

Getting Under the Hood: Exploring Issues That Affect Provider-Based Recall Using an Immunization Information System

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The authors have no conflicts of interest to disclose.

Presented in part at the 44th National Immunization Conference, Atlanta, Ga, April 19–22, 2010; and the Pediatric Academic Societies' Annual Meeting, Vancouver, Canada, May 1–4, 2010.

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Received for publication August 23, 2010; accepted December 8, 2010.

ABSTRACT

OBJECTIVE: To assess 1) pediatric practices' use of provider-based recall using an immunization information system 8 months after training on the recall process; 2) initiation and sustainability barriers to provider-based recall using an immunization information system; 3) strategies that facilitated recall initiation; and 4) recommendations for alternative approaches for conducting recall.

METHODS: In 2008, 11 practices received training on the automatic recall function in the Colorado Immunization Information System (CIIS) for both infants and adolescents. The 2-hour computer-based training provided an opportunity for attendees to run real-time recall reports with CIIS staff assistance. Eight months later, key informant interviews were conducted with 24 providers and staff from these practices.

RESULTS: Eight months after training, only 4 of 11 practices had implemented recall using CIIS: 3 practices recalled children ≤ 2 years of age, and 1 practice recalled adolescent girls for human papillomavirus vaccine. Initiation barriers included

lack of awareness of baseline immunization rates, distrust in the accuracy of CIIS-generated data, and perceived difficulties recalling adolescents. Having unrealistic expectations about recall effectiveness was a barrier to sustainability. Strategies that facilitated recall included having a dedicated staff person for recall efforts and recalling children ≤ 2 years of age. Most key informants viewed population-based recall conducted by public health departments or schools as an acceptable alternative to provider-based recall.

CONCLUSIONS: Even with a promising tool to assist pediatric offices, implementing provider-based recall is challenging for pediatric practices. Given existing barriers, providers expressed support for alternative recall methods.

KEYWORDS: immunization information systems; immunizations; recall and reminder messages

ACADEMIC PEDIATRICS 2011;11:44–49

WHAT'S NEW

Practices' choices and attitudes about provider-based reminder messages using an immunization information system were assessed 8 months after a recall training. Their attitudes were not assessed by the immunization information system, and their opinions about recall methods were solicited. Providers expressed support for alternative recall methods, particularly recall conducted by public health entities and/or schools.

rates within primary care settings, particularly among young children.^{1–3} Recall messages, usually in the form of postcards, letters, or phone calls, have been shown to be effective in private practices, academic clinics, public health sites, and health maintenance organizations.⁴

Despite the evidence about the effectiveness of recall, initiating and sustaining recall activities within private practices remains challenging. A recent national survey of pediatricians, who vaccinate more than 70% of children in the United States,⁵ revealed that only 16% use recall methods in their practices.⁶ Barriers to recall include lack of staff time and funding, lack of software to identify immunization-deficient patients, and a lack of knowledge of how to begin.^{6,7}

REMINDER OR RECALL messages have long been regarded as an effective way to increase immunization

To address some of these challenges, immunization information systems (IIS), otherwise called immunization registries, have been proposed as a tool to conduct recall.³ The Centers for Disease Control and Prevention (CDC) identified 12 minimum functional standards for all IIS, including the identification of individuals who are due or late for immunizations.⁸ In most IIS, recall can either be provider based (initiated at the practice level for patients within a practice) or population based (initiated at a central location for all patients in a given geographic area).⁹

Despite recommendations and the ability of IIS to offer recall capabilities, there is little research on how IIS might facilitate provider-based recall. To evaluate this, we trained pediatric practices to use the recall function within the Colorado Immunization Information System (CIIS) and then explored issues surrounding the initiation and sustainability of provider-based recall using CIIS. Given the insufficient information on what appeared to be a complex decision, a qualitative approach was necessary to increase understanding of practices' decisions to initiate provider-based recall after training. Of particular interest were barriers to implementing and sustaining provider-based recall, strategies that facilitated recall efforts, and providers' recommendations for alternative recall methods.

METHODS

OVERVIEW

We offered provider-based recall training to eligible practices in the fall of 2008 and conducted follow-up interviews in June–August 2009. The Colorado Multiple Institutional Review Board approved this protocol. Written informed consent was not required.

