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RESEARCH

Impact of a peer comparison intervention on seasonal influenza vaccine uptake in community pharmacy: A national cluster randomized study

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ABSTRACT

Background: Seasonal influenza vaccine (SIV) uptake in the United States remains suboptimal, requiring new and innovative strategies.

Objective: To evaluate the impact of a behavioral peer comparison (PC) intervention on SIV uptake in community pharmacies across the United States.

Methods: A cluster randomized study was conducted across a national network of Walmart community pharmacies (> 4500 sites) during the 2019-2020 influenza season. The clusters consisted of 416 markets, each containing an average of 11 pharmacies. All pharmacies in a market were randomly assigned to either no intervention or the PC intervention, a software-delivered communication informing on-site staff, including pharmacists and pharmacy technicians, of their pharmacy's weekly performance, measured as SIV doses administered, compared with that of peer pharmacies within their market. The outcome was the pharmacy-level cumulative SIV doses administered during the intervention period (September 1, 2019,-February 29, 2020). Linear regression models were used to estimate the PC impact, with multiway cluster-robust SEs estimated by market and state.

Results: A total of 4589 pharmacies were enrolled in the study, with 2297 (50.1%) randomized to the control group and 2292 (49.9%) randomized to the PC intervention group. Overall, compared with the control pharmacies, the PC pharmacies administered 3.7% (95% CI −0.3% to 7.9%) additional SIV doses. Among large-format pharmacies, the PC pharmacies administered 4.1% (95% CI 0.1%–8.3%) additional SIV doses compared with the controls. Historically low-performing large-format PC pharmacies administered 6.1% (95% CI 0.5%–11.9%) additional SIV doses compared with the controls. No statistically significant treatment effects were observed among small-format pharmacies.

Conclusion: Our findings demonstrate that PCs can improve SIV uptake among large-format community pharmacies, with historically low-performing pharmacies potentially exhibiting the greatest relative impact. Wide-scale implementation of PCs in community pharmacies may help to further improve SIV uptake in these settings.

Disclosures: Matthew M. Loiacono, Christopher B. Nelson, and Ayman Chit are full-time employees of Sanofi Pasteur, a company that manufactures influenza vaccines. Stacy Zulueta is a full-time employee of Walmart (US). Laura Lee Hall has received support from Sanofi Pasteur for research and educational programming. The authors declare no other relevant conflicts of interest or financial relationships.

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Data access, responsibility, and analysis: Matthew M. Loiacono had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Key Points

Background:

- Community pharmacies are a leading provider of vaccinations, including seasonal influenza vaccines (SIVs).
- SIV coverage across all vaccination provider settings is suboptimal.
- Various provider-directed interventions, including peer comparisons (PCs), have been previously shown to significantly increase the volume of health services provided. There is little evidence, however, of the impact of PCs on SIV uptake in community pharmacies.

Findings:

- Our findings demonstrated that PCs—relatively simple digital interventions—can improve SIV uptake in this setting, particularly among large-format pharmacies (i.e., those located in big-box stores).
- Depending on a pharmacy's relative historical performance (i.e., previous influenza season SIV uptake), the PC impact may vary in magnitude, with historically low-performing pharmacies potentially exhibiting the greatest relative impact.

Each year in the United States, up to 20% of the population is infected with influenza, resulting in 12,000-61,000 deaths, 140,000-810,000 hospitalizations, 9.3-45 million symptomatic illnesses,[1] and an associated economic burden of $11.2 billion.[2] Seasonal influenza vaccines (SIVs) are the most effective means of reducing influenza-associated morbidity and mortality.[3] Yet, SIV coverage in the United States remains suboptimal, failing to reach the Healthy People 2030 70% benchmark.[4] Among adults aged 65 years or older, coverage has remained between 65% and 70% over the past decade.[5] Coverage among adults aged 18-64 years with conditions that place them at elevated risk, however, has been considerably lower, failing to exceed approximately 45%.[5] As others have noted,[6] addressing suboptimal SIV coverage likely requires new, innovative strategies.

Although vaccinations have traditionally been adminstered in physicians' offices, they are increasingly being administered in community pharmacies as well.[7] State legislation allowing pharmacists to administer vaccines, adopted in all 50 states and territories (District of Columbia and Puerto Rico) by 2009, was estimated to have increased state-level SIV coverage by up to 7%.[8,9] Estimates from previous influenza seasons indicate that more than 22% of all adult influenza vaccinations in the United States are administered in pharmacies.[7] In terms of vaccination sites, pharmacies offer several advantages that may have contributed to their expanded use. Compared with physician offices, pharmacies are typically more accessible in residential areas, have longer operating hours, and are more likely to provide unscheduled walk-in service. Pharmacies also cater to patients without a primary care provider,[10] many of whom have limited access to health care and are without health insurance.[11,12] Given these advantages, pharmacies are ideally suited to increase SIV uptake rates.

