Individual QI projects from single institutions

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A Quality Improvement Initiative to Increase and Sustain Influenza Vaccination Rates in Pediatric Oncology and Stem Cell Transplant Patients

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Abstract

Introduction: Influenza vaccination of pediatric oncology and stem cell transplant (SCT) patients is crucial due to high risk of complications. Achieving high vaccination rates to prevent illness is often limited by competing demands and intensive treatment. A quality improvement (QI) initiative beginning influenza season 2012–2013 aimed to achieve and sustain high vaccination rates in active patients > 6 months of age, receiving cancer therapy or SCT within 6 months before or at any time during the season, and > 100 days after allogeneic SCT. **Methods:** We identified key drivers and barriers to success from an initially developed vaccination process that proved to be burdensome. Change ideas were implemented through multiple tests of change during the QI initiative. Iterations within and across 4 subsequent seasons included patient identification through chemotherapy orders, provider education, incorporating vaccination into routine work-flow, continuous data analysis and feedback, and use of new reporting technology. **Results:** Initial vaccination rates were < 70%, increasing to 89% after the QI initiative began and subsequently sustained between 85% and 90%. Active patients were significantly more likely to be vaccinated during the initiative (odds ratio, 3.7; 95% CI, 2.9–4.6) as compared with the first 2 seasons. **Conclusions:** High influenza vaccination rates can be achieved and maintained in a pediatric oncology/SCT population using strategies that correctly identify patients at highest risk and minimize process burden. *(Pediatr Qual Saf 2018;1:e052; doi: 10.1097/pq9.0000000000000052; Published online January 5, 2018.)*

INTRODUCTION

Pediatric oncology (PO) and stem cell transplant (SCT) patients are at high risk of significant morbidity and mortality from influenza.[1–3] Vulnerability is greatest during immunosuppressive treatment and for at least 6 months after therapy or SCT, until return of immune function.[4–9] Influenza is often associated with more severe complications than in immunocompetent hosts and may cause interruptions in treatment that can be detrimental.[1–3,10] During the 2009 influenza A (H1N1) virus pandemic, 70% of pediatric patients with influenza admitted to 35 intensive care units (ICUs) had 1 or more chronic conditions, and a compromised immune system was an independent risk factor for mortality.[11]

Compared with unvaccinated children, those vaccinated have a 74% decreased likelihood of being admitted to the ICU due to influenza, highlighting the importance of prevention through vaccination.[12] The Centers for Disease Control and Prevention recommends annual vaccination for children > 6 months of age, including those with chronic conditions and compromised immune function.[13] Consensus recommendations for the PO/SCT population also advise vaccination during treatment.[10,13–16] Yet, the competing demands of intensive cancer treatment and its complications often take priority over ensuring vaccination. Consequently, vaccination adherence has been suboptimal.[17,18] Freedman et al.[19] achieved a vaccination rate of 78% in a single-season quality improvement (QI) initiative. Doganis et al.[20] reported higher rates in pediatric cancer patients as a response to the H1N1 pandemic. However, they excluded those undergoing intensive treatment. Evidence of sustained high rates of influenza vaccination in the active PO/SCT population is lacking.

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Sustainability of improvement initiatives is a key measure of success but rarely is addressed. High rates of failure often follow initial improvements.[21–23] In the high-risk group of active PO/SCT patients, sustaining high rates of vaccination to prevent influenza and its catastrophic complications, is critical.

Before the 2009–2010 influenza A H1N1 pandemic, our program did not have a structured influenza vaccination strategy. We did not track vaccination rates. The pandemic triggered purposeful efforts to develop a vaccination process, but it was not until season 2012–2013 that a structured QI initiative was implemented to increase and maintain influenza vaccination rates in active PO and SCT patients.

METHODS

Planning the Intervention

The project was carried out at a single academic program, the Dana-Farber/Boston Children's Cancer and Blood Disorders Center, encompassing an ambulatory clinic and in-hospital units. Approximately 3,000 unique patients are seen each year for active treatment, second-opinion consultation, and long-term survivorship care. This QI effort focused on active patients, those on treatment or during early posttreatment recovery, as they are at greatest risk of infectious complications.[1–9] We defined active patients as those having received cancer-directed therapy, including radiation, or SCT at any point 6 months before the start or during the influenza season. Patients were considered eligible if they were > 6 months of age and had no medical contraindications to vaccination.[13] Allogeneic SCT patients were eligible if they were > 100 days from transplant. Timing was planned to avoid vaccination during corticosteroid administration. The largest patient group affected by this were those diagnosed with a lymphoid leukemia or lymphomas who receive pulses of corticosteroid throughout therapy. Primary oncology providers could determine additional contraindications based on clinical judgment.

