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RESEARCH

Increasing use of immunization information systems for routine vaccinations in independent community pharmacies: A randomized controlled trial

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ABSTRACT

Background: Only 60% of adults nationwide and just 36.8% of adults in Alabama have immunization data recorded in an Immunization Information System (IIS). The objective of this study, which took place before the coronavirus disease 2019 (COVID-19) pandemic, was to evaluate the impact of an IIS training program on pharmacists' IIS enrollment, participation, awareness, knowledge, intention, and attitudes.

Methods: A randomized controlled trial was conducted in 2019 among Alabama pharmacists ($N = 41$) practicing in independently owned pharmacies and providing vaccination services but whose pharmacy was not enrolled in Alabama's IIS (Immunization Patient Registry with Integrated Technology [ImmPRINT]). Intervention pharmacists were offered a 2-hour IIS training program, including an online continuing pharmacy education article, demonstration videos, implementation guide, and informational flyer. Control pharmacies received the informational flyer only. Pharmacy-level outcomes, including enrollment and participation, were obtained from ImmPRINT administrative records. Pharmacist-level outcomes, including awareness, knowledge, intention, and attitudes, were self-reported using baseline, 1-month, and 3-month surveys. Two-way mixed analysis of variance, chi-square, and independent t tests were used to analyze differences in outcomes between and within groups.

Results: Enrollment in ImmPRINT was significantly greater among intervention pharmacists' pharmacies ($P = 0.035$). In particular, 59.1% of intervention pharmacies compared with 26.3% of control pharmacies were enrolled in ImmPRINT at 3 months. No statistically significant differences were found between groups in terms of participation in ImmPRINT. Intervention pharmacists' awareness of IIS was significantly greater than control pharmacists ($P = 0.028$) at 1 month (postintervention). Furthermore, the IIS training program significantly improved intervention pharmacists' knowledge ($P = 0.030$) and attitudes ($P = 0.016$) toward IIS over 3 months compared with the control group.

Conclusions: This pharmacist-centered training program focused on practical strategies to integrate IIS into pharmacy workflow. Results show that pharmacists' enrollment, awareness, knowledge, and attitudes significantly improved as a result of this training. As pharmacists become more involved in immunization efforts, particularly in response to COVID-19, awareness of and participation in responsible immunization documentation are critical.

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Ethics Approval and Informed Consent: The Auburn University Institutional Review Board approved this randomized controlled trial as an expedited

review. As part of the enrollment process, an informed consent was obtained from all participants. Participants were free to withdraw from the study at any time.

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Key Points**Background:**

- Immunization Information Systems (IISs) allow immunization providers, including pharmacists, to accurately assess immunization status.
- Pharmacy participation is critical for routine and coronavirus disease 2019 vaccine distribution; however, only 53.8% of pharmacists report routine vaccines to their IIS.

Findings:

- A randomized controlled trial evaluated the impact of an IIS community pharmacy training program.
- Pharmacists' IIS enrollment, awareness, knowledge, and attitudes improved.

Background

Immunization information systems (IISs), or immunization registries, are computerized databases that record and consolidate immunization doses administered by participating providers.¹ Complete immunization records are critical in planning outbreak response efforts, a concern that is timely given the coronavirus disease 2019 (COVID-19) pandemic.² However, this information is also critical at the point of clinical care. Substantial decreases in administered vaccine doses owing to the COVID-19 pandemic have been reported for children, adolescents, and adults, underscoring the need for health care providers to assess vaccination status and recommend needed vaccines at every clinical encounter.^{3,4} Vaccine doses recorded in IISs allow providers to accurately identify which vaccinations are due for an individual, reducing missed opportunities and preventing overvaccination.²

The COVID-19 pandemic has highlighted the importance of and the insufficiencies in many U.S. IISs. With each state, territory, and some individual cities maintaining their own IIS,¹ there is much variation in IIS quality and policies. This can include age groups of included patients, whether patient consent must be obtained before enrollment, how data are shared, and whether provider participation is mandatory. Many IISs face challenges in data quality often owing to low provider participation rates in the reporting of administered doses for routine vaccinations. The inability of many providers to seamlessly exchange data from their current system presents a challenge, with pharmacies at the core of these concerns. Before the COVID-19 pandemic, only 53.8% of pharmacies reported routine vaccinations to their IIS and even less so in states like Alabama without mandatory reporting.⁵ Low pharmacy participation is likely caused by limited awareness of IISs and difficulties implementing manual data entry into daily workflow.⁵⁻⁷ Although pharmacy COVID-19 vaccine distribution efforts have likely increased pharmacy enrollment in IISs, at the time of this study, only 27% of independent pharmacies in Alabama were currently enrolled in the state IIS, Immunization Patient Registry with Integrated Technology (ImmPRINT).

Therefore, the goal of this study was to increase the use of IISs in Alabama community pharmacies. Combining best practice strategies identified through qualitative interviews with pharmacists and IIS representatives across multiple states,⁸ a training program was developed to assist Alabama pharmacists in implementing the state IIS, ImmPRINT, in their workplace.⁹ The impact of this program on IIS enrollment, IIS participation, awareness, knowledge, attitudes, and intention to enroll was assessed.