Across vaccination sites, including both pharmacies and physician offices, improving SIV uptake is an ongoing challenge. In a recent systematic review and meta-analysis of provider-directed interventions to improve SIV uptake, team-based training, education and one-off provisions of guidelines to providers were found to be most effective at improving uptake among adult patients, followed by reminder prompts.[13] On the basis of their findings, the authors noted that reminder systems in clinical settings are expected to significantly increase SIV uptake, a sentiment that has been echoed by the Centers for Disease Control and Prevention.[14] However, as concluded in this systematic review, the availability of evidence on interventions to improve influenza vaccine uptake in community pharmacy settings is limited.[13]

One potential way to increase SIV uptake in community pharmacies is to encourage pharmacists to do so. Although this may be achieved through the use of basic reminder prompts, innovative interventions derived from behavioral science, such as peer comparisons (PCs), are a promising alternative. Leveraging the power of social influence and one's inherent tendency to conform to social norms,[15] PCs have been shown to have a significant impact on provider behavior in several health care settings.[16-18] By intermittently reminding providers of their own behavior compared with that of their highest performing peers, prior research has shown that providers will tend to work to conform more closely to the perceived social norm by improving on their own behavior.[16-18] PCs can be implemented in several ways, including mailing, e-mail, or through software systems; software-delivered PCs are particularly compelling because they can be scaled up across vast networks of health care settings with relatively low cost and effort. The use of PCs toward improving provider influenza vaccination behavior is, however, limited[19,20] and, to our knowledge, has yet to be evaluated in community pharmacy settings.

In this study, we investigated the implementation and impact of a PC intervention on SIV uptake in community pharmacies using a national cluster randomized design.

Objectives

1. To implement and evaluate the impact of a randomized PC intervention on SIV uptake across a national network of community pharmacies during the 2019-2020 influenza season.
2. To assess potential heterogeneity of the PC impact across pharmacies by relative historical performance.

Methods

Study sites and eligibility

This study was conducted in U.S. Walmart pharmacies. There were initially 4618 eligible pharmacies across the contiguous United States and Hawaii (Washington, DC, included). Of these, 3910 were "large format" (i.e., located within a larger, higher-volume big-box Walmart retail store), 695 were "small format" (i.e., located within a smaller, lower-volume Walmart-branded grocery store, known as a "Walmart

Neighborhood Market"), and 13 were "standalone" (i.e., Walmart pharmacies located on college campuses, in car manufacturing facilities, and so on). We included pharmacies that (1) participated in influenza vaccination campaigns during both the 2018-2019 and 2019-2020 influenza seasons and (2) used a standardized vaccine-ordering software platform (Unify, VaxServe). Owing to their inherently different structure, compared with large- and small-format pharmacies, in combination with the small total number of locations, standalone pharmacies were excluded. The 2018-2019 influenza season encompassed September 1, 2018, to February 28, 2019, and the 2019-2020 influenza season encompassed September 1, 2019, to February 29, 2020. A total of 4589 pharmacies were eligible for study enrollment (Figure 1).

Pharmacy markets and regions

Walmart pharmacies are organized into markets and regions for reporting and management purposes. Markets (416 in total) are groups of pharmacies located in relatively close proximity to one another and are managed by a single pharmacy market manager; the average size of a market is 11 pharmacies (minimum: 4; maximum: 19; interquartile range: 10-12). Most markets consist of pharmacies of the same format (either large or small); approximately 1% of the markets have a mixture of large- and small-format pharmacies. Although pharmacists may work at more than 1 pharmacy within a market, it is rare that pharmacists would work at pharmacies across multiple markets (i.e., cross-contamination among markets is minimal). Markets are grouped into 41 regions across the United States, each serving the same approximate patient population size. Regions are comparable in structure to United Statesstates, with the exception of densely populated areas (e.g., New York City), which are allocated their own region, and less densely populated areas (e.g., Midwest United States), which may encompass portions of several states.

PC intervention

The PC intervention was software-based and delivered through automated notifications and banners through a software platform, Unify, used across all Walmart pharmacies. The Unify platform allows pharmacists and pharmacy technicians (herein referred to as pharmacy staff, unless noted otherwise) to order vaccine doses for their site as well as access training materials.

The pharmacies were ranked weekly, from highest to lowest, on the basis of their cumulative SIV doses administered since September 1, 2019, compared with other pharmacies in their market. On logging in to the Unify platform, on-site pharmacy staff were notified of their store's weekly performance classification through a pop-up notification that required them to close the pop-up to proceed to the home page. In addition, a persistent banner appeared on the top of the home page. During the influenza season, pharmacy staff accessed the Unify platform at least once per week; they were exposed to the intervention on each login.

Pharmacies in the top quartile of their markets received communications stating, "Your store is a top performer!"; a brief accompanying message provided positive reinforcement. The remaining pharmacies in the market received