The goal was to vaccinate > 95% active patients by the end of each season and sustain rates to prevent ICU admissions and mortality. We offered vaccination to all medically eligible patients, but we only tracked active patients' status. Stakeholders were identified, and a multidisciplinary working group was created, including physicians, nurses, and administrative staff.

Before the QI initiative, an initial static process had been developed for influenza season 2010–2011 (season 1) and 2011–2012 (season 2). This effort targeted vaccination of all patients seen in the clinic during influenza season without a specific focus on patients receiving treatment or during early recovery. Before the QI initiative, we identified patients through review of clinic visit reports (at least 1 visit in the 6 months preceding the start of the season and at least 1 other during the season, regardless of the visit reason). Vaccine availability was promoted through a focused effort of information dissemination including patient-family letters and multiple announcements. We developed a questionnaire to determine medical eligibility, vaccination status, and patient interest. The pre-QI vaccination process depended on multiple steps and hand-offs (Fig. 1A) in the clinic. Vaccines administered were manually recorded in a spreadsheet. We tabulated and reported results to stakeholders only at the end of each season. Informal feedback from these seasons suggested that the entire process was burdensome for staff and families. For example, families did not want to return to clinic for a separate vaccination visit. The process was limited as it did not did not accurately differentiate active patients from nonactive, and did not capture or target other opportunities for patients to be vaccinated outside the clinic (eg, in the hospital).

Before season 3 (2012–2013) began, additional physicians, nursing, and administrative staff were added to the multidisciplinary working group to analyze the root causes and drivers to achieve the desired goal (Fig. 2). A QI initiative was launched with multiple interventions employed and iterated through tests of change beginning season 3 and expanded across 3 subsequent influenza seasons: 2013–2014 (season 4), 2014–2015 (season 5), and 2015–2016 (season 6).

Interventions

Improved Identification of Patients

Monthly reports from a free-standing chemotherapy order entry system and radiation oncology treatment visits were used to identify the growing set of active patients receiving chemotherapy, SCT regimens, and/or radiation therapy within the established timeframe. This review was done to ensure complete identification of active patients and focus efforts more effectively on them.

Designated Roles in the Vaccination Process

A program nurse became responsible for tracking, documenting, and maintaining accountability of the process in real-time. As of season 6, a population health manager who worked within our quality and safety program assumed this role. Approximately 8 hours a week were dedicated specifically to the influenza immunization effort. In the clinic, a rotating nurse was assigned to vaccinate and accommodate unscheduled same day vaccination into routine clinic visits.

Development of a Clinic Vaccine Standard Order Form

We updated the vaccination questionnaire to serve both as a screening and order form called the "Flu Shot Form" (FSF; Fig. 1B). It identified vaccination status, medical contraindications, and served as a patient-specific order. This by-passed the need for a prescriber to place an order in the electronic medical record and facilitated vaccinations during routine clinic visits. To serve as a patient-specific order, the FSF was approved by the relevant hospital