Methods*Study design*

A randomized controlled trial (RCT) was conducted in independent community pharmacies in Alabama to assess the impact of an IIS training program ([ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT03796585) identifier: NCT03796585).¹⁰ Alabama was selected as the study state because it has one of the lowest rates of adult enrollment in the state IIS, ImmPRINT,¹¹ and approximately half of community pharmacies are independently owned with no technology that interfaces with ImmPRINT. This intervention took place in 2019 with 3-month follow-up concluding in June 2019. The impact of this intervention on awareness, knowledge, attitude, and intention to participate was assessed at the individual pharmacist level, whereas enrollment and actual participation in the Alabama IIS, ImmPRINT, were assessed at the pharmacy level. All procedures were approved by Auburn University's Institutional Review Board via expedited review.

Recruitment and inclusion criteria

A 3-month rolling recruitment strategy was used to enroll and randomize pharmacists on a weekly basis. Recruitment efforts initially targeted independent pharmacies in rural areas, selected using the Alabama Rural Health Association methodology.¹² However, after recruitment efforts in rural areas were exhausted, independent pharmacies in nonrural areas were contacted and invited to participate. Pharmacy contact information was obtained from the Hayes Directory to distribute recruitment materials using multiple methods including e-mail, telephone, and fax. Only 1 pharmacist was included per pharmacy. Interested pharmacists were screened and those meeting the following inclusion criteria were included: (1) not enrolled in the IIS (verified with ImmPRINT), (2) currently providing at least 1 type of nonseasonal vaccination, (3) independently owned, and (4) agreed to provide requested data for assessment.

Sample size estimation and group allocation

T.J.H. discussed the study with each interested participant meeting the inclusion criteria and obtained a written informed consent. Each pharmacy was randomized using a computerized random number generator. Based on power calculation with Cohen's *d* effect size of 0.8¹³ and alpha level of 0.05¹⁴ and using chi-square test on the primary outcome of proportion of IIS enrollment and accounting for at least 20% loss to follow-up (randomized pharmacies that do not complete the final 3-month questionnaire),¹⁵ it was determined that a minimum

sample size of 52 pharmacies (26 per group) was needed to assess enrollment between groups with 80% power.

Intervention: Training program development and components

The training intervention tested in this study was developed using a participatory design approach.⁹ A review panel consists of 2 Alabama IIS personnel, 2 Alabama pharmacists, and 2 pharmacists from high participation states reviewed the program and provided feedback to ensure that content was relevant and that the continuing pharmacy education (CE) format was acceptable. The program was shared with the review panel via e-mail and feedback gathered via the Delphi method.¹⁶ Each pharmacist panel member received \$100 to compensate for their time.

The newly developed training program was hosted on www.alabamaimmunizers.com. Estimated time to complete was 120 minutes, with 2.0 Accreditation Council for Pharmacy Education hours (0.2 CE unit). Participants were required to score 75% or higher on the post-test to receive CE credit. Those scoring less than 75% were offered an opportunity to retake the test; however, only participants' first attempt was retained for data analysis. The training program consisted of an online article, demonstration videos, and an implementation guide.

Online article

The CE article focused on practical strategies to improve pharmacies' willingness to adopt the IIS and their ability to integrate the IIS into pharmacy workflow. Topics addressed within the CE article included (1) IIS introduction, (2) IIS policies, (3) Benefits of participation, (4) Enrollment, (5) Documentation of historical and administered vaccines, (6) Assessment and recommendation of additional vaccines, (7) Using IIS to provide patient records, (8) Vaccines for children, and (9) Recommendations for pharmacies. The article could be downloaded or viewed on the study website and consisted of 15 pages. Throughout the article, cases were presented to provide specific examples.

Demonstration videos

Demonstration videos were recorded demonstrating common tasks that users would need to complete to enroll in ImmPRINT and use it on a regular basis. Ten short videos were created, ranging from 28 seconds to 3 minutes and 25 seconds in length. Video topics included (1) site enrollment agreement, (2) user registration, (3) patient search, (4) add a new patient, (5) establish patient list, (6) document historical and administered vaccines, (7) add new lot number, (8) forecast needed vaccines, (9) print certificate of immunization and patient/parent card, and (10) doses administered report.

Implementation guide

The program also included a concise implementation guide to assist pharmacies in the manual data submission process and how to retrieve data to identify an immunization gap. This downloadable guide to assist was intended to be easily referenced in the pharmacy as needed.

Intervention and control groups

Participating pharmacists assigned to the intervention group received the training program, including the online article, demonstration videos, and implementation guide. Training program instructions were emailed to intervention participants immediately after enrollment in the study. Both intervention and control pharmacists received an informational flyer briefly describing the IIS and providing ImmPRINT contact information for IIS enrollment. Upon completion of the training (1 month), intervention pharmacists received CE credit. Control pharmacists were also offered the training program and accompanying CE credit at study completion.

Measures and data collection

This study measured multiple variables including pharmacist and pharmacy characteristics, IIS enrollment, IIS participation, awareness, knowledge, attitudes, and intention. Pharmacist characteristics identified included sex, race, ethnicity, title, education, age, number of years practicing as a pharmacist, and number of years practicing at current site. Pharmacy characteristics included ImmPRINT enrollment status and rurality. Alabama pharmacies enroll in ImmPRINT by completing a site enrollment agreement and new user registration, after which they are scheduled for an on-site face-to-face ImmPRINT training session with the Alabama Department of Public Health Immunization Division staff. Pharmacy enrollment status was the primary outcome and was provided by ImmPRINT through a data sharing agreement. Pharmacies that had completed the site enrollment agreement and new user registration were classified as "1" for "did enroll in the IIS." Pharmacies that had not completed the site enrollment agreement and new user registration were categorized as 0 for "did not enroll in the IIS." This information was obtained at 2 time points throughout the study including baseline and 3 months.

