Published in final edited form as:

J Am Pharm Assoc (2003). 2014 ; 54(4): 415–418. doi:10.1331/JAPhA.2014.13094.

Impact of pharmacist integration in a pediatric primary care clinic on vaccination errors: A retrospective review

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Abstract

Objective—To measure the impact of ambulatory clinical pharmacist integration in a pediatric primary care clinic on vaccination error rates and to evaluate missed opportunities.

Methods—A retrospective, quasi-experimental review of electronic medical records of visit encounters during a 3-month period compared vaccine error rates and missed opportunities between two pediatric residency primary care clinics. The intervention clinic has a full-time ambulatory clinical pharmacist integrated into the health care team. Pharmacy services were not provided at the comparison clinic. A vaccine error was defined as follows: doses administered before minimum recommended age, doses administered before minimum recommended spacing from a previous dose, doses administered unnecessarily, live virus vaccination administered too close to a previous live vaccine, and doses invalid for combinations of these reasons.

Results—900 encounters were randomly selected and reviewed. The error rate was found to be 0.28% in the intervention clinic and 2.7% in the comparison clinic. The difference in error rates was found to be significant ($P = 0.0021$). The number of encounters with greater than or equal to one missed opportunity was significantly higher in the comparison clinic compared with the intervention clinic (29.3% vs. 10.2%; $P < 0.0001$).

Conclusion—The pediatric primary care clinic with a pharmacist had reductions in vaccination errors as well as missed opportunities. Pharmacists play a key role in the pediatric primary care team to improve the appropriate use of vaccines.

Keywords

Immunizations; errors; primary care; pediatrics; medication safety; ambulatory care

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Disclosure: The authors declare no conflicts of interest or financial interests in any product or service mentioned in this article, including grants, employment, gifts, stock holdings, or honoraria.

Vaccines continue to be an important public health measure. Childhood and adolescent vaccine schedules published annually by the Advisory Committee on Immunization Practices, American Academy of Pediatrics, and American Academy of Family Practitioners currently recommend immunizations against 16 vaccine-preventable diseases.¹ Increased knowledge of diseases and immunization technology has fueled development of new vaccines.

Practitioners at all levels are faced with the task of understanding and remaining up to date with vaccine schedules. While the increasing number of vaccines has shown a public health benefit, the recommended schedules have increased in complexity. Vaccine schedules outline timing between doses needed to achieve the highest rates of vaccine effectiveness. Deviations from these recommended schedules can decrease vaccine effectiveness. For example, studies have shown early administration of the third hepatitis B vaccine results in decreased immunity.² This level of complexity and the dynamic nature of vaccine recommendations can be a barrier to appropriate vaccine use.

Previous research has shown that invalid vaccine doses occur with varying frequency. A retrospective analysis of provider-reported vaccine histories found that 10.5% of U.S. children received at least one invalid dose (any vaccine dose administered 5 days before recommended minimum age or interval).³ Additionally, a prospective evaluation of vaccine records found 35.5% of patients received at least one invalid vaccine dose.⁴ In another study, invalid doses contributed to a decline in overall vaccination rates when removed from evaluation.⁵

In addition to the problem of invalid doses, missed vaccine opportunities in the pediatric population result in decreased coverage rates. The primary cause of underimmunization at 3 months of age was missed opportunities.⁶

Vaccines have been shown to reduce the burden of diseases. However, the efficacy and safety of vaccines depends on appropriate use. The role of pharmacists in the primary care setting is expanding, with pharmacist involvement capable of improving patient outcomes in many areas. Accordingly, research is important to understanding the impact of pharmacist interventions. However, prior to this study, there had been no available research investigating the impact of pharmacist involvement in a pediatric primary care clinic on the appropriate use of vaccines.

Objectives

The primary objective of this study was to measure the impact of ambulatory clinical pharmacist integration in a pediatric primary care clinic on vaccination error rates. The secondary objective of the study was evaluation of missed opportunities.

Methods

This study was conducted at Nationwide Children's Hospital in Columbus, Ohio—a freestanding pediatric hospital and health system that consists of 10 primary care locations located throughout central Ohio. In 2011, the primary care network cared for 65,053

patients. The hospital's institutional review board granted its approval before initiation of the study.

