Improving the Combination Pneumococcal Vaccination Rate in Systemic Lupus Erythematosus Patients at an Adult Rheumatology Practice

Shivani Garg, Katina Tsagaris, Raluca Cozmuta, and Aliza Lipson

ABSTRACT. ***Objective.*** The risk of developing invasive pneumococcal infection is 13 times higher in patients with systemic lupus erythematosus (SLE) in comparison with the general population. The US Centers for Disease Control and Prevention anticipates a US$7.6 million medical cost reduction by providing pneumococcal vaccination. The objective of this study was to improve the rate of combination pneumococcal vaccination (pneumococcal polysaccharide vaccine 23 + pneumococcal conjugate vaccine 13) in patients with SLE in our adult academic rheumatology practice.

Methods. With the use of physician- and staff-based surveys, we analyzed the underlying barriers in providing vaccination. We then planned a multifaceted intervention including pre-visit planning, day-of-visit planning, weekly review, and monthly feedback.

Results. Our project is one of the few studies planned to improve combination pneumococcal vaccination rates in adult patients with SLE and we report an impressive improvement from 10% baseline rate to 59% vaccination rate by the end of the study period. This highlights the role of planning an intervention with an integrated workflow and the importance of sharing performance data, which leads to high compliance among team members.

Conclusion. The significant improvement in combination vaccination rate in eligible patients with SLE and the additional rise of vaccine rates seen in other eligible patients in the practice draws attention to the high adaptiveness of the intervention resulting in a true practice change. Our quality project design can serve as a model that can be adapted by other specialty clinics to achieve higher vaccination standards. (J Rheumatol First Release September 1 2018; doi:10.3899/jrheum.171377)

Key Indexing Terms:
VACCINATION QUALITY OF LIFE SYSTEMIC LUPUS ERYTHEMATOSUS

Pneumococcal infections comprise both invasive pneumococcal disease (including meningeal infections and sepsis) and nonbacteremic pneumococcal pneumonia. Patients with systemic lupus erythematosus (SLE) are at 13 times higher risk of developing invasive pneumococcal infection and 8 times higher risk of developing nonbacteremic pneumococcal pneumonia, irrespective of their immunosuppressive therapy[1,2,3]. The role of specific genetic polymorphisms in patients with SLE, increasing their susceptibility to pneumococcal infection, has been investigated and the results suggest the importance of polymorphism in the genes that encode tumor necrosis factor 238A (TNF–238A) and Fc-γ receptor (FCγRIIa-R131)[3,4]. The TNF-238A gene polymorphism inhibits the expression of Toll-like receptor 4 (TLR-4) on dendritic cells and thereby decreases the production of interferon-γ, leading to an ineffective innate immune response against bacterial infections. Similarly, FCγRIIa-R131 is proposed to be primarily responsible for phagocytosis of opsonized pneumococcal bacteria, and polymorphism of this gene can lead to ineffective phagocytosis and hence make the host highly susceptible to pneumococcal infections[3,5]. These findings highlight the need to prevent pneumococcal infection in patients with SLE.

Pneumococcal polysaccharide vaccine (PPSV23) and pneumococcal conjugate vaccine (PCV13) are 2 vaccinations recommended for the adult population. PPSV23 contains 12 serotypes present in PCV13 and 11 additional serotypes that give a broad protection against different serotypes causing invasive pneumococcal infection[1,6,7,8]. PCV13 includes 12 serotypes of PPSV23 and 1 unique serotype, hence it potentiates immune response generated by PPSV23 and provides immunity against pneumococcal pneumonia as well[1,6,7,8]. In comparison to prior vaccination recommendations in immunosuppressed patients, the Advisory Committee for Immunization Practices (ACIP) has recommended combination pneumococcal vaccination, specifically PCV13, followed by PPSV23 8 weeks later. This recommendation