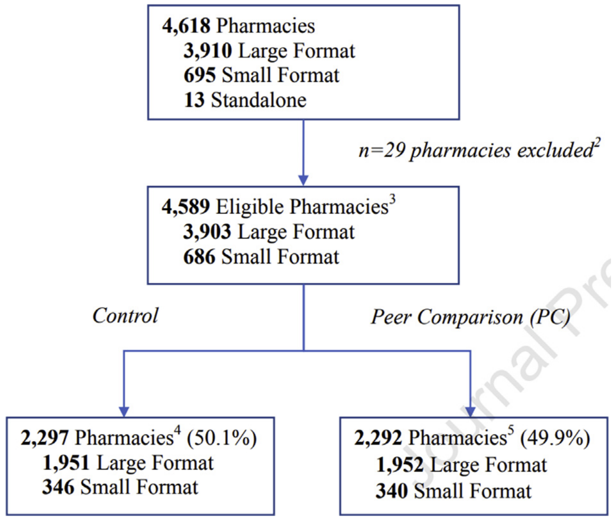

Figure 1. Overview of pharmacy randomization[a]. Note: Small format: pharmacies located within a grocery store; large format: pharmacies located within big-box retail stores; standalone: pharmacies located on college campuses, at car manufacturing facilities, and so on. [a]A cluster randomized design was used, where markets of pharmacies were the unit of clustering. Randomization was stratified by pharmacy format and blocked on region. [b]Pharmacies excluded consisted of standalone sites, those that did not participate in the 2018-2019 and 2019-2020 influenza vaccination campaigns, and those that did not use a standardized vaccine-ordering software platform. [c]A total of 416 markets of pharmacies were eligible for randomization. [d]A total of 208 markets were randomized to the control group. [e]A total of 208 markets were randomized to the PC intervention group.

communications stating, "Your store is not a top performer." The accompanying message suggested that they review their influenza vaccination training materials (a hyperlink to the training page was included) and continue to work toward preventing influenza outbreaks by administering more SIVs.

The influenza vaccination training materials, provided as standard of care to all Walmart pharmacies (completion of which was nonmandatory), served to (1) reinforce the pharmacy staff's role as a trusted source of information, (2) provide an effective patient-communication strategy, and (3) review common misconceptions surrounding influenza vaccination and knowledge to address them. These training materials were developed by Sanofi Pasteur and during the conduct of the study were made freely available to health professionals outside of Walmart (see https://immyounity.vaccines.com); further details are available in the Appendix (eMethods).

All PC communications provided an indication of the pharmacy's change in numerical rank compared with the previous week (i.e., increase, decrease, or equal), in addition to information describing how the rankings were calculated. Examples of the PC communications as well as further details regarding their design and technical implementation are provided in the Appendix (eMethods). The design of the PC intervention implemented in this study is an adaptation of an intervention used by Meeker et al.[16] to reduce inappropriate antibiotic prescribing behaviors among providers.

Randomization

The PC intervention was randomly assigned to all pharmacies in the same cluster (herein referred to as "PC

Table 1
Summary of PC intervention randomization, overall and stratified by pharmacy format and historical performance

Pharmacy strata	Total N	Control		PC	
		n	(%)	n	(%)
Overall[a]	4589	2297	50.1	2292	49.9
Large format (all)	3903	1951	50.0	1952	50.0
Low (< 30%)	948	474	50.0	474	50.0
Moderate (30% −70%)	1625	811	49.9	814	50.1
High (> 70%)	1330	666	50.1	664	49.9
Small format (all)	686	346	50.4	340	49.6
Low (< 30%)	168	89	53.0	79	47.0
Moderate (30% −70%)	281	136	48.4	145	51.6
High (> 70%)	237	121	51.1	116	48.9

Abbreviation used: PC, peer comparison.
Note: A cluster randomized design was used, where markets of pharmacies were the unit of clustering. Randomization was stratified by pharmacy format and blocked on region.
Small-format pharmacies are located within grocery stores, whereas large-format pharmacies are located within big-box retail stores.
Historical performance was based on a pharmacy's within-market percentile, calculated by cumulative SIV doses administered during the 2018-2019 season and designated as low (below the 30th percentile), moderate (between the 30th and 70th percentiles), and high (above the 70th percentile).
[a] A total of 416 markets of pharmacies were eligible for randomization; 208 were randomized to the control group, and 208 were randomized to the PC intervention group.

pharmacies"). Cluster randomization was performed to align with the operation and delivery of the intervention itself (i.e., the market serving as the group of peer comparators), as well as to minimize between-markets contamination. Randomization was stratified by pharmacy format and blocked on region. Doing so ensured that treatment allocation was not only balanced across regions, but also by pharmacy format within respective regions. Three instances of pharmacy mismatch occurred within the PC-randomized markets (e.g., a small-format pharmacy being included within a market of large-format pharmacies); these pharmacies were manually excluded from the PC intervention and considered to be control pharmacies. All pharmacy staff had access to the voluntary influenza training materials as standard of care. Randomization was conducted using R version 3.4.3 (The R Foundation for Statistical Computing).[21]

An overview of the intervention randomization is provided in Figure 1 and Table 1. After excluding 29 pharmacies, 4589 pharmacies across 416 markets in total were eligible for study inclusion. Of these, 2297 (50.1%) pharmacies (208 markets) were randomized to the control group consisting of 1951 large-format and 346 small-format pharmacies, and 2292 (49.9%) pharmacies (208 markets) were randomized to the PC intervention group consisting of 1952 large-format and 340 small-format pharmacies. Stratifying the sample by format and historical performance, balance between control and PC randomization was similarly maintained (Table 1).

Intervention implementation and blinding

On September 15, 2019, and each week thereafter, rankings for the PC intervention were calculated, and the corresponding communications were provided to the pharmacies through pop-up notifications and banners on the Unify platform. The PC intervention remained active until February 29, 2020. All pharmacy staff and management (with the exception of the organization's national-level leadership, who were informed for approval purposes) were blinded to the study conduct and intervention assignment.

Outcome measure

The outcome measure was SIV uptake, defined as the pharmacy-level cumulative number of SIV doses administered during the intervention period (September 1, 2019, to February 29, 2020).

