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Implementation of Immunization Services Through a Pediatric Urgent Care Clinic

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BACKGROUND AND OBJECTIVES: Pediatric urgent care (PUC) centers may bolster immunization campaigns by offering vaccination during acute care visits, but few such programs have been described.

METHODS: We conducted a quality improvement initiative at an academically affiliated federally qualified health center that provides primary, specialty, and PUC services to children. Our PUC began offering routine immunizations in July 2020. The percentage of visits by eligible patients age ≤ 21 years during which immunization screening (process) and administration (outcome) occurred was measured from March 1, 2021, to February 19, 2023. Administration rates were measured across age, sex, race, language, and medical home groups. Data were analyzed with statistical process control methods. Grievance and adverse event data were monitored (balancing).

RESULTS: We completed 4 plan-do-study-act cycles. Provider-facing bundles that included training, decision support, electronic health record signaling, and financial incentives were not associated with meaningful changes in screening and administration (cycles 1–3). A dedicated nurse vaccinator (DNV) was added on October 31, 2022 (cycle 4). The mean screening rate increased from 44.7% to 67.4% during the DNV period, and the mean administration rate increased from 26.5% to 50.8%. Lower administration rates were observed during visits by Black and English-speaking patients, and by patients empaneled outside our site.

CONCLUSIONS: Provider-facing interventions alone were not effective at increasing vaccine screening and administration in our PUC, but marked improvement was observed with the addition of a DNV. Future interventions are needed to address disparities. Additional investigation is needed to determine whether our results are reproducible in other PUCs with access to vaccines.

Shelter in place orders¹ and the rise of telehealth services^{2,3} disrupted conventional immunization infrastructure during the severe acute respiratory syndrome coronavirus 2 pandemic. Pediatric immunization rates fell dramatically for all age groups from March to April 2020^{4–6} and remained below baseline 6 months later.⁷ Although the medical community called for unconventional strategies to bolster immunization campaigns,^{8,9} to date, few such strategies have been evaluated.

Pediatric urgent care (PUC) centers have proliferated since the 1980s.¹⁰ Roughly one-fourth of American children access PUCs regularly.¹¹ Immunization during acute care visits is amenable to families¹² and does not affect subsequent primary care follow-up,¹³ but little is known about how these programs are implemented.

abstract



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Dr Gordon conceptualized the study design, codeveloped all provider-facing interventions, and drafted the initial manuscript; Ms Vega codeveloped all nurse-facing interventions, created the dedicated nurse vaccinator program, and analyzed project data as a core member of the quality improvement team; Dr Aulakh directed the Zuckerberg San Francisco General Hospital resident incentive project, and codeveloped all resident-facing interventions; Ms Bhargava-Shah codesigned the data reports and codeveloped the project's analysis methodology; Dr Bardach provided consultation on several change ideas in the quality improvement project; Dr Jain codeveloped several interventions; and all authors critically reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

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The Zuckerberg San Francisco General Hospital Children's Health Center (CHC) is an academically affiliated, federally qualified health center that provides primary, specialty, and PUC services to an urban community with high coronavirus disease 2019 (COVID-19) incidence.¹⁴ It shares an electronic health record (EHR) with 8 family medicine clinics in the San Francisco Health Network (SFHN). Early in the COVID-19 pandemic, the fraction of SFHN children (46.0%) and adolescents (77.0%) up to date on immunization for age were below Centers for Disease Control and Prevention (CDC) targets.¹⁵

In July 2020, the SFHN authorized the CHC's PUC to administer routine immunizations for SFHN patients. We initiated a quality improvement (QI) project when performance data became available in March 2021, hypothesizing that a blend of interventions directed at providers would influence vaccine decision-making. We aimed to administer all overdue CDC-recommended immunizations for age during 50% of visits by eligible patients age ≤ 21 years. In this report, we describe our experience implementing the program.

METHODS

Context

Our PUC is staffed by University of California San Francisco faculty pediatricians with diverse primary care experience. Pediatrics and family medicine residents rotate through PUC every 2 weeks. Patients are triaged by registered nurses. PUC operates on a drop-in basis 362 days per year and manages patients up to age 25 years with mild to moderate acuity. We also accept newborns that overflow from the CHC primary care clinic. Providers manage roughly 13 000 visits per year, field telephone consults from community physicians, support a nurse advice line, and address laboratory

and imaging results for all CHC service lines. Remote interpreter services are available.

Standard procedures permit nurses at the CHC to order and administer immunizations independently, with subsequent cosignature from providers. Nurses reconcile unclear records against the state vaccine registry and any documentation presented by the patient. Immunization is postponed until clarity is established. At baseline, these procedures were not applied in PUC. All CDC-recommended¹⁶ childhood and adolescent vaccine types are stocked in the CHC refrigerator, but before the COVID-19 pandemic, only influenza (seasonally) and tetanus (where clinically indicated) immunizations were offered in PUC.

