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RESEARCH REPORT

Pediatric influenza vaccination in the perioperative setting: A quality improvement project

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Abstract

Introduction/Background: Unmet need for seasonal influenza vaccination administration to pediatric patients exists at national and local levels. Vaccination during the perioperative period remains controversial, though opportunity exists to meet vaccination need through perioperative programs. The initial SMART Aim of this quality improvement initiative was to establish and increase seasonal influenza vaccination rate in eligible patients during in person preoperative clinic visits in a pediatric perioperative surgical home (PSH) to 10%. Informed by each prior season's experience, we increased our SMART Aim target for vaccinations in seasons two and three to 15 and 18%, respectively.

Methods: Following the Model for Improvement methodology, the PSH team developed and implemented a perioperative pediatric influenza vaccination program. Across three influenza seasons, key interventions included updates to organizational perioperative vaccination policy, obtaining material influenza vaccination supplies, development of EHR tools, PSH staff education, and communication with patient–families. Rate of eligible patients receiving influenza vaccination at their PSH clinic appointment was tracked over time. Influenza vaccination rates were reported monthly during Season 1, then weekly during seasons two and three. The balancing measure was same day surgery case cancellations related to influenza vaccination given at PSH clinic appointment. Statistical analysis methods utilized include Shewart's control chart and statistical process control (SPC) standards. Special cause variation was determined by eight or more consecutive data points above or below the centerline.

Results: The influenza vaccination rates in each of the three influenza seasons exceeded vaccination rate goals of 10, 15, and 18%, respectively. A total of 695 vaccines have been administered since program inception. No same day surgical case cancellations were observed as balancing measure.

Conclusions: Over three consecutive influenza vaccination seasons, we safely established and met vaccination rate goals of 10, 15, and 18% to eligible patients during preoperative clinic visits within a pediatric PSH system. Through iterative PDSA cycles, we continue to identify opportunities for future improvement. This suggests that the perioperative period presents opportunity for seasonal influenza vaccination with potential program expansion to include routine vaccines of childhood.

KEYWORDS
influenza, perioperative period, vaccination

1 | INTRODUCTION

The U.S. Department of Health and Human Services has made increasing vaccination rates a priority goal in their Healthy People 2030 campaign.[1] Through the COVID-19 pandemic, disruption of childhood vaccination schedules and ongoing vaccine hesitancy has impacted the delivery of recommended vaccinations.[2,3] Seasonal vaccinations have been similarly impacted during recent influenza seasons, with pediatric influenza vaccination observed to have decreased compared to the prepandemic period.[4] This drop occurred despite proven benefits of influenza vaccination, including a number needed to treat of 5 to prevent an influenza infection during the decade spanning 2009/2010 through 2019/2020.[5] Recent guidance encourages healthcare providers to use every opportunity to administer influenza vaccines to eligible persons.[6]

For many years, merits of perioperative vaccination have been debated in the literature without a resulting consensus.[7,8] Several concerns related to perioperative vaccination have been noted. Anesthetic and surgical stressors have been noted to alter normal immune function.[9] Such alterations have raised concern of decreased vaccine efficacy if administered during the perioperative period, though no definitive studies have shown real clinical impact.[8] Another concern is vaccine related side effects and their potential interpretation as anesthetic or surgical complications.[10] However, only one reported case of a serious event, febrile convulsions in an infant with history of MMR vaccine, has been reported.[11] Furthermore, when vaccines have been given in accordance with vaccination schedules, it has resulted in surgical case cancellations that may not be necessary.[12] A strategy favoring vaccinations "at every opportunity" poses a conflict with perioperative vaccine avoidance strategy that is, in part, informed by a paucity of scientific investigations and a variety of statements and recommendations regarding the timing and practice of perioperative vaccination.[10,13]

