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The effects of vaccination forecasts and value-based payment on adult immunizations by community pharmacists

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ABSTRACT

Background: The prevalence of vaccine-preventable diseases in adults remains a significant public health issue in the United States. The objectives of this demonstration project were to increase the number of influenza, pneumococcal, pertussis, and herpes zoster immunizations administered to adults by community pharmacists, evaluate the percentage of immunizations documented in the state immunization information system (IIS), and design and pilot a value-based payment model.
Methods: A one-year prospective, observational demonstration project was conducted in 70 community pharmacies in western Washington State from September 1, 2016 to August 31, 2017. An immunization interface was integrated into workflow at each pharmacy to enable "forecasting" of and proactive recommendation to patients about their vaccine needs and documentation of vaccines administered in the state IIS. Categorical value-based payment models were developed and implemented in a subgroup of 12 community pharmacies from March 1 to November 30, 2017. The change in the number of immunizations administered in comparison to the baseline period and the percentage of immunizations documented in the state IIS during the demonstration period were analyzed using descriptive statistics.
Results: There was a 15% total increase in the collective number of influenza, pneumococcal, pertussis, and herpes zoster vaccines administered in the demonstration year in the 70 pharmacies, due to increases in influenza and pertussis vaccinations. Eighty-three percent of the vaccines administered were documented in the state IIS. Pneumococcal, pertussis, and herpes zoster performance appeared to be unaffected by the value-based payment models while influenza performance improved across the 12 pilot pharmacies.
Conclusions: This work demonstrated that community pharmacists contribute to improving adult immunizations through vaccine "forecasting" and proactive recommendation. Meaningful quality measures with both positive and negative incentives could further drive adoption of best immunization practices. Further implementation and outcomes research is needed to fully examine the impact and scalability of these strategies.

1. Introduction

Immunizations are one of the greatest global public health achievements [1,2]. Yet, vaccine-preventable diseases remain a major global cause of morbidity and mortality [3]. Further, the overall prevalence of vaccine-preventable diseases among adults exceeds that of children due to ongoing low vaccine coverage among United States (US) adults [4]. While the *Healthy People 2020* target for achieving 30% herpes zoster vaccination coverage was met in 2015, other vaccination targets in the US were unmet [3,4]. Lack of physician recommendations, false assumptions, concern for possible side effects, lack of regular well-care visits, and lack of effective reminders systems have been identified by patients and healthcare providers as barriers to adult vaccination [5]. On the other hand, an immunization provider recommendation to a patient is a strong predictor of vaccination [6,7]. Innovative solutions are needed to both expand access to and increase adult immunization utilization in order to address this public health issue.

The significant contributions of pharmacists and pharmacies in increasing immunization rates over the past two decades has been

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widely described [8–10]. Due in part to their accessibility to the public and status as highly trusted healthcare providers, pharmacists in all 50 states, the District of Columbia, and Puerto Rico have the legal authority to administer immunizations [5,11]. In 2016 the Pharmacy Quality Alliance (PQA) Adult Immunization Task Force identified critical areas for continuing to improve adult immunization rates via community pharmacist-delivered vaccination [12]. The critical areas centered on achieving more widespread uptake of the National Vaccine Advisory Committee's (NVAC) Standards for Adult Immunization Practice through the development of quality measures for community pharmacy-based immunization programs [13,14]. The NVAC Standards recommend that all healthcare professionals take the following 4 steps to ensure all adult patients are fully immunized: assessing the immunization status of all patients at every clinical encounter; strongly recommending vaccines based on patient need; administering needed vaccines or referring patients to a vaccination provider; and documenting administered vaccines.

The Project Impact Immunization pilot demonstrated the effect of community pharmacists implementing the NVAC Standards in Washington State, a state that does not mandate reporting to the immunization information system (IIS) yet has above average adult participation in the IIS [15–17]. In 2016, 72.4% of adults 19 years and older had at least one immunization documented in the Washington State IIS compared to national average of 44% [17]. As part of the Project Impact Immunization pilot, 8 community pharmacy practices in Washington State utilized IIS data to identify adult patients' unmet vaccination needs during the 2015–2016 influenza season [15]. When a patient presented to these pharmacies for their annual influenza vaccine, pharmacists used a clinical decision-support technology to generate a vaccination forecast. This forecast was based on patient information documented in the IIS. This strategy resulted in identification of 1335 unmet vaccination needs and a 41.4% increase in the number of adult vaccines administered in the 8 pharmacies.