Statistical analyses

For descriptive analyses, we generated summary statistics describing sample size and randomization balance. In addition, we constructed box plots of the pharmacy-level cumulative SIV doses administered during the intervention period among the PC versus control pharmacies to visualize the PC impact as well as general heterogeneity in SIV uptake.

For objective 1, a linear regression of the log-transformed outcome measure (i.e., SIV uptake) was used to estimate the impact of the PC intervention; a log transformation was used to correct for the right-skewed nature of the data, rendering their distribution more normal. The estimated coefficient of the PC indicator in this regression, once exponentiated, approximated the average percentage change in SIV doses administered among the PC pharmacies compared with the control pharmacies.[22,23] Because randomization was stratified by pharmacy format, regressions were estimated for the overall sample, as well as separately among the respective samples of large- and small-format pharmacies. The regression models were additionally fit using the untransformed outcome measure (results available in the Appendix [eTables]).

To account for potential dependence among the observations owing to clustering as well as external factors that may have affected the outcome, we calculated multiway cluster-robust SEs, an approach to SE estimation commonly used in econometrics.[24,25] Specifically, we allowed for clustering by market and state. Markets were a natural cluster in this study design because they were the unit of randomization and are overseen by a single pharmacy market manager. State clustering accounted for unobserved factors that may have affected SIV uptake, such as state vaccination policies and the extent of health insurance coverage. Simultaneously accounting for both levels of clustering was also important because these clusters were not necessarily nested (i.e., markets can cross state lines). On the basis of the multiway SE estimation, we report 95% CIs and *P* values. Results based on both unadjusted as well as state and market one-way clustered SE estimates are provided in the Appendix (eTables).

For objective 2, to investigate potential heterogeneity in the impact of the PC, separate regression models were estimated for subsamples stratified by SIV uptake in the previous season (i.e., 2018-2019 influenza season). Pharmacies were classified as historically low-performing (i.e., bottom 30% of the distribution of pharmacy-level SIV uptake within their markets), high performing (i.e., top 30%), or moderate performing (i.e., 30%-70%). Aligning approximately with terciles, these cutoffs were determined from a descriptive assessment of the distribution of SIV uptake during the 2018-2019 season. All analyses were conducted using R version 3.4.3.[21]

Ethics approval

Given that the intervention described herein was designed and implemented in such a way that minimally impeded the daily workflow of pharmacy staff, consent for enrollment among staff was not required. This study had approval waived by a U.S. institutional review board (IRB) (Western IRB, now WCG IRB) and received approval by the University of Toronto Research Ethics Board.

Results

Variability in SIV uptake among the control and PC pharmacies as well as estimates of the impact of the PC are presented in Figure 2. Across nearly all strata, the mean and median numbers of SIV doses administered among the PC pharmacies were greater than those of the respective control pharmacies. Stratifying by historical performance among large- and small-format pharmacies, SIV uptake varied substantially. For example, among large-format pharmacies, historically low-performing pharmacies on average administered approximately 50% fewer doses than historically high-performing pharmacies, illustrating the relatively widespread variation in SIV uptake even among pharmacies of the same format.

In terms of the PC impact, overall, the PC pharmacies administered an average of 3.7% (95% CI, −0.3% to 7.9%) additional SIV doses compared with the control pharmacies. Among large-format pharmacies specifically, we observed a statistically significant impact, where the PC pharmacies administered an average of 4.1% (95% CI, 0.1%−8.3%) additional SIV doses compared with the controls. Among small-format pharmacies, point estimates suggested an increase in doses administered among the PC pharmacies, but the estimated impact was substantially more variable, and no statistically significant treatment effect was observed.

Stratifying by historical performance, the PC impact on average was greatest among historically low-performing pharmacies and smallest among historically high-performing pharmacies. Most notably, historically low-performing large-format PC pharmacies administered an average of 6.1% (95% CI, 0.5%−11.9%) more SIV doses, whereas the impact progressively decreased among historically moderate performing (4.0% [95% CI, −0.5% to 8.8%]) and high-performing (2.9% [95% CI, −1.2% to 7.1%]) pharmacies. A similar trend was observed among historically low- and moderate-performing small-format pharmacies, but, as previously noted, the impact was highly variable across the 3 historical performance strata, and none of the estimated impacts were statistically significant.

Discussion

In this study, we implemented and evaluated the impact of a PC intervention on SIV uptake across a national network of community pharmacies during the 2019-2020 influenza season using a cluster randomized design. In doing so, we demonstrated that a PC intervention can improve SIV uptake in this setting, specifically among large-format pharmacies. Furthermore, there was evidence of heterogeneity in the impact of the PC, where the impact was larger among historically low-performing large-format pharmacies. In contrast, no statistically significant treatment effect was observed among small-format pharmacies randomized to the PC intervention group, suggesting that perhaps this intervention may be best suited to large-format−style pharmacies.

Although the discrepancy observed between the pharmacy formats may be attributed to the smaller overall sample size of small-format pharmacies included in our study, it is more likely reflective of key differences among these pharmacies. By definition, large-format pharmacies—those located in big-box stores—have a substantially greater volume of patient flow than small-format pharmacies. Therefore, it is possible that staff within small-format pharmacies, compared with those within large-format pharmacies, may have had less exposure to the intervention owing to less frequent ordering of SIV doses. Similarly, with pharmacies typically being provided an initial allotment of SIV doses at the start of the season, dispensing these doses may have taken longer among small-format pharmacies, further minimizing and potentially delaying their exposure to the intervention.