In July 2020, a QI team was assembled consisting of the PUC associate medical director, the CHC nurse manager, and the CHC charge nurse. A driver diagram informed our initial workflow (Fig 1). PUC nurses were trained in vaccine operations by CHC primary care nurses. PUC attending physicians were trained during a provider meeting. Providers used an EHR "vaccines due" alert to screen for overdue vaccines, and confirmed vaccine status by comparing the patient's record to CDC guidelines. Tipsheets and CDC guidelines were posted in the provider workroom and in a cloud-based resource library. Placards listing vaccine eligibility criteria were affixed to each provider workstation. An immunization "preference list" was created in the EHR to align ordering options with available vaccine formulations. Primary care nurses were available for vaccine schedule consultation during weekdays from 9 AM to 5 PM. PUC providers were registered for maintenance of certification category 4 credit through the American Board of Pediatrics.

Performance data became available on March 1, 2021. Statistical process control (SPC) charts were shared and discussed through biweekly provider meetings and

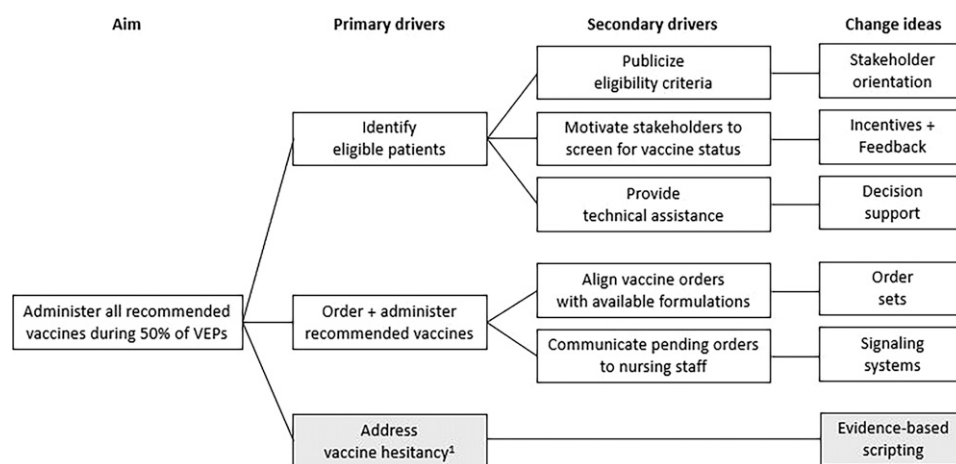


FIGURE 1

Driver diagram, vaccine administration at Zuckerberg San Francisco General Hospital pediatric urgent care. ¹Interventions to address vaccine hesitancy were postponed until clinic operations were optimized.

e-mails. Data collected through June 27, 2021, were used as baseline.

Population

Patients aged 0 to 21 years presenting in-person to PUC who were missing at least 1 vaccine for age per CDC guidelines were screened by their provider for vaccine eligibility. Influenza immunization was excluded to isolate the effect of our project from preexisting workflows, which included influenza immunization. COVID-19 immunization was excluded because coimmunization was contraindicated at the time of our project. Tetanus immunization was included because, at baseline, it was rarely administered.

Non-SFHN patients, patients for whom a vaccine record could not be obtained, patients with a contraindication to any recommended vaccine, and patients scheduled for an in-person well-child visit in the 30 days after their PUC visit were considered ineligible. Non-SFHN patients were excluded because we did not have authorization from out-of-network clinics to offer immunization. We excluded patients with upcoming well-child checks to alleviate staff concerns that immunization in PUC might affect subsequent primary care attendance.

Interventions

Unless specifically mentioned, each cycle's intervention bundle was superimposed upon the previous cycle's bundle without modification (Table 1).

Cycle 1 (June 28, 2021–November 14, 2021): One third-year resident and 2 second-year residents were recruited onto the QI team. Resident interviews identified inadequate incentives, education, decision support, and communication systems as additional drivers. The project was registered with the hospital resident incentive program, which offers financial remuneration to contributing residents if targets are met. A project description was included in resident orientation materials. A vaccine decision-making menu was inserted into the "past medical history" section of all PUC note templates. The menu was configured to prevent note signature until an option was selected. Workstation placards were updated to include a list of participating SFHN clinics and a quick response code linking to the PUC vaccine resource folder. A new column was inserted into the PUC EHR trackboard that flagged pending vaccine orders.

Cycle 2 (November 15, 2021–April 17, 2022): A "Vaccines OK?" (yes/no) sign was installed in the provider workroom. Nurses flipped the sign to no when staffing shortages or task load prohibited immunization services.

Cycle 3 (April 18, 2022–October 30, 2022): Vaccine project updates were incorporated into daily team huddles. The EHR messaging system was used to promote closed-loop communication between providers and nurses when vaccines were ordered. To improve visibility, the vaccine decision-making menu was moved to the "history of present

illness" section of the note template and inserted into the third-year resident attestation template.