More widespread dissemination of these strategies and collaboration among all immunization stakeholders is required to close the gaps in adult vaccine coverage and achieve the "immunization neighborhood" [12,13,18]. We report the findings from a community-based collaboration of immunization stakeholders in western Washington State to increase adult vaccinations delivered by community pharmacists. Our project sought to increase the number of influenza, pneumococcal, pertussis, and herpes zoster immunizations administered to adults by community pharmacists, evaluate the percentage of immunizations documented in the state IIS, and design and pilot a value-based payment model. In the process of conducting this initiative, we created a real-world "immunization neighborhood" and innovation hub resulting in the generation of solutions intended to enhance existing community pharmacy-based immunizations programs to better align with the NVAC Standards for Adult Immunization Practice. We report our findings to foster incremental enhancements to immunization care in community pharmacies.

2. Methods

We conducted a one-year prospective, multisite, observational demonstration project in 70 community pharmacies in western Washington State. Forty Bartell Drugs locations and 30 Quality Food Centers (QFC) Pharmacy locations served as the demonstration sites. Bartell Drugs is a family-owned chain pharmacy with 64 locations in western Washington State. All 40 Bartell Drug locations participating in this demonstration project had some level of prior experience using the immunization interface and immunization forecaster. QFC Pharmacy is a grocery-based pharmacy division of the Kroger Company with 30 pharmacies in Washington State. Two of the 30 QFC pharmacy locations had prior experience with the immunization interface prior to this project. All of the participating community pharmacies had been providing adult immunizations prior to this demonstration through collaborative practice agreements (CPA). The UW Human Subjects Division determined the demonstration nature of the project was not research and Institutional Review Board review and approval was not required.

2.1. Vaccine forecast and proactive recommendation model

An immunization interface and immunization forecaster, ImmsLink™ (Scientific Technologies Corporation, Scottsdale, AZ), was integrated into the workflow at each pharmacy to enable proactive checking of the IIS and "forecasting" of and recommendation to patients about their vaccine needs, with emphasis on vaccines for four diseases: influenza, pneumococcal including both the conjugate and polysaccharide vaccines, pertussis, and herpes zoster. The interface facilitated the pharmacists' assessment of patients' vaccine needs at every encounter via proactive immunization "forecasting" and querying of the state IIS. Pharmacy teams were instructed to follow this workflow:

1. When adult patients with a potential age or medical indication for any of the focus vaccines presented to the pharmacy in-person or via telephone, an immunization forecast was run from the patient's vaccination history in the state IIS. Each individual pharmacy could determine whether the pharmacist or pharmacy technician would run the forecast based on their workflow and staffing.
2. Pharmacists used the vaccine forecast to proactively engage in individualized discussions with patients about their vaccine needs and provide a strong recommendation for all indicated vaccine(s).
3. With patient consent, pharmacists would also administer the recommended vaccine(s) to patients who had no contraindications to the vaccine(s).
4. Administered vaccinations were documented in the state IIS via the immunization interface to facilitate sharing of immunization information. One community pharmacy partner used a centralized and automated process to report vaccines administered to the interface vendor daily. The other partner entered data manually into the interface.

Although the interface was designed to be bi-directional, it was not integrated with either community pharmacy organization's dispensing system. Rather, the interface was accessed by pharmacy staff via the internet.

2.2. Implementation strategy

A multifaceted implementation strategy was used to promote implementation of the vaccine forecast and proactive recommendation model in the 70 demonstration pharmacies, including training and performance measurement methods. An initial training program was collaboratively developed and executed by the research team and community pharmacy partners to orient pharmacists and technicians to the project, the immunization interface, and workflow changes and enhancements. Using role play or real patient scenarios, the training also included practice interpreting the vaccine forecasts, making a strong recommendation for indicated vaccines, and documenting care. All pharmacists and technicians were individually evaluated by a trainer using a role play or real patient scenarios to ensure optimal competency with these key skills.

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Bartell Drugs implemented the vaccine forecast and proactive recommendation model in all 40 of their demonstration locations at the same time due to their prior experience with the immunization interface. The training program was delivered to Bartell Drugs through trainer visits to each pharmacy over a one-month period from September-October 2016. QFC Pharmacy implemented the model in two phases. Ten pharmacies implemented the model in phase one in September 2016. An initial in-person training program was delivered via two different strategies for these 10 pharmacies to assess the most effective training strategy to be used for the broader implementation to the remaining 20 pharmacies in phase two. One strategy utilized a same-day training approach for the entire pharmacy team. The other strategy utilized a "train-the-trainer" approach for a pharmacist-pharmacy technician pair from each pharmacy. These pharmacist and technician champions then trained their pharmacy team members upon return to the practice. The results of an evaluation of these training methods has been published [19]. The train-the-trainer approach was used to on-board the remaining 20 QFC Pharmacy locations in January 2017.

Both of the community pharmacy partners offered ongoing coaching to assist pharmacy teams in adapting the intervention to their individual site and train new staff. Monthly newsletters were developed by the project team and distributed throughout the project period as an additional source of ongoing training and communication. Each newsletter contained updates from the project leadership team including a year-to-date performance comparison of immunizations administered, immunization best practices during the project, and clinical updates or cases about the 4 focus vaccines.

