



The potential for centralized reminder/recall to increase immunization rates: A national survey of immunization information systems (IIS) managers

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ABSTRACT

Little is known about Immunization Information System (IIS) attitudes and experiences using Centralized IIS-based Reminder/Recall (CI-R/R), an effective approach to increasing immunization rates.

To describe among IIS managers as it relates to CI-R/R: 1) past experiences and future plans conducting it; 2) attitudes and barriers, 3) IIS capabilities and policies that influence, and 4) factors that differentiate IIS who have and have not conducted CI-R/R.

Electronic Surveys were sent to all IIS managers in July 2018 using a member listserve.

Fifty-seven of 62 IIS programs contacted (92%) responded. The majority (61%) had ever conducted CI-R/R; 34% reported they were "very likely" to conduct CI-R/R within 6 months. The majority (64%) were in favor of CI-R/R. Barriers included lack of staff (78%), competing demands (76%), and cost (63%). Thirty percent reported receiving a $\geq 75\%$ of immunization data via real-time electronic interfaces (HL7). Overall, 49% and 24% of jurisdictions had mandatory immunization reporting from private and public health entities for childhood and adult immunizations, respectively. Differences between IIS that ever and never performed CI-R/R, respectively, included: mandatory reporting from private and public entities for children (65% v 27%, $p = 0.006$), having a legal mandate for CI-R/R (50% v 19%, $p = 0.02$), less likely to prefer practice-based R/R to CI-R/R (68% v. 91%, $p = 0.04$), and not reporting having too many competing demands (29% v 67%, $p = 0.007$).

Most IIS have conducted CI-R/R and have positive attitudes towards it. Given its effectiveness and low cost, efforts to sustain it should be considered.

1. Introduction

Reminder/recall (R/R), whereby people are reminded about upcoming immunizations or recalled for overdue immunizations, is an evidenced-based approach for increasing immunization rates recommended by the U.S. Community Preventive Services Task Force ([The Community Guide, 2015](#)). There are numerous studies showing that

practice-based R/R, conducted by private practices, is effective for a variety of vaccines and age groups. ([Jacobson Vann et al., 2018](#)). Yet, barriers exist that prevent initiation and sustainability of practice-based R/R ([Saville et al., 2011](#); [Pereira et al., 2012](#)). State Health Departments conducting centralized R/R using an Immunization Information System (IIS) have been shown to be more effective and cost-effective than practice-based R/R approaches for increasing immunization rates at the

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population-level, with increased immunization rates between 5 and 9% (Kempe et al., 2013, 2015). Research trials demonstrating effectiveness of Centralized IIS-based R/R (CI-R/R) have usually involved researchers working with IIS or integrated health systems performing R/R on behalf of the IIS (Kempe et al., 2013, 2015, 2017; Hurley et al., 2018; Dombkowski et al., 2012; Stockwell et al., 2012a, 2012b), with few publications regarding CI-R/R conducted by state health departments or Immunization Information Systems (IIS) themselves (Coley et al., 2018). It is unclear to what extent IIS and/or health departments in the U.S. are currently using CI-R/R to improve immunization rates. Also unknown is what populations CI-R/R efforts are targeting, the types of barriers they are encountering and their ability to sustain CI-R/R efforts.

IIS, also known as immunization registries, and their accompanying state and local health departments, are uniquely positioned to perform CI-R/R as they have access to consolidated immunization records for populations at the regional and state level and have capabilities to run required reports to initiate CI-R/R. Further, IIS regularly incorporate standards to better support reminder and recall activities at both provider and population-level (System, 2019). Yet, IIS policies and functionalities can vary region to region and may affect decision making about CI-R/R (Martin et al., 2015; Murthy et al., 2017).

The Centers for Disease Control and Prevention (CDC) and the American Immunization Registry Association (AIRA) both work to promote quality and standardization among IIS systems. The CDC develops and updates a set of IIS functional standards that describe the operations, data quality, and technology needed by IIS to support immunization programs, including reminder/recall; AIRA works with IIS jurisdictions to develop best practices, provide education, and evaluate the IIS according to how well they align to standards. Ultimately, each state or local IIS jurisdiction has to make decisions about how these standards are interpreted and implemented and these functional standards may play a role in whether and how CI-R/R might be performed. Capabilities such as running an R/R report at the population level, receiving immunization and contact information via Health Level 7 (HL7) data exchange, or ability to link a provider's name to an individual patient vary by platform and have the potential to influence CI-R/R.