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was based on studies highlighting the poor immunogenicity of PPSV23 alone in immunocompromised adults[7]. PPSV23 is a polysaccharide vaccine that generates an immune response solely by B cell activation, which is a T cell–independent process. The effect is that this generates an insignificant memory response, waning immune response after vaccination, and poor immunogenicity. Previous studies report PCV13 to be highly efficacious because it not only potentiates the initial immune response but also generates a strong memory response by activating T cells (through MHCII upregulation) and prevents pneumococcal pneumonia by generating IgA2 antibodies on the mucosal surfaces[9,10]. By implementing this strategy, the US Centers for Disease Control anticipates a US$7.6 million reduction in medical costs and an incremental gain of 1360 quality-adjusted life-years as a result of preventing invasive pneumococcal infection and pneumonia-related hospitalizations in immunocompromised groups[7,11].

In patients with SLE, vaccine efficacy (a measure of attainment of protective antibody titers) varies from 38–75% for PPSV23 and 60–80% for PCV13; the European League Against Rheumatism recommends both these vaccinations for good immunogenicity and preventing infections[5]. It is proposed that the efficacy of combination vaccination is superior to individual vaccines, and studies have shown that immunosuppressive medications used in patients with SLE do not interfere with vaccine efficacy[5,9]. The variability in immunogenicity, specifically in patients with SLE, may be partially attributed to immunosuppressive medications used in these patients. However, given the high susceptibility of these patients to develop pneumococcal infections, it is recommended to administer a combination pneumococcal vaccination to all patients with SLE[12,13,14]. Despite the need for vaccination in patients with SLE, the national average is < 25% in specialty clinics[13]. Based on these findings and recommendations, we designed a multifaceted quality improvement project with the aim of improving combination pneumococcal vaccination rates in patients with SLE at an adult rheumatology practice at Emory University in Atlanta, Georgia.

MATERIALS AND METHODS

To understand the preintervention vaccination status and plan interventions accordingly, we calculated the baseline combination pneumococcal vaccination rate during the preintervention period (6 mos prior to the study period).

Based on ACIP guidelines, eligible patients should be administered PCV13 if they have not received any pneumococcal vaccination in the past, followed by PPSV23 8 weeks later. If patients have received PPSV23 in the recent past (< 5 yrs), those patients should be administered PCV13 one year after the PPSV23 administration date[7].

We implemented a 25-week (April–October 2016) single center-based quality improvement project that targeted all patients with SLE who were receiving care at an adult rheumatology practice at Emory University. We used the hospital's electronic medical record (EMR) system and Emory University's IT department for generating reminders and data extraction, respectively. The Emory University Institutional Review Board exempted the study and did not require consent from the patients based on the features and design of study.

Before planning the intervention, we obtained baseline PCV13, PPSV23, and PCV13 + PPSV23 vaccination rates in the 6 months before intervention was planned and conducted physician- and staff-based surveys, aiming to better understand the barriers leading to low baseline immunization rates (Figure 1). Subsequently, we were able to identify some of the barriers in our practice. Survey data demonstrated forgetfulness and insufficient time during the clinic visits as the most significant barriers. Daily clinic flow was observed to plan an intervention that would be most effective and least disruptive to the day-to-day practice. With the use of the survey data and by observing daily clinic flow, we prepared a cause-and-effect diagram by placing different team members in different sections of the diagram and placing the respective barriers in those sections.

A multifaceted intervention was planned that included previsit planning, day-of-visit planning, a weekly review of data, and monthly feedback sessions organized for staff and physicians. The principal investigator was responsible for the previsit planning, which included chart review to confirm SLE diagnosis, eligibility for vaccination, and previous pneumococcal vaccination documentation. During the previsit planning, the principal investigator also prepared a daily list of eligible patients, including their known vaccination history. The staff, principal investigator, and physicians were collaboratively responsible for the day-of-visit planning phase (Figure 2). Specifically, the principal investigator shared the list of eligible patients with the staff, and daily reminders were sent to the physicians regarding eligible patients coming to the clinic that day. Based on this list and after interviewing the patients, the staff completed a vaccination form by documenting their individual vaccination history and willingness to receive any pending pneumococcal vaccines. This vaccination form was reviewed by physicians at the time of the visit and they subsequently discussed the recommendation of combination pneumococcal vaccination with the patients. For patients willing to receive the vaccination, physicians were responsible to place correct orders, communicate with the staff, and sign the vaccination form. In case the patient declined to receive a vaccination, counseling was given by the physicians and was documented on the form. The staff was responsible for vaccination administration and updating patient immunization records in EMR. Finally, all forms were collected for weekly review.