Cycle 4 (October 31, 2022–February 19, 2023): SFHN reassigned a "dedicated nurse vaccinator" (DNV) to PUC from another site. The DNV identified eligible patients, pended vaccine orders, and administered overdue immunizations. The DNV was assigned no other clinical duties. This resource was available on weekdays from 9 AM to 5 PM. When the DNV was unavailable or missed an opportunity to immunize, providers followed the cycle 3 workflow.

Measures

Demographics

Patient age, sex, self-reported race, language, and medical home were extracted from the EHR for all visits by eligible patients (VEPs). Age was stratified into "<37 months" and "37 months to 10 years" cohorts to align with national measurement standards,¹⁷ and into "11 to 17 years" and ">17 years" cohorts to distinguish the effect of adolescent and adult vaccine decision-making, respectively. Race was stratified into Latinx, Black, and other cohorts to measure performance among communities known to have high and low immunization coverage, respectively. Medical home was stratified into CHC and non-CHC cohorts to capture the effect of empanelment at our colocated primary care practice on immunization.

Outcome (Primary)

Administration rate was calculated as "VEPs during which all recommended immunizations were administered/VEPs."

Process

Screening rate was calculated as "VEPs during which all recommended immunizations were administered or any immunization was declined/VEPs." Declination rate was calculated as "Visits by patients screened for immunization during which any immunization was declined/visits by patients screened for immunization." Declinations were captured if documented in the progress note. Visits by patients receiving some but not all recommended immunizations were considered declinations.

Because the EHR was unable to calculate our outcome and process measures from a single report, we generated weekly immunization "missed opportunities" and "vaccines administered" reports. The missed opportunities report listed PUC visits by patients overdue for at least 1 vaccine at the time the report was run. The QI team performed chart reviews for each missed opportunity to confirm vaccine eligibility at the time of the visit. If a patient visited PUC more than once during the week of data capture and was underimmunized at the time the report was run, both visits were considered missed opportunities. The vaccines administered report listed PUC visits during which patients

TABLE 1 Barriers Identified and Countermeasures Implemented to Influence Immunization Practice at ZSFG Pediatric Urgent Care, March 1, 2021–February 19, 2023

| Cycle ^a | Barrier | Countermeasure | Start Date | Description | Corresponding Change Idea(s) |
|--------------------|--|--|-------------------|--|------------------------------|
| Baseline | Providers unfamiliar with vaccination program | Provider orientation | July 1, 2020 | PUC director introduced immunization workflow at biweekly provider meeting | Stakeholder orientation |
| | Providers unfamiliar with vaccination workflow | Provider tipsheets | July 1, 2020 | PUC immunization workflow tipsheet and decision support algorithm posted in cloud-based PUC resource library | Stakeholder orientation |
| | Providers unfamiliar with vaccination standard of care | Immunization references | July 1, 2020 | CDC immunization schedule posted in provider workroom and cloud-based PUC resource library | Decision support |
| | Providers unfamiliar with available vaccine formulations | Nurse consultation | July 1, 2020 | Primary care nurses supported PUC providers with vaccine decisions on a case-by-case basis | Decision support |
| | — | Standard order set | July 1, 2020 | Preference list created in EHR featuring available vaccine formulations | Order sets |
| | Providers perceive additional work with unknown benefit to patients or providers | Group feedback | March 18, 2021 | PUC performance presented biweekly at CHC provider meeting | Incentives + feedback |
| | — | ABP MOC4 credit | March 22, 2021 | Project enrolled for MOC4 credit | Incentives + feedback |
| 1 | Insufficient resident engagement | Resident incentive project | July 1, 2021 | Registered initiative as a ZSFG resident incentive project, which offers financial reward to participating residents if targets are reached | Incentives + feedback |
| | Interresident variation in behavior | Resident orientation | July 12, 2021 | Information about vaccine program incorporated into resident wiki for PUC rotation; vaccine program overview included in chief resident's "switch day" | Stakeholder orientation |
| | — | EHR note prompt ^c | July 13, 2021 | Mandatory drop-down menu forces provider to document vaccine decision-making before locking note | Decision support |
| | Residents unfamiliar with participating clinics | Workstation placards: Participant list | July 13, 2021 | Laminated placard listing all SFHN clinics affixed to each workstation | Decision support |
| | Hospital firewall slows connection to vaccine resource library | Workstation placards: Resource link | July 13, 2021 | Laminated QR code affixed to each workstation connects residents to cloud-based PUC resource library via mobile device | Potential |
| | Nursing staff unaware that vaccine order has been | Vaccine column on trackboard | August 3, 2021 | New column inserted into PUC trackboard displaying a flag when a vaccine has been ordered | Signaling systems |
| 2 | Nurse deployment and absenteeism during omicron surge reduces nursing bandwidth for vaccine administration | Shift to "if able" vaccine policy | December 15, 2021 | Providers must ask permission from nurses before ordering vaccines | Mitigation ^f |