IIS policies and regulations also vary state to state and may affect CI-R/R including differing laws and regulations to whether providers must upload immunizations into the IIS, IIS's ability to contact patients, or how patients consent to their data being included in an IIS (Murthy et al., 2017). Each may affect decision making about CI-R/R and also affect the data quality guiding CI-R/R efforts.

Because CI-R/R is an effective and cost-effective method of increasing immunization rates and because IIS are uniquely situated to conduct CI-R/R, the potential public health possibilities of CI-R/R nationally is important to understand. Therefore, we conducted a national survey among IIS managers to assess their: 1) past experiences and future plans with conducting CI-R/R; 2) attitudes and barriers regarding CI-R/R, 3) IIS capabilities and policies that impact CIIS-based R/R and 4) factors that differentiated IIS who have and have not conducted CI-R/R.

2. Methods

This project was approved as an expedited protocol by the Colorado Multiple Institutional Review Board (COMIRB) with a waiver of written documentation of consent.

2.1. Study population

Each IIS typically has a manager or similar leader who oversees the administration of the IIS and maintains contact with both AIRA and the CDC. IIS managers, as identified by AIRA's member network of key contacts, were targeted to complete the survey as the best representative for IIS jurisdictions. At the time of the study, there were 62 IIS programs which had a primary contact listed in the AIRA member list and

represented 50 states and the District of Columbia, as well as 5 territories, and 6 large metropolitan areas.

2.2. Survey design and administration

The study team, in collaboration with members of AIRA, developed the survey. Questions requested IIS managers to answer based on the experience of the IIS program, not the manager's personal experience. Both Likert scale and discrete variable questions assessed the following as it relates to CI-R/R: 1) previous experience and future interest in conducting CI-R/R questions: *Has your IIS ever performed a CI-R/R for any patients?* and *How likely is it that your health department will conduct CI-R/R for any group in the next 6 months?*; 2) descriptions of populations that were the focus of the R/R; 3) attitudes and barriers regarding CI-R/R, 4) policy questions including information on who can report immunization data to IIS, legal mandates to conduct reminder/recall, and information regarding consent for inclusion of data for children and adults in the IIS. We also assessed IIS functionality including HL7 real-time uploading, which sends immunization data and patient contact data from the practice's electronic health records directly to IIS in "real-time" to improve quality of CI-R/R; abilities to perform reminder/recall at the population-level (county or zip code); and patient active and inactive status (PAIS), which links a patient with an assigned provider (1:1 relationship) or links a patient with all providers that provide immunization services to the patient (1:Many relationship).

PAIS, at the provider and geographic level is relevant for CI-R/R as it would allow an IIS to collaborate with providers to include the provider name on patient reminder notifications and/or to identify and remove patients on a geographic-level who have moved out of state. Some of the questions regarding patient consent, immunization provider reporting, and IIS-related policy, were adapted using similar questions that appeared in a previous IIS survey. We piloted with one IIS and received feedback from two AIRA leaders.

Surveys were sent via email to the IIS manager using Qualtrics® survey software. Up to three email reminders and three follow-up phone calls to non-responders occurred across a two-month period. A \$25 gift card was offered to respondents upon completion.

2.3. Data analysis

Descriptive statistics were generated for all questions. In order to understand what factors might influence the decision to do CI-R/R, we looked at attitudes and barriers, IIS capabilities and policies, and future interest in CI-R/R to see if there were differences between those IIS that ever performed CI-R/R and never performed CI-R/R. Using Chi-squared and Fisher's Exact tests, as appropriate, answers to these questions were compared between IIS who answered yes to "ever conducted CI-R/R" and those that said no. Responses to questions with Likert style responses were purposively collapsed into two categories based on the distributions of responses.

Multivariable logistic regression was performed using least absolute shrinkage and selection operator (LASSO) with 10-fold cross-validation to select the optimal tuning parameter. This method performs variable selection when there are multiple correlated predictors (Tibshirani, 1996). All the variables in Table 4 were included, with the exception of the independent variable "very likely to run R/R in next 6 months;" and since all IIS who answered "yes" had "ever done R/R," we determined it was not a helpful discriminant.