Locally, there has been an organizational initiative to improve seasonal influenza vaccination in patients. At the same time, there was an observed decrease in seasonal influenza vaccination rate through the COVID-19 pandemic. The resulting priority and gap in care provided a sense of urgency to identify new opportunities to "meet patients where they are" and increase rate of seasonal influenza vaccination. Our institution utilizes a perioperative surgical home (PSH) model of care to perform preoperative evaluation, preparation, and coordination of care of perioperative patients. To address the local decrease in influenza vaccination rate, our PSH team sought to begin a perioperative seasonal influenza vaccination program. The primary aim with this quality improvement (QI) project was to increase the PSH preoperative clinic seasonal influenza vaccination rate in Season 1 from 0 to 10% through the establishment of a novel perioperative influenza vaccination program to identify and administer seasonal influenza vaccine in eligible patients. This rate was selected as an initial goal to guide our QI efforts, as there are no similar reports to benchmark against. During subsequent seasons of the project, the goal was expanded based on our QI learnings.

What is already known about the topic?

Perioperative vaccination has previously been debated in the literature. Very few studies have investigated the implementation of a perioperative seasonal influenza vaccination strategy.

What new information this study adds?

We report the successful implementation of a perioperative seasonal influenza vaccination program utilizing the pediatric perioperative surgical home model of care.

2 | METHODS

2.1 | Setting and improvement methodology

The QI project was reviewed and deemed exempt from institutional review board oversight. The improvement project was conducted at a large, multi-campus, freestanding academic children's hospital with 443 beds, 1.2 million outpatient visits, and 17 000 surgeries, of which 11 000 receive preoperative evaluation through our PSH department. The PSH department has clinical operations on two campuses, as well as capabilities to prepare patients through telehealth appointments. The improvement project spanned from August of 2020 through March of 2023.

Across the enterprise, PSH outpatient clinics have nine dedicated examination rooms and three additional flex rooms for telehealth visits and other clinical needs. Dedicated PSH staffing includes advanced practice registered nurses (APRN), registered nurses (RN), child life specialists (CLS), medical assistants (MA), scheduler, and registrar. There is an anesthesiologist medical director, as well as onsite anesthesiologists available at both campuses for consultation during clinic hours.

The improvement project was guided by the Model for Improvement methodology, which was chosen for its proven success and ease of use.[14] This model provides a framework for improvement that can be used to support diverse quality improvement

efforts across many fields and project types. This framework can be applied to varying degrees, depending on formality and complexity of projects, to apply five fundamental principles of improvement; knowing why improvement is needed, utilizing a feedback mechanism to gauge if improvement is occurring, developing effective change that results in improvement, testing a change before attempting to implement, and implementing the change.

Our project utilized a layered committee structure. The local PSH influenza vaccine project group functioned as a subcommittee within the larger organizational influenza committee. The steering committee provided oversight to the PSH group, as it does for multiple improvement teams within various specialty clusters of the organization, during each influenza vaccination season. The PSH project team was multidisciplinary and included an anesthesiologist, APRN, RN, quality improvement specialist, and an electronic health record (EHR) specialist. Ad hoc input was solicited early in the project from an infectious disease physician and PSH clinic staff. Key improvement tools included a key driver diagram, process mapping, simplified failure modes and effects analysis, and plan-do-study-act (PDSA) cycle testing. Rate of eligible patients receiving seasonal influenza vaccine during their PSH clinic appointment is the primary outcome measure for this project.

2.2 | Interventions and testing

The global and SMART (specific, measurable, applicable, realistic, and timely) aims, combined with key drivers and potential interventions, are identified in the most recent key driver diagram for Season 3 of the QI project (Figure 1). Among the listed key drivers and interventions necessary to achieve the improvement goal for the perioperative seasonal influenza vaccination program, our team identified and prioritized several key interventions. The initial SMART Aim of this quality improvement initiative was to establish and increase seasonal influenza vaccination rate in eligible patients during in person preoperative clinic visits in a pediatric PSH to 10%. Using QI methodology, we built upon our QI learnings and successes, improved our processes, and increased our SMART Aim in seasons two and three to 15 and 18%, respectively.