TABLE 1 Continued

| Cycle ^a | Barrier | Countermeasure | Start Date | Description | Corresponding Change Idea(s) |
|--------------------|---|--|--------------------|--|------------------------------|
| | Providers uncertain whether nursing can or cannot administer vaccines | Program status placard | February 1, 2022 | Laminated green/red Yes/No flip sign suspended in provider workroom to signal vaccine program status | Mitigation ^f |
| 3 | Irregular scheduling affects institutional memory | Morning huddle prompt | June 22, 2021 | Inserted vaccine update prompt into morning huddle checklist | Signaling systems |
| | Vaccine decision-making prompt not visible at time of patient encounter | Relocate EHR note prompt ^d | June 22, 2021 | Mandatory vaccine decision-making menu moved from plan to HPI section of note template | Potential ^g |
| | Nursing staff unaware that vaccine order has been placed | Introduce EHR “chat” feature | August 30, 2022 | Established EHR chat as standard for RN–MD communication, promoted closed-loop communication around vaccine orders | Signaling systems |
| | Nonstandard behavior among precepting R3s ^b | EHR attestation note template modification | September 28, 2022 | Inserted mandatory vaccine decision-making menu into R3 attestation note template | Decision support |
| 4 | Nonstandard vaccine ordering behavior among providers | DNV ^e | October 31, 2022 | Licensed vocational nurse reassigned from primary care to PUC vaccine program; standard procedures allowed LVN to determine eligibility, pend orders, and administer immunizations | Mitigation |

ABP, American Board of Pediatrics; HPI, history of present illness; LVN, licensed vocational nurse; MD, Doctor of Medicine; MOC4, Maintenance of Certification category 4; QR, quick response; R3, third-year resident; RN, registered nurse; ZSFG, Zuckerberg San Francisco General Hospital.

^a Baseline: March 1, 2021, to June 27, 2021; cycle 1: June 28, 2021, to November 14, 2021; cycle 2: November 15, 2021, to April 17, 2022; cycle 3: April 18, 2022, to October 30, 2022; cycle 4: October 31, 2022, to February 19, 2023.

^b Pediatric third-year residents precept with minimal supervision in PUC. Inserting the note prompt into the third-year resident attestation template was meant to improve visibility while the patient was present.

^c “Vaccine decision-making: [select one];” options include “Up to date on vaccines,” “Declined vaccine(s),” “Reliable vaccine record unavailable,” “Not empaneled at an SFHN clinic,” “Nursing unable to administer vaccine(s),” “Contraindication to recommended vaccine(s),” and “Other (please specify).”

^d Relocating the note prompt to the history of present illness was designed to improve visibility while the patient was present.

^e DNV. Service available from 9 AM to 5 PM Monday through Friday. When DNV unavailable (8 AM–9 AM and 5 PM–8 PM Monday–Friday, 9 AM–5 PM on weekends), the availability of vaccine services is communicated through a program status placard in the provider workroom (Yes/No).

^f During cycle 2, measures were taken to mitigate staffing shortages but little was done to promote vaccination.

^g Implemented to potentiate behavior change interventions or optimize workflow.

received at least 1 immunization. Visits by patients with medical record numbers common to both the missed opportunity and vaccines administered reports were considered partially immunized and treated as declinations.

Balancing

Safety events reported by employees through the hospital alert system and grievances filed by patients against PUC were monitored for vaccine-related content. Visits by ineligible patients who mistakenly received recommended vaccinations were also monitored.

Analysis

Screening, administration, and declination rates were plotted every 14 days on p-type SPC charts. Special cause variation

was identified using established rules.¹⁸ Center lines were adjusted when sustained special cause variation aligned with expected process changes. All special cause variation was investigated. We set our screening target at 65%, corresponding to the 2020 Medicaid benchmark for all immunizations up to date among patients aged 19 to 35 months. We set the administration rate target at 50% to account for declinations. The QI team analyzed quality gaps using 5 whys, chart reviews, provider interviews, and feedback from provider meetings. New plan-do-study-act (PDSA) cycles were considered when special cause variation was detected, following the Model for Improvement.¹⁹

Administration rates stratified by age group, sex, race, language, and medical home were calculated post-hoc. Separate calculations were made for pre-DNV and DNV periods.

SPC charts were generated using the Performance Improvement Products QI Charts plug-in for Microsoft Excel (Performance Improvement Products. 2015. Available at: <https://pipproducts.com/store>; Microsoft Corporation. 2016. Available at: <https://office.microsoft.com/excel>). This unfunded project was deemed exempt from ethical review by the University of California San Francisco institutional review board.

RESULTS

In total, PUC fielded 2717 visits by VEPs during the study. Most VEPs were age <18 years (96.2%), Latinx (72.8%), non-English-speaking (62.7%), and empaneled for primary care at the CHC (80.2%) (Table 2). A patient was screened for immunization during 1303 visits and all recommended immunizations were administered during 629 visits (48.0% and 23.2% of VEPs, respectively). Partial immunization occurred during 45 visits and declinations were documented during 674 visits (3.5% and 51.7% of visits by patients screened, respectively).