3. Results

Fifty-seven of 62 IIS managers representing all potential IIS jurisdictions (92%) responded to the survey. Table 1 describes respondents. The full version of the survey is provided in Supplemental Table 1.

Table 1
Description of IIS Respondents.

Characteristic	Category	% (n)
Number of full time equivalent (FTE) at IIS	0-2	18 (10)
	2.1-4	21 (12)
	4.1-6	26 (15)
	6.1-8	18 (10)
	≥8.1	18 (10)
	IIS manager length of time in current position	<1 year
	1-3 years	33 (19)
	4-6 years	21 (12)
	7-9 years	11 (6)
	10+ years	28 (16)
Real-time HL7 data exchange (among all immunizations received at IIS)	0%	9 (5)
	1-24%	18 (10)
	25-49%	11 (6)
	50-74%	32 (18)
	75-100%	30 (17)
Ever conducted centralized R/R	Yes	61 (34)
	No	39 (23)

3.1. Previous and future centralized R/R projects

Nearly two-thirds (61%) of IIS had ever conducted CI-R/R. Among these, 83% had performed CI-R/R by identifying eligible patients within counties or geographic areas (population-level R/R). Eighty-three percent of IIS had performed CI-R/R for young children (0-3 years) and 79% for adolescents (11-17 years). Thirty-six percent of IIS reported

conducting CI-R/R for adult populations > 19 years. In Fig. 1, 84% focused on the childhood immunization series, 70% on Human Papillomavirus Vaccine (HPV) and 61% on other adolescent vaccines (MCV4, Tdap). Thirty-five percent and 19% had performed CI-R/R for influenza vaccine for children and adults, respectively. Twenty-six percent had performed CI-R/R for adult vaccines other than influenza. The vast majority (91%) of IIS reported sending CI-R/R notifications by mail, while 33% sent autodial calls, 10% sent text messages, and 3% sent emails (data not shown in a table or figure).

Overall, 34% reported they would be “very likely” to conduct CI-R/R in the next 6 months, and another 14% said they were somewhat likely to conduct CI-R/R. Among those very likely (n = 19), 100% had conducted CI-R/R before. Most of these (89%) anticipated performing CI-R/R for early childhood vaccines, 50% for the adolescent series, and 47% for HPV. Less than a quarter (18%) and (12%) anticipated running CI-R/R for influenza vaccine in children or adults, respectively. Twenty-nine percent anticipated running CI-R/R for other adult vaccines.

3.2. Attitudes and barriers

As shown in Fig. 2, IIS managers expressed positive to neutral attitudes about CI-R/R. The vast majority (86%) strongly or somewhat agreed that CI-R/R would help increase immunization rates in their state or region. Sixty-four percent strongly or somewhat agreed that they were in favor of the health department sending out CI-R/R to patients in need of immunizations. However, 77% strongly or somewhat agreed that practice-based R/R is preferable to CI-R/R.

In Table 2, with reported major and moderate barriers considered together, lack of staff to conduct the IIS-based R/R (78%), competing demands (76%), and costs (63%) were most frequently reported. Forty percent felt that concerns over data quality in IIS were a barrier to implementing CI-R/R, 40% reported concerns that parents/patients would be upset that the reminder/recall came from the IIS, 39% had concerns about the Telephone Consumer Protection Act (FCC, 2018) specifically (which puts regulatory restrictions on autodial and text reminders), and 34% thought legal concerns generally were a major/moderate barrier. Lack of support from leadership at the health department or IIS and lack of knowledge or training on how to perform