A novel immunization dashboard was developed to provide each of the 70 pharmacy teams with the ability to monitor their impact in close to real time and enact timely process improvement to increase their impact on adult immunization care. The dashboard contained a separate section for each vaccine and displayed a variety of data visualizations that compared immunization performance during the demonstration period from the baseline year. Each section first displayed a high-level monthly overview of immunization performance with a bar chart sorted by performance to quickly identify pharmacy stores that may be having difficulties. Secondly, the dashboard displayed a line chart with a weekly breakdown of immunization performance and a bar chart of overall store performance to determine if interventions were needed to increase immunizations. Additionally, a timeline of milestones and interventions provided by project leads were documented on the footer of the dashboard. Examples of documented milestones included television and radio advertisements promoting immunizations. The dashboard was updated monthly and lived on the UW's server with access restricted to only project participants. An example of the dashboard is provided in Fig. 1.

2.3. Value-based payment models

Value-based payment models for influenza, pneumococcal conjugate and polysaccharide, pertussis, and herpes zoster vaccines were developed using a stakeholder and data driven approach. In September 2016, a group of key stakeholders were brought together to brainstorm a feasible structure for a value-based incentive model for immunizations delivered in community pharmacies. This group of stakeholders included representation from our two community pharmacy partners and the Washington State Healthcare Authority, our primary payer partner. This group also included representation from independent pharmacy practice, the immunization interface vendor, the state pharmacy association, the Washington State Department of Health, and other healthcare professions. The stakeholder group identified the following 3 guiding principles for developing a value-based payment model:

- Separate models should be developed for each vaccine;
- A tiered incentive structure with an increase to immunization payment based on changes in immunization rates was viewed as most ideal; and,

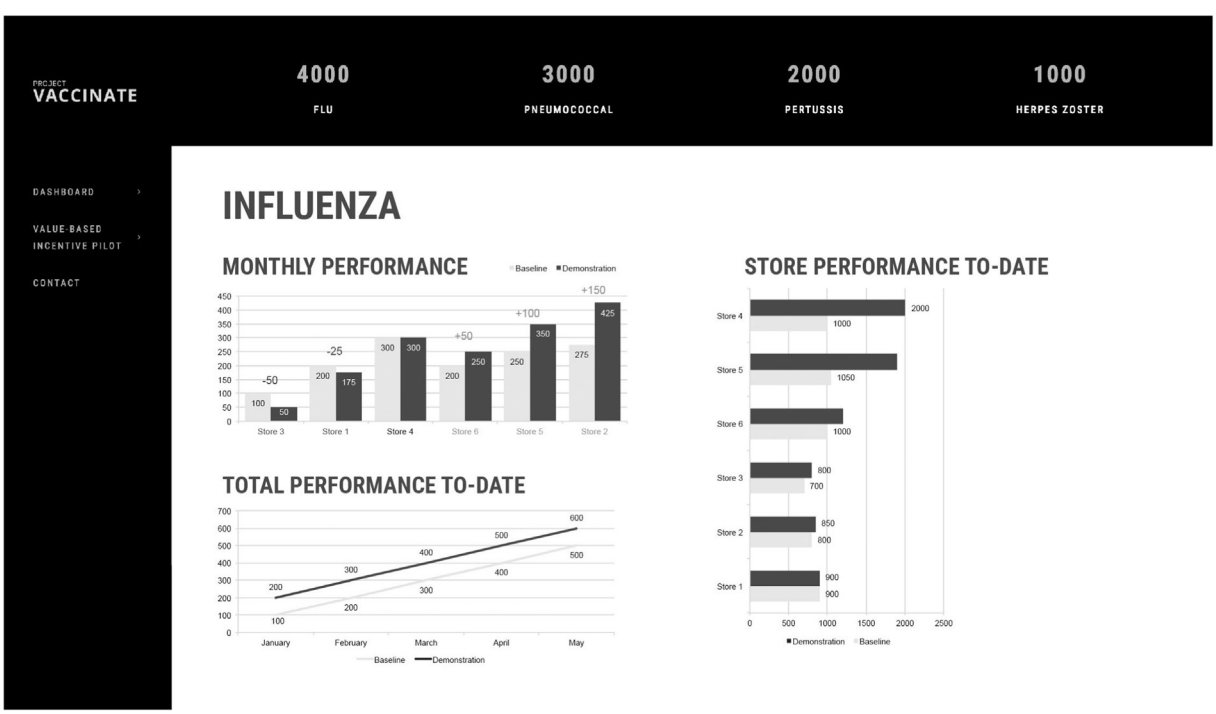

Fig. 1. Pharmacy immunization dashboard example for monitoring influenza vaccination performance.