A retrospective, quasi-experimental chart review was designed to determine the impact of pharmacist integration in a pediatric primary care clinic. Two clinics in the primary care network were selected for comparison. Physically, both clinics are located in the same zip code and are separated by one mile. The clinics have similar schedule templates, as demonstrated by the distribution of visit types and unique patients served (Table 1). Vaccine policies, including schedules, storage, and administration, are standardized across the network. No vaccine shortages were present within the network during the study period.

Staffing levels are consistent throughout all clinics in the primary care network, but different individuals staff each clinic. Within each clinic, attending physicians, residents, and staff remained consistent throughout the study period. Across the network, resident physicians are enrolled in the same residency program, and attending physicians are managed under the same department.

However, the intervention clinic has a full-time, board-certified ambulatory clinical pharmacist integrated in its health care team. At the time of the study, this pharmacist had been practicing in the pediatric primary care setting for 6 years. This pharmacist regularly reviews charts and provides education to both providers and patients to ensure appropriate use of immunizations, in addition to numerous other interventions. No electronic clinical decision support for vaccines was available during the study period.

In contrast, the comparison clinic has no pharmacy personnel on staff to ensure appropriate use of immunizations through chart review interventions or provider and patient education.

Inclusion criteria

Encounters included in the study were all visits (well-child, sick, and immunization-only visits) for the months of April, May, and June 2011. Charts were excluded for patients older than 18 years of age. Encounters were randomized through computer randomization.

Data collection

Data was collected from the health system's electronic medical record, and two pharmacists on the research team conducted chart reviews. Each pharmacist conducted reviews individually, with periodic consults between reviewers to ensure consistency. Reviewers analyzed encounters for which they were not involved in care.

The research team reviewed each randomized chart using the 2011 recommended immunization schedules published by the Centers for Disease Control and Prevention (CDC). For each encounter, the following was documented by the research team: visit type, provider type, number/type of vaccine doses given, vaccine errors administered on encounter date, and missed opportunities based on encounter date.

A vaccine error was defined as follows: doses administered before minimum recommended age, doses administered before minimum recommended spacing from a previous dose, doses

administered unnecessarily, live virus vaccination administered too close to a previous live vaccine, and doses invalid for combinations of these reasons.

Missed opportunities were defined as vaccine doses due at date of encounter and not given. Vaccine doses were not considered missed opportunities if documentation was present for vaccine delay or refusal by provider or patient.

Data analysis

A priori power analysis found that to achieve 80% power to detect a difference between a 4% and a 1% error rate in the two clinics, 424 encounters in each clinic needed to be analyzed (848 total encounters). Error rates were calculated by dividing the number of errors in each clinic by the respective number of vaccine doses administered.

Vaccine error rates and missed opportunities were compared between the intervention clinic and comparison clinic using SAS 9.3 (SAS Institute, Cary, NC). Chisquare analysis was preformed to determine statistical significance. A biostatistician conducted statistical analysis for this study.

Results

During the 3-month study period, there were a total of 2,998 clinic encounters (1,552 in the intervention clinic and 1,446 in the comparison clinic). Both clinics were similar in number of unique patients in 2011, patient encounters during the study period, and visit types during the study period (Table 1).

The research team reviewed 450 randomized encounters from each clinic. There was no difference ($P = 0.4882$) between the distributions of visit types between clinics.

Overall, 19 errors were found in the evaluation of randomized encounters. The error rate was 0.28% in the intervention clinic and 2.7% in the comparison clinic ($P = 0.0021$, Table 2).

The type of error varied. The most common, resulting in 31% of errors in both clinics, was associated with the *Haemophilus influenzae* type b (Hib) vaccine. In all instances of this error, the vaccine dose was administered unnecessarily. The second most common error was associated with the pneumococcal vaccine (Table 2).

A secondary objective was to determine the impact of pharmacist integration on missed vaccine opportunities. In the comparison clinic, 132 randomized encounters were found to have greater than or equal to one missed opportunity, compared with 46 randomized encounters in the intervention clinic. A significant difference in the rate of encounters with greater than or equal to one missed opportunity was found when comparing between the two clinics ($P < 0.0001$, Table 2). The vaccine most commonly associated with missed opportunities across both clinics was the hepatitis A vaccine, accounting for 25% of total missed vaccine dose opportunities. The hepatitis B vaccine was the second most common vaccine associated with missed opportunities.