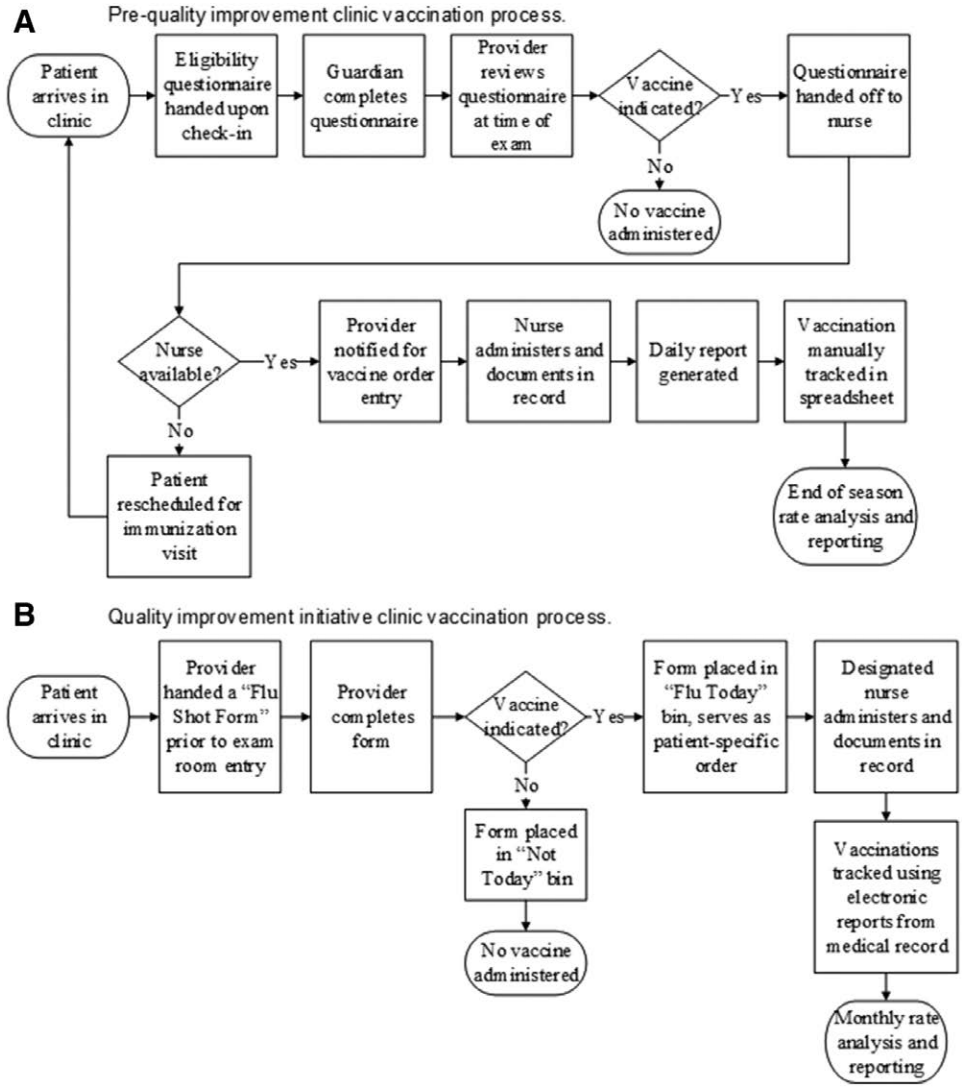

Fig. 1. Clinic vaccination process before and after the QI implementation. A, Demonstrates the prequality improvement process where target patients were identified through clinic visit reports. B, Shows the QI initiative process. Target active patients were identified through chemotherapy and radiation oncology reports.

committees. During a clinic visit, the FSF was handed directly to providers before entering a patient's room. Throughout successive seasons, we minimized hand-offs through multiple tests of change. It transitioned from providers needing to find an available nurse, to placing the completed form in 1 of 2 designated bins: "Today" or "Not Today," routinely monitored by the designated nurse for vaccination administration.

Continuous Data Analysis and Feedback

An existing patient population database was adapted to track vaccination status, analyze, and report rates to replace a manually maintained spreadsheet. We reviewed and updated the list of active, eligible patients monthly. Rates were regularly reviewed, triggering a variety of targeted interventions to reach unvaccinated patients and are described in Table 1. In particular, monthly reminder e-mails were being sent to providers identifying unvaccinated patients. Iterations through rapid cycle changes to maximize responses and vaccination included sending personalized instead of mass e-mails to providers and ensuring these were sent close to a patient's upcoming visit.

Additional Data-capture Tool

A newly developed institution-based electronic reporting system was implemented to capture data directly from the electronic medical record during season 6. It was used to produce reports of vaccination rates for active patients on a monthly basis, eliminating manual review and tracking.