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- The incentive models needed to be operationalized in such a way that all pharmacy team members were incentivized, not just pharmacists.

Using this input from our stakeholders, three potential approaches were mathematically modelled using immunization data from the demonstration pharmacies to assess feasibility. These models were then presented back to our stakeholders in December 2016. By mathematically modeling the incentive structures, our stakeholders were able to visualize the models with the change in the pharmacies' performance over the past year, and the resulting financial implications, in order to make informed decisions about the long-term sustainability of each model. Ultimately, the stakeholders selected the tiered, or categorical, incentive models for each vaccine (Fig. 2).

The value-based incentive models were then piloted in a subgroup of 12 of the demonstration pharmacies. Six demonstration pharmacies – two low performing pharmacies in immunizations at baseline, 2 medium performers, and 2 high performers – were randomly selected from each partner organization to participate in the value-based payment model pilot. Low, medium, and high performers were determined based on the number of immunizations administered in the baseline year. The payment models, with the exception of the influenza payment model, were initially piloted over a 6-month period from March to August 2017 to determine if the financial incentive affected immunization care delivered by the pharmacy teams. The influenza payment model was not initially piloted because it was not influenza season. The 12 value-based incentive pilot pharmacies received quarterly reports of their immunization performance and earnings from the payments models during this time, similar to what one would expect from an insurer-based initiative and separate from the novel immunization dashboard previously described. Value-based incentive earnings were paid to each community pharmacy partner quarterly at a corporation level. Management within each community pharmacy partner then made each pharmacy's earnings available for the team to use how they desired. Pharmacy teams spent the earnings in a number of ways ranging from purchasing supplies for the pharmacy to providing gift cards for technicians and assistants.

Due to minimal performance improvements, the value-based payment models were reassessed after the initial 6-month pilot. In August 2017, 17 staff members from 6 demonstration pharmacists were interviewed to provide feedback on the payment models. Two themes emerged from these interviews. First, the pharmacy staff indicated they were more motivated to vaccinate patients because it is the right thing to do rather than by the financial incentive. The staff felt they may have been more motivated by a shared risk structure, where they could be rewarded for improved immunization performance and penalized for missed immunization opportunities. Second, pharmacy staff indicated they desired more frequent communication from pharmacy management about their performance and successful strategies for promoting immunizations. Interviewees suggested monthly rather than quarterly communication regarding immunization performance.

This feedback was used to modify and test an adapted version of the payment models for an additional 3 months (September–November 2017). First, we modified the pneumococcal, herpes zoster, and pertussis models by rounding the tiers to the nearest whole numbers and tripling the incentives. In the first iteration of the models, the incentives ranged from $1.00 to $6.00 per vaccine. In the revised models, the incentives range from $3.00 to $18.00 per vaccine (Fig. 3). Second, due to the time of year, the influenza incentive model was also piloted due to the start of flu season. Lastly, performance reports were provided to the pharmacy teams monthly rather than quarterly.

2.4. Data collection and analysis

The vaccine forecast and proactive recommendation model was evaluated by assessing the percent change in number of immunizations administered in comparison to the baseline year and percentage of immunizations documented in the IIS by the 70 demonstration pharmacies during the demonstration year. The number of immunizations administered at the demonstration pharmacies were collected in and obtained from the community pharmacy partners' dispensing records. The number of vaccines documented were collected in and obtained from the immunization interface. Influenza, pneumococcal, pertussis, and herpes zoster vaccinations administered by pharmacists at the 40 Bartell Drugs pharmacies and 10 phase 1 QFC pharmacies to adults 18 years or older during the demonstration year (September 1, 2016–August 31, 2017) or baseline year (September 1, 2015–August 31, 2016) were included in the analysis. Influenza, pneumococcal, pertussis, and herpes zoster vaccinations administered by pharmacists at the 20 phase 2 QFC pharmacies to adults 18 years or older during the demonstration period (December 1, 2016–August 31, 2017) or baseline period (January 1, 2016–August 31, 2016) were also included in the analysis.

The value-based payment model was evaluated by assessing the percent change in the number of immunizations administered at the 12 pilot pharmacies, and separately based on baseline performance categories, during the pilot period in comparison to the baseline year. Pneumococcal, pertussis, and herpes zoster vaccinations administered by pharmacists at the 12 value-based payment pilot pharmacies to adults 18 years or older from March 1 to November 30, 2017 were included in the analysis. The baseline period for these vaccines was March 1–November 30, 2016. Influenza vaccinations administered by pharmacists at the 12