2.3 | Season 1

Prior to going live with the first vaccine administration for the 2020–2021 influenza vaccination program, the team focused on drivers relating to organizational policy, education, material supply needs, and EHR. First, the team identified need to update our organizational policy for vaccination and immunization of perioperative and procedural patients. The policy update reflected newer medical literature, expert and local opinion, peer health organization and council best practice and policy review, as well as population health goals of the organization. The policy update removed restrictive perioperative vaccination guidelines and encouraged seasonal influenza vaccination up to 3 days prior to elective surgery. Further, policy update removed automatic case cancellation

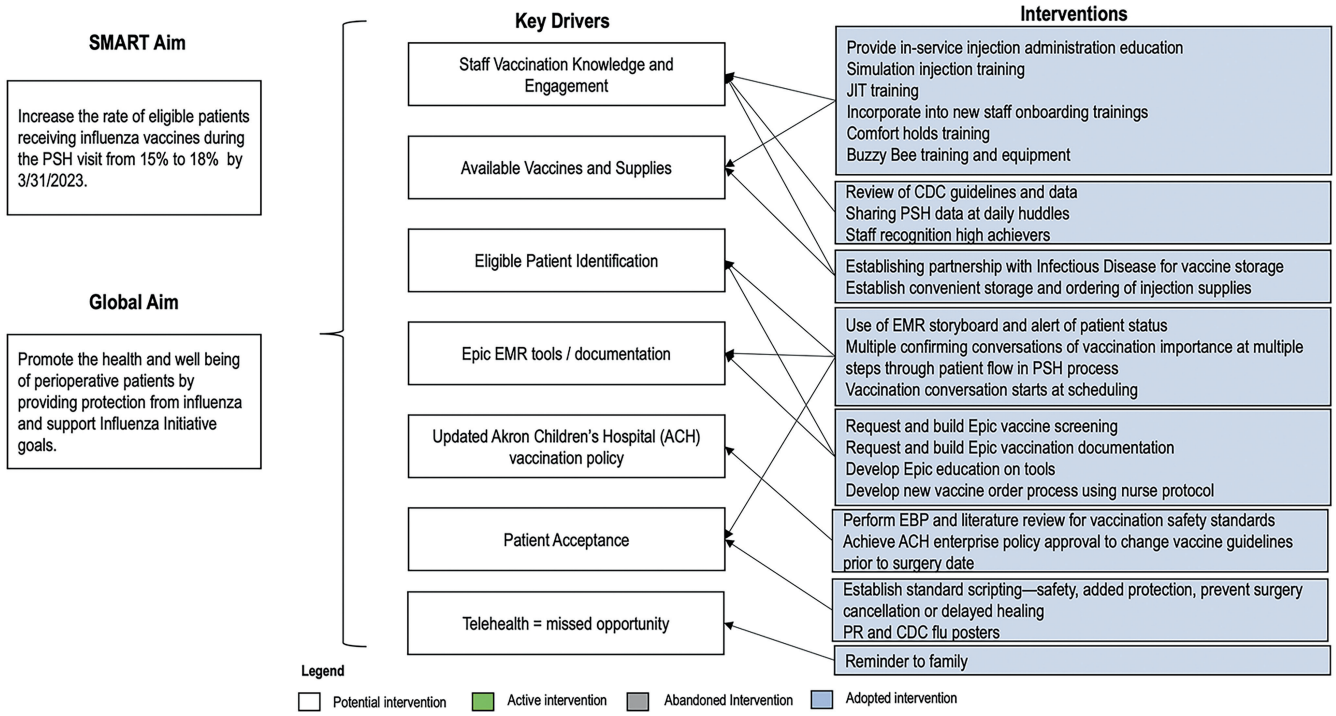

FIGURE 1 Perioperative surgical home (PSH) seasonal influenza vaccination program key driver diagram. Revision date September, 1, 2022. CDC, Centers for Disease Control and Prevention; EBP, evidence based practice; JIT, just in time; SMART, specific, measurable, applicable, realistic, and timely.

when vaccine administered within this window and encouraged anesthesiologist and surgeon evaluation, discussion of perioperative concerns, and joint decision making when deciding to proceed or cancel elective cases. After administrative review and approval, policy updates were incorporated into the larger organizational influenza vaccination policy.