IIS participation was defined as the extent to which the participant's pharmacy immunization data were accurate and complete in ImmPRINT. To obtain a degree of accuracy, pharmacy immunization data were compared with data recorded in the IIS. ImmPRINT provided data indicating the number and type of all vaccines entered into the IIS by each pharmacy. To protect patient confidentiality, all identifying information was removed by ImmPRINT staff. As part of the 3-month questionnaire, pharmacies were asked to query the immunization records within their pharmacy system and indicated the actual number of each vaccine administered. This allowed for the evaluation of the accuracy and completion of pharmacies' reporting to the IIS by comparing the number of vaccines actually administered with the number of vaccines recorded in the IIS per pharmacy. Discrepancies between the IIS data and pharmacy-reported vaccines indicated that pharmacists had enrolled in the IIS but had not implemented reporting into their workflow. Participation was calculated as the proportion of doses administered reported in ImmPRINT.

In addition to IIS enrollment and participation, awareness (3 items), knowledge (8 items), intention (3 items), and attitudes (25 items) of intervention and control participants were assessed via an online Qualtrics (Qualtrics International Inc, Provo, UT) questionnaire at baseline, 1 month, and 3 months. Awareness and knowledge were measured using 3 and 8 true

or false items, respectively. Each item was scored 0 for incorrect answer and 1 for correct answer. An awareness index was created as the sum of 3 items, ranging from 0 to 3. Similarly, a knowledge index was created as the sum of the 8 items ranging from 0 to 8. Intention and attitudes were measured using Likert scales. A 3-item intention scale was adapted to measure intention to enroll in the IIS.¹⁷ Attitudes were defined in this study as the participant's attitude toward attributes of IISs, informed by the intervention characteristics domain within the CFIR.¹⁸ A 25-item scale was developed to measure attitudes, informed by previous research examining intervention characteristics.¹⁹⁻²⁴ Participants were asked to rate their level of agreement with statements from strongly disagree to strongly agree. Each Likert-type item was scored, ranging from 0 for strongly disagree to 6 for strongly agree. Mean scale scores were calculated for the 3 intention scale items and the 25 attitude scale items so that intention and attitudes scores each ranged from 0 to 6. All questionnaires were pretested among a convenience sample of 5 independent community pharmacists before distribution. Information gained through this pretest was used to revise the questionnaires.

Data analysis

All statistical analyses were conducted using SPSS version 22.0 (IBM, Armonk, NY).²⁵ Pharmacist and pharmacy characteristics were described using descriptive statistics. Exploratory factor analysis was conducted using principal components and varimax rotation to ensure that the intended structure and actual structure of items were consistent. The Cronbach alpha and Kuder-Richardson 20 were used to assess reliability. Attitudes, awareness, knowledge, and intention were collected at baseline, 1 month, and 3 months. Thus, reliability was assessed at all 3 time points for these variables. Two-way mixed analysis of variance was used to compare awareness, knowledge, attitudes, and intention between intervention and control groups across baseline, 1-month, and 3-month time points. Chi-square and independent *t* tests were used to compare enrollment and participation at the 3-month time point between groups. A significance level of 0.05 was used for all statistical analyses.

Results

Recruitment and retention

Figure 1 describes the study recruitment, enrollment, and randomization process. At the time study recruitment began, there were 1282 pharmacies in Alabama; 52 pharmacists were enrolled in the RCT with 26 randomized to the intervention group and 26 to the control group. Eleven pharmacists were lost to dropout before completion of the baseline survey. A total of 41 pharmacists, including 22 in the intervention group and 19 in the control group, completed the baseline survey. A total of 40 (22 intervention and 18 control) and 33 pharmacists (18 intervention and 15 control) completed the 1-month and 3-month surveys, respectively.

Pharmacist and pharmacy characteristics

Most participants were staff pharmacists (53.7%) with a PharmD degree (78.0%). The mean number of years practicing as a pharmacist was 15.40 (11.8) with a mean of 10.03 (11.4) years at the current pharmacy site (Table 1). ImmPRINT verified the enrollment status of each pharmacy to ensure that no participating pharmacists' pharmacies were enrolled in ImmPRINT at baseline. Interestingly, of the participating pharmacists, 12 reported being unsure whether their pharmacy was enrolled in ImmPRINT and 7 pharmacists indicated that their pharmacy was enrolled in ImmPRINT, when in fact they were not. Only 22 pharmacists (53.7%) correctly indicated that their pharmacy was not enrolled in ImmPRINT. No statistically significant differences in demographic characteristics were found between groups at baseline. There were also no statistically significant differences found in participants' awareness, knowledge, intention, or attitudes at baseline.

Exploratory factor analysis

Exploratory factor analysis indicated that the attitudes domain was composed of 3 factors (improving patient care, intervention source support, and ease of use). The Cronbach alpha was high at 0.871 for the attitudes scale overall. The subscales improving patient care, intervention source support, and ease of use also demonstrated high reliability with the Cronbach alpha of 0.903, 0.817, and 0.748, respectively. Awareness and knowledge demonstrated reasonable reliability, with scores of 0.626 and 0.781, respectively. Finally, intention also demonstrated good reliability with the Cronbach alpha of 0.909 at baseline.