With regard to the overall impact among large-format pharmacies, our findings are reflective of the relevant literature on PC interventions evaluated in health care settings. In a cluster randomized controlled trial, Meeker et al.[16] demonstrated that a PC intervention effectively reduced inappropriate antibiotic prescribing in primary care practices from an absolute rate of 19.9% to 3.7%. Similarly, Sacarny et al.[26] demonstrated that a PC intervention significantly reduced inappropriate prescribing of antipsychotic agents among older adults, resulting in a 3.9% decrease in antipsychotic prescription duration. In terms of vaccination behavior, Barton et al.[19] evaluated a PC intervention to improve SIV coverage in a health maintenance organization and demonstrated a 22% absolute increase in SIV coverage among older adults compared with the previous season without the PC.

The findings from our stratified analyses provided evidence for potential heterogeneity in the impact of the PC intervention. Across the historical performance strata, variation in SIV uptake was substantial, with a nearly 50% difference in total SIV uptake between historically low- and high-performing pharmacies. One possible explanation for the increased impact that we observed among historically low-performing pharmacies may be that these pharmacies have more areas in which they can directly act on to improve their SIV uptake (e.g., increase engagement with patients, order more doses, increase uptake of training among staff, and so on). Similarly, these same factors may simultaneously contribute to the fact that these pharmacies were historically low-performing. Nevertheless, these findings suggest that a PC intervention may be more effective among lower-performing pharmacies, whereas already high-performing pharmacies may benefit from other means of improvement such as financial incentives or even non−performance-based reminder prompts.[13]

It is also important to note that the implementation of the PC in this study was done using a third-party software system and was not directly linked to official internal reporting. Unlike official performance reports, typically provided by pharmacy

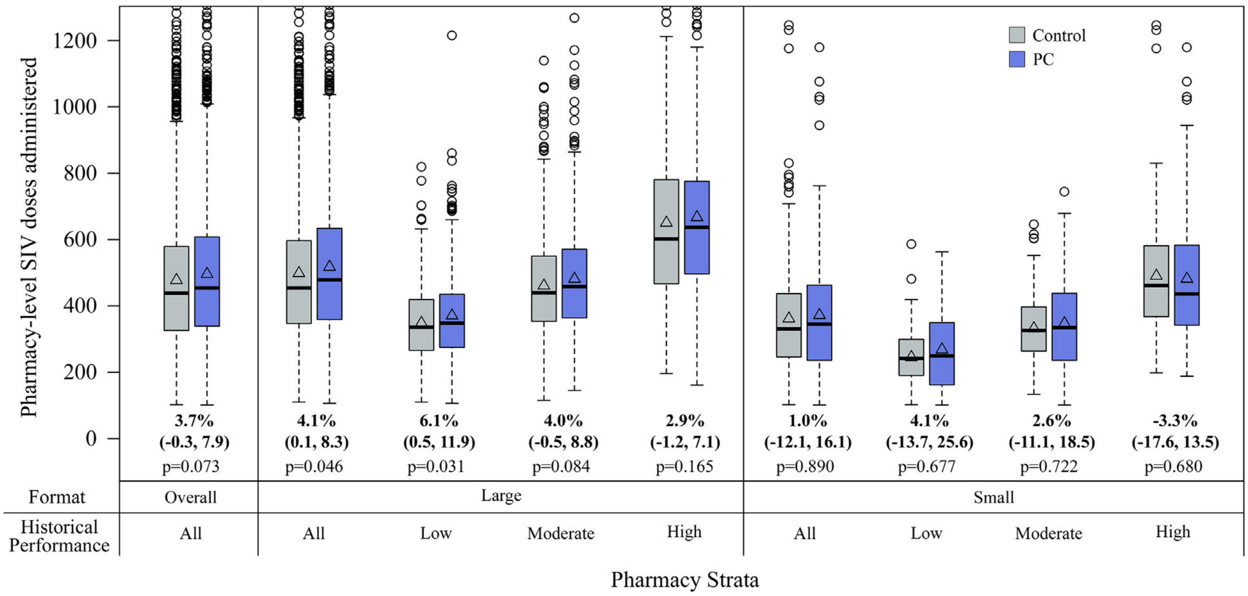

Figure 2. Impact of the PC intervention during the 2019-2020 season, overall and stratified by PC intervention assignment, pharmacy format,[a] and historical performance.[b] Abbreviations used: PC, peer comparison; SIV, seasonal influenza vaccine. Note: Values in boldface are estimates from the linear regression model, approximating the percentage change in the average number of SIV doses administered among PC pharmacies compared with control pharmacies; 95% CIs and corresponding *P* values are based on multiway cluster-robust SEs by market and state. Boxplot specifications: box encompasses 25th to 75th percentiles, thick horizontal lines represent the median, whiskers represent the median ± (1.5 × interquartile range), circles (○) represent outliers, and triangles (△) represent the mean. Y-axis limited to [0, 1250] to improve readability. [a]Small-format pharmacies are located within grocery stores, whereas large-format pharmacies are located within big-box retail stores. [b]Historical performance was based on a pharmacy's within-market percentile, calculated by cumulative SIV doses administered during the 2018-2019 season and designated as low (below the 30th percentile), moderate (between the 30th and 70th percentiles), and high (above the 70th percentile).