A second priority key driver was to determine material supply needs for storage and administration of influenza vaccinations. Interventions included leveraging our multidisciplinary team and partnering with the infectious disease (ID) department for required vaccine refrigeration storage and dry injection supplies. Multidisciplinary partnership with ID allowed the PSH to better determine initial amount of vaccine and vaccine administration supplies to order, as well as determine priority re-stocks as season progressed. By eliminating preconceived care barriers, rapid PDSA, and sharing of information, the team was able to develop these interventions.

A third crucial key driver again leveraged the multidisciplinary layered committee for development of EPIC EHR tools for screening and documentation. Specific PSH clinic build included rapid PDSA development and optimization of vaccine screening, education tools, and documentation. This led to the use of an EHR storyboard and alert of patient status that the PSH clinical team used to initiate vaccine opportunity education to patient–families when first scheduling appointments.

These were all new processes for PSH staff, and multiple education related interventions were identified and tested. The unit educator assigned multiple self-study modules that were further supported by hands on training using mannequins. A resource book was created and included information such as the Vaccine Information Statement, hospital policies for immunization and intramuscular medications, Centers for Disease Control recommendations for needle gauges, needle lengths, and guidelines for intramuscular administration. Staff were also educated on the proper flu vaccine to give.[15] Standard work instructions (SWI) were created to guide staff on correct process of giving the flu vaccine. EHR training for compliance of patient eligibility documentation, patient–family education and CDC vaccine information sheet distribution, and vaccine administration information were performed according to organizational policy. CLS were engaged in offering comfort positioning and techniques. These education and process initiation rapid cycle PDSAs resulted in delay of vaccination, with first vaccine given in late October 2020.

A process map was developed. The KDD was iteratively updated. Weekly PSH clinical team huddles reviewed local immunization processes, issues encountered, and recommendations for PDSA cycle improvement. These were reviewed monthly at PSH project group and organizational influenza committee meetings. The organizational influenza committee meetings enabled shared experiential learning with other departments that informed PDSA cycles and process improvements, which accelerated PSH seasonal influenza vaccination program improvement.

2.4 | Season 2

Learning from successes of the 2020–2021 flu season program, there were core SWI and fully adopted sets of interventions in place. Differently, in 2021–2022 immunization season, there was urgency to obtain and administer vaccine earlier in the influenza season; as soon as the influenza vaccine was available to the organization. This change was achieved with earlier engagement of the multidisciplinary team and organization influenza committee, resulting in additional opportunity to provide vaccine. As this full season occurred during the COVID-19 public health pandemic, the team faced vaccine and supply challenges that were met through PDSA improvements of organizational vaccine resource sharing from ID and pharmacy. Additional KDD based improvements included education enhancement toward staff for communication of immunization benefits to the patient–families, as well as better prepared staff for response to common reasons for immunization hesitancy and refusal. PDSA resulted in establishing standard scripting of vaccine safety, health benefits, and surgery not being canceled.

Persistent hesitancy and rejection of the vaccine offering contributed to staff apathy for the project. Thus, iterative interventions to boost staff involvement were implemented, such as achievement-based recognition and improved department awareness through wearing immunization themed t-shirts.

PSH immunization rate challenges were shared across the organization through monthly meetings with the organizational immunization committee.