Mean screening rates increased from 44.7% during cycles 1 to 3 to 67.4% during cycle 4 (Fig 2). Mean administration rates decreased from 26.5% to 16.2% during cycle 2, then increased to 50.8% during cycle 4 (Fig 3). Mean declination rates decreased from 54.8% to 31.4% during cycle 4 (Supplemental Fig 4).

During baseline, performance declined progressively for both screening and administration. During cycle 1, performance stabilized for screening and administration. Declination did not change.

During cycle 2, San Francisco's COVID-19 omicron surge began. Sick calls and deployments among PUC nurses disrupted vaccine operations. In December 2021, nurses asked providers to seek permission before ordering vaccines during VEPs. The project data manager began a 3-month leave on October 9, 2021, and provider meeting vaccine presentations were discontinued on November 15. Performance declined for screening and administration. Declination did not change. Special cause variation was detected for administration on February 13, 2022, reflecting exceptional performance from a single third-year resident (S.A.). This resident was interviewed, and findings informed the cycle 3 bundle. The center line was not adjusted for this observation.

During cycle 3, the omicron surge abated and nurse staffing stabilized. Provider meeting vaccine presentations restarted. Performance did not change for any measure.

During cycle 4, screening and administration rates increased. Performance targets were met for both measures. Declination declined.

Administration rates by subgroup and DNV exposure are shown in Table 3. Rates during the pre-DNV period were comparable by sex and language. Lower rates were observed among visits by patients age 37 months to 10 years and >17 years (15.9% and 15.7%, respectively, versus 19.8% and 21.5% for <37 months and 11–17 years, respectively), Black patients (13.5% vs 19.9% and 19.5% for Latinx and other, respectively), and non-CHC patients (13.2% vs 20.5%). Rates during the DNV period were comparable by sex. Lower rates were observed among visits by older patients (36.2% and 35.0% for 11–17 years and >17 years, respectively, versus 38.8% and 42.0% for <37 months and 37 months–10 years, respectively), Black patients (24.3% vs 41.4% and 40.0% for Latinx and other, respectively), English-speaking patients (32.1% vs 42.7%), and non-CHC patients (26.0% vs 42.1%).

No safety events or patient grievances related to vaccines were filed against PUC. Recommended immunizations were mistakenly administered to ineligible patients during 142 visits, all of whom were ineligible because they had a medical home outside the SFHN (18.4% of all visits by patients receiving vaccines).

DISCUSSION

Our PUC implemented a routine immunization program that achieved its target screening and administration rates. Large-magnitude improvements were observed when provider-facing interventions were combined with a DNV program. No safety events were reported. The inclusion of patients age 0 to 21 years and the use of complete immunization as a primary measure distinguish our approach from related studies.

TABLE 2 Visits by Patients Eligible for Immunization at ZSFG Pediatric Urgent Care, March 1, 2021–February 19, 2023, by Demographics (*n* = 2717)

| | <i>n</i> | % |
|---------------------------------|----------|------|
| Age category | | |
| <37 mo | 952 | 35.2 |
| 37 mo–10 y | 827 | 30.4 |
| 11–17 y | 835 | 30.7 |
| >17 y | 103 | 3.8 |
| Sex (male) | 1370 | 50.4 |
| Self-reported race | | |
| Latinx | 1979 | 72.8 |
| Black | 329 | 12.1 |
| Other | 409 | 15.1 |
| Preferred language (English) | 1014 | 37.3 |
| Medical home (CHC) ^a | 2180 | 80.2 |

Data from June 27 to July 3, 2022 (cycle 3) omitted because of file corruption. ZSFG, Zuckerberg San Francisco General Hospital.

^a Zuckerberg San Francisco General Hospital CHC colocalizes with Zuckerberg San Francisco General Hospital pediatric urgent care; non-CHC clinics include Zuckerberg San Francisco General Hospital Family Health Center, Silver Avenue Health Center, Southeast Health Center, Potrero Hill Health Center, Maxine Hall Health Center, Castro Mission Health Center, and Chinatown Public Health Center.