management or through first-party software systems, our PC intervention had no broader implications beyond the awareness of one's relative performance. Similarly, it is unlikely that pharmacy staff would have misinterpreted these communications as additional expectations from management, given the use of a third-party software system combined with the fact that all staff and management were blinded. Despite this caveat, we still observed an increase in SIV uptake associated with the intervention. Although pharmacy staff may have access to performance-related information (including peer performance), the PC represents a potentially more efficient and impactful way of encouraging behavioral change, effectively automating the provision of such information in a minimally invasive manner, while simultaneously capitalizing on the power of social influence.[27]

To our knowledge, this study was the first evaluation of a PC intervention to improve SIV uptake in the community pharmacy setting. A fundamental strength of this study was the rigorous national cluster randomized design, which enabled us to observe the PC impact independently from any background change in SIV uptake. In hindsight, this was a noteworthy point because there were various organizational changes (implemented in 2019) outside of the scope of the study that manifested in substantial growth in overall SIV uptake compared with the previous year. Nevertheless, even amid this environment of rapid growth, we still managed to observe an increase in SIV uptake among large-format pharmacies randomized to the PC intervention group.

There are several limitations of our study that must be acknowledged. First, considering that the PC intervention was only significantly impactful among large-format pharmacies, our findings may not be universally applicable to all pharmacy formats. Second, although we were unable to adjust our statistical models for patient population and pharmacy-level characteristics (owing to the unavailability of such data), it is reasonable to assume that the cluster randomized design adequately controlled for overall differences in patient populations as well as region-level factors (e.g., influenza spread, severity, and local vaccination policy) that may have affected SIV uptake.

Third, although the training materials were provided to all enrolled pharmacies, we measured neither the use and completion rates of these materials owing to limitations, nor their efficacy because doing so was not an objective of this study. Nonetheless, with all enrolled pharmacies having received the same materials and randomization ensuring that the patterns of use would be equivalent among the treatment groups, it is unlikely that this would have affected the overall findings. Similarly, we were unable to collect any feedback from the pharmacy staff who were the focus of this study. With increasing workloads and performance-related pressures, burnout among pharmacy staff is a growing concern.[28] Therefore, we recommend that community pharmacy management remain prudent with regard to the implementation of PCs, ensuring that they are minimally invasive and provide simple, positive steps for improvement.

Fourth, by measuring pharmacy-level SIV uptake as the primary outcome, we could not necessarily conclude whether the observed increase in SIV uptake was the result of an increase in SIV coverage or, rather, of a redistribution of SIV doses. Further research would be needed to specifically assess the impact of PCs on SIV coverage at the population level.

Finally, because our study was limited to a single influenza season, we were unable to assess the sustainability of the PC impact. Although the sustainability of the impact of behavioral interventions such as PCs is not guaranteed, it has been shown that combining these interventions with other quality improvement measures such as clinician education can help to sustain their impact.[29] Therefore, although further research would be needed to assess the sustainability of the PC impact within community pharmacies, it is advisable that any future PC implementations are accompanied with appropriate training materials for pharmacy staff.

Conclusion

In this study, we evaluated the impact of a PC intervention on SIV uptake across a national network of community pharmacies during the 2019-2020 influenza season using a cluster randomized design. Although the impact of the PC was not statistically significant in the overall sample of pharmacies, a statistically significant increase in SIV uptake was observed among large-format pharmacies (i.e., those located in big-box retail stores), with historically low-performing large-format pharmacies having exhibited the greatest relative impact. Considering the simplicity of the intervention and relatively minimal disadvantages, other community pharmacy networks that use a common software platform (e.g., vaccine-ordering system, electronic health record, and so on) may similarly benefit from implementing automated PCs within their networks in an effort to improve SIV uptake and, thereby, patient outcomes. With pharmacies increasingly providing expanded access to immunizations, especially among patients classified as high risk and older adults, where coverage has remained suboptimal,[5,30-32] wide-scale implementation of PCs may help to further improve SIV uptake in the community pharmacy setting.

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Appendix

Contents

eMethods

Peer Comparison (PC) Design & Calculations

The design of the PC implemented in this study was based on the PC as described in Meeker et al. 2016, with a few distinct differences.[1] Their implementation relied on the 90th percentile for the "top performer" designation, as this comparison has been shown to improve performance, relative to comparisons with average performers.[2] However, doing so in our study would have resulted in most markets only having one top performer, given the relatively small size of markets. Instead, we considered a 75th percentile cutoff, as to allow for more than one "top performer" per market, while also ensuring that we were comparing pharmacies to high-performing peers, versus the average performing peer.

Additionally, our PC integrated a weekly indicator of change in rank, relative to the prior week. Given the timing of SIV administrations throughout the influenza season, where most doses are administered by mid-November, it was expected that a pharmacy's cumulative number of doses would stabilize 2-3 months into the observation period. The consequence of this would be a reduction in the frequency of transitions from "top performer" to "not a top performer," and vice versa. Therefore, "not top performer" stores would be more likely to remain in the bottom 75% for the duration of the study period. This indication of weekly change in rank was intended to provide an additional layer of motivation and indication of progress, especially so for those pharmacies that would be deemed "not top performers" for weeks on end.

