	0.39	[0.09, 1.67]	0.36	[0.08, 1.59]	0.50	[0.10, 2.52]
Nepali	[c]		1.44	[0.42, 5.02]	1.22	[0.37, 3.98]	0.57	[0.16, 2.07]	0.46	[0.11, 1.86]
Arabic	[c]		0.69	[0.20, 2.37]	0.41	[0.12, 1.39]	0.24*	[0.07, 0.90]	0.22*	[0.05, 0.89]
Swahili	[c]		0.20*	[0.04, 0.98]	0.36	[0.07, 1.72]	0.20*	[0.04, 0.97]	0.21	[0.04, 1.07]
Burmese	[c]		0.89	[0.19, 4.24]	0.86	[0.19, 3.89]	0.34	[0.07, 0.90]	0.38	[0.07, 2.13’
Farsi/ Persian	[c]		0.37	[0.05, 3.02]	1.00	[0.11, 9.23]	0.40	[0.04, 3.90]	0.27	[0.03, 2.83]
Other[f]	[c]		1.11	[0.26, 4.82]	1.25	[0.31, 5.07]	0.80	[0.18, 3.65]	0.71	[0.14, 3.66]
Mother age at birth	1.02	[0.95, 1.10]	1.03	[0.98, 1.07]	1.05*	[1.01, 1.10]	1.07*	[1.02, 1.13]	1.08*	[1.02, 1.13]
Children per household	0.90	[0.71, 1.15]	0.83*	[0.70, 0.99]	1.01	[0.85, 1.21]	1.07	[0.89, 1.27]	1.07	[0.89, 1.28]
WIC services	1.65	[0.71, 3.84]	1.88*	[1.13, 3.13]	1.82*	[1.10, 3.02]	2.07*	[1.24, 3.45]	2.56*	[1.49, 4.38]

Note. *n* = number of children in analysis; OR = odds ratio; CI = confidence interval; WCC = well-child check; DRC = Democratic Republic of the Congo;. WIC = Women, Infants & Children. Non-significant variables were maternal education level, interpreter used for visit (if English not listed as preferred language in EMR), presence of English speaker in the home, number of specialists involved in care, developmental pediatrics specialist involved in care, proportion of sick visits to well visits, emergency department visits per

year, hospitalizations per year, use of CHIP services, involvement of a registered nurse care coordinator, and experience of trauma by child or family member.

*$p < .05$

[a]Number of missed well-child check per year receiving care at the International Family Medicine Clinic

[b]Due to colinearity, the country Somalia was excluded from the final regression results.

[c]Due to small number of cases, odds ratio estimates were too high to be reliable.

[d]Refers to less-commonly represented countries: Iran (*n*=4), Togo (*n*=3), Colombia (*n*=2), Ethiopia (*n*=2),, Palestine(*n*=2), Tibet (*n*=1), Liberia (*n*=1), Gambia(*n*=1), Pakistan (*n*=1), Hong Kong (*n*=1).

[e]Due to colinearity, the language Karenni was excluded from the final regression results.

[f]Refers to the less commonly represented languages: Somali/MaiMai (*n*=5), Kirundi (*n*=3), French (*n*=2), Spanish (*n*=2), Russian (*n*=2), Mandarin (*n*=1), Urdu (*n*=1), Tibetan (*n*=1), Krahn (*n*=1), and Ewe (*n*=1).