Age-Specific Strategies for Immunization Reminders and Recalls

A Registry-Based Randomized Trial

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Background: Although previous studies have found reminder/recall to be effective in increasing immunization rates, little guidance exists regarding the specific ages at which it is optimal to send reminder/recall notices.

Purpose: To assess the relative effectiveness of centralized reminder/recall strategies targeting age-specific vaccination milestones among children in urban areas during June 2008–June 2009.

Methods: Three reminder/recall strategies used capabilities of the Michigan Care Improvement Registry (MCIR), a statewide immunization information system: a 7-month recall strategy, a 12-month reminder strategy, and a 19-month recall strategy. Eligible children were randomized to notification (intervention) or no notification groups (control). Primary study outcomes included MCIR-recorded immunization activity (administration of ≥ 1 new dose, entry of ≥ 1 historic dose, entry of immunization waiver) within 60 days following each notification cycle.

Results: A total of 10,175 children were included: 2,072 for the 7-month recall, 3,502 for the 12-month reminder, and 4,601 for the 19-month recall. Immunization activity was similar between notification versus no notification groups at both 7 and 12 months. Significantly more 19-month-old children in the recall group (26%) had immunization activity compared to their counterparts who did not receive a recall notification (19%).

Conclusions: Although recall notifications can positively affect immunization activity, the effect may vary by targeted age group. Many 7- and 12-month-olds had immunization activity following reminder/recall; however, levels of activity were similar irrespective of notification, suggesting that these groups were likely to receive medical care or immunization services without prompting.
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Introduction

Failure of providers and parents to recognize that a child is due (or overdue) for vaccinations is a persistent and important underlying cause of inadequate vaccination.[1–4] Reminder/recall systems use mail, telephone, or computers to encourage appointments for upcoming vaccinations (reminder) or those that are overdue (recall). In 2011, the Task Force on Community Preventive Services reasserted its strong recommendation, in place since 2000, supporting the use of reminder/recall and population-based immunization information systems (IISs).[5–8] Despite this long-standing recommendation, reminder/recall is not widely used by pediatric or family medicine childhood immunization providers.[9–13] Prior studies indicate that perceived staff time and cost requirements are major factors in private providers' unwillingness to implement reminder/recall.[12,13] This suggests that a centralized, population-based approach may be more acceptable to providers and ultimately a more feasible long-term strategy.[14]

Prior studies[15–26] have found reminder/recall to be effective in increasing immunization rates. These

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findings suggest that reminder/recall can prompt a variety of immunization activities, such as the entry of historic doses into statewide IISs and administration of new doses.[26] However, little guidance exists regarding the specific ages at which it is optimal to send reminder/recall notices. Therefore, the objective of this study was to assess the relative effectiveness of alternative reminder/recall strategies among children who live in an urban area using a randomized trial.

Methods

This study assessed the effectiveness of centralized reminder/recall by local health departments (LHDs) that employed three notification strategies aimed at children at different age milestones during June 2008–June 2009. Each strategy used existing capabilities of the Michigan Care Improvement Registry (MCIR), a well-established statewide IIS. The alternative strategies considered in this study were (1) recall of children not up to date (UTD) at age 7 months, focusing on the immunization schedule of the first 6 months of life; (2) reminder of all children aged 12 months, to prospectively direct parents' attention to the need to schedule an immunization appointment for doses recommended at age 1 year; and (3) recall of children not UTD at age 19 months, targeting completion of the primary vaccination series. Reminder/recall effectiveness was evaluated based on MCIR evidence of any immunization activity (e.g., new vaccine dose or input of historic immunization doses). Additional analyses were conducted to document the cost associated with reminder/recall. This study was approved by the University of Michigan and Michigan Department of Community Health IRBs.

Study Setting and Population

The intervention community included the greater Detroit urban area, encompassing the city of Detroit and all of surrounding Wayne County. MCIR was used to identify study-eligible children residing in the study area. MCIR is a statewide IIS that is used widely by public and private providers throughout Michigan; state law requires that all vaccination doses administered to children aged <20 years be entered into MCIR. In addition to tracking individual vaccination doses, MCIR has extensive assessment, reporting, and reminder/recall notification capabilities based on recommendations of the National Vaccine Advisory Committee.[27,28] All reminder and recall notifications sent in this study were generated using MCIR.