PC Ranking Calculation Algorithm

To deliver the PC intervention, we had to determine a pharmacy's weekly ranking, based on SIV doses administered. The algorithm used to determine pharmacy rank and deliver the corresponding PC communications was as follows:

1. Measure pharmacy's SIV_d each Sunday night (11pm Eastern Time) as:

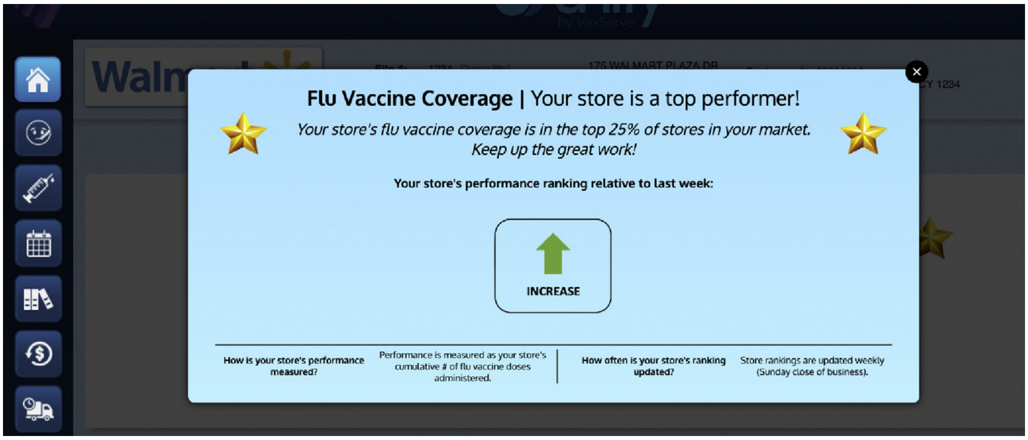
$$SIV_d = Cumulative\ total\ \#\ of\ SIV\ doses\ administered\ (\text{since Sep. } 1,\ 2019)$$

2. Numerically rank pharmacies within a market, based upon SIV_d, from highest to lowest (e.g., 1=highest SIV_d)
3. For each market, identify pharmacies within the top 25% ("top performer") and bottom 75% ("not a top performer)", in terms of SIV_d ranking:
   - If a tie exists for a top performer spot, assign all tied stores as top performers
   - Assign all tied stores the equivalent rank # for that week
4. Compute an indicator of change in the numerical rank, relative to the prior week's numerical rank:
   - *Equal*: rank is the same as the prior week
   - *Increase*: rank has improved since the prior week
   - *Decrease*: rank has gotten worse since the prior week
5. Display the appropriate notification/banner via *Unify*, to reflect the pharmacy's performance category and indicator of change in numerical ranking.

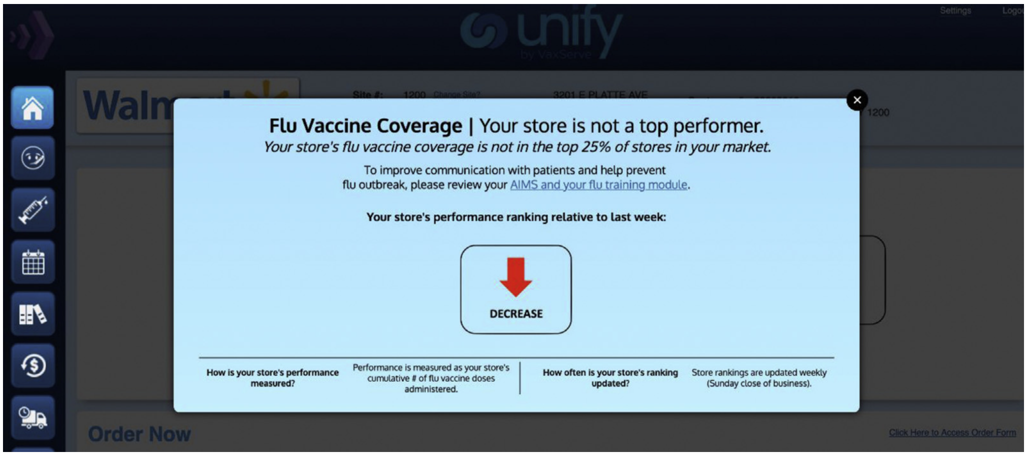
Sample PC Communications

Based upon the above calculations, the appropriate PC communication were delivered to the pharmacy. Below are samples of the two primary types of communications delivered. For each communication, the "indicator of change" could vary between three forms: equal (equal sign), increase (green up arrow), and decrease (red down arrow).

Top Performer



Not a Top Performer



Training Materials

At the start of the intervention period (September 1, 2019), all pharmacy staff were provided access to influenza and communications training material as standard-of-care, consisting of four modules. Engagement with and completion of these modules by pharmacy personnel was done on a voluntary basis. The first module, predicated on observations that providers often underestimate the influence of their recommendations on vaccine acceptance, reinforced their role as trusted sources of information and advice.