2.5 | Season 3

Building on prior season success, winning the hearts and minds of patient–families to accept the flu vaccine was the primary key driver of focus. Interventions during the 2022–2023 cycle included increasing effective patient–family communication and education. This was achieved through intervention with high visibility public relations and educational materials in the form of posters. Iterative PDSA cycles occurred in collaboration with the anesthesiology department to promote advantages of influenza vaccination on overall health of pediatric surgical patients. The public relation department guided appropriate marketing and branding efforts. These were prominently displayed in the PSH waiting room lobby, registration area, and examination rooms. Additional emphasis for PSH staff education was placed on messaging that influenza and COVID vaccines are safe to be administered together and within the same time frame. PDSA cycles led to focused education during orientation of new employees to encourage the vaccine and how to approach perioperative families. The team participated in PDSA improvements and data sharing through ongoing weekly staff and monthly PSH influenza project group and organizational influenza committee meetings.

Across the three seasons, scripting, staff engagement, and patient education had multiple ramps for PDSA cycles as key interventions to address recurrent challenges. Weekly feedback and data analysis led to rapid adaptations and improvement to our processes.

3 | MEASUREMENT AND ANALYSIS

3.1 | Primary, secondary, and balancing measures

The primary outcome measure was rate of eligible patients receiving seasonal influenza vaccine during their PSH clinic appointment. Eligible patients were defined as those seen in-person for their PSH clinic appointment, at least 72 h in advance of surgery, and had not received a seasonal influenza vaccine that season. Any administered influenza vaccine was counted in the numerator, including patients receiving their first ever flu vaccine regardless of the first or second dose. The primary measure was tracked monthly in Season 1, then weekly in Seasons 2 and 3, via an EHR report (EPIC, Verona, Wisconsin). Data were displayed on a control chart, reported weekly at PSH huddles and monthly at both PSH influenza project group meetings and organizational influenza committee meetings. Vaccine rates were not reported during the noninfluenza months (April–August) for any season.

Our initial team compliance with task-based mannequin training, online learning modules, and EPIC documentation training was tracked as a secondary measure, as was educational compliance for staff onboarded after initial program launch.

A balancing measure of same day surgery cancellation rate and reason for cancellation was tracked. This was derived from EHR report and reviewed monthly by the PSH medical director and influenza project group.

3.2 | Analysis

Data for the primary measure were extracted from the EHR and calculated using simple statistics in Cincinnati Children's Hospital control chart templates, created using macro enabled Microsoft Excel (Redmond, WA) for centerline mean and rate. To understand performance over time, Shewart's control chart and statistical process control (SPC) standards were utilized. Special cause variation and centerline shift were determined using eight or more consecutive data points above (shift up) or below (shift down) the centerline.[16] Secondary and balancing measures were calculated with simple statistics, as above.

4 | RESULTS

The annotated control chart (Figure 2) shows rate of influenza vaccine administered over time, as well as key interventions.

4.1 | Outcome measure

4.1.1 | Season 1

During this improvement period, preintervention rate was 0% with SMART aim goal of 10%. After interventions of policy change, staff education, engagement, EHR build, and vaccine arrival, vaccine administration rate sharply increased. A peak rate of 16% was achieved, which was above the 10% goal for this season. Upward centerline shift above goal line was observed, indicating we surpassed our goal during this time period. A total of 134 vaccines were given.

4.1.2 | Season 2

During this improvement period, the SMART aim goal was increased to a rate of 15%. There was shift above goal line upon vaccine arrival. A higher peak rate of 27% was observed after vaccine supply sharing. Centerline shift maintained goal rate of 15% for 7 weeks during peak vaccine season, indicating we surpassed our goal during this time period. Late season (mid-December onwards) downward shift of centerline was noted, but 11% rate was maintained through end of season. A total of 300 vaccines were given.

4.1.3 | Season 3

During this improvement period, the SMART aim goal was increased to a rate of 18%. There was shift above goal line with introduction of patient education and vaccine arrival. A peak rate of 25% was observed after new staff education. Centerline shift maintained above goal rate of 18% for 15 weeks during peak vaccine season, indicating we surpassed our goal during this time period. The late season decrease in vaccination rate was again seen. A total of 261 vaccines were given.