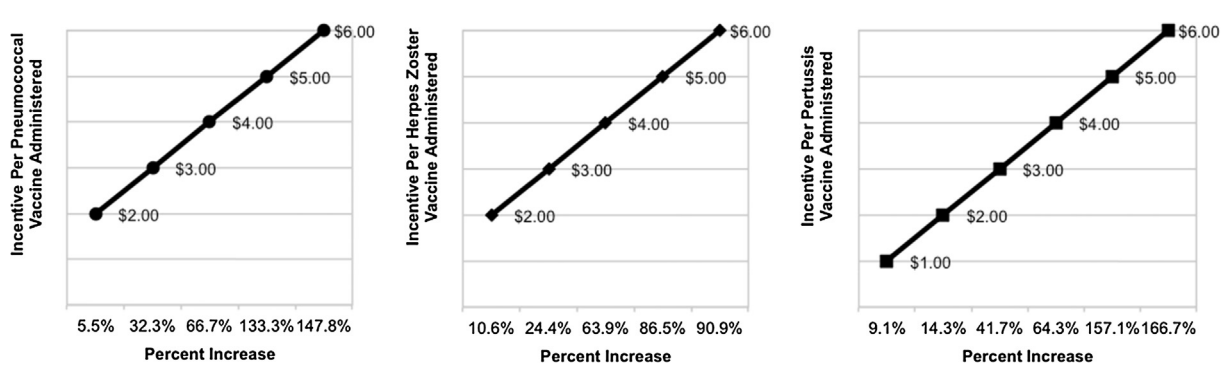

Fig. 2. Initial value-based payment models for pneumococcal, herpes zoster and pertussis vaccinations implemented from March 1 to August 31, 2017.

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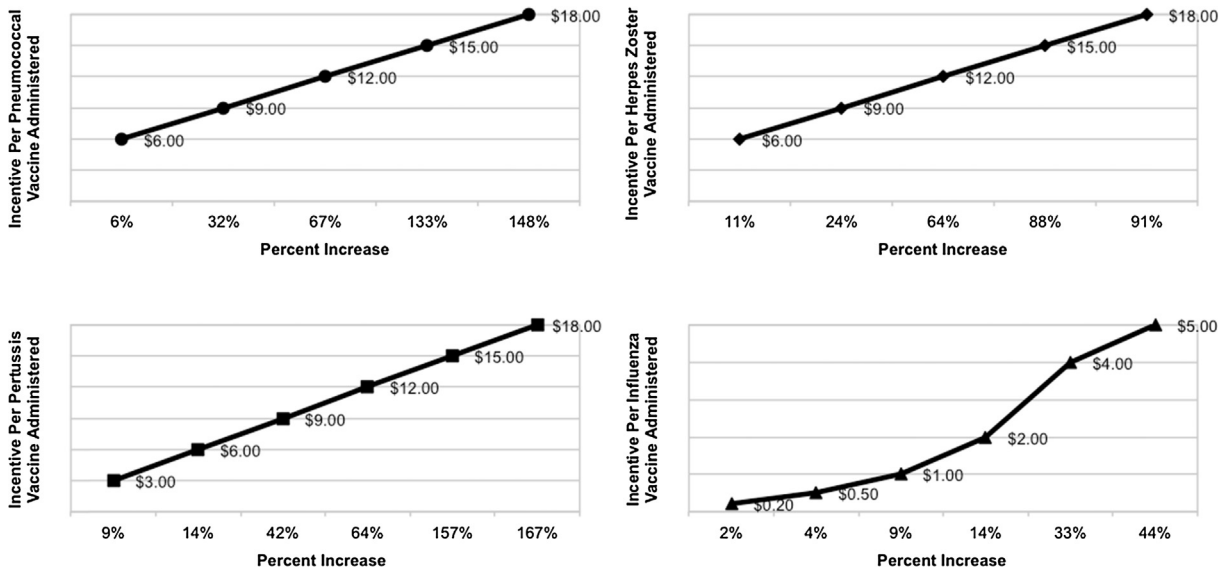

Fig. 3. Revised value-based payment models for pneumococcal, herpes zoster, pertussis, and influenza vaccinations implemented from September 1 to November 30, 2017.

value-based payment pilot pharmacies to adults 18 years or older from September 1 to November 30, 2017 were included in the analysis. The baseline period for the influenza vaccination was September 1–November 30, 2016. Differences in immunization performance between the 12 high, medium, and low performing value-based payment pilot pharmacies were also assessed. All outcomes were analyzed using descriptive statistics.

3. Results

In total, 70,280 influenza, pneumococcal, pertussis, and herpes zoster vaccines were administered by pharmacists at the 70 demonstration community pharmacies during the one-year project period compared to 61,170 vaccines during the baseline year (Fig. 4). The 9110 additional vaccines resulted in a 15% increase in the number of vaccines administered. The number of influenza and pertussis vaccines administered increased by 19.8% and 13.3%, respectively. The number of pneumococcal and herpes zoster vaccines administered decreased by 14.9% and 21.2%, respectively. Fig. 4 summarizes the change in influenza, pneumococcal, pertussis, and herpes zoster vaccines administered from the baseline year to the demonstration year.