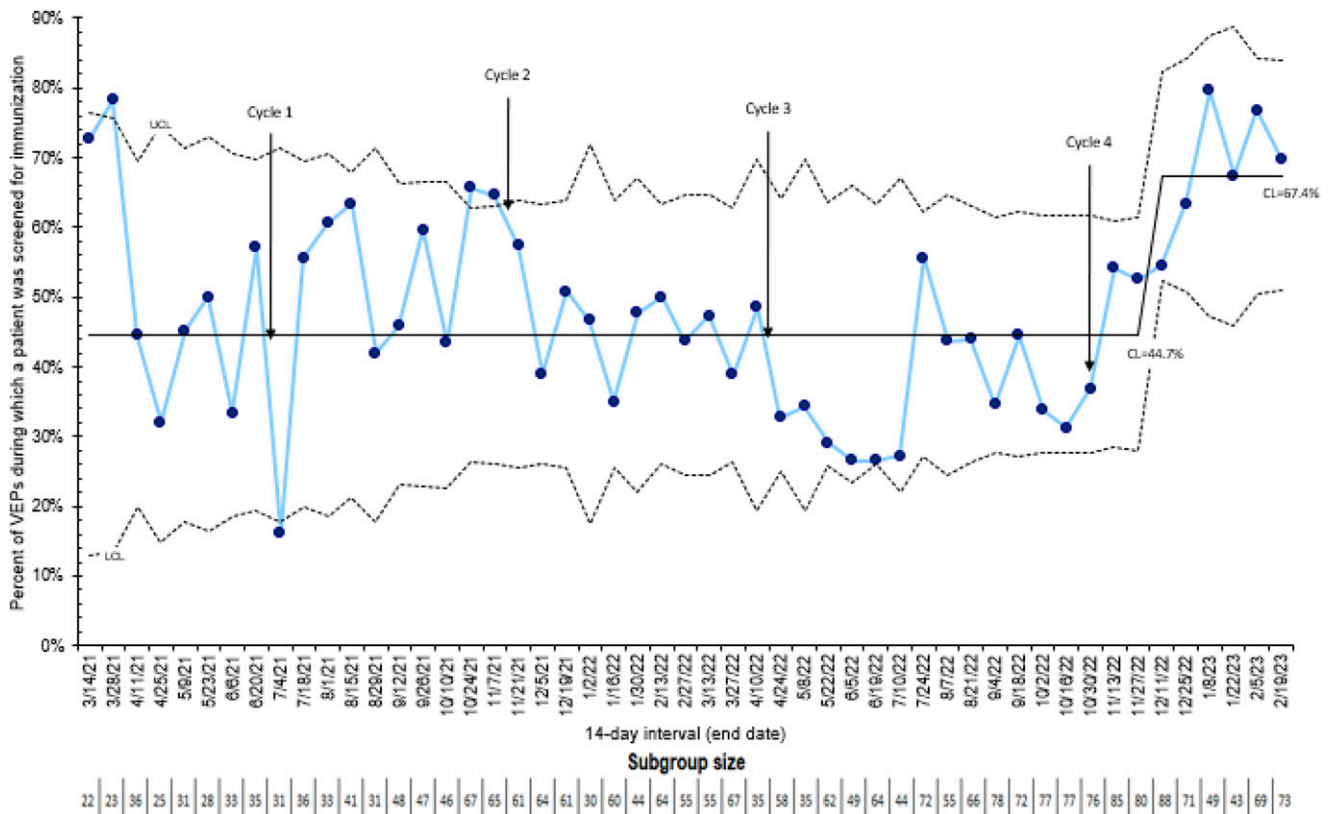


FIGURE 2

P chart, percentage of visits by eligible patients during which immunization screening occurred, Zuckerberg San Francisco General Hospital pediatric urgent care, March 1, 2021, to February 19, 2023 ($n = 2717$). Data from June 27 to July 3, 2022 (cycle 3), omitted because of file corruption. The special cause variation detected on July 4, 2021, was not sustained. We initiated a new PDSA cycle but did not adjust the center line. The special cause variation detected on June 5, 2022, was not sustained. It reflects lingering staffing and operational changes implemented during the COVID-19 omicron surge. We did not adjust the center line. CL, center line; LCL, lower control limit; UCL, upper control limit.

Provider-facing interventions have improved immunization practice in the acute care setting,^{20,21} but alone, they did not improve screening or administration in our PUC. Team heterogeneity and turnover presented 1 challenge. Over half the attending pediatricians in our PUC had no recent experience managing immunizations, residents rotated every 14 days, and nurses were deployed elsewhere throughout the COVID-19 response. These conditions may have impeded practice standardization. Conflicting priorities presented another challenge. PUC providers manage patients with relatively high acuity while juggling follow-up and telehealth tasks unrelated to acute care. These responsibilities may have distracted providers from vaccination opportunities. The provider-centered approach may be more effective at PUCs with consistent staffing and workload.

The introduction of a DNV coincided with dramatic improvements in vaccine screening and administration at our PUC. Nurse-driven vaccine programs are cost-effective^{22,23} and have improved immunization in other acute care settings.²⁴ Conclusions from our study should be made

cautiously because provider-facing interventions may have acted synergistically with the DNV program.