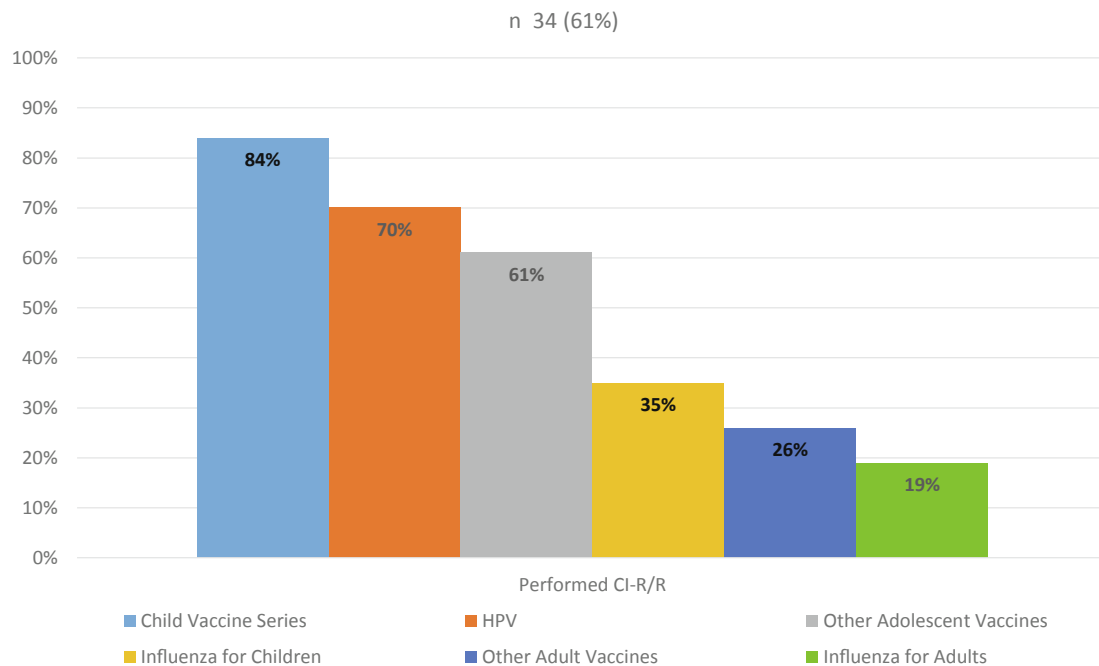


Fig. 1. Targeted vaccines among IIS that ever performed CI-R/R* n = 34 (61%) *Numbers do not add to 100% as respondents could check “yes” or “no” to each vaccine category. “Other adolescent vaccines” include Tdap, MCV4 and “other adult vaccines” includes Herpes Zoster and Pneumococcal vaccines.