ImmPRINT enrollment and participation

Results of the chi-square test indicate that enrollment in ImmPRINT at 3 months was significantly different in the intervention group compared with the control group. There was a statistically significant association between group and enrollment status, $\chi^2_{(1)} = 4.447$, $P = 0.035$. In particular, at 3 months, 13 participants (59.1%) in the intervention group were enrolled in ImmPRINT compared with only 5 control group participants (26.3%) (Table 2). However, participation in ImmPRINT at 3 months was not significantly different in the intervention group compared with the control group. Among 13 intervention and 5 control participants enrolled in ImmPRINT at 3 months, 350 total administered doses were recorded, with 227 and 123 doses contributed by the intervention and control groups, respectively. Mean doses administered and recorded in ImmPRINT by group are reported in Table 2. There were no statistically significant differences in the proportion of doses recorded between groups.

Awareness, knowledge, intention, and attitudes

Descriptive statistics for awareness, knowledge, intention, and attitudes variables are shown in Appendix 1 separately by group and time point (baseline, 1 month, and 3 months). A statistically significant difference in mean awareness at the different time points was found ($F_{(1,514)} = 4.879$, $P = 0.019$) (Appendix 2). Although the mean awareness was slightly

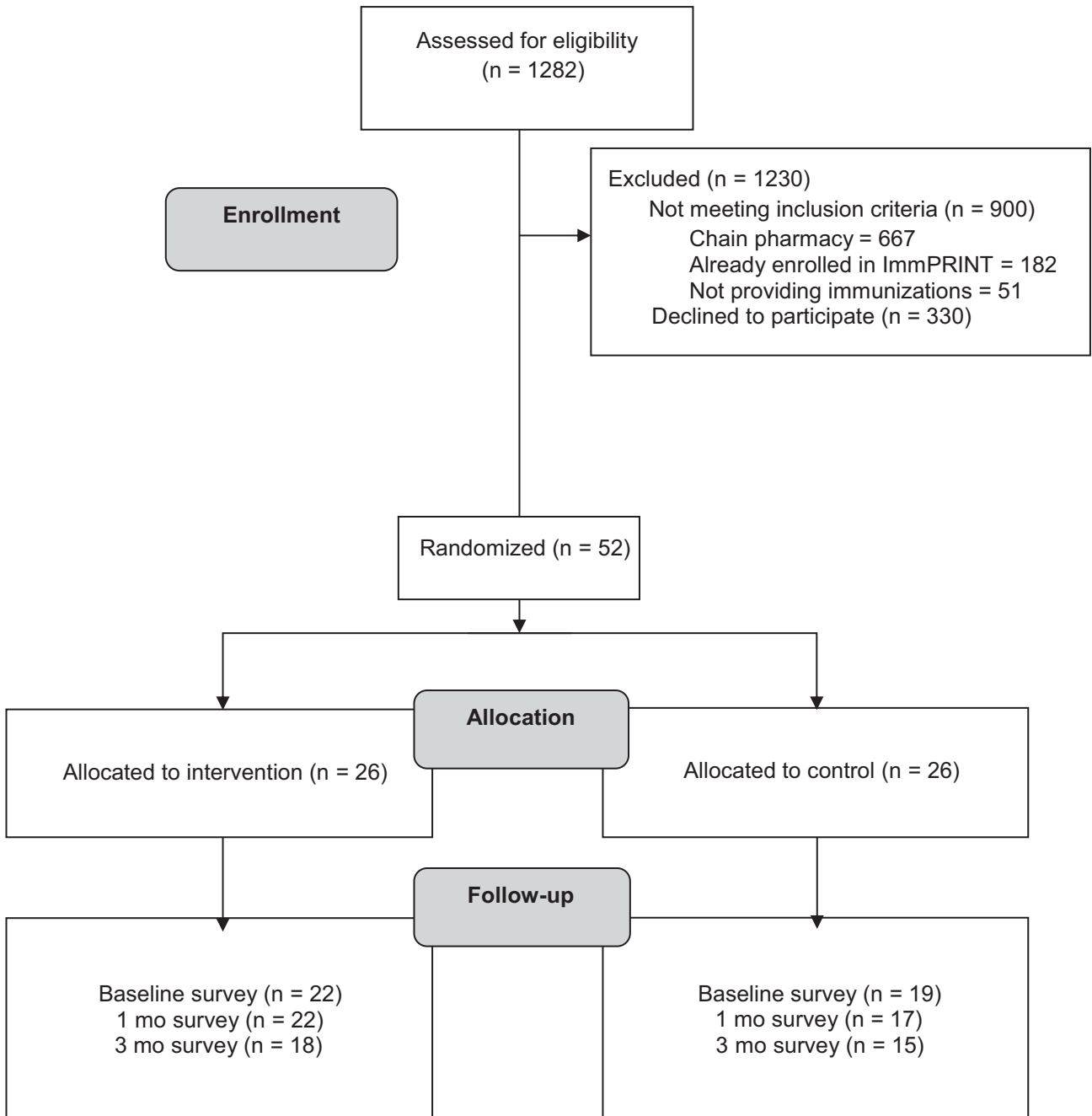


Figure 1. Study CONSORT flow diagram. Abbreviation used: CONSORT, Consolidated Standards of Reporting Trials; ImmPRINT, Immunization Patient Registry with Integrated Technology.