During the DNV period, administration rates improved for all demographic cohorts. Administration gaps narrowed for patients age 37 months to 10 years; persisted among older (>17 years), Black, and non-CHC patients; and widened for English-speaking patients. The improvement among patients aged 37 months to 10 years aligns with national trends, which featured exceptionally low rates early in the COVID-19 pandemic followed by rapid recovery.⁷ To our knowledge, none of our interventions disproportionately benefitted this cohort. Underimmunization among adult and Black patients also aligns with national trends^{25–27} and may reflect differences in vaccine hesitancy for these groups. Confusion among clinicians regarding which non-CHC clinics were participating in the immunization program may explain the underperformance for this cohort. To our knowledge, underimmunization among English-speaking patients has not been described elsewhere. We hypothesize that language may correlate with race, because many Black patients prefer English

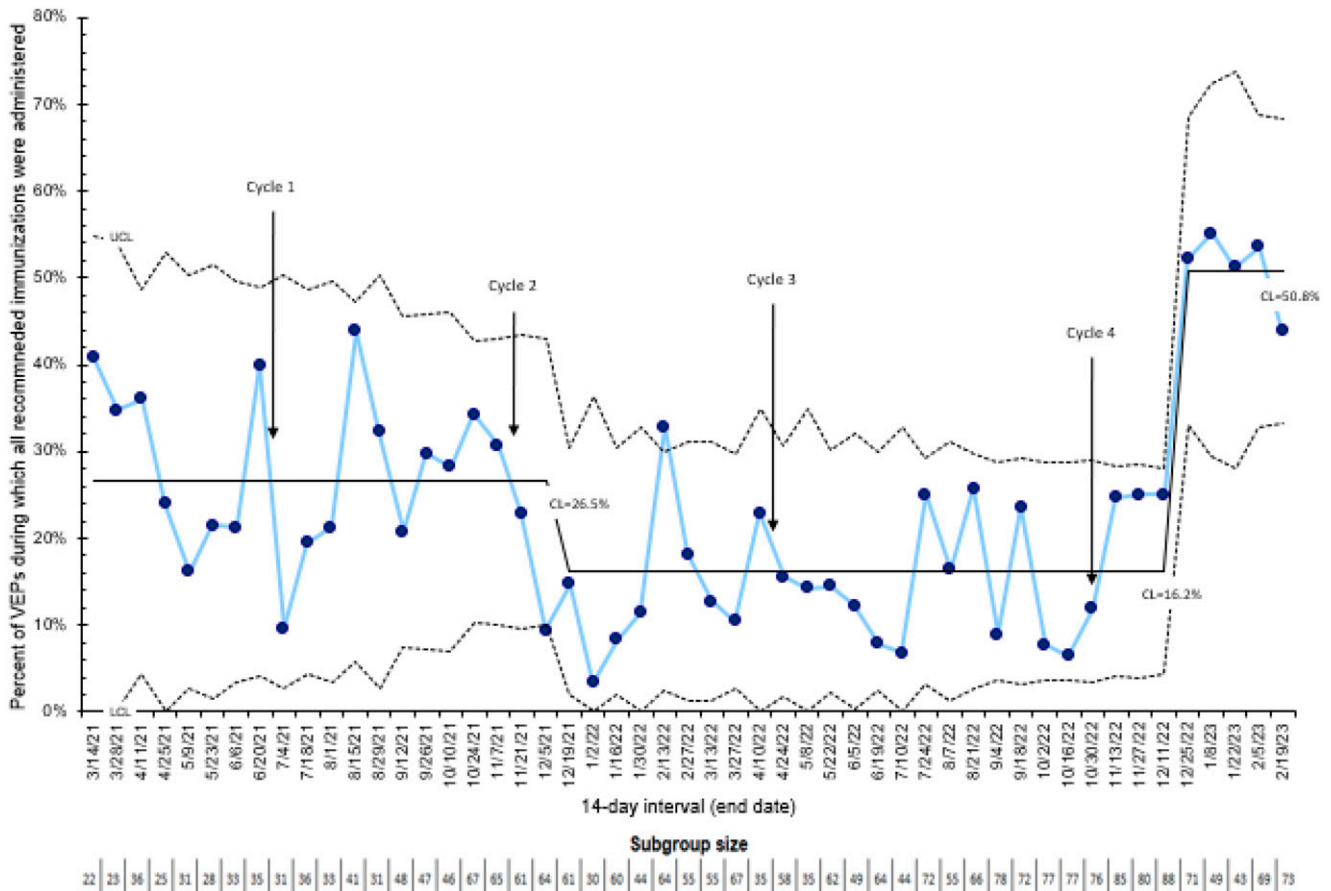


FIGURE 3

P chart, percentage of visits by eligible patients during which all recommended immunizations were administered, Zuckerberg San Francisco General Hospital pediatric urgent care, March 1, 2021, to February 19, 2023 ($n = 2717$). Data from June 27 to July 3, 2022 (cycle 3), omitted because of file corruption. The special cause variation detected on February 13, 2022, was not sustained. It reflects exceptional performance from a pediatrics resident (S.A.). We did not adjust the center line. The special cause variation detected on June 19, 2022, was not sustained. It reflects lingering staffing and operational changes implemented during the COVID-19 omicron surge. We did not adjust the center line. CL, center line; LCL, lower control limit; UCL, upper control limit.

at our site. Additional investigation is needed to confirm these hypotheses. Vaccine disparities should be prioritized in future PDSA cycles.