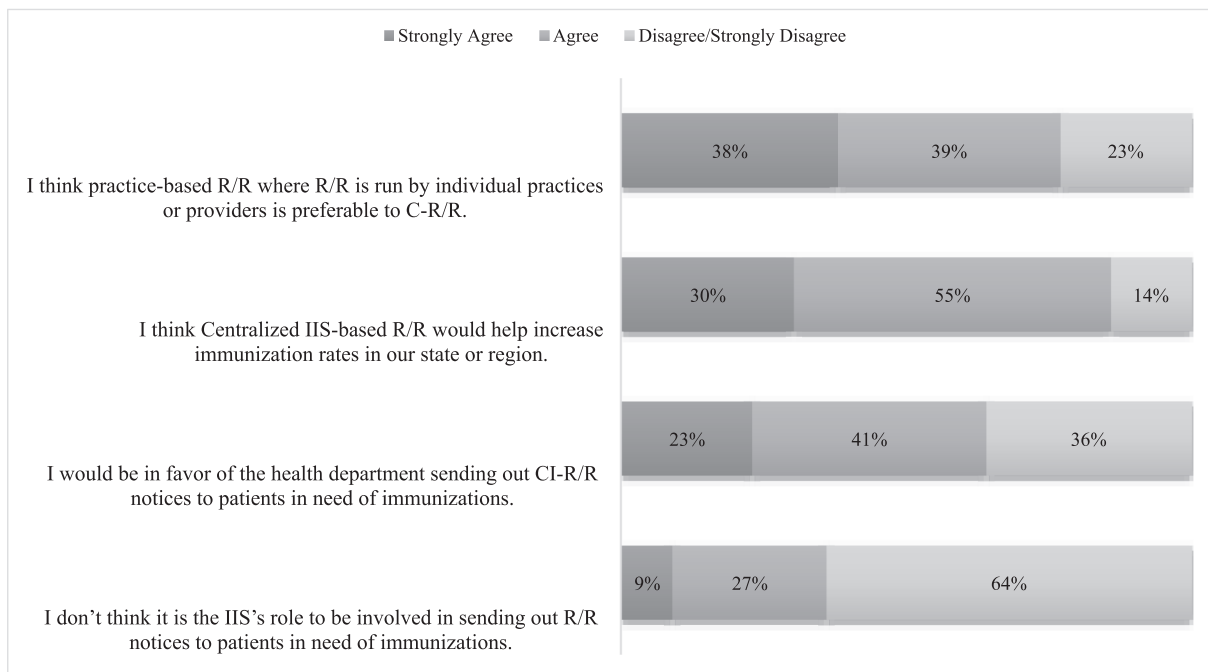


Fig. 2. Attitudes about Centralized IIS-Based R/R (N = 56).

Table 2
Barriers to Conducting CI-R/R*

	Major Barrier % (n)	Moderate Barrier % (n)	Minor Barrier % (n)	Not Barrier at All % (n)
Lack of staff	40 (22)	38 (21)	15 (8)	7 (4)
Competing demands	44 (24)	33 (18)	11 (6)	13 (7)
Cost	35 (19)	28 (15)	24 (13)	13 (7)
Concerns over TCPA	20 (11)	19 (10)	20 (11)	41 (22)
Legal concerns	17 (9)	17 (9)	21 (11)	45 (24)
Lack of support from IIS leadership	4 (2)	4 (2)	20 (11)	72 (39)
Concerns about IIS data quality	13 (7)	27 (15)	45 (25)	15 (8)
Patients would be upset R/R didn't come from provider	15 (8)	25 (14)	42 (23)	18 (10)
Not enough providers participate in IIS	7 (4)	13 (7)	11 (6)	69 (37)
Lack of support from health department	2 (1)	9 (5)	30 (16)	59 (32)
Lack of knowledge/training	2 (1)	9 (5)	47 (26)	42 (23)

* Numbers may not add up to 100 due to rounding.

CI-R/R were minor barriers.

3.3. IIS platform capabilities and IIS policies

Almost a third (30%) of IIS said they received 75–100% of immunization data via real-time HL7. The majority reported their IIS has the capability of running a reminder/recall report at the county (83%) or zip code (76%) levels. When asked about capabilities of local public health departments using the IIS, the majority also reported that they have the ability to run R/R at the county (67%) and zip code (56%) level.

The majority of IIS managers (74%) reported that PAIS is automatically designated within the IIS based on where the patient's last shot was given. Among those familiar with the different levels of PAIS in their IIS (n = 51), 66% said their IIS has the ability to have a one to one (1:1) relationship between the patient and the provider, meaning a patient can be affiliated with only one provider within the IIS database. Thirty-

nine percent reported their IIS having the ability to have a 1:Many relationship, meaning a patient can be linked to multiple providers depending on where immunizations were given. Over half (58%) said there is a 1:1 association between a patient and a geographic location allowing for patients who moved out of state to be inactivated in the IIS, while less than a quarter (14%) said that there is a 1:Many association between a patient and a geographic location. IIS could select more than one response to this question (data are not shown in a table).

Regarding children <19 years old, the vast majority (82%) reported at least one type of provider was mandated to provide immunizations to IIS. As shown in Table 3, nearly half (49%) of IIS reported mandated

Table 3
Provider Reporting to IIS.

Provider type	Mandated % (n)	Voluntary % (n)	Not Allowed to Report % (n)
Children < 19 years			
Hospital systems	46 (26)	54 (31)	–
Public entities e.g. local health departments	58 (33)	42 (24)	–
Private entities (primary care practices)	49 (28)	51 (29)	–
Pharmacies	63 (35)	37 (21)	–
School-based health clinics	51(28)	45(25)	4 (2)
Clinics enrolled in the VFC program	73 (41)	27 (15)	–
Public entities and private entities*	49 (28)	51 (29)	N/A
Adults > 19 years			
Hospital systems	24 (13)	75 (41)	2 (1)
Public entities e.g. local health departments	33 (18)	65 (36)	2 (1)
Private entities (primary care practices)	24 (13)	74 (40)	2 (1)
Pharmacies	45 (25)	53(29)	2 (1)
Clinics enrolled in the VFC program	N/A	N/A	N/A
Public entities and private entities*	24 (13)	76 (42)	N/A