The weekly review included review of data from the vaccination forms and data received from Emory's data warehouse. A weekly graph was created to track vaccination rates during the intervention period. Monthly feedback sessions were organized with the team. During the feedback sessions, compendium lectures were presented to reinforce the need for vaccination and the team provided feedback regarding the interventions. These monthly review and feedback sessions made our study dynamic as we implemented or modified interventions to achieve higher vaccination rates.

During the study, we calculated the combination vaccination rate, which was defined as the percentage of eligible patients receiving the second pneumococcal vaccination (PCV13 or PPSV23, based on their vaccination history). Eligible patients for combination vaccination were defined as patients who received either PPSV23 at least 1 year prior to PCV13, or PCV13 at least 8 weeks prior to PPSV23. We also calculated the weekly PCV13 vaccination rate (% eligible patients who received PCV13 vaccination). Eligible patients were defined as patients who received PPSV23 one year prior or received no pneumococcal vaccination in the past. PPSV23 vaccination rates (% eligible patients who received PPSV23) were measured as well. Eligible patients were defined as patients who received PCV13 at least 8 weeks prior. Vaccination refusal rate (% eligible patients refusing vaccination for which they were eligible on that visit) and historical error rate (% SLE patients with incomplete pneumococcal vaccination history, including date of administration and type of vaccination administered in the past) were also tracked. During the initial part of the study period, we found high historical error rates contributing to a low immunization rate. Therefore, we enrolled in the Georgia Registry of Transaction and Services (GRITS) to overcome this barrier[15]. By enrolling in GRITS, the vaccination history was synced with Emory's EMR and the vaccination history was completed,