Overall vaccine declination was high, aligning with reports from other acute care settings.^{13,21} Declination decreased during the DNV period, but remained higher than national benchmarks.²⁸ Vaccine declination decreases with evidence-based communication tools,^{23,29} even in the acute care setting.²⁰ Offering scripts to providers and including families on our QI team may address hesitancy in future PDSA cycles.

No safety events or patient grievances pertaining to immunization were reported. Of the visits during which immunizations were administered, however, nearly 1 in 5 were by non-SFHN (ineligible) patients. These errors of commission may have several explanations. First, our eligibility restrictions were quite complex, likely affecting adherence. Second, our PUC sees a large proportion of

underimmunized non-SFHN patients. Well-meaning providers may have disregarded our restrictions for the benefit of this group. Third, as vaccine procedures became routine, the default practice among some providers may have shifted in favor of immunization. In any case, the risk of immunizing non-SFHN patients is low, provided that no contraindications were reported. The practice also contributed to community immunization, even if outside the scope of our project.

This study has several limitations. First, our PUC collocates with a primary care operation, affording us supplies and systems that facilitated immunization at baseline. Our population was predominantly Latinx and restricted to patients with documented medical homes. These nuances may affect the reproducibility of our results. Second, our health network supported the DNV program. PUCs serving communities with higher baseline immunization may not attract the same support from their health systems. Third, data from cycle 4 may

TABLE 3 Visits by Eligible Patients During Which All Recommended Immunizations Were Administered at ZSFG Pediatric Urgent Care, by Demographic, Pre-DNV Versus DNV (*n* = 2717)

| | <i>n</i> (%) | |
|---------------------------|----------------------------|-----------------------|
| | Pre-DNV (<i>n</i> = 2159) | DNV (<i>n</i> = 558) |
| Age category | | |
| <37 mo | 145 (19.8) | 85 (38.8) |
| 37 mo–10 y | 103 (15.9) | 76 (42.0) |
| 11–17 y | 150 (21.5) | 50 (36.2) |
| >17 y | 13 (15.7) | 7 (35.0) |
| Sex | | |
| Male | 210 (19.3) | 113 (40.4) |
| Female | 201 (18.8) | 105 (37.8) |
| Self-reported race | | |
| Latinx | 311 (19.9) | 171 (41.4) |
| Black | 35 (13.5) | 17 (24.3) |
| Other | 65 (19.5) | 30 (40.0) |
| Preferred language | | |
| English | 150 (18.2) | 61 (32.1) |
| Non-English | 261 (19.6) | 157 (42.7) |
| Medical home ^a | | |
| CHC | 354 (20.5) | 191 (42.1) |
| Non-CHC | 57 (13.2) | 27 (26.0) |

Pre-DNV: March 1, 2021, to October 30, 2022; DNV: October 31, 2022, to February 19, 2023. ZSFG, Zuckerberg San Francisco General Hospital.

^a Zuckerberg San Francisco General Hospital CHC colocates with Zuckerberg San Francisco General Hospital pediatric urgent care; non-CHC clinics include Zuckerberg San Francisco General Hospital Family Health Center, Silver Avenue Health Center, Southeast Health Center, Potrero Hill Health Center, Maxine Hall Health Center, Castro Mission Health Center, and Chinatown Public Health Center.

be insufficient to demonstrate sustainability. Further follow-up is needed. Fourth, our vaccine program may have affected operating costs, cycle times, or preexisting workflows, but our study was not designed to capture these effects. Fifth, we did not calculate associations between demographic variables and immunization because such an analysis was beyond the scope of this report. Additional evaluation is needed.

Finally, we were unable to generate an EHR report that met all data needs, leading us to develop a workaround that may have affected the accuracy of our data. First, VEPs presenting just before a vaccine due date may have been falsely captured as missed opportunities, leading us to underestimate screening and administration. We attempted to minimize this effect by running the report frequently (weekly). Second, we did not capture visits during which vaccines were ordered but not administered. This leads us to underestimate screening but not administration. Third, visits during which providers documented declination in the vaccines due alert were not captured in the missed opportunities report, leading us to underestimate screening and overestimate administration.

Routine immunization services were effectively and safely implemented in our PUC. Our next intervention bundle must address disparities and vaccine hesitancy. Additional

investigation is needed to determine whether our program affected community immunization, whether it is sustainable under evolving conditions, and whether it is reproducible in other PUCs with vaccine access.

ABBREVIATIONS

CDC: Centers for Disease Control and Prevention

CHC: Children's Health Center

COVID-19: coronavirus disease 2019

DNV: dedicated nurse vaccinators

EHR: electronic health record

PDSA: plan-do-study-act

PUC: plan-do-study-act

PUC: pediatric urgent care

QI: quality improvement

SFHN: San Francisco Health Network

SPC: statistical process control

VEP: visit by eligible patient

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