Recall Group (7 and 19 months). Children were eligible for inclusion in the immunization recall portion of the study if they were aged 7 or 19 months and not UTD for at least one dose as recommended by the Advisory Committee on Immunization Practices (ACIP)[29] during one of four cycles (June 2008, September 2008, January 2008, or June 2009). At age 7 months, UTD criteria included having valid doses for three diphtheria, tetanus, and pertussis (DTaP), two hepatitis B (HepB), three pneumococcal conjugate (PCV), and two polio vaccines; at age 19 months, UTD criteria required valid doses for four DTaP, three polio, three HepB, four PCV, one measles, mumps, and rubella, and one varicella vaccine. Valid doses were determined by MCIR based on ACIP minimum age and interval requirements; a 4-day grace period is used by MCIR as per the CDC guidelines. The *Haemophilus influenzae* type b (Hib) series was not included in these assessments owing to a concurrent shortage of Hib vaccine, as well as revised booster dose recommendations by the ACIP during the study period.[30] Similarly, annual influenza vaccination and the rotavirus series were not included in these assessments per standard practices of the participating LHDs. Recall notices indicated the specific doses needed by the child. The recall notice was sent to the individual listed in MCIR as the child's responsible party, directing them to contact their child's immunization provider.

Reminder Group (12 months). Children were eligible for inclusion in the immunization reminder portion of the study if they were turning age 12 months in August 2008, regardless of vaccination status. The reminder notice outlined the vaccinations that were due following a child's first birthday and also included any doses for which a child was overdue. Similar to the recall notices, the child's reminders were sent to the child's responsible party in MCIR files.

Children were ineligible for notifications if they were designated in MCIR as having died, documented previously as having moved out of the jurisdiction ("moved or gone elsewhere"); opted out of MCIR by their parent; or if their MCIR record indicated another reminder/recall notification in the prior 60 days. When these inclusion and exclusion criteria were applied, 2,996 children were eligible for a 7-month recall, 3,502 children were eligible for a 12-month reminder, and 6,264 children were eligible for a 19-month recall (Figure 1).

Mailed Recall and Reminder Intervention

In each cycle, children eligible for reminder/recall were randomized to either the notification (intervention) or no notification group (control), using an automated group assignment process. Reminder/recall efforts were based on existing business processes in place at the LHDs. Staff at the Wayne County Health Department and the City of Detroit Health Department mailed standard reminder/recall letters generated using MCIR for eligible children residing in their respective LHD jurisdictions and notified providers in the area of reminder/recall efforts. For children assigned to the notification group, health department staff prepared the mailings and sent them by U.S. mail, with envelopes marked "return service requested." Reminder/recall letters were not mailed to children assigned to the no notification group, which served as the control group for this study. Once the MCIR system is used to generate a reminder/recall notice, subsequent notifications are automatically blocked by the system for 60 days. Therefore, private providers were unable to independently use MCIR to send reminder/recall notifications to the study population during the period immediately following each of our notification cycles.

Study Outcomes

The primary study outcome was evidence in MCIR of some form of immunization activity (any versus none) within the 60 days following each reminder or recall notification cycle. Immunization activity was classified for both the notification and no notification group subjects in three ways: (1) new doses for children with ≥ 1 new dose administered and recorded in MCIR, where the date of