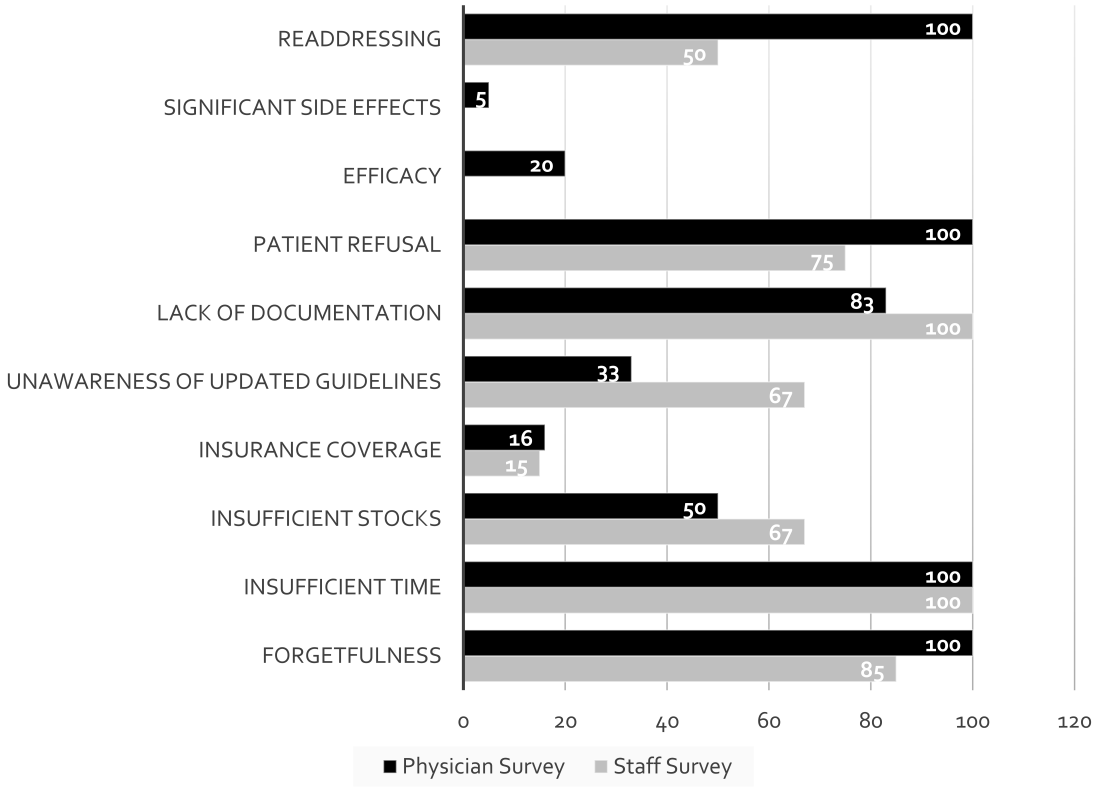

Figure 1. Results of physician- and staff-based surveys conducted before implementation of intervention. The graphs highlight insufficient time, forgetfulness, lack of documentation, and readdressing as the common barriers. Based on analysis of these barriers, interventions in the clinic were planned.

including type of pneumococcal vaccination and date of administration. With this information, we were able to administer the remaining component of combination vaccination to eligible patients.

We also obtained data regarding pneumococcal pneumonia-related hospitalizations in patients with SLE in both the preintervention and study periods at the 3 different hospitals affiliated with our institution. At the completion of the study, final rates were calculated, and this was compared with the preintervention period (baseline immunization rates obtained 6 mos before the study period). Additionally, we monitored combination pneumococcal vaccination rates in eligible patients with other autoimmune diseases (excluding SLE) in our clinic during the preintervention and study periods. This was done to monitor the adaptiveness of the intervention and passive improvement in compliance to administer vaccination to eligible patients (according to the ACIP guidelines).

RESULTS

In the preintervention period, the baseline PCV13 vaccination rate, PPSV23 vaccination rate, and combination vaccination rate were noted to be 2%, 8%, and 10%, respectively. In total, 612 patients with SLE were found to be eligible (for any vaccine). Across the board, significant improvements in vaccination rates were seen. Specifically, the PCV13 immunization rate increased from 2% to 39.28%, PPSV23 immunization rate increased from 8% to 56.5%, and the combination pneumococcal vaccination rate increased from 10% to 59%.

To monitor for compliance of the intervention and passive improvement in adaptiveness to administer pneumococcal vaccination, we calculated the weekly combination immunization rate in eligible patients with other autoimmune diseases aside from SLE (sarcoidosis, rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis, antineutrophil cytoplasmic antibody–associated vasculitis, and IgG4-related disease). At the completion of the study, we found an impressive improvement in combination vaccination rates from 9% to 30.76% in these patients.

The graph (Figure 3) depicting weekly trends of combination vaccination rate highlights high vaccination rates in the initial study period. This was likely due to the relatively small number of patients eligible for combination vaccination at the start of the study, given the low baseline PCV13 and PPSV23 vaccination rates during the preintervention period. After Week 8, the graph depicted a downward trend in the combination vaccination rate, which corresponded with the high historical error rate. As the vaccination history was incomplete during the initial period (prior to enrollment in GRITS), it was impossible to gauge the timeline and type of pneumococcal vaccination administered in the past and hence, the remaining part of the combination vaccination could not be administered initially. After enrollment in the