During the one-year demonstration period, 58,871 total influenza, pneumococcal, pertussis, and herpes zoster vaccines, or 83.8% of the vaccines administered, were documented in the IIS via the immunization interface. Of this total, 82% of the influenza vaccines, 89% of the pneumococcal vaccines, 99.5% of the pertussis vaccines, and 86.8% of the herpes zoster vaccines administered were documented in the IIS. Table 1 summarizes documentation performance for each vaccine during the demonstration period.

3.1. Value-based payment models

The results of the initial pilot of the pneumococcal, pertussis, and herpes zoster value-based payment models from March 1 to August 31, 2017 are summarized in Table 2. Year over year

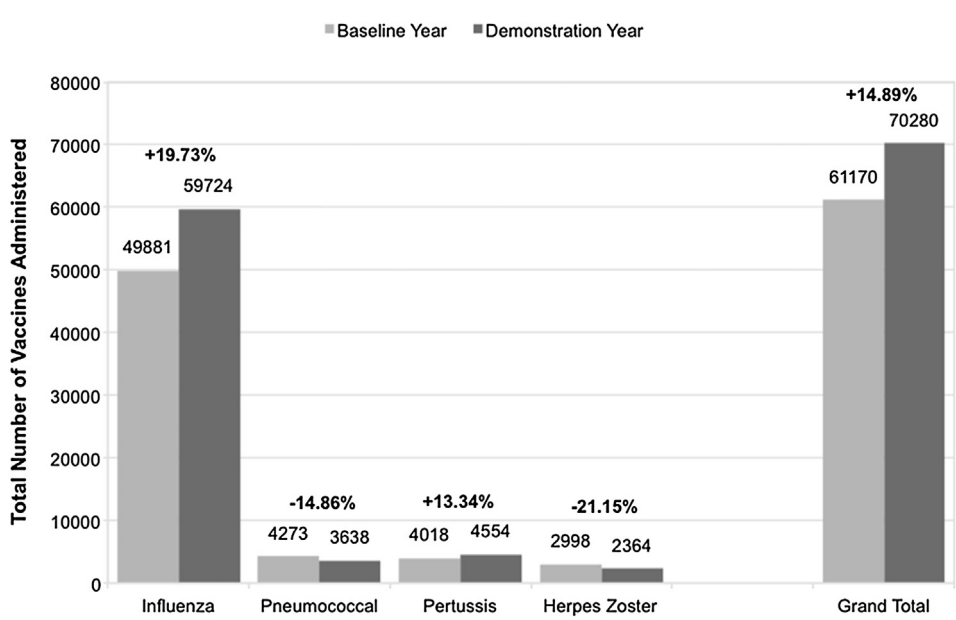

Fig. 4. Change in influenza, pneumococcal, pertussis, and herpes zoster vaccines administered from the Baseline Year to the Demonstration Year.

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Table 1
Immunizations documentation performance in the demonstration period[1] for influenza, pneumococcal, pertussis, and herpes zoster.

Vaccine	Number of vaccines administered	Number of vaccines documented and %
Influenza	59,724	49,047 (82.12%)
Pneumococcal	3638	3238 (89.00%)
Pertussis	4554	4534 (99.56%)
Herpes Zoster	2364	2052 (86.80%)
Total	70,280	58,871 (93.77%)

[1] The demonstration period was September 1, 2016–August 31, 2017 for 50 pharmacies and December 1, 2016–August 31, 2017 for 20 pharmacies.

pneumococcal vaccinations declined across all pilot pharmacies, between 12% and nearly 24%, during the initial value-based payment model period. Herpes zoster vaccinations also declined over this period, with the medium baseline performance pharmacies administering nearly 50% less immunizations during this period. However, there were no other clear patterns of change in immunization performance across the 12 pilot pharmacies. Pilot pharmacy incentive earnings during the initial incentive period ranged from $0 to $163.

The results of the pilot of the revised influenza, pneumococcal, pertussis, and herpes zoster value-based payment models from September 1 to November 30, 2017 are summarized in Table 2. During this period, pneumococcal and herpes zoster immunizations continued to be lower than the prior year, unaffected by the increased incentives. However, influenza immunizations were higher in all baseline performance group categories, with low performance pharmacies having the highest increase of 23%. Pertussis immunizations appeared to be relatively non-responsive to the value-based payment models as they continued to show lower rates from the initial period through the revised period in both the low and high-performance groups but increases in the medium performance groups. Pilot pharmacy incentive earnings ranged from $0 to $2,407.