* Responses were counted as mandated if public health entities and private practice entities were both selected on survey. Responses may not add to 100% due to rounding.

immunization reporting from *both* primary care practices and public health entities. For adults > 19 years, 51% of IIS reported mandated reporting among any provider type to IIS. Nearly a quarter (24%) reported mandated immunization reporting for adults older than 19 years of age from *both* primary care practices and public health departments. Mandatory reporting varied by provider type and age of patient. Of note, among those who reported that mandated reporting was required for at least one healthcare entity, 58% stated that the mandate was actually enforced in some way (not shown in table).

Policies around patient consent to participate in the IIS were similar for children and adults. For children under 19, more than half (55%) require only implicit (or indirect) consent, with the right to opt-out by of the IIS by the parent, while 16% reported mandatory participation with no individual right to opt-out. The remaining IIS reported explicit (direct) consent (9%), mandatory with the right to opt-out (11%) or mandatory *without* the right to opt-out (16%). Similarly for adults > 19 years of age, more than half (57%) required only implicit consent with the right to opt-out followed by explicit (direct) consent (9%), mandatory with the right to opt-out (9%) or mandatory *without* the right to opt-out (9%).

Slightly more than a quarter (27%) said their IIS had a specific legal mandate that allows the IIS or health department to send out reminder or recall messages to all populations if they need an immunization; 11% said there was a legal mandate allowing IIS-based R/R among certain populations; and the majority (62%) said no legal mandate existed to explicitly allow CI-R/R.

3.4. Differences between IIS who ever and never performed CI-R/R

The bivariate p-value in Table 4 demonstrates comparisons between those IIS who had ever conducted CI-R/R and those that had never conducted CI-R/R. There were statistically significant differences observed between the groups, ever and never conducted CI-R/R, respectively, for: a) mandated reporting requirements among public and private health entities for children (65% v 27%, p = 0.006); b) legal mandates allowing the IIS/health department to perform R/R for all or some populations (50% v 19%, p = 0.02); and c) being “very likely” to perform CI-R/R in next 6 months (56% v 0%, p < 0.001).

As shown in Table 4, among attitudes and barriers, there were statistically significant differences between those that ever and never performed CI-R/R. All attitude questions were significant between ever and never groups. Significant differences between major barriers between ever and never, respectively included: lack of staff to do the work (29% v. 57%, p = 0.04), concerns about legality of CI-R/R (6% v. 37%, p = 0.007), and too many competing demands (29% v. 67%, p = 0.007). Other barriers were not significantly different between the groups.

In the lasso regression, there was one IIS capabilities and policy, one attitude, and two major barriers with nonzero coefficients (Table 4). Factors positively associated with ever conducting CI-R/R were being in favor of the health department doing R/R, and having mandated reporting for children. Having too many competing demands, and concerns about legality of conducting CI-R/R were negatively associated with ever conducting CI-R/R.

4. Discussion

This study is the first to report IIS experiences, attitudes and capabilities to conduct CI-R/R for different vaccinations nationally and provides important insight about issues that may affect initiation and sustainability of CI-R/R. Surprisingly, the majority of IIS reported previously conducting CI-R/R at the population-level, mostly for childhood and adolescent vaccination series. Most IIS reported positive attitudes towards CI-R/R yet barriers existed, particularly related to costs, staff, and competing demands. This study also gives us a glimpse at how differences in certain IIS policies, capabilities, attitudes and barriers may influence an IIS’ decision to implement CI-R/R.

Table 4
Differences between IIS that ever and never conducted CI-R/R (significant differences are bolded).