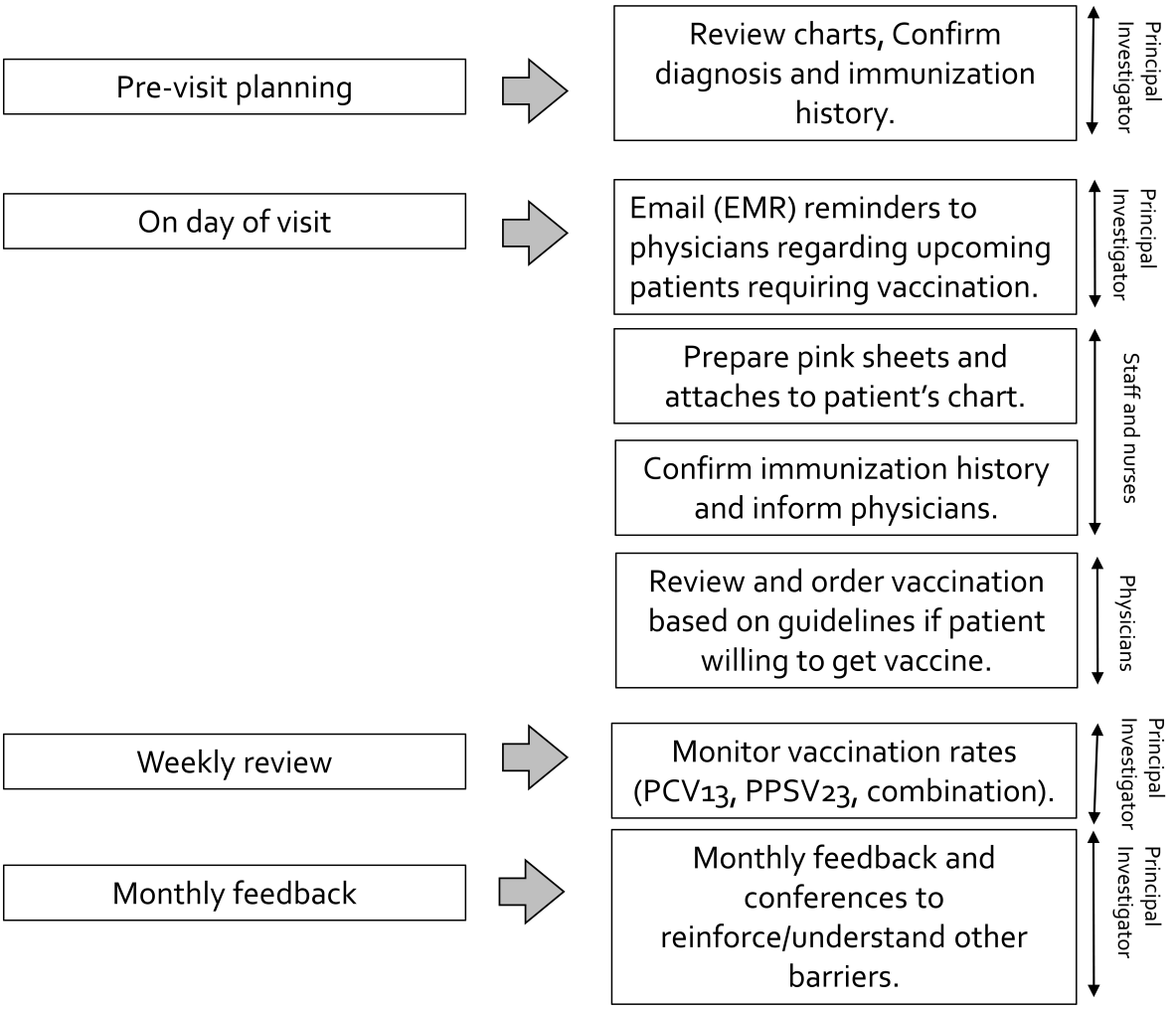

Figure 2. Multifaceted intervention planning highlighting different phases of intervention: previsit planning (included review of immunization history and confirmation of diagnosis of upcoming visit), day-of-visit planning (including e-mail reminders to physician, preparation of pink sheets, ordering vaccination, and updating vaccination history), weekly review (updating weekly immunization rates for the clinic), and monthly feedback session (monthly progress reviewed, conferences held to reinforce the need of vaccination and understand other barriers). PPSV23: pneumococcal polysaccharide vaccine 23; PCV13: pneumococcal conjugate vaccine 13; EMR: electronic medical records.