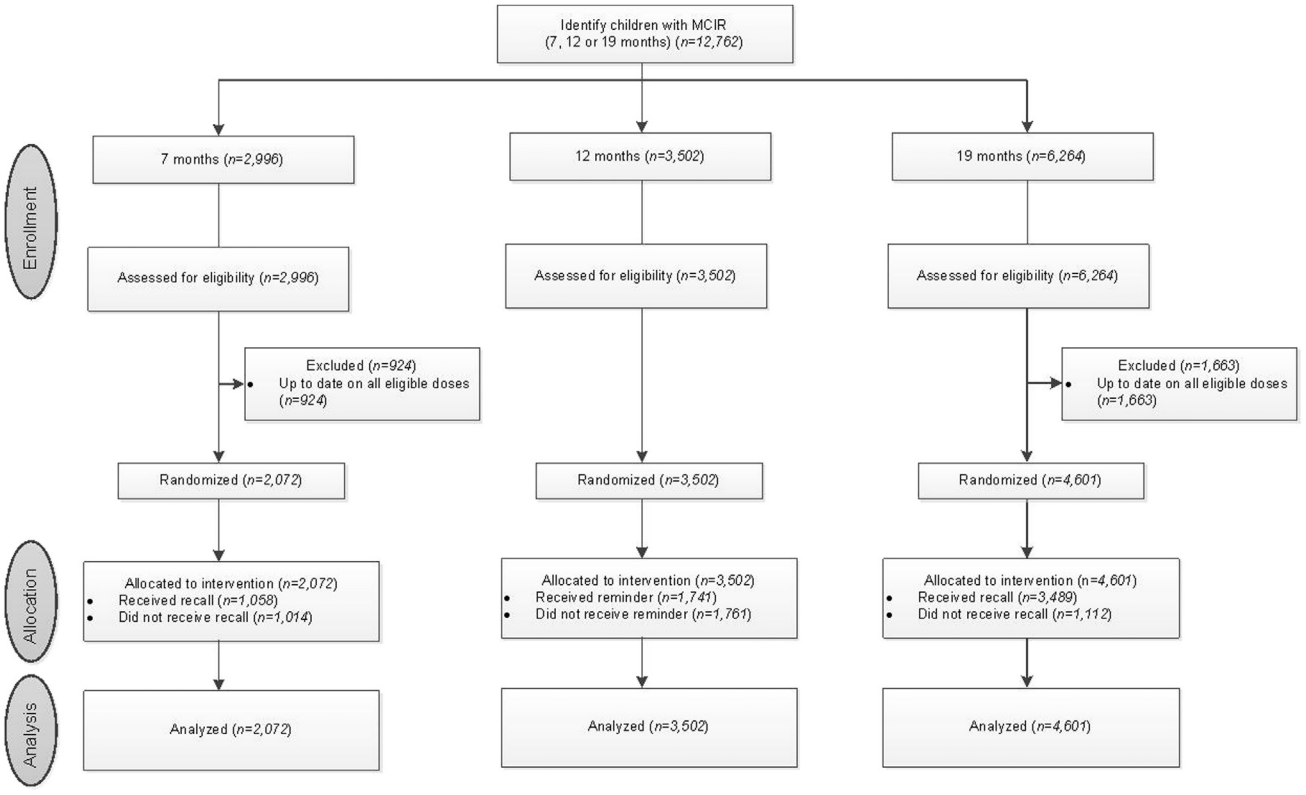

Figure 1. Study group assignment
MCIR, Michigan Care Improvement Registry

dose administration was within 60 days after the notification mailing date; (2) historic doses for children with ≥1 dose recorded in MCIR, where the date of dose administration was prior to the notification mailing date but the dose data entry into MCIR was within 60 days after the notification mailing date; or (3) waivered doses for children with ≥1 immunization waiver recorded, where the waiver date was within 60 days after the notification mailing date.

Secondary outcomes included the completeness of immunization activity following the date of notification and the timing of immunization activity. Completeness of immunization activity was defined as whether children received all, some, or no eligible doses in the 60 days following the notification date. Importantly, a child may have been eligible to receive fewer doses than those for which they were age-eligible, given the time interval requirements between some doses; interval requirements for dose eligibility were automatically determined by MCIR based on ACIP guidelines.[29] Timing of immunization activity was defined as the mean days until any immunization activity (≥1 new dose administered and recorded in MCIR, ≥1 historic dose recorded in MCIR, or ≥1 immunization waiver recorded in MCIR) and mean days to become UTD for all doses for which the child was eligible at the time of notification.