4. Discussion

This collaborative demonstration project in western Washington State resulted in a 15% collective increase in the total number of influenza, pneumococcal, pertussis, and herpes zoster vaccinations administered by community pharmacists in 70 pharmacy locations in a one-year period, due to increases in influenza and pertussis vaccinations. These findings suggest that implementation of an immunization interface in community pharmacy workflow to facilitate "forecasting" and proactive recommendation of immunization needs can contribute to increasing adult vaccinations. These findings highlight the key role of community pharmacists in closing adult immunization gaps because of their access to and trusted relationship with the communities in which they practice.

More widespread uptake of the NVAC Standards for Adult Immunization Practice is critical for community pharmacists to fulfill this key public health role. Both community pharmacy partners in this project already had the ability to administer needed vaccines through a CPA (NVAC Standard #3); however, a number of key adaptations were made to community pharmacy workflow as part of this demonstration project to promote full adoption of the other 3 NVAC Standards.

An immunization interface was implemented to facilitate pharmacist assessment of patients' vaccine needs at every encounter (NVAC Standard #1) via its immunization "forecasting" functionality. There is growing evidence that immunization programs that incorporate pharmacists' proactive identification of patients' vaccination needs, rather than reactive identification of vaccines upon patient request, results in increased immunizations rates [9,15,20–22]. Evidence also indicates that a recommendation from an immunization provider is the strongest predictor of an adult getting vaccinated [5,23–25]. A training program was developed and deployed to enhance the pharmacists' ability to strongly recommend vaccines that patients needed (NVAC Standard #2). Interactive training was developed using simulated patient cases, role play, and assessment to ensure adequate development of professional immunization competencies per the NVAC Standards. Training in providing a strong recommendation to a patient was identified as a need by the community pharmacy partners at the beginning of the project. This demonstration project was not designed to evaluate the effectiveness of the training or the effectiveness of a strong recommendation from a pharmacist; however, future work should further explore the best communication strategies for healthcare providers to use when strongly recommending vaccines.

Many of the components of a strong recommendation supported by the NVAC Standards align with motivational interviewing principles indicating its potential utility in this area [26]. Brackett et al. conducted a small pilot evaluation of motivational interviewing-based intervention by community pharmacists; however, they were unable to determine the effect of the intervention due to a limited sample size [27]. Additional recent work has highlighted the effectiveness of indirect behavioral prompts, such as reminder and recall interventions, over education-based interventions [28,29]. Combining a strong recommendation with indirect behavioral prompts could represent an effective tactic for increasing adult immunization rates.

The immunization interface also facilitated documentation of vaccines administered in the Washington State Immunization Information System (NVAC Standard #4.) As a direct result of this demonstration, 42 community pharmacies continued their documentation of immunizations and 28 community pharmacies began documenting adult immunizations to the state IIS. Reporting of

Table 2
Percent change in immunization performance in the value-based payment model for influenza, pneumococcal, pertussis, and herpes zoster.

Vaccine	March 1 to August 31, 2017			September 1 to November 30, 2017		
	Low performers[1]	Medium performers[1]	High performers[1]	Low performers[1]	Medium performers[1]	High performers[1]
Influenza	N/A	N/A	N/A	▲23.38%	▲4.91%	▲20.37%
Pneumococcal	▼−12.24%	▼−23.86%	▼−20.00%	▼−14.68%	▼−3.03%	▼−29.72%
Pertussis	▼−13.38%	▲20.22%	▲8.00%	▼−39.13%	▲38.18%	▼−17.19%
Herpes Zoster	▲2.13%	▼−49.57%	▼−24.05%	▼−22.86%	▼−36.05%	▼−41.67%
Total	▼−10.08%	▼−20.75%	▼−6.80%	▲15.53%	▲1.94%	▲10.33%

[1] Low, medium, and high performers were determined based on the number of immunizations administered at each pharmacy in the baseline year and each community pharmacy partner's internal performance standard thresholds.

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pharmacy immunization data to an IIS is not currently mandatory in all states [30]. Increasing and optimizing community pharmacies connectivity to and documentation in immunization information systems represents a significant opportunity to improving immunization care across the country. Improved reporting to IIS will optimize the utility of clinical decision-support and forecast technology for patient care because the accuracy of these tools are dependent on the immunizations records reported to IIS.

In this demonstration project, 84% of the vaccines administered were documented in the state IIS via the immunization interface. The 16% of vaccines not documented in the state IIS highlights the challenges of documentation in community pharmacy workflow. One of the community pharmacy partners was able to report vaccines administered using a centralized and automated process to alleviate burden in workflow. However, some of the pharmacy teams were required to report vaccines administered via manual documentation in workflow. This documentation process involved leaving the dispensing system to access the immunization interface through the internet. Documentation has been noted as a barrier in the provision of community pharmacist provided patient care services [31]. Community pharmacists have identified that an ideal documentation system is accessible via the dispensing system, promotes time efficiency, is easy to use, and has the ability to generate patient reports [32]. Facilitating connectivity between immunization and dispensing systems and enhancing data reporting processes will be critical to increasing the number of pharmacies documenting adult immunizations to their state IIS. Further, optimizing immunization care requires strengthened links between all electronic healthcare systems, such as electronic medical records, dispensing systems, and immunization information systems, to ensure timely and efficient communication among all healthcare providers and optimize immunization care [33,34].