Each season the goal was increased, from 10% to 15% to 18%, respectively. Centerline shift above goal was observed, with Season 3 having longest sustained centerline shift. Centerline shift is a validation of our QI process improvements and interventions, based on the above special cause statistical definitions. Given this improvement, we were able to adjust our SMART aim goals in subsequent seasons. The control chart reflects seasonal variation during all seasons.

For all three seasons, secondary measures for PSH staff education and mannequin training compliance were verified with 100% completion for applicable staff.

The balancing measure of same day surgical case cancellations was tracked during each season. Cancellation data were reviewed monthly by the PSH medical director and influenza project group. There were no cancellations noted due to seasonal influenza vaccination administration.

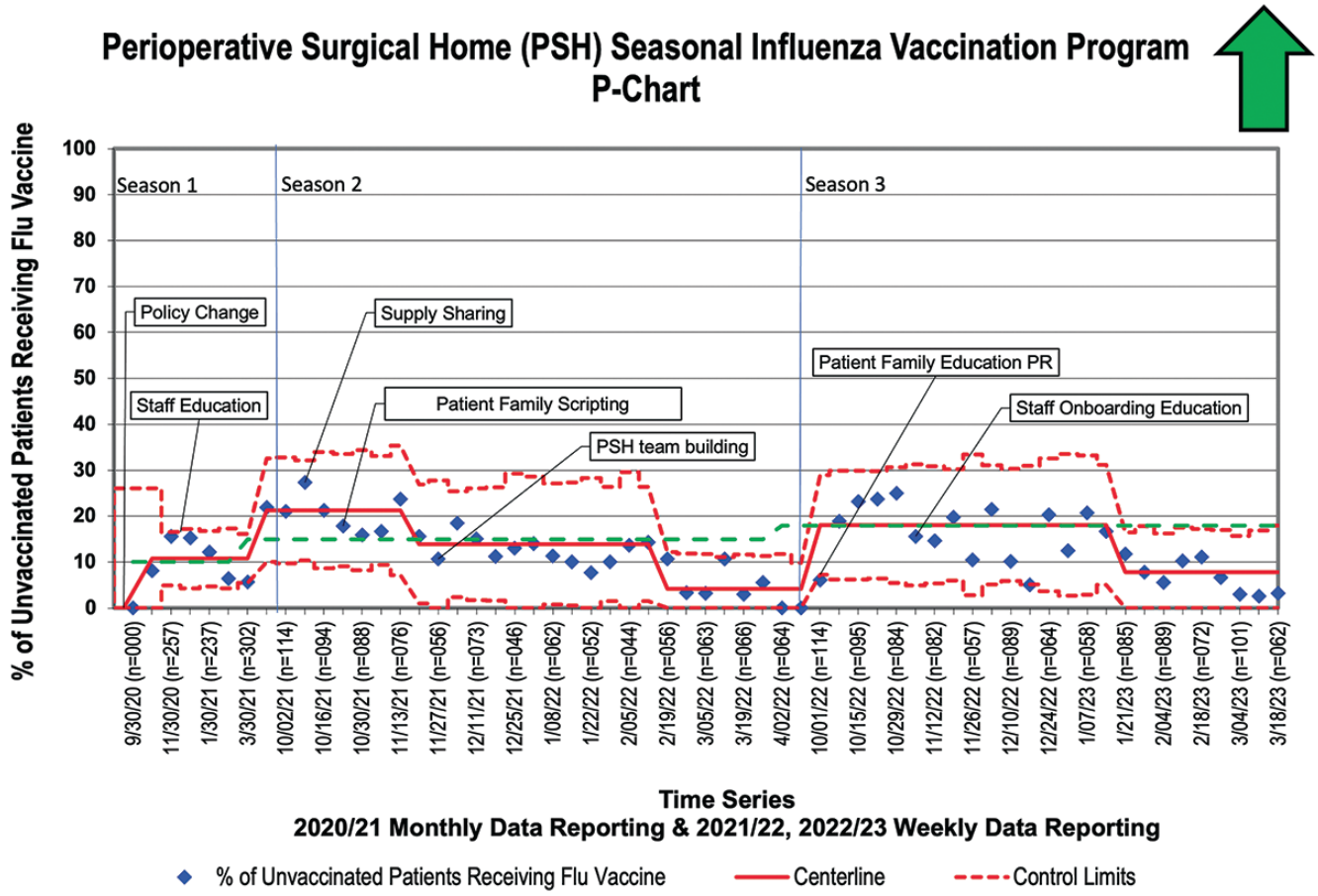

FIGURE 2 P control chart revealing vaccine administration rate to eligible perioperative surgical home (PSH) patients on a monthly (Season 1) then weekly (Seasons 2 and 3) basis.

5 | DISCUSSION

With this quality improvement initiative, we sought to accomplish two keys aims: (1) increase the rate of eligible patients receiving influenza vaccine during their PSH clinic visit and (2) promote the health and well-being of perioperative patients through providing protection from influenza as part of organizational influenza initiative goals. The primary aim of increasing PSH clinic seasonal influenza vaccination rate from 0 to 10% through establishing a novel perioperative vaccination program was accomplished in Year 1. Our QI project then increased vaccination rate goals to 15 and 18% in influenza seasons two and three, respectively. As observed on our control chart, the height (rate of vaccination) met goal each season and length (sustainment of vaccination rate) met goal and increased each season. Such sustainable results are likely due to the reliability of key QI process improvements. Each season we observed in season variability, as well as late season decrease in vaccination rates. Of note, while our centerline shift to goal was of longest duration in Season 3, our total vaccines administered were less than Season 2. We postulate this decline could be due to ongoing vaccine hesitancy of patient–families, as well as frequently changing COVID testing guidelines that necessitated restricting PSH appointment times and ability to offer vaccination.