Child characteristics, including the number of vaccine doses recalled, presence of ≥1 vaccination waiver in MCIR, Medicaid enrollment at the time of notification, LHD jurisdiction, and the setting of prior immunizations, were assessed using data from MCIR. To calculate the number of vaccine doses for which a child was recalled, the total number of doses identified by MCIR for which a child was eligible to receive on the date of notification was determined. Medicaid enrollment was defined as a child's enrollment status as of the month in which the notification mailing took place. LHD jurisdiction defined whether the child resided in the jurisdiction of the City of Detroit or Wayne County LHD. The setting of prior immunizations was categorized as all doses administered in a private provider setting; ≥1 dose administered in an LHD (i.e., some or all doses provided at an LHD); or no doses recorded in MCIR.

Data Analysis

Demographic characteristics and outcome measures were compared by group assignment (notification versus no notification) using frequencies and chi-square tests, stratified by child's age at the time notifications were mailed (7, 12, and 19 months). Within age groups, the distribution of days from notification until any immunization activity and days from notification until receipt of all eligible doses was compared by notification group using the Wilcoxon–Mann–Whitney test. All statistical analyses were conducted using SAS, version 9.1 (SAS Institute, Cary NC).

Personnel Cost assessment. An assessment of the personnel costs associated with generating and mailing recall notifications among 7- and 19-month-old children was conducted. Cost estimates were based on three reminder/recall cycles (September 2008, January 2009, and June 2009) for which complete data were available from the LHDs. Participating LHDs were asked to record time spent by employees generating/printing recall letters, folding/

stuffing recall letters, and following up on returned notifications; undeliverable notifications are common in many jurisdictions and have been reported previously.[31] LHDs conducted the reminder/recalls documented in this study in conjunction with their ongoing jurisdiction-wide notifications. As it was impractical for participating LHDs to separately determine costs for the subset of children randomized to receive notifications, LHDs tracked the total time spent by employees on processing recall letters for all notifications sent during the three cycles. Consequently, the average cost estimates reported here are based on the total labor required to support all reminder/recall notifications generated by the LHDs during these notification cycles (N=40,459). Job titles of employees working on each notification were grouped into two job categories from the Bureau of Labor Statistics (manager or clerk) to allow national generalizable cost estimates.[32] Hourly wages were determined from the Bureau of Labor Statistics data for each job category, allowing estimation of the personnel costs per hour spent on recall activities. Two cost estimates were determined: (1) overall personnel costs, the number of recorded labor hours multiplied by the estimated hourly wage of employees; and (2) average personnel costs, overall personnel costs divided by the total number of recalls disseminated to estimate the personnel costs per recall notice.

Results

Children who received all overdue (recalls) or eligible (reminders) doses during the interim period following randomization and prior to notification mailings were identified using MCIR; this process excluded 2,587 children (Figure 1). Thus, a total of 10,175 children (79.7%) were included in data analyses: 2,072 for the 7-month recall, 3,502 for the 12-month reminder, and 4,601 for the 19-month recall strategy (Table 1). The majority of children in each age group resided in the Wayne County LHD jurisdiction, had no waivers in the statewide IIS, were enrolled in Medicaid, and had received all prior doses in a private provider setting. Most

Table 1. Demographic characteristics of the study population (*n*=10,175), %

	7-month recall (*n*=2,072)			12-month reminder (*n*=3,502)			19-month recall (*n*=4,601)		
	Recall (*n*=1,058)	No recall (*n*=1,014)	*p*-value	Reminder (*n*=1,741)	No reminder (*n*=1,761)	*p*-value	Recall (*n*=3,489)	No recall (*n*=1,112)	*p*-value
LHD jurisdiction									
City of Detroit	41.2	44.4	0.15	44.6	47.1	0.14	44.8	46.3	0.38
Wayne County	58.8	55.6		55.4	52.9		55.2	53.7	
Number of vaccine doses recalled									
1	15.2	14.6		—	—		27.3	29.1	
2	25.1	26.8	0.67	—	—	—	19.8	18.3	0.12
3 or 4	59.6	58.6		—	—		24.5	22.0	
≥5	0.0	0.0		—	—		28.4	30.6	
≥1 waiver in MCIR									
No	98.5	97.7	0.21	99.6	99.3	0.26	98.3	98.5	0.80
Yes	1.5	2.3		0.4	0.7		1.7	1.5	
Medicaid enrollment									
Not enrolled	44.8	40.3	**0.04**	42.3	44.5	0.19	48.3	48.4	0.95
Enrolled	55.2	59.7		57.7	55.5		51.7	51.6	
Location of prior immunization									
All shots in private setting	87.3	89.6		93.0	92.8		89.0	90.1	
Some/all shots at an LHD	5.2	4.0	0.27	4.1	4.5	0.83	7.9	6.5	0.25
No shots recorded in MCIR	7.5	6.4		2.9	2.7		3.1	3.4	