GRITS database, which corrected the historical error, the downward trend quickly corrected. After Week 22, there was a lower average combination vaccine rate (35%) noted, which corresponded with the high vaccination refusal rate (49%) seen during this period. Downward deflection of combination vaccination rate was also noted during weeks 18 and 20, but no plausible explanation was found.

Given the previous studies highlighting the efficacy of PCV13 and PPSV23 in preventing pneumonia and invasive pneumococcal disease, we obtained data regarding pneumococcal pneumonia-related hospitalizations in patients with SLE during the preintervention period and study period. We found a small decrease in pneumococcal pneumonia-related hospitalization from 3.6% in the preintervention period to 2.2% during study period. No cases of invasive pneumococcal disease in patients with SLE were reported during the preintervention nor study periods.

DISCUSSION

Pneumococcal infections account for 7–11% of all serious infections[16] in patients with SLE. The prevention of pneumococcal disease is important as it contributes to significant morbidity and mortality in patients with SLE. Previous studies have suggested a significant role of combination pneumococcal vaccination in preventing invasive pneumococcal infection as well as pneumococcal pneumonia-related hospitalizations in immunocompromised and SLE populations. Our multifaceted quality improvement project was one of the few studies planned to improve combination pneumococcal vaccination rate in patients with SLE, especially in the