Study of the Intervention, Measures, and Analysis

The primary outcome was the percentage of active PO and SCT patients receiving > 1 influenza vaccine in each season. To compare vaccination rates in the active population in the pre- versus post-QI initiative seasons, we

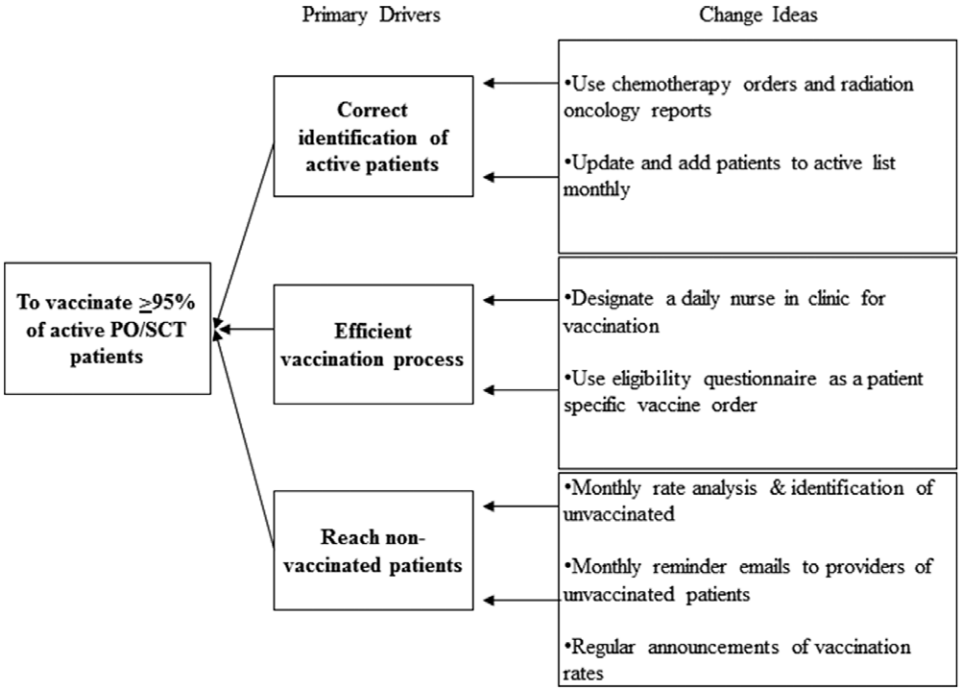

Fig. 2. Key driver diagram developed before season 3 QI process implementation.

Table 1. Targeted Interventions to Reach Unvaccinated Patients during the QI Initiative Starting Season 3

Intervention	Description	Timing
Staff reminders	Reminder to inpatient providers to vaccinate patients before discharge or during prolonged hospitalizations	Routinely throughout seasons 3–6
	Patient-specific, at least monthly, reminders to primary oncology providers identifying unvaccinated patients	Routinely throughout seasons 3–6
Guideline development	Recommend timing for providers to vaccinate during therapy (eg, relative to steroid administration)	Implemented during season 5 and disseminated throughout seasons 5–6
Provider/family education	Clarification of evidence-based contraindications versus common misconceptions that deferred vaccination (eg, neutropenia is not a contraindication)	Implemented during season 5 and disseminated throughout seasons 5–6
	Encourage families to obtain vaccine at primary care office if not routinely coming to our institution	Routinely throughout seasons 3–6
Culture change	Regular notification to all clinic staff of current vaccination rates and targets (e-mails and newsletters)	Routinely throughout seasons 3–6
	Clinic video monitor announcements encouraging families to ask about the vaccine	Routinely throughout seasons 3–6
Increased data capture	Routine patient inquiry about vaccination at outside sites (eg, primary care office) with data confirmation and recording	Routinely throughout seasons 3–6

included only those who met the definition of active in the analysis to ensure that changes in vaccination rates reflected the same population. Available chemotherapy order entry reports were used to determine whether patients previously identified using clinic scheduling reports during seasons 1 and 2 met the definition of active as established during the QI initiative or if we had missed active patients. Because reports of chemotherapy orders and radiation oncology visit reports were not as readily available for seasons 1–2, we conducted a retrospective analysis looking through documentation in the medical record that would indicate whether the patient was receiving active treatment or was in the early recovery phase during the influenza season that would define them as active and confer inclusion in the analysis. Patients who no longer received care at our program before the start of influenza season or transferred care elsewhere after less than a month of treatment were excluded. Active patient characteristics were obtained for comparison across seasons. Retrospective chart review supplemented with the new electronic vaccination reporting system confirmed vaccination status that had not previously been captured and was used to determine if patients met exclusion criteria. We obtained annual influenza-related morbidity and mortality data through the hospital's Infection Prevention and Control Department.