Note: Boldface indicates statistical significance; *p*-values reported for χ^2 tests of association.
LHD, local health department; MCIR, Michigan Care Improvement Registry

7- (60%) and 19-month-old (53%) children were recalled for ≥3 vaccine doses. The notified and not notified populations in each age cohort were similar across all characteristics, except for Medicaid enrollment, which was lower in the 7-month recall group.

The participating LHDs generated a total of 40,549 recall notifications over the three recall cycles among the 7- and 19-month-old children, using a total of 1,720 labor hours. Applying the hourly labor costs ($18.62 per hour) to conduct the recalls equated to total personnel costs of $32,026 and an average of $0.79 in personnel costs per recall notification.

Figure 2 displays the proportion of children in the 7-, 12-, and 19-month groups with immunization activity within 60 days of the notification date. Overall, immunization activity within 60 days of the notification date was most common for 12-month-olds, followed by 7-month-olds; however, immunization activity was similar between the notified versus not notified groups in both age groups (Figure 2). In contrast, a lower overall proportion of 19-month-olds had any immunization activity within 60 days compared to other age groups, although significantly more 19-month-old children in the recall notification group had immunization activity compared to their counterparts who did not receive the notification ($p<0.0001$). Recalled 19-month-old children were more likely to have ≥1 new dose administered ($p<0.04$) and to have ≥1 historic dose entered into MCIR ($p<0.001$) during the 60-day assessment period compared to their counterparts. Few children in any age group had immunization waivers recorded during the 60-day assessment period. One third of notified and not notified 7-month-old children received all eligible doses—more than twice the proportion of 12- or 19-month-old children; however, no differences were observed between the notified and not notified groups among the 7- and 12-month-olds. Among the 19-month-old children, a significantly greater proportion of the recall notification group received all eligible doses (18%) within 60 days compared to those that were not sent recall notices (11%, $p<0.0001$).

Table 2 shows the median time until initial immunization activity following the notification date among children with any immunization activity, as well as the median time until children received all eligible doses. For the 12-month reminder notification strategy, median time until receipt of all doses was restricted to the subset of children who were not UTD for ≥1 doses at notification. The median number of days from notification until receipt of all eligible doses significantly differed by notification assignment within the 12-month population; contrary to expectations, children who were not assigned to receive a reminder received all eligible doses earlier than children assigned to receive a reminder. The median time until immunization activity and receipt of all eligible doses did not differ by notification group within all other age groups.