Lastly, we augmented the efforts to increase immunizations by incorporating a financial incentive to the pharmacies in the form of value-based payments for increasing vaccination rates at the pharmacy level. While pharmacies have previously been incentivized by pharmacy benefit managers for adherence, clinical guidelines, and medication safety, to our knowledge this is the first adult immunization-focused value-based incentive to be implemented in community pharmacies. The value-based payment models that we implemented were not successful in motivating an overall increase in immunizations or within any of the immunization types other than influenza. We also cannot rule out that the influenza rates would have increased in the absence of the value-based incentives. Importantly, we piloted an initial stakeholder-driven set of financial incentives that were modest but deemed adequate by both pharmacy leadership and our state payer member of the stakeholder group. When those incentives failed to produce widespread increases in immunizations, we tripled the incentives and simplified the approach based on feedback from the pilot pharmacies. Even with these increased incentives and communication to the pilot locations, the pharmacies did not respond with higher immunization rates.

It is important to note several external factors that may have affected the number of immunizations administered during this demonstration project. There was a 21.2% decrease in the number of herpes zoster vaccinations administered during the demonstration year (September 1, 2016–August 31, 2017) in comparison to the previous year among pilot site pharmacies. Data on herpes zoster vaccination coverage in Washington state for 2016 are not yet available to determine if coverage also decreased across the state. The pending approval of the zoster vaccine recombinant, adjuvanted may have affected both pharmacist and patient behavior, contributing to this decrease.

There was also a 15% decrease in the number of pneumococcal vaccinations administered during the demonstration year in comparison to the previous year. Community pharmacy partners' prior year vaccine initiatives and marketing campaigns by the pneumococcal vaccines' manufacturers may have contributed. External factors contributing to this decrease are less clear; however, there was overall 2% decrease in pneumococcal vaccination coverage among adults 18–64 years at increased risk and adults $\geq$65 years from 2015 to 2016 in Washington State [35].

Future work on increasing immunizations delivered in community pharmacies should further investigate the most effective and efficient implementation interventions to enhance the adoption and sustained use of the NVAC Standards for Adult Immunization Practice. Additional work is also needed to refine a value-based payment model for adult vaccines administrated via community pharmacy-based immunization programs. Shared risk structures where the pharmacies assume risk for missed immunization opportunities represent one possibility for future value-based payment model iterations.

4.1. Limitations

These findings could have been impacted by a number of factors. Staffing changes in the pharmacies resulting in staff untrained in this intervention could have affected the results; however, the project team offered ongoing coaching and monitored immunization performance via the dashboard to limit the potential impact of staff turnover. Further, patients may have received a strong recommendation from their pharmacists to receive a vaccine and have chosen to be vaccinated by a different immunization provider, such as their primary care provider, or chosen to not receive the vaccine at all due to a barrier, such as cost. We did not capture the number of patients who received a vaccine forecast and strong recommendation but declined to receive a vaccine at the pharmacy. We also did not capture patients' reasons for declining a vaccine at the pharmacy.

This demonstration of a vaccine "forecasting" and proactive recommendation model to increase adult immunizations delivered and documented by community pharmacists was conducted in 70 pharmacies in only one state. Value-based payment incentives were implemented in a small subset of these pharmacies. Generalizability to other community pharmacy practices and different state regulations across the United States may be limited. Further, the immunization interface was not integrated into the dispensing system of each community pharmacy organization limiting the generalizability to pharmacists with an integrated system.

The demonstration nature of this work and analysis of immunization counts, rather than immunization rates, limited our ability to evaluate the true effect of the forecasting and proactive outreach model and the value-based payment models on adult vaccinations. The ability to evaluate the true effect of the model was also limited by some pharmacies' prior experience with the immunization interface. This prior experience most likely affected our measurement of these pharmacies' baseline performance. Lastly, combining the pneumonia polysaccharide and pneumonia conjugate vaccine counts into one pneumonia count may have also limited out ability to evaluate the true effect of the model.

5. Conclusion

This work demonstrated that community pharmacists can contribute to improving adult immunizations through "forecasting" and proactive recommendation of immunization needs. Using these strategies, pharmacists in 70 community pharmacies across western Washington State increased the total number of influenza, pneumococcal, pertussis, and herpes zoster vaccinations administered by 15% in one year, due to increases in influenza

and pertussis vaccinations. These results were driven by uptake of the NVAC Standards for Adult Immunization Practice. Meaningful quality measures with both positive and negative incentives could further drive adoption of best immunization practices by community pharmacy staff.

Declaration of interest

None.

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