greater in the intervention group than the control group at all 3 time points (Figure 2), this difference was statistically significant between the intervention and control groups at the 1-month (postintervention) time point ($P = 0.028$). The interaction between group and time on mean participant knowledge was significant ($F_{(1,606)} = 4.118$, $P = 0.030$) (Appendix 2). At baseline, control group participants had slightly higher knowledge than intervention participants. Although this was not a significant difference at baseline ($P = 0.487$), by the 1-month time point (postintervention),

intervention group knowledge had surpassed that of the control group and was significantly greater ($P = 0.015$). This effect was not sustained at 3 months ($P = 0.973$). Although intention was slightly greater in the intervention group than the control group at all 3 time points, this was not statistically significant at baseline ($P = 0.217$), 1 month ($P = 0.067$), or 3 months ($P = 0.561$). The effect of the interaction between the intervention and time on mean participant attitudes toward ImmPRINT was significant ($F_{(2)} = 4.424$, $P = 0.016$). Attitudes improved significantly from baseline to 1 month within the

Table 1
Pharmacist and pharmacy characteristics (N = 41)

Characteristic	Intervention (n = 22)	Control (n = 19)	Total (N = 41)	P value ^a
	n (%)			
Sex				0.538
Male	13 (59.1)	9 (47.4)	22 (53.7)	
Female	9 (40.9)	10 (52.6)	19 (46.3)	
Race				-
White	22 (100)	19 (100)	41 (100)	
Ethnicity				0.475
Hispanic	0 (0)	1 (5.3)	1 (2.4)	
Non-Hispanic	22 (100)	18 (94.7)	40 (97.6)	
Job title				0.142
Staff pharmacist	9 (40.9)	13 (68.4)	22 (53.7)	
Manager	13 (59.1)	3 (15.8)	16 (39.0)	
Owner/Partner	7 (31.8)	7 (36.8)	14 (34.1)	
Pharmacist education				0.525
BSPHarm	4 (18.2)	6 (31.6)	10 (24.4)	
PharmD	17 (77.3)	15 (78.9)	32 (78.0)	
Residency	1 (4.5)	1 (5.3)	2 (4.9)	
Masters	1 (4.5)	1 (5.3)	2 (4.9)	
Other	1 (4.5)	0 (0)	1 (2.4)	
Rurality ^b				0.945
Rural	6 (27.3)	5 (26.3)	11 (26.8)	
Nonrural	16 (72.7)	14 (73.7)	30 (73.2)	
ImmPRINT enrollment Status				0.306
Correctly identified	12 (54.5)	10 (52.6)	22 (53.7)	
Incorrectly identified	2 (9.1)	5 (26.3)	7 (17.1)	
Don't know/not sure	8 (36.4)	4 (21.1)	12 (29.2)	
	Mean (SD)			P value ^a
Pharmacist age	43.41 (12.8)	40.58 (9.4)	42.09 (11.3)	0.667
No. years practicing as a pharmacist	15.90 (13.1)	14.87 (10.6)	15.40 (11.8)	0.967
No. years practicing at current site	12.23 (13.0)	7.71 (9.2)	10.03 (11.4)	0.270

Abbreviation used: ImmPRINT, Immunization Patient Registry with Integrated Technology.

^a Analyzed using the Fisher exact and chi-square test of homogeneity and 2-tailed Mann-Whitney *U* tests for categorical and continuous data, respectively.

^b Pharmacies classified as rural versus urban using the Alabama Rural Health Association definition.¹

intervention group ($P < 0.001$). When evaluating the attitudes subscales, the effect was significant within the *intervention source support* ($F_{(2)} = 7.209, P = 0.002$) and *ease of use* subscales ($F_{(2)} = 3.787, P = 0.028$). Although the mean *improving patient care* scale scores were higher among the intervention group than control, this difference was not statistically significant (Figure 3).

Discussion

Strong health care provider recommendations are the single most influential factor in patient acceptance of vaccination.^{26,27} Pharmacists are uniquely positioned to make vaccine recommendations, given that they remain one of the most trusted health care professionals and are easily accessible within the community.²⁸⁻³⁴ Recognizing this and in response to the substantial decline in vaccination from March to May 2020 and the insufficient ability to achieve catchup vaccination since,⁴ federal law recently expanded pharmacists' authority to vaccinate children and adolescents in all U.S. states.³⁵ In addition to expanded pediatric vaccination efforts, the role of pharmacists in immunization delivery for those 12 years of age and older has been highlighted during the COVID-19 pandemic, with more than 108 million doses of COVID-19 vaccine administered (as of August 5, 2021) by community pharmacies as part of the Federal Retail Pharmacy Program.³⁶

However, to effectively assess vaccination status, recommend, and administer needed vaccines, community pharmacies, like all immunization providers, need access to accurate immunization records available through IISs. In fact, COVID-19 vaccine providers are required to document administration of COVID-19 vaccines to the relevant IIS for their jurisdiction within 72 hours.³⁷ Awareness and appropriate use of IISs by community pharmacists will be critical to the success of pharmacy-based efforts to increase COVID-19 vaccination and plan for future booster doses, especially in states like Alabama with less than 50% of the state population vaccinated.