Characteristic	Category	Ever % (n) n = 34	Never % (n) n = 22	Bivariable p value	LASSO coef
IIS capabilities and policies					
Percentage of immunization data received via real-time HL7 exchange < 75%	75%-100%	29% (10)	33% (7)	0.76	–
Mandated reporting of all public health and private entities for children	Yes	65% (22)	27% (6)	0.006	0.23
Mandated reporting of all public health and private entities for adults	Yes	27% (9)	18% (4)	0.44	–
Legal mandate allowing the IIS or health department to conduct CI-R/R	Yes, to all/ some populations	50% (17)	19% (4)	0.02	–
Consent requirements for children	Implicit (opt-out)	91% (31)	91% (20)	0.99*	–
Consent requirements for adults	Implicit (opt-out)	85% (29)	91% (20)	0.69*	–
Ability to run R/R by county or zip code	Yes	94% (31)	76% (16)	0.10*	–
Attitudes					
I think Centralized IIS-based R/R would help increase immunization rates in our state or region.	Strongly/ somewhat agree	97% (33)	68% (15)	0.004*	–
I would be in favor of the health department sending out Centralized IIS-based R/R notices to patients in need of immunizations.	Strongly/ somewhat agree	82% (28)	36% (8)	<0.001	0.22
I think Practice-based R/R, where R/R is run by individual practices or providers, is preferable to Centralized IIS-based R/R.	Strongly/ somewhat agree	68% (23)	91% (20)	0.04	–
I don't think it is the IIS's role to be involved in sending out R/R notices to patients in need of immunizations.	Strongly/ somewhat agree	21% (7)	59% (13)	0.003	–
Major Barriers					
Too many competing demands	Major barrier	29% (10)	67% (14)	0.007	–0.33
Costs	Major barrier	32% (11)	40% (8)	0.57	–
Lack of knowledge or training	Major barrier	0% (0)	5% (1)	0.38*	–
Concerns about interpretation of	Major barrier	15% (5)	30% (6)	0.29*	–

(continued on next page)

Table 4 (continued)

Characteristic	Category	Ever % (n) n = 34	Never % (n) n = 22	Bivariable p value	LASSO coef
the Telephone Consumer Protection Act (TCPA)					
Concerns about data quality	Major barrier	14% (5)	10% (2)	0.70*	–
Lack of staff that can do the work	Major barrier	29% (10)	57% (10)	0.04	–
Concerns about the legality of conducting a Centralized IIS-based R/R	Major barrier	6% (2)	37% (7)	0.007*	–0.57
Providers would object or parents would be upset*	Major barrier	0% (0)	33% (7)	0.03*	–
Lack of support from leadership at the IIS	Major barrier	0% (0)	10% (2)	0.13*	–
Lack of support from leadership at the health department	Major barrier	0% (0)	10% (2)	0.13*	–
Concerns there are not enough providers that participate in our IIS	Major barrier	0% (0)	15% (3)	0.14*	–
Future CI-R/R					
Very likely to run R/R in next 6 months	Yes	56% (19)	0% (0)	<0.0001	–

* Fisher's exact test.

Previous articles have described the laws and policies that govern and guide IIS across time (Martin et al., 2015; Murthy et al., 2017). This study offers the latest published information on these policies and capabilities particularly as it relates to CI-R/R. Our study, compared to a previous 2013 survey, showed changes in IIS over time, especially regarding mandated reporting of immunizations among at least one type of provider (from 59% in 2013 to 82% in the current study) and implicit or mandatory consent laws for uploading patient information into IIS (from 68% to 75%). Our study went a step further and assessed mandated reporting required by both primary care practices and public health entities where most children receive immunizations. We found mandated provider reporting for children to be associated with ever performed Centralized IIS-based R/R.

In addition to policies and laws, this study also assessed how patients are linked to providers and geographic areas (PAIS), examined the extent to which IIS are capable of performing centralized R/R on the population level, and assessed the prevalence of HL7 real-time uploading information. The fact that most IIS have the capability to identify patients and perform CI-R/R on the population-level and that the majority receive 50–100% of their immunization data through HL7 real-time exchange has important implications for future CI-R/R efforts. HL7 real-time reporting is especially critical to ensuring the accuracy of immunization and patient contact data which are the backbone of centralized R/R. As HL7 real-time reporting continues to increase, CI-R/R will become even more efficient and effective due to the ability to update contact information and ensure the immunization data guiding R/R are accurate.

Other articles have examined perspectives and experiences among providers, patients and parents about centralized R/R, including their opinions about the health department conducting it (Albright et al., 2014; Saville et al., 2014, 2016, 2018; Hurley et al., 2019). Previous articles suggest the majority of parents and providers are supportive of centralized R/R performed by a health department using an IIS. Our data

provide a glimpse at the experiences and attitudes of IIS managers regarding CI-R/R. Similar to data from parents and providers, our data demonstrate favorable attitudes towards CI-R/R. In fact, most IIS have previous experience with CI-R/R. This has important implications, given the unique opportunities IIS have to perform population-wide R/R, with potential to increase immunization rates at the population level.