We used descriptive analysis to determine vaccination rates by season and characterize patient variables. To compare characteristics across time, we applied analysis of variance (ANOVA) and chi-square test for continuous and

categorical variables, respectively. To understand the impact of the QI initiative, generalized estimating equations were used to estimate the odds ratio (OR) of vaccination after the QI implementation (seasons 3–6) relative to the existing process (seasons 1–2). This methodology was also employed for a subanalysis of the Hematologic Malignancy (HM) population to assess change after the QI implementation. Both adjusted and unadjusted ORs were obtained from models. Analyses were conducted using SAS v.9.3 for windows statistical package (SAS Institute Inc., Cary, N.C.).

The project was undertaken as a QI initiative and as such was not formally reviewed by the Dana-Farber/Harvard Cancer Center Institutional Review Board per their policies.

RESULTS

During seasons 1–2 (before the QI initiative), only 70% of the targeted population for vaccination identified through clinic visits were in fact active patients as defined during the QI initiative. Characteristics of active patients did not significantly differ across the 6 seasons (Table 2). The mean age was approximately 10 years, with fewer female patients. Patients with HM accounted for > 40% in each season and allogeneic SCT recipients represented < 10%. The proportion of patients within disease categories was not significantly different ($P = 0.16$) across the seasons.

We observed lower vaccination rates during seasons 1–2, as compared with the QI initiative from seasons 3–6 (Fig. 3). The vaccination rate of active patients decreased from 70.3% in season 1 to 66.1% in season 2. Once the QI initiative began, rates increased by 23% and remained stable throughout. During seasons 3, 4, 5, and 6, the vaccination rates of active patients were 89%, 89.3%, 85.4%, and 89.7%, respectively. Active patients were significantly more likely to receive vaccination after the QI implementation compared with the prior 2 seasons (OR, 3.6; 95% CI, 2.88–4.54). After adjusting for age, gender, and disease group, the association remained constant (OR, 3.66; 95% CI, 2.92–4.60).

In the HM population, 71.9% were vaccinated in season 1 and 67.4% in season 2. Vaccination rates subsequently rose to 93.9% for season 3 and were 94.5% (season 4), 90% (season 5), and 89.1% (season 6). There was a higher likelihood of vaccination during the QI initiative relative to seasons 1–2 (unadjusted OR, 4.87; 95% CI, 3.40–6.98). This finding remained significant after adjusting for age and gender (OR, 4.98; 95% CI, 3.47–7.15).

Throughout the 6 seasons, there was 1 influenza-related ICU admission in an unvaccinated patient during season 4 (2013–2014). This patient had not been vaccinated per our program standard contraindication of continuous high-dose steroid treatment. There were no influenza-related deaths reported during the 6 seasons.

DISCUSSION

Optimizing protection of active PO and SCT patients through influenza vaccination is essential to minimize the risk of serious complications, but a process to achieve sustained high rates had not previously been described.[19,20] Our initiative demonstrated a feasible process to achieve and sustain high rates of influenza vaccination in active PO and SCT patients. We observed high rates of vaccination sustained at > 85% during the QI intervention over 4 seasons, validated by the overlapping CI in seasons 3–6.

Table 2. Characteristics of Active Pediatric Oncology and Stem Cell Transplant Patients Eligible for Influenza Vaccination Throughout 6 Consecutive Seasons