This RCT demonstrated that a tailored training program intervention can improve independent community pharmacy enrollment in an IIS, as well as awareness, knowledge, and attitudes. To the best of our knowledge, this is the first study with an aim to improve implementation of IISs specifically in independent community pharmacies. Previous research has found that pharmacists' behavior change related to implementation of a health care technology is motivated through attitudes and knowledge.³⁸ Although this intervention was successful in improving awareness, knowledge, attitudes, and enrollment, sustainability does remain a challenge. The improvement of these outcomes at the 1-month time point demonstrates the immediate impact of the training program. However, the decrease in knowledge and lack of participation at 3 months indicate that the effect was not sustained. Factors have been

Table 2
Enrollment status and participation of participating pharmacies at 3-month postintervention (N = 41)

Study group	Enrolled	Not enrolled	P value ^a	Self-reported doses administered	P value ^b	Doses recorded in ImmPRINT	P value ^b	Proportion of doses recorded	P value ^b
	n (%)								
Intervention (n = 22)	13 (59.1)	9 (40.9)	0.035 ^c	20.67 (21.37)	0.615	18.92 (45.03)	0.797	0.83 (0.85)	0.923
Control (n = 19)	5 (26.3)	14 (73.7)		26.6 (21.37)		24.60 (25.37)		0.79 (0.53)	

Abbreviation used: ImmPRINT, Immunization Patient Registry with Integrated Technology.

- ^a Chi-square test.
- ^b Independent samples *t* test.
- ^c Significant at the 0.05 level.

identified that hinder sustainment of innovations, which may be applicable to pharmacy implementation of IIS. These include a lack of resources, competing demands, a lack of support from organizational leadership, a lack of trained personnel to continue use of innovation, and inability to adapt the innovation.³⁹ Implementation of IIS is a change that requires support of all pharmacy staff, including the pharmacy owner, manager, staff pharmacists, and pharmacy technicians. Training should be extended to all pharmacy personnel, to ensure consistent reporting of administered vaccines to ImmPRINT. Although important, future research should also look beyond improving

knowledge and beliefs, incorporating additional implementation strategies to address participation.

Development and support of structures and processes that will allow IISs to be routinized in the pharmacy setting are critical to improving pharmacy participation and the overall reliability of these systems.³⁹ Providing independent pharmacies with resources to support bidirectionally integrated technology, allowing for automatic exchange of data between their pharmacy dispensing software and IIS, would address many barriers faced by pharmacy personnel including a lack of time and competing demands. Future research should also