The second module taught the application of the AIMS algorithm in short provider-patient conversations. The algorithm begins with an upfront 'Announcement' that vaccination will take place, based on studies that indicate that just assuming vaccination will take place increases rates of acceptance [30]. Inquire and Mirror steps teach an active listening approach that can increase psychological receptivity (parasympathetic nervous activation) and mutual understanding [31]. Trainees are shown how to respond to concerns without increasing reactivity or reinforcing misleading information, and this step is supported by the content in the fourth module that introduces common influenza vaccine-related concerns and provides the knowledge necessary to address them.

The last step of the AIMS algorithm is 'Secure trust', in which trainees are encouraged to focus above all on sustaining the trust of the caregiver or patient. The third module provides several conversation vignettes which illustrate the use of the AIMS approach in different conversation scenarios (e.g. accepting, hesitant, or refusing patients, and those with specific co-morbidities).

The educational materials used in this study were not exclusively developed for Walmart and were also made available to other health care providers during and after the study conduct (https://immyounity.vaccines.com).

eTable 1
Absolute impact of the PC intervention during the 2019/20 season, overall and stratified pharmacy format[1] and historical performance[2]

Pharmacy Strata	Average # of SIV Doses Among Controls (95% CI)	Average Increase in # of SIV Doses in PC Pharmacies (95% CI)	p-value[3]
Overall	477.8 (436.1, 519.5)	18.2 (-1.8, 38.2)	0.073
Large Format (all)	498.4 (456.4, 540.4)	19.3 (-1.6, 40.2)	0.071
Low (<30%)	348.4 (317.9, 378.9)	21.8 (3.6, 40.0)	0.019
Moderate (30-70%)	461.0 (420.8, 501.2)	20.5 (-0.89, 41.8)	0.060
High (>70%)	650.8 (593.6, 708.0)	16.6 (-14.4, 47.6)	0.295
Small Format (all)	361.8 (316.1, 407.5)	10.3 (-42.6, 63.2)	0.704
Low (<30%)	245.3 (216.9, 273.7)	23.1 (-28.2, 74.4)	0.378
Moderate (30-70%)	332.0 (289.3, 374.7)	15.3 (-35.5, 66.1)	0.555
High (>70%)	489.3 (414.8, 563.8)	-7.7 (-92.4, 77.1)	0.860

1 Small format pharmacies reside within grocery stores whereas large format pharmacies reside within big-box retail stores.
2 Historical performance was based upon a pharmacy's within-market percentile, calculated by cumulative SIV doses administered during the 2018/19 season, and designated as low (below the 30^{th} percentile), moderate (between the 30^{th} and 70^{th} percentile), and high (above the 70^{th} percentile).
3 P-values shown are for the PC indicator variable of the linear regression model.

eTable 2

Estimates of the impact of the PC across all study sites, as well as stratified by store format

Model	Variable	Beta (95% CI)[OLS]	p-value[OLS]	Beta (95% CI) [One-way: State]	p-value [One-way: State]	Beta (95% CI) [One-way: Market]	p-value [One-way: Market]	Beta (95% CI) [Multiway]	p-value[Multiway]
All Pharmacies	Intercept	477.8 (468.5, 487.1)	<0.0001	477.8 (436.4, 519.2)	<0.0001	477.8 (458.9, 496.7)	<0.0001	477.8 (436.1, 519.5)	<0.0001
	PC	18.2 (5.1, 31.3)	0.0064	18.2 (-0.3, 36.7)	0.0532	18.2 (-10.0, 46.4)	0.2058	18.2 (-1.8, 38.2)	0.0733
	PC (% change in doses)[1]	3.7 (1.1, 6.4)	0.0053	3.7 (0.1, 7.4)	0.0432	3.7 (-2.3, 10.1)	0.2338	3.7 (-0.3, 7.9)	0.0721
Large Format	Intercept	498.4 (488.3, 508.5)	<0.0001	498.4 (456.6, 540.2)	0.0000	498.4 (478.9, 517.9)	<0.0001	498.4 (456.4, 540.4)	<0.0001
	PC	19.3 (5.0, 33.6)	0.0084	19.3 (-0.8, 39.4)	0.0602	19.3 (-9.5, 48.1)	0.1899	19.3 (-1.6, 40.2)	0.0705
	PC (% change in doses)[1]	4.1 (1.4, 6.9)	0.0029	4.1 (0.3, 8.1)	0.0356	4.1 (-1.6, 10.1)	0.1618	4.1 (0.1, 8.3)	0.0461
Small Format	Intercept	361.8 (343.5, 380.1)	<0.0001	361.8 (317.7, 405.9)	<0.0001	361.8 (326.9, 396.7)	<0.0001	361.8 (316.1, 407.5)	<0.0001
	PC	10.3 (-15.8, 36.4)	0.4407	10.3 (-37.8, 58.4)	0.6758	10.3 (-50.2, 70.8)	0.7396	10.3 (-42.6, 63.2)	0.7042
	PC (% change in doses)[1]	1.0 (-5.7, 8.1)	0.7774	1.0 (-10.8, 14.3)	0.8767	1.0 (-14.8, 19.7)	0.9098	1.0 (-12.1, 16.1)	0.8903

Dependent variable was cumulative SIV doses administered during the 2019/20 influenza season, unless noted otherwise. Standard error estimation includes OLS (unadjusted), one-way clustered robust (state; market), and multiway clustered robust (state & market).

[1] Calculated from exponentiated coefficient in a regression model with the outcome variable log transformed

eReferences

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