Season	1	2	3	4	5	6	
	2010–2011 (N = 380)	2011–2012 (N = 378)	2012–2013 (N = 335)	2013–2014 (N = 349)	2014–2015 (N = 376)	2015–2016 (N = 416)	*P*
Age, mean (SD)	10.2 (6.0)	10.1 (6.0)	9.6 (6.1)	10.5 (6.1)	10.2 (5.9)	10.5 (6.3)	0.41
Female, n (%)	161 (42.4)	162 (42.9)	138 (41.2)	138 (39.5)	149 (39.6)	179 (43.0)	0.86
Disease center, n (%)							0.16
HM	178 (46.8)	178 (47.1)	146 (43.6)	164 (47.0)	160 (42.6)	175 (42.1)	
Solid tumor	101 (26.6)	108 (28.6)	91 (27.2)	104 (29.8)	122 (32.4)	111 (26.7)	
Neurooncology	74 (19.5)	75 (19.8)	74 (22.1)	69 (19.8)	67 (17.8)	93 (22.4)	
Stem cell transplant	27 (7.1)	17 (4.5)	24 (7.2)	12 (3.4)	27 (7.2)	37 (8.9)	
Treatment group, n (%)							0.22
Acute lymphoblastic leukemia/lymphoma	118 (31.1)	119 (31.5)	102 (30.4)	108 (30.9)	109 (29.0)	121 (29.1)	
Central nervous system tumor	74 (19.5)	75 (19.8)	74 (22.1)	69 (19.8)	67 (17.8)	93 (22.4)	
Sarcoma	50 (13.2)	51 (13.5)	37 (11.0)	50 (14.3)	54 (14.4)	48 (11.5)	
Allogeneic stem cell transplant	27 (7.1)	17 (4.5)	24 (7.2)	12 (3.4)	27 (7.2)	37 (8.9)	
Hodgkin lymphoma	25 (6.6)	16 (4.2)	17 (5.1)	19 (5.4)	11 (2.9)	18 (4.3)	
Neuroblastoma	20 (5.3)	26 (6.9)	19 (5.7)	23 (6.6)	27 (7.2)	24 (5.8)	
Non-Hodgkin lymphoma	9 (2.4)	18 (4.8)	12 (3.6)	14 (4.0)	19 (5.1)	21 (5.0)	
Acute myeloid leukemia	16 (4.2)	17 (4.5)	5 (1.5)	10 (2.9)	8 (2.1)	5 (1.2)	
Kidney tumor	13 (3.4)	9 (2.4)	14 (4.2)	15 (4.3)	9 (2.4)	10 (2.4)	
Rare solid tumor*	16 (4.2)	17 (4.5)	17 (5.1)	13 (3.7)	21 (5.6)	22 (5.3)	
Liver tumor	2 (0.5)	5 (1.3)	4 (1.2)	3 (0.9)	11 (2.9)	7 (1.7)	
Other†	10 (2.6)	8 (2.1)	10 (3.0)	13 (3.7)	13 (3.5)	10 (2.4)	

*Rare solid tumor = retinoblastoma, carcinoma, chordoma, melanoma, pheochromocytoma.
†Other = Langerhan's cell histiocytosis, hemophagocytic lymphohistiocytosis, chronic myelogenous leukemia.

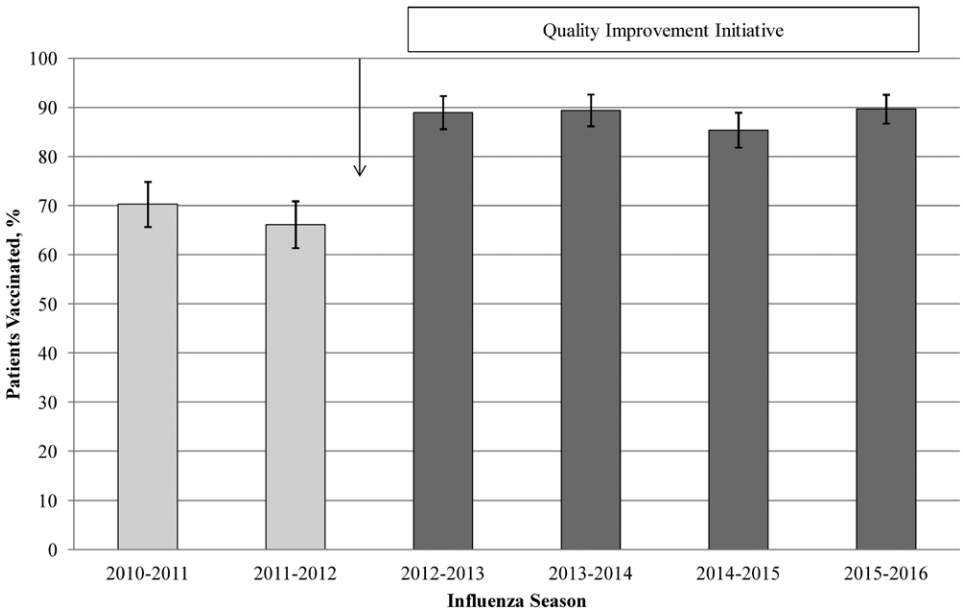

Fig. 3. Rates of influenza vaccination. The light gray bars represent the 2 first influenza seasons. The dark gray bars represent the period of QI. The error bars represent the 95% CIs. The arrow represents the time point of new QI process implementation.