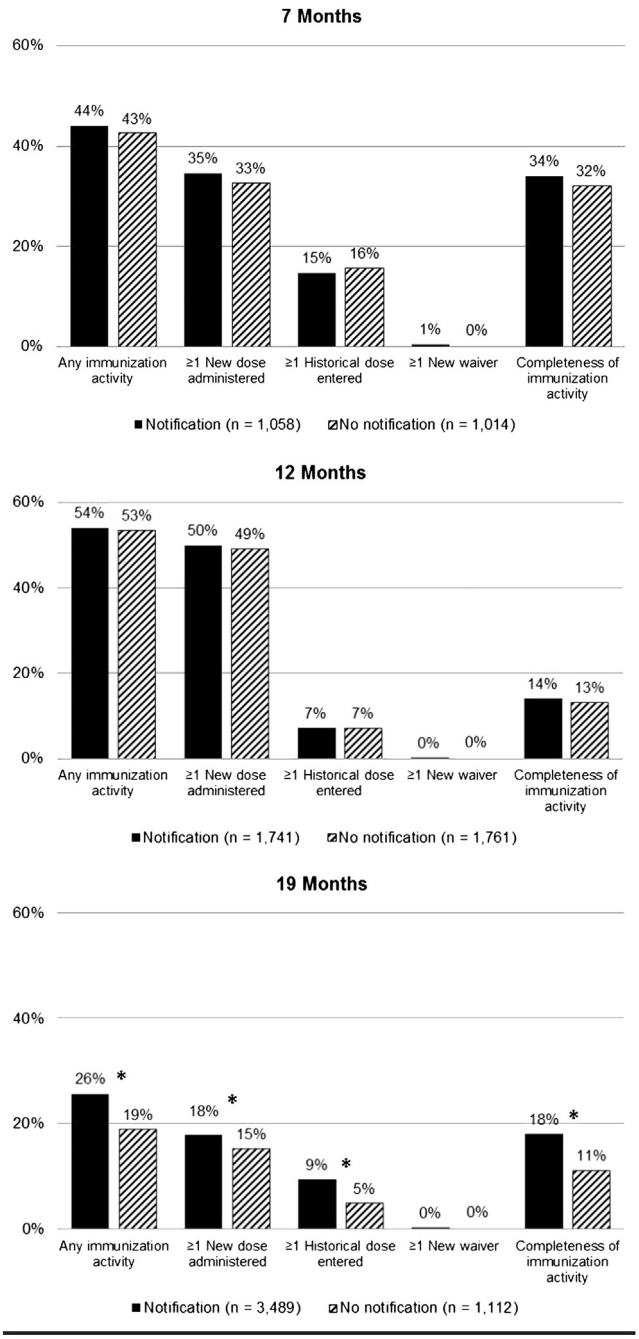

Figure 2. Proportion of children in the 7-, 12-, and 19-month groups with immunization activity within 60 days of the notification date

*Statistically significant difference ($p<0.05$)

Discussion

Our findings provide important insight into the effectiveness of centralized reminder/recall by LHDs using

Table 2. Timing of immunization activity among children who were immunized during the 60 days after reminder/recall

	7-month recall			12-month reminder			19-month recall		
	Notification	No notification	z-score, p-value*	Notification	No notification	z-score, p-value*	Notification	No notification	z-score, p-value*
Median time until any immunization activity			z=0.82, p=0.41			z= −0.42, p=0.67			z=0.28, p=0.78
n	466	431		941	939		894	209	
Days	22	23		26	26		21	22	
Median time until receipt of all eligible doses			z=0.02, p=1.0			**z= −2.14, p=0.03**			z=0.34, p=0.73
n	362	327		239	220		612	127	
Days	28	28		32	27		21	22	

Note: Boldface indicates statistical significance.
*z-scores and *p*-values are results of the Wilcoxon–Mann–Whitney test. Underlying distributions of days until any immunization activity and days until receipt of all eligible doses were considered significantly different by notification assignment within age group using a *p*-value of 0.05.

IIS-based notifications. This study found that although recall notifications can positively affect immunization activity, the effect may vary by targeted age group. Although many 7-month-olds had evidence of immunization activity following recall notification, the levels of immunization activity were similar, irrespective of recall notification. Similarly, most 12-month-olds had some form of immunization activity following reminder notification, although the effects were similar between notified and not notified groups. In contrast, although fewer 19-month-olds had evidence of immunization activity following notification, recall notification in this age group was observed to have a greater impact.