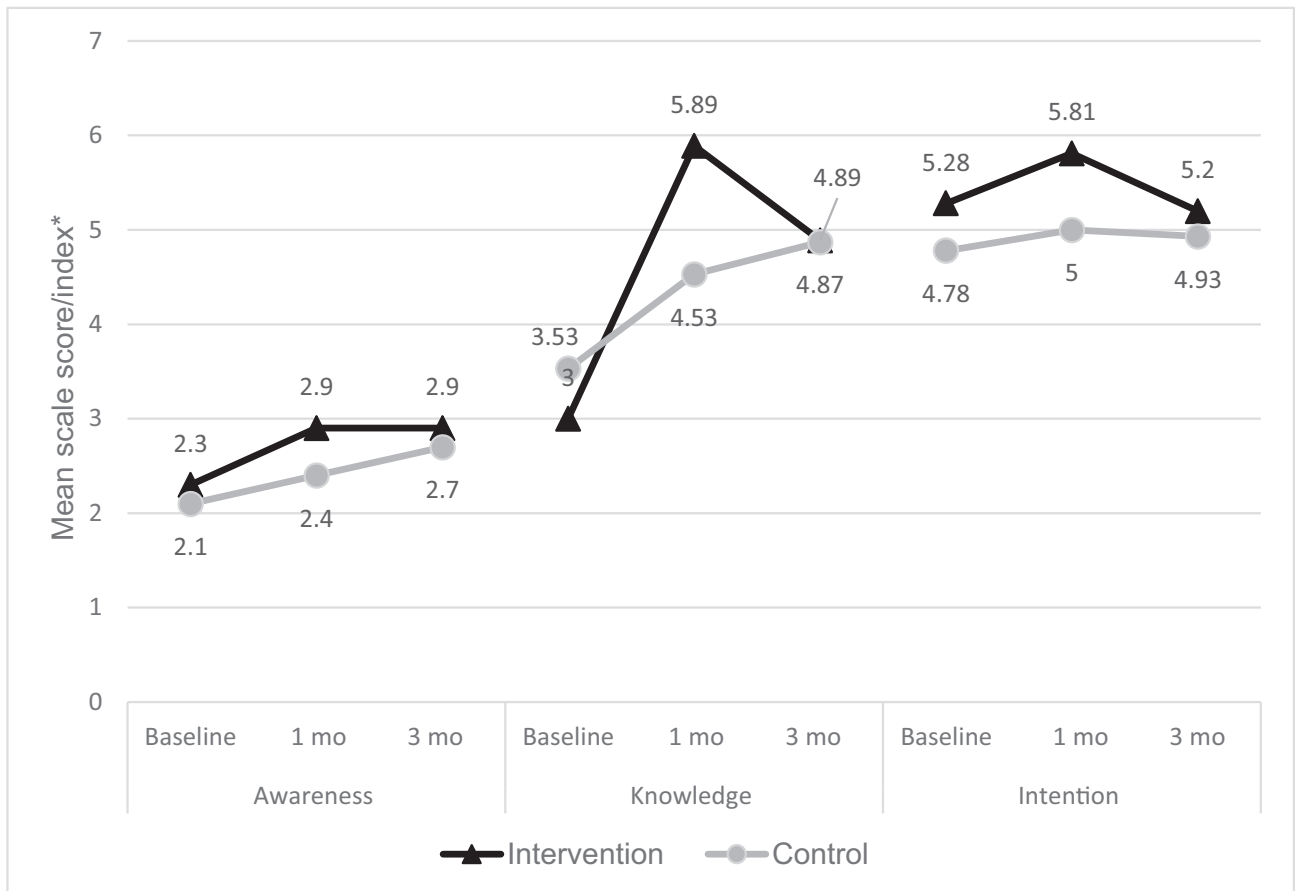


Figure 2. Change in awareness, knowledge, and intention over time by group.

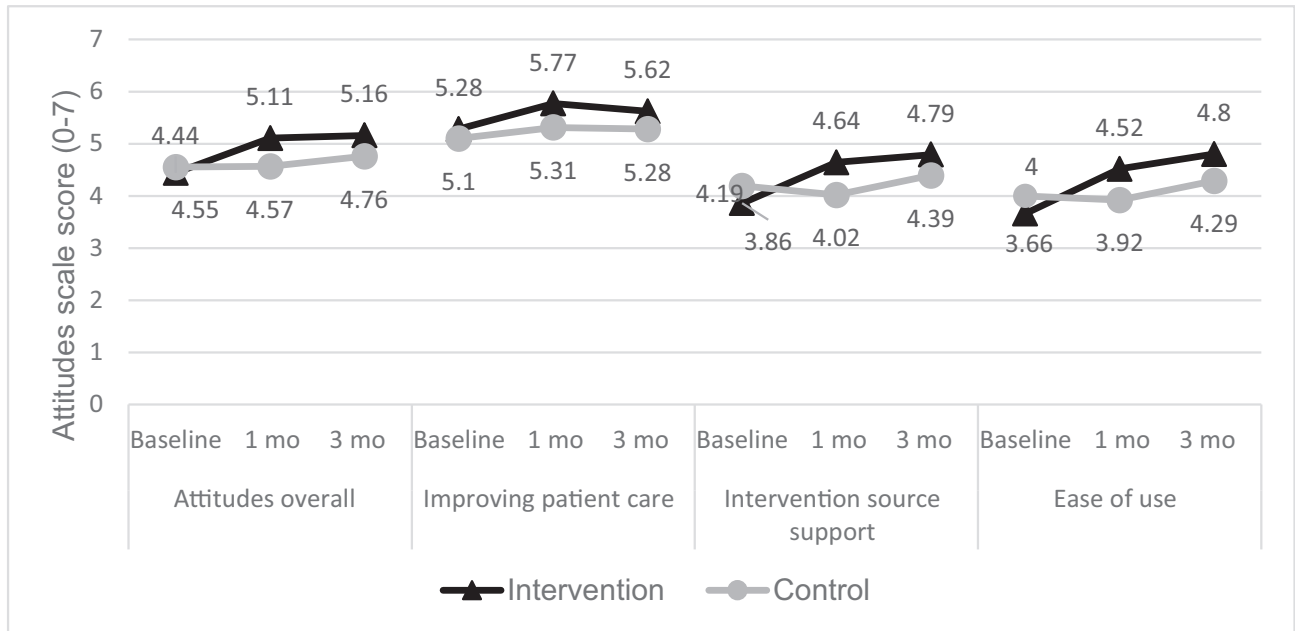


Figure 3. Change in attitudes over time by group.

include use of IISs to assess and recommend additional vaccines. Despite the proven success of vaccination to control and prevent disease, vaccination rates remain inadequate and strong health care provider recommendations remain essential as the single most influential factor in patient acceptance of vaccination.^{26,40} This could be accomplished through the integration of immunization interface and forecaster technologies into pharmacy dispensing software, allowing pharmacists to easily assess immunization status using IIS data at the point of care. Previous research has shown an increase in vaccination rates when IISs are used by immunization providers.^{41,42} Furthermore, timeliness of pharmacy data entry is associated with method of entry. Pharmacy data submission using Health Level-7 or electronic exchange was found to be significantly more timely than manual data entry.⁴³ Although bidirectionally integrated technology would be ideal, many independent pharmacies may not have the resources or be willing to pay to obtain this technology. Alternative mechanisms should be explored, but this process could still be achieved with some pharmacies simply querying the state IIS and integrating the assessment and recommendation process into routine workflow as described above.