The success achieved highlights the importance of several QI principles: correct measurement, quick analysis and feedback to drive change, and the importance of focusing on sustainability throughout implementation. The greatest improvement in vaccination rates (23% increase from season 2–3) was seen at the start of the QI initiative when we implemented the majority of changes. This included a process that truly identified "active patients," which probably was 1 of the main contributors to the improvement achieved. Approximately 30% of patients identified for vaccination using clinic visit reports before the QI initiative were not true active patients, likely because our clinic serves many patients who are not on treatment or during early recovery. This fact suggests that vaccination efforts may have been diluted during this time when it targeted a much larger group, rather than focusing on the active patient population. Using the analysis of drivers and the experience gained in the first 2 seasons, we implemented interventions focused on sustainability, primarily to minimize the burden of vaccination on staff and families to maintain the program. Other key interventions included designation of roles, added resources, incorporation of the process in to routine workflow, and culture change. Similarly, our initial process had no ongoing data analysis, for which we set out to establish timely and routine data-feedback during the QI initiative to drive change for improvement. For example, our lowest rate during the QI initiative was seen during season 5 (85%), which triggered a response to transition the accountability of the program from a nurse to a population health manager from the quality and safety program who helped automate the process. This allowed for increased timeliness and more efficiency in monthly rate analysis triggering interventions to reach the goal, with an increased rate of approximately 90% observed in the following season. This emphasizes the importance of rapidly studying an intervention after implementation. The success of these interventions in aggregate highlights the importance of employing multiple strategies concomitantly to achieve and sustain the desired goal, suggesting that interventions in our program were synergistic and of equal importance.

The program aimed to achieve > 95% vaccination rates, but achieved a maximum rate of about 90%, suggesting that areas for improvement remain to be addressed. Some contributing factors were elucidated after analysis of all unvaccinated patient characteristics and root causes. These included repeated refusal by families, limited opportunities to vaccinate due to infrequent clinic visits, deprioritization due to competing situations such as end-of-life care, and a process highly dependent on provider vigilance.

The dynamic nature of QI programs and the initiation of multiple interventions concurrently does not allow us to identify which specific intervention had the greatest impact on improved vaccination rate and sustainability. This observation is 1 of the several limitations to drawing conclusions. Another limitation is that rates were tabulated based on patients receiving at least 1 vaccination during a season, yet some patients likely had indications for a second dose to be considered fully immunized.[13] We chose this criterion for measurement due to the rapid turn-over of the patient population, the complexity of determining vaccination history, and limited data about the number of doses needed to confer protection in this population.[7,10,24] Even though we instituted standardized guidelines, individual providers may also have determined unique medical contraindications for patients. We cannot determine whether these clinical judgments

remained constant throughout seasons, although the high rates of vaccination and the similarity of characteristics of the active patient population across seasons argue against this. In addition, we focused efforts primarily on the highest risk patients, those on active treatment and early recovery, but a process that can ensure high vaccination rates of all patients is imperative. As a subspecialty referral center, 1 intervention that we piloted and could be considered for further implementation, was to partner with primary care providers to ensure that patients receive their vaccination in their office. Lastly, we did not include a patient/family advocate in our multidisciplinary working group, an intervention which could have contributed to family engagement and potentially decreased vaccination refusals. Efforts to further increase our influenza vaccination rates are ongoing and will focus on active patient/family engagement to decrease patient vaccine refusals, ensuring reliability of vaccine contraindications, developing a process to ensure complete vaccination, and further systematizing the vaccination process.

Overall, our program demonstrates that it is feasible to achieve and sustain high rates of influenza vaccination in a high-risk population. It highlights that ensuring influenza vaccination of active PO and SCT patients requires real-time analysis and interventions, correct identification of the population of interest, integration of the vaccination process into routine workflow, culture change to prioritize vaccination, and targeted interventions to reach unvaccinated patients as the season progresses. Continuous analysis of root causes for nonvaccination is necessary to ensure that all high-risk patients are vaccinated.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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