Discussion

Our research found that the pediatric primary care clinic with a pharmacist had reductions in vaccination errors and missed opportunities. Error rates in both clinics were below those previously published, but differed significantly between clinics.

The administration of unneeded pediatric vaccine doses exposes patients to the potential for unnecessary adverse reactions. Unnecessary vaccine administrations often mean additional injections, adding discomfort to pediatric patients and resulting in increased health care costs.

A reduction in invalid doses and missed opportunities has important consequences, including improved public health, decrease in preventable harm, reduction in child discomfort, and potential cost savings.

Vaccines continue to be an important cornerstone of public health in the United States. Published by the U.S. Department of Health and Human Services, Healthy People 2020 outlines specific objectives to increase population vaccination rates across all age groups.⁷ Our study showed the integration of an ambulatory clinical pharmacist in a pediatric primary care clinic reduced vaccine error rates. These results support pharmacist involvement in the primary care setting as a method to improve vaccine use by reducing vaccine errors and missed opportunities.

Further research of pharmacist involvement in several areas of vaccine use is needed. This study did not include an economic evaluation of improved use of vaccines. Additional research investigating the economic implications of pharmacist integration into the primary care setting on vaccine use is needed.

The presence of electronic clinical decision support has increased in health systems. While this approach has potential to improve appropriate vaccine use, it does not provide practitioner or patient education. Additionally, current electronic clinical decision support does not adequately assist providers in appropriate vaccine use in the setting of complex catch-up vaccine schedules and disease-specific vaccine recommendations. Impact of these electronic support systems on vaccine use and pharmacist involvement in the building and maintenance of these systems is another area where future research is warranted.

Limitations

There are limitations to this research. Our study was retrospective and relied on previously documented chart data. Errors in documentation could have impacted our calculated error rates. Additionally, retrospective analysis only allows us to draw correlation results.

Chart reviews only allowed the research team to evaluate one aspect of vaccine administration. This research did not evaluate other vaccine errors such as vaccines administered to the wrong patient or administration of the wrong vaccine.

While the practice environments were similar between the two clinics evaluated, many variables could have influenced results. Different individuals staff each clinic; however,

staffing levels are consistent throughout the network for physicians and nurses. Differences in individual provider practice styles could have influenced results and limits the interpretation of our study.

Conclusions

This study provided evidence to suggest pharmacist integration into a pediatric primary care clinic can reduce vaccine errors and missed opportunities. With frequent updates and detailed schedules, strict adherence to vaccine recommendations can be challenging for providers. Pharmacists are uniquely positioned in the pediatric primary care setting to reduce the barriers to appropriate vaccine use.

The appropriate use of vaccines, with the goal of increasing population vaccine rates, should be a priority for providers and health care systems. Pharmacist integration into a primary care team can be considered one method for achieving this goal. Improving the appropriate use of vaccines is one of the many benefits pharmacists can bring to the pediatric ambulatory care setting.

Acknowledgments

Wei Wang, MS, MAS, biostatistician.

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Table 1

Clinic encounters during 3-month chart review

Patients/encounters	Comparison clinic	Intervention clinic	<i>P</i>
No. patients ^a	3,044	3,057	
No. encounters	1,446	1,552	
No. vaccine doses administered in randomized encounters	623	718	<0.0001
Visit type of randomized encounters			0.4882
Well visits	231	248	
Sick visits	204	190	
Immunization only	15	12	

^aUnique patients 18 years of age.

Table 2

Comparison of vaccine error rate and missed opportunities detected in chart review

Events	Comparison clinic (n = 450 encounters)	Intervention clinic (n = 450 encounters)	<i>P</i>
Invalid vaccine doses	17	2	
Hib	5	1	
Pneumococcal	4	0	
Error rate (%)	2.7	0.28	0.0021
Missed vaccine dose opportunities	275	93	
Missed hepatitis A doses	77	15	
Missed hepatitis B doses	30	15	
Encounters with 1 missed opportunity	132	46	
Encounters with 1 missed opportunity (%)	29.3	10.2	<0.0001

Abbreviation used: Hib, *Haemophilus influenzae* type b.