This article highlights key differences in those IIS that ever performed CI-R/R to those that have never performed CI-R/R, providing important insight into the issues influencing decision-making to conduct and sustain CI-R/R. Our results imply that some policies pave the way for CI-R/R, including mandated reporting among public and private providers for children and having a legal mandate to allow IIS to perform CI-R/R. Policy recommendations from health departments and partner organizations such as local and national professional associations for mandatory reporting among providers and the incorporation of policies that directly give IIS authority to perform CI-R/R would likely be powerful tools to increasing CI-R/R and increasing immunization rates at the population level.

Another finding from our study suggests that IIS who are very likely in the near future to conduct CI-R/R have all conducted CI-R/R previously. This finding implies that having done CI-R/R before influences their decision to do it again in the future. Therefore focusing on efforts to encourage initiation of CI-R/R may also help with sustainability. It is possible that focusing on interventions to increase CI-R/R initiation among IIS/health departments may be needed. Facilitators such as a toolkit and webinars and/or educational symposiums offered in collaboration with IIS who are successfully implementing CI-R/R at relevant conferences (e.g. annual AIRA National Meeting, CDC's National Immunization Conference), might also shed light on how best to remove barriers and improve facilitators to initiate CI-R/R.

Competing demands, costs and staff resources required to perform CI-R/R are major barriers to performing CI-R/R according to our results. IIS tend to be located within public health departments that suffer from lack of resources and IIS themselves have limited abilities to obtain additional funding (Martin et al., 2015). Given these issues, perhaps partnerships with private entities such as health systems, insurance companies, and/or pharmaceutical companies should be further explored. As highlighted in another study, these health entities often collaborate with IIS to offer financial support via funding or providing R/R materials e.g. postcards, or call centers, while the IIS leads the identification of eligible population and centrally sends out notifications to patients at a state or regional level (Fisher et al., 2019). Although collaborations with pharmaceutical companies may be more controversial, public-private collaborations in general could prove an important tool in facilitating CI-R/R initiation and in easing the burden of sustainability while simultaneously supporting public health goals and system needs to meet quality metrics.

In addition, the high percentage of IIS using mailed reminders begs the question of why other inexpensive modes of R/R are not being utilized, including autodial or text. Regulations related to the Telephone Consumer Protection Act (FCC, 2018) (TCPA) are likely responsible for making health departments question their authority to send reminders via autodial and text, though some are using them nonetheless. Exploring how IIS jurisdictions interpret these regulations and are able to use these less expensive technologies could be very useful to addressing the cost and regulatory barriers revealed in this paper.

This paper has several strengths and limitations. This paper is one of the first to look at how IIS capabilities and policies relate to CI-R/R specifically and is the first to assess the prevalence of IIS conducting CI-R/R. Despite small numbers, our sample represented all U.S. and we had a high response rate. There are also several limiting factors. We did not ask about sustainability or funding sources for CI-R/R or about the reporting structure of IIS managers that might affect their decision-making. These factors may influence whether R/R is pursued. This article also did not explore IIS attitudes or insights regarding practice-based R/R which may be increasing in prevalence given substantial

improvements in interoperability between electronic health records and IIS in the last decade. It also does not address practice-based R/R that may be conducted by clinics or practices using recall functionality within IIS. These are both areas for future studies. Further, our data cannot elucidate the influence of the many competing demands and policies that IIS managers face in making decisions about whether to do CI-R/R. Finally as in all surveys, there is the potential for reporting bias, especially for items that could be perceived as socially desirable.

This paper gives us a glimpse into the potential for centralized IIS-based R/R to raise immunization rates nationally. Given the demonstrated success of this approach to R/R from other studies and its low cost, wider dissemination should optimally involve state and regional IIS. Our data highlight the willingness of IIS to engage in this effort as well as identify policies that may be helpful to promoting CI-R/R as well as barriers that will need to be overcome for such an approach to be sustainable.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2020.101296>.

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