Our current QI report is the first to describe a successful program for vaccinating pediatric patients against seasonal influenza during preoperative appointments in a pediatric PSH setting. The pediatric PSH model of care has been described as a team-based patient-centered model designed to improve the delivery of health care, reduce cost, and enhance value provided to the patient–family and organization.[17] Ferrari further comments a PSH often involves serving as an entry point to perioperative care to manage patient populations according to acuity, comorbidities, and risk factors using evidence-informed clinical care. Our clinic has long coordinated patient care across the perioperative spectrum and was positioned well to develop a novel approach to the organizational goal of increasing seasonal influenza vaccination rate. To our knowledge, there is only one other report describing sustained QI program success of a perioperative pediatric influenza vaccination program, though that project focus was vaccinating patients while under general anesthesia.[18] Literature lacks consensus on the approach to perioperative vaccination, including influenza vaccination, for pediatric patients. Some advocate for a conservative approach to vaccination and surgery, citing potential for vaccine related adverse events and immunomodulation induced by anesthesia and surgery adversely affecting vaccine efficacy as avoidable risks to patients.[19,20] Others advocate for liberalization

of perioperative vaccination, citing the benefits of vaccination outweigh what they view as low and theoretical risks to the patient.[21,22] These viewpoints have resulted in a lack of societal guidelines and nonconsensus among practicing pediatric anesthesiologists, despite calls to incorporate available evidence into best practice guidelines.[23] An early and major key driver for our project success was to build consensus among diverse perspectives regarding perioperative influenza vaccination within our anesthesia and surgical disciplines. Frequent engagement and discussion by local experts resulted in balanced policy change, early buy-in across diverse specialties, and forward momentum in promoting this new program within our organization.