The results of this study suggest that reminder and recall notifications may be most effective among children who are not otherwise anticipated to seek medical care for a well visit. These findings may be a reflection of the increased frequency of ongoing well child visits among younger groups of children, leading to a higher likelihood of receiving vaccinations—irrespective of reminder or recall notification. The American Academy of Pediatrics recommends well child visits at ages 9 months, 12 months, and 15 months,[33] and previous studies have shown that health supervision rates decline progressively after children turn 1 year of age.[34]

As a consequence, the group of 7-month-old children—both notified and not notified—may have been equally likely to seek medical care in conjunction with their regularly scheduled well visit at 9 months, which would be within the study's 60-day outcomes observation period. Similarly, well child visits are recommended at 12 months; our findings may reflect the higher likelihood of children in this age group making a regularly scheduled well visit, thereby potentially negating any differences that may otherwise occur based on reminder notification status. Generally, a 19-month-old child would not be scheduled for a well visit until 24 months; as a consequence, a recall notification may be more likely to prompt parents to take action without waiting for the child's next scheduled visit.

Importantly, our results suggest that reminder and recall notifications may be an effective prompt to trigger a variety of immunization-related outcomes. Not only were new doses administered, but reminder/recall notifications also prompted the entry of historic data into the statewide IIS. These findings are consistent with a prior study that found recalls to be effective in prompting parents who receive incorrect recall notifications to contact LHDs or providers to ensure that missing doses are recorded.[26] Consequently, the labor costs invested in conducting reminder/recalls may yield additional dividends in terms of improving the completeness of IIS data, which may decrease unnecessary vaccine administration

and reduce the volume of subsequent recall letters. These outcomes should be considered in subsequent evaluations of reminder/recall cost effectiveness.

Other improvements to IIS data quality may be realized through technology enhancements that are underway and widespread across IIS jurisdictions. One strategy to improve the timeliness and accuracy of contact information may include initiatives to foster interoperability between electronic health records (EHRs) and IISs.[2,35] Achieving EHR-IIS bidirectional interoperability could substantially improve the accuracy of contact information through real-time updates and help reduce undeliverable reminder notices and associated costs.

The benefits of these strategies will likely extend beyond postal mail as newer technologies, such as e-mail or text messaging, are adopted for reminder/recall notifications.[36–39] The use of newer technologies represents an option for low-cost targeted reminder/recalls and may allow for more immediate contact with parents while also offering increased opportunity for providers to verify reminder/recall receipt. Parent preferences indicate support for electronic notifications and may offer a more stable address to which immunization reminders can be sent.[40]

This study has several potential limitations. It is unknown whether pediatric offices or other local providers independently sent reminder/recall notifications concurrent with this study; such notifications could potentially overstate the apparent effectiveness of our intervention. Second, our cost analyses may not reflect the unique processes and staffing assignment of LHDs. All labor hours devoted to recall tasks were attributed as direct costs, when in actuality, these labor hours reflect a proportion of a staff person's regular hours that would have been worked regardless of whether the recall occurred.

Future studies should examine whether the recall-related labor hours occupy excess capacity in existing staffing levels, more efficient use of existing staff hours, or opportunity costs where recall-related hours are supplementing other work tasks. Additionally, the cost assessment analysis did not include costs for supplies (such as paper, envelopes, and printing) or postage and consequently our estimates of total costs are understated. Because our reminder/recall efforts were built on existing business processes at the LHDs, 7- and 19-month-old children were studied at time points that aligned with their normal notification schedules; subgroup analyses comparing the notification cohorts were not possible because of sample size limitations.

Our findings that the 12-month reminder intervention was not effective may reflect the timing of reminders sent by LHDs (August), which could potentially have been influenced by limited available appointments during the back to school season. The degree to which the 12-month reminders were received by children prior to their first birthday is unknown. Finally, we report median times until vaccination-related outcomes because we determined early in our analysis that no significant patterns were revealed using time until event (i.e., survival analysis) methods.

Conclusions

Centralized, IIS-based recall can positively impact immunization activity among urban children, but may not be useful for children of all age groups. Age-specific strategies for reminder/recall may be crucial in increasing immunization rates, particularly among children aged >1 year and not anticipated to seek medical care for a well child visit. Importantly, these recall notifications can serve as an effective prompt for the administration of new doses and entry of historic doses. However, reminder/recalls can only be effective to the extent that the notices are successfully delivered to the intended recipients.[31,41] Future interventions should also consider strategies to improve IIS contact information for reminder/recall notifications.

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