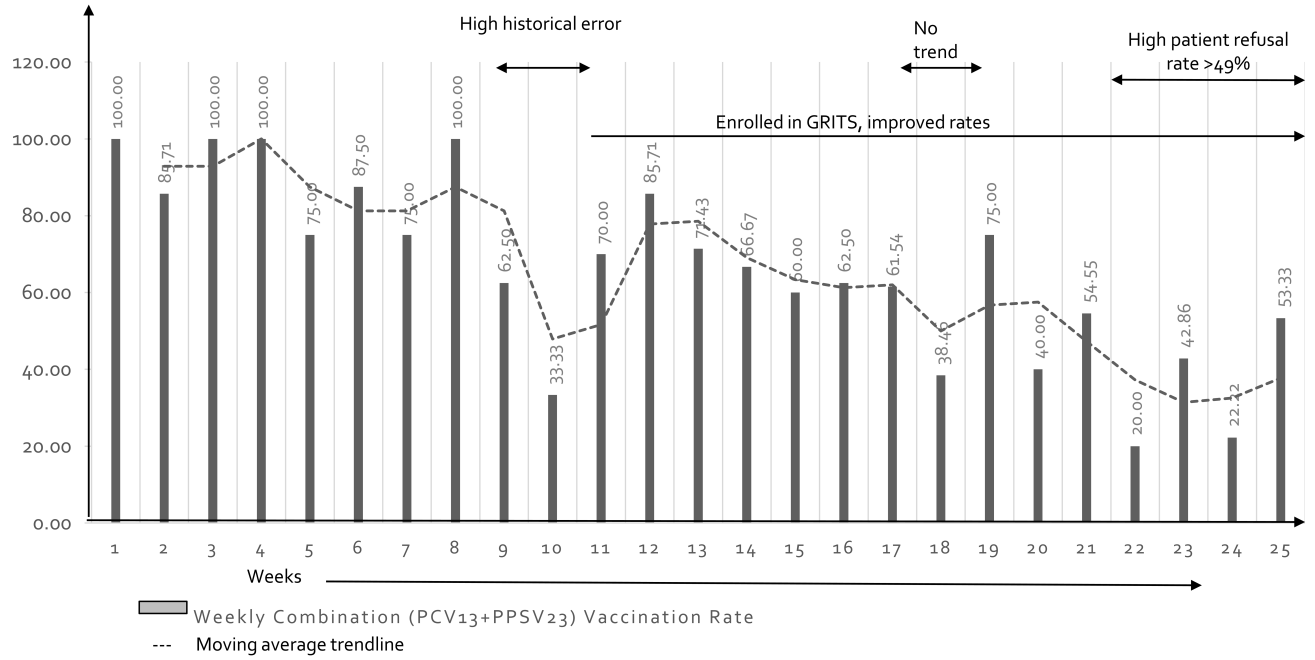

Figure 3. Combination pneumococcal vaccination weekly rate with graph indicating downward trend in weeks 9–10, corresponding to high historical error rate, which improved after enrolling in GRITS; Week 18 deflection with no significant explanation; and weeks 22–25 downward trend with high patient refusal rate. GRITS: Georgia Registry of Transaction and Services; PPSV23: pneumococcal polysaccharide vaccine 23; PCV13: pneumococcal conjugate vaccine 13.

adult community. Our study reports an impressive improvement in combination vaccination rate from 10% to 59%. To our knowledge, our study is one of the few that reported a significant improvement in combination pneumococcal vaccination rate in adult patients with SLE. A previous study by Baker, *et al* reported only a 10.4% improvement in the combination pneumococcal vaccination rate from a baseline of 0%[17]. Although we found previous studies targeting combination pneumococcal vaccination in pediatric and adolescent populations with impressive improvement in vaccination rates, not many studies were found that target adult populations with autoimmune diseases[18,19]. A relatively higher number of studies were reported regarding improving only PPSV23 vaccination rates in adult patients[20].

We attribute the improvement in the combination vaccination rate to the implementation of our intervention, which was problem-focused, feasible, and user-friendly. Our initial aim was to understand the underlying physician- and staff-based barriers leading to low baseline vaccination rates in patients with SLE at our practice. The physician- and staff-based surveys helped us in recognizing these barriers and planning adaptable interventions to overcome them. Forgetfulness was one of the major barriers projected in our surveys, followed by insufficient time during clinic visit and lack of knowledge of updated vaccination guidelines. This is comparable to results reported by other quality improvement studies aiming to improve vaccination rates in patients with SLE[18,19]. Our study was structured to overcome forgetfulness by sending daily reminders to staff and physicians, and by the use of a vaccination form acting as a second reminder during the clinic visit. With the help of process mapping we were able to plan, and to add or eliminate steps to the intervention, making it simple to implement in the existing clinic flow.

A previous systematic review on vaccine-specific quality improvement projects highlighted modest improvement in pneumococcal vaccination rates by reinforcing or assigning key interventions to nonphysician personnel and educating them about pneumococcal disease and vaccine guidelines[21]. Based on this study, we organized a monthly feedback session of our intervention, which reinforced the need of vaccination among the team members.

The passive improvement in the combination vaccination rate from 2% to 39.6% in other autoimmune disease patients supports the adaptiveness of the intervention and also highlights a true practice change at our clinic. Because the interventions were user-friendly and easily adaptable, they became part of daily clinic flow and even after the end of the study period, a stable pneumococcal vaccination rate was reported.

The dynamic features of our design allowed us to add or eliminate interventions such as enrolling in GRITS, which helped in improving and stabilizing the vaccination rates.

As previously mentioned, the combination pneumococcal vaccination weekly rate graph (Figure 3) shows high initial

combination vaccination rate, which is likely due to a small total number of eligible patients in the beginning of the study, given the low baseline vaccination rate. The graph after 8 weeks shows a true depiction of our weekly vaccination rate and the downward trend seen during weeks 9–10 and weeks 22–25 corresponds to the high historical error rate and high vaccination refusal rate, respectively.

Our study used simple yet effective interventions and given the similar barriers reported in other studies, we believe that the basic structure of the interventions can still be used for improving combination vaccination rates at other facilities.

In our study, fatigability is a barrier that is witnessed in any other quality-improvement project. During the project, monthly review sessions encouraged our team to remain motivated and focused, and continuing these efforts will assist in overcoming this limitation. Finally, the patient refusal rate was noticed to be significantly high, especially toward the end of the study period, and is one of the major barriers in improving vaccination rates that remained unaddressed in our current study (Figure 4). Future projects will be planned to target this problem with patient surveys and patient education, through educational handouts and counseling sessions following clinical visits, and conducting surveys for analysis of unaddressed barriers.