As with many guidelines and protocols, implementation of standardized work processes by themselves were not enough to create meaningful change in practice pattern. There were multiple internal challenges we met with key interventions for program success. Early in our program we identified missed opportunities for vaccination, as staff often forgot to introduce the option when scheduling appointments or forgot to offer vaccination during the clinic visit. Some staff expressed initial reluctance to engage and educate parents when presenting influenza vaccine opportunity, particularly when facing patient–family vaccine hesitancy. Keys to addressing this included in season rapid PDSA cycles to develop scripting of scheduling phone calls, scripting for common questions and discussions during in clinic visits, and PR materials that addressed vaccination benefits and common patient–family concerns. We also observed late season drop off in vaccination rate each season. We learned patient–families, as well as our own staff, are more receptive and eager to offer vaccination at beginning of season and experienced vaccination "fatigue" as seasons progressed. This led us to focus intervention efforts to maximize opportunities for strong roll out at beginning of vaccination seasons. During seasons two and three, supply chain navigation and leveraging multidisciplinary relationships to address vaccine and related supply shortages was key. Last, we noticed a growth and promotion of QI thinking and methodology within our department, indicating our PSH team and clinic venue have potential to drive continuous quality improvement.

External factors also impacted our program and required rapid PDSA cycles. The COVID-19 pandemic presented significant challenge to our program. Across multiple PDSA cycles and seasons, we had to frequently adjust our vaccination offerings due to changing appointment restrictions, as well as coordinating clinic visits to coincide with mandatory presurgical COVID-19 testing. Appointments and COVID testing often occurred 72 h prior to surgery, which, under our perioperative vaccination policy, makes a patient ineligible for influenza vaccination. This likely led to loss of vaccination opportunity during the preoperative testing seasons. Further, a shift in public health narrative toward promoting COVID vaccine may have taken away momentum from seasonal influenza vaccine acceptance. Additionally, during the COVID-19 pandemic there were episodes of highly publicized and politicized vaccine messaging regarding the COVID-19 vaccine and the expansion of this messaging may have indicted harm with other vaccines.[24,25] During this time, we noticed increased vaccine hesitancy and significant inquiries from families seeking accurate and honest vaccination information. Despite our key interventions of educational materials focused on both influenza and COVID vaccine safety, many patient families remained hesitant and declined influenza vaccination, which seems consistent with experiences reported elsewhere in the healthcare community.[26] This will require ongoing focus as our program matures.

5.1 | Limitations

There are some limitations to this quality improvement project. First, this is a single-site improvement initiative set in a pediatric PSH environment. In organizations without a PSH, preoperative clinic, or with a different process for preoperative preparation, they may not have the capacity and efficiency to accomplish this additional vaccine administration duty. Second, due to lack of comparable published reports, our initial aim was for a modest a 10% vaccination rate. QI learning and process improvements promoted expanded goals to 15 and 18% in subsequent seasons. Also, while we achieved our goal rates and program has matured from no vaccination to now almost one-in-five eligible patients, many eligible patients still do not receive vaccine. While the authors were hopeful our efforts would drastically increase our vaccination rate, there are several considerations that influenced our results. This could be due to factors such as patients planning to get vaccine at another provider, those patients and families already choosing not to vaccinate, vaccine hesitancy or undecided status, mandatory preoperative COVID testing imposing on perioperative vaccination ability during study period, and worry of surgical case cancellation. Further, we did not have ability to track case cancellations prior to day of surgery due to vaccine related adverse events. Additionally, minor vaccine reactions were not tracked by our project. Last, the potential for immunomodulatory effects of vaccine coincident with anesthesia on either the vaccine effectiveness or recovery from anesthesia and surgery were not evaluated.

6 | CONCLUSIONS

This quality improvement project demonstrates the establishment and sustained improvement of safely administering seasonal influenza vaccines to eligible patients during preoperative clinic visits within a pediatric PSH system over three consecutive influenza seasons. This occurred without impact on same day surgery case cancellations. Our results suggest the process for perioperative influenza vaccination is reasonable and could potentially be leveraged for improving pediatric preventative care provided in the perioperative setting.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interests to disclose related to this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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