Although more difficult to accomplish, states with low participation may consider legislation to mandate participation among all providers. Ultimately unsuccessful legislation was proposed during the study period that would make reporting to the IIS mandatory for all providers in Alabama, including pharmacists. Discussion surrounding this proposed legislation may have increased awareness of study participants during the study period. However, the experimental design of this study controls for these potential threats to internal validity, and we can conclude that the effects seen between groups were caused by the intervention itself and not outside factors. Initial planning stages for efforts introducing

legislation to mandate participation should engage representatives from all key stakeholder groups, including pharmacists. Furthermore, these states should incorporate meaningful ways of assessing and enforcing this mandated participation. It is important to note that, although some states do have these mandates in place, not all states with mandatory provider participation see this effort translate into high-quality IIS data.^{44,45}

The RCT design used in this study is a strength that limits potential threats to internal validity. Within the control group, there were no statistically significant changes in awareness, knowledge, attitudes, or intention. However, 20% of control pharmacists did enroll in ImmPRINT. Receipt of surveys and reminder emails could have contributed to a Hawthorne effect, whereby control pharmacists, aware they were participating in a study, altered their behavior. Furthermore, a question-behavior effect may have affected the results. The surveys completed by both intervention and control participants may have served as reminders to complete the behaviors in question. Most data collected were self-reported and could be subject to associated biases including recall and social desirability bias. The short, 3-month time frame for this study limited the amount of participation data that could be collected. Although none of the pharmacies participating in this study were enrolled in ImmPRINT at baseline, many believed that they were enrolled. This may have affected their reported intention to enroll in the IIS. Although the RCT design strengthens the internal validity of this study, there is a need to test external validity. The study was limited to independent pharmacists in Alabama and may not be generalizable to other pharmacists or states. The small sample size owing to pharmacist dropout is another limitation that should be considered when interpreting the results of this study. Demographic characteristics and baseline immunization documentation

practices were compared between the 3-month survey responders and nonresponders. The number of years the pharmacist had been practicing at their current practice site was significantly different between the responders and nonresponders ($P = 0.009$). The mean number of years at the current practice site for responders was 7.84 (SD 10.4) and the nonresponders was 20 (SD 11.1).

Conclusion

Despite documented effectiveness of IISs, uptake among independent community pharmacies remains low. In Alabama, less than 50% of adults older than the age of 19 years have immunization data recorded in the state IIS, ImmPRINT.¹¹ Improving documentation within the pharmacy setting is critical to not only improving immunization delivery in the community pharmacy setting but also ensuring that appropriate vaccines are administered in a safe and effective manner. This pharmacist-centered training program focused on practical strategies to integrate IIS into pharmacy workflow. Results show that pharmacists' awareness, knowledge, attitudes, and enrollment significantly improved. Although some information is specific to Alabama's IIS, ImmPRINT, this program could be adapted and disseminated to other states struggling with IIS participation. Strategies to improve sustainment of the intervention effect over time should be incorporated.

Acknowledgments

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Appendix

Appendix 1

Awareness, knowledge, intention, and attitudes over time

Outcome	Group	Mean (SD)		
		Baseline	One-month	Three-months
Awareness	Intervention	2.3 (1.03)	2.9 (0.32)	2.9 (0.32)
	Control	2.1 (0.92)	2.4 (0.83)	2.7 (0.82)
Knowledge	Intervention	3.00 (1.71)	5.89 (1.13)	4.89 (1.45)
	Control	3.53 (2.61)	4.53 (1.85)	4.87 (2.23)
Intention	Intervention	5.28 (1.13)	5.81 (1.25)	5.20 (1.46)
	Control	4.78 (1.15)	5.00 (1.20)	4.93 (1.11)
Attitudes Overall	Intervention	4.44 (0.38)	5.11 (0.62)	5.16 (0.92)
	Control	4.55 (0.41)	4.57 (0.56)	4.76 (0.55)
Attitudes Subscales:				
Improving Patient Care	Intervention	5.28 (0.87)	5.77 (0.76)	5.62 (1.10)
	Control	5.10 (0.67)	5.31 (0.64)	5.28 (0.84)
Intervention Source Support	Intervention	3.86 (0.53)	4.64 (0.64)	4.79 (1.05)
	Control	4.19 (0.33)	4.02 (0.76)	4.39 (0.62)
Ease of Use	Intervention	3.66 (0.67)	4.52 (0.93)	4.80 (0.95)
	Control	4.00 (0.69)	3.92 (0.90)	4.29 (0.89)

Appendix 2

Two-way mixed ANOVA for awareness, knowledge, intention, and attitudes

Outcome	Group	Time	Time*Group
Awareness			
df	1	1.514	1.514
MS	0.755	3.481	0.279
F	3.748	4.879	0.391
P-value	0.062	0.019*	0.621
Knowledge			
df	1	1.606	1.606
MS	0.648	44.067	2.331
F	0.295	18.902	4.118
P-value	0.591	<0.001*	0.030*
Intention			
df	1	1.640	1.640
MS	2.284	1.733	0.745
F	2.219	1.978	0.850
P-value	0.146	0.156	0.413
Attitudes Overall			
df	1	2	2
MS	0.631	1.866	0.957
F	2.785	8.628	4.424
P-value	0.105	<0.001*	0.016*
Attitudes Subscales:			
Improving Patient Care			
df	1	2	2
MS	0.875	1.062	0.165
F	2.000	2.684	0.418
P-value	0.167	0.076	0.660
Intervention Source Support			
df	1	2	2
MS	0.435	2.628	1.997
F	1.424	9.487	7.209
P-value	0.242	<0.001*	0.002*
Ease of Use			
Df	1	2	2
MS	0.531	4.241	2.222
F	1.630	7.226	3.787
P-value	0.211	0.002*	0.028*

df = degree of freedom

F = test value

MS = mean squares value

p = significance,

* Significant p-values at the 0.05 level indicated in bold print