Pneumococcal infection is a significant threat in patients with SLE and can be prevented by administering combination vaccination. Our study highlights that developing an integrated workflow and sharing performance data can dramatically increase the rates of combination pneumococcal vaccination in adult patients with SLE. Our quality project design can serve as a model that can be adapted by other specialty clinics to achieve higher vaccination standards.

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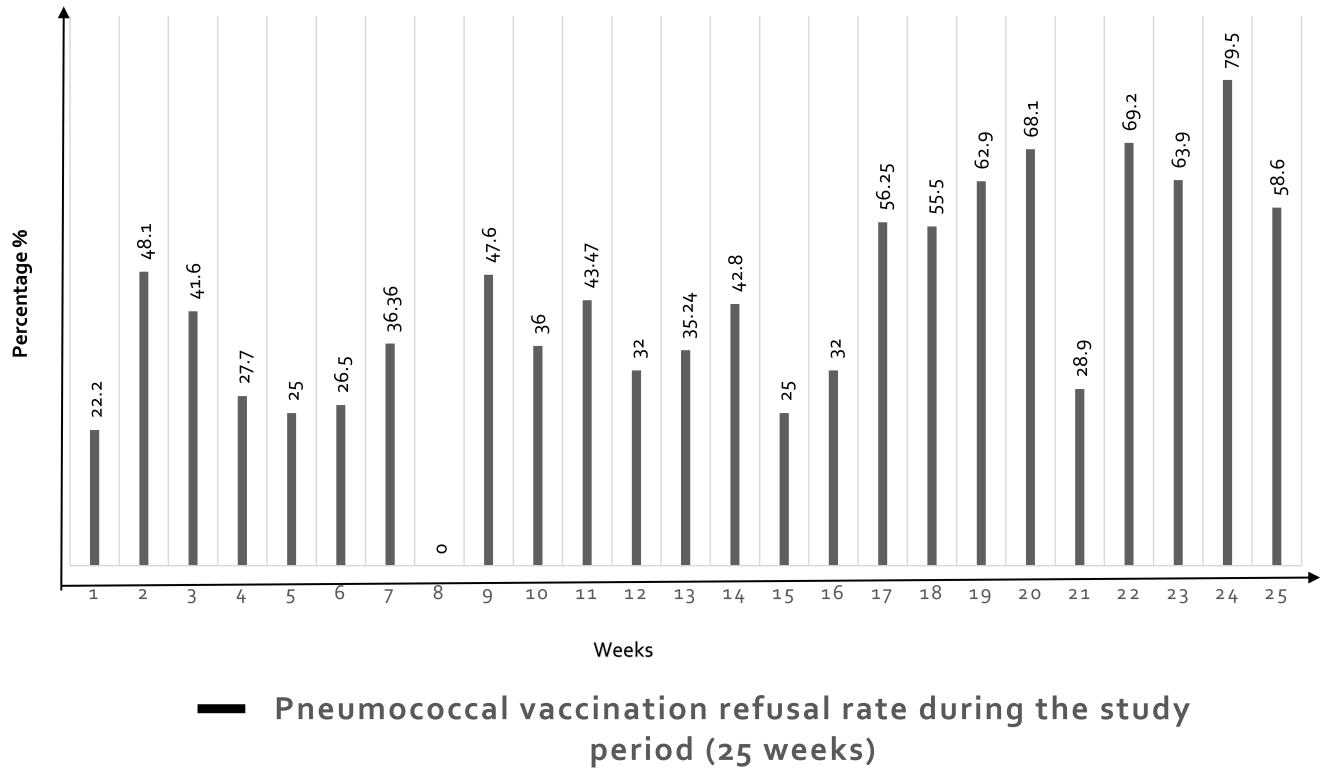

Figure 4. The graph highlights significantly increasing patient refusal rates during the study period. This correlates with the downward trend in combination vaccination toward the end of study period.

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