COLORADO IMMUNIZATION INFORMATION SYSTEM

The CIIS has been a fully functioning IIS since 2002 and meets all functional IIS standards set by the CDC, including the ability to recall children behind on immunizations. CIIS receives client and vaccine event data through live, direct data entry and electronic downloads from participating practices throughout Colorado. Users in participating offices have access to view the consolidated record via the CIIS Web application. In 2008, 82% of Colorado children under age 6 had at least 2 immunization records in CIIS.⁹ One hundred percent of public health departments and 73% of pediatric practices in Colorado were enrolled in CIIS in 2007.¹⁰

RECALL USING CIIS

CIIS has an automatic recall function to identify children who are overdue for immunizations according to Advisory Committee on Immunization Practices recommendations.¹¹ CIIS participating practices can use the recall function to identify age parameters for patients who are registered with their practice. Once a recall report is generated, patient addresses and phone numbers can be downloaded into useable file formats for recall notices. There are currently 8 default age parameters available in CIIS:

9–10 months, 9–23 months, 19–20 months, 19–35 months, 1–2 years, 4–5 years, 11–12 years, and 13–14 years. Customized age groups can be created upon request. Recall capabilities are only accessible to practices that have undergone a collaborative data quality assessment process comparing a random sample of patient records to data in CIIS. Offices with a $\geq 10\%$ error rate are encouraged to complete a systematic review of data before beginning a recall project.

STUDY POPULATION

We recruited highly motivated, well-organized pediatric practices viewed as having the greatest likelihood of implementing recall. To identify eligible practices, we generated a list of 50 potential pediatric sites in the Denver metropolitan area from the CIIS provider database. We then eliminated 25 practices from the list: 4 because they had conducted recall using CIIS in the previous 12 months (October 28, 2007 to October 28, 2008) and 21 because CIIS coordinators did not think that the practices had adequate resources to implement recall. The remaining 25 practices were believed by CIIS staff to be more proactive about updating records, keeping passwords current, and having a consistent contact person who corresponded regularly with CIIS. Personnel from eligible practices were invited to participate in a recall training offered by CIIS; 11 agreed to participate (Table). Attendees were primarily office managers or nursing staff from each practice. The reasons for nonparticipation are not fully understood.

Before the recall training, a data quality assessment was conducted at each practice to determine the error rate between CIIS charts and patient medical records. If the error rate was $\geq 10\%$, the site was permitted to attend the recall training with the recommendation that all patient data be reviewed before recall to ensure that CIIS accurately reflected the patient's true immunization status. In addition, retraining by CIIS staff to improve data quality was offered to all practices with an error rate of $\geq 10\%$.

The recall training was conducted in the fall of 2008 in a computer lab where attendees each had their own

Table. Practice Descriptions*

Practice	No. of Providers	No. of Staff Members	% Medicaid or SCHIP	EMR	Data Quality Error (%)
A†	21	85	15	Yes	1
B	4	12	60		10
C	2	5	20	Yes	6
D	4	16	35		44
E†	3	10	11	Yes	1
F	5	20	1		26
G	5	21	35		8
H†	17	100	10		6
I	2	5	2		2
J	11	41	30		24
K†	8	27	60		3

*SCHIP = State Children's Health Insurance Program; EMR = electronic medical record.

†Initiated provider-based reminder/recall using the Colorado immunization information system.

computer. The 2-hour training included a CIIS Web site overview and the opportunity for each attendee to perform a test recall using practice-specific data overseen by a CIIS coordinator. Recall examples for both adolescents and infants were demonstrated. Attendees received a manual that included computer screen shots of how to use the recall reports in CIIS. Follow-up assistance was provided upon request.

KEY INFORMANT INTERVIEWS

Semistructured interviews were conducted approximately 8 months after the training with 24 representatives from 11 participating practices. One partner pediatrician was interviewed from each practice ($n = 11$), and 13 interviews were conducted with staff members identified as primary implementers and/or overseers of recall implementation in practices (10 nurses, 3 practice administrators). At least one interviewee per practice attended the training. Interviews lasted approximately 30–45 minutes and assessed which practices initiated recall; which age groups were targeted; barriers to implementing recall; strategies that facilitated recall; and recommendations for alternative recall methods.

DATA ANALYSIS

This study used an iterative, inductive, and deductive tool kit of analytical strategies, drawing particularly on qualitative content methods of analysis and reflexive team analysis.^{12–14} Interviews were digitally recorded and transcribed verbatim. Analysis of the transcripts began with repeated readings to achieve immersion¹³ and was followed by initial coding using an emergent rather than a priori approach, in order to emphasize respondent perspectives and to deemphasize team member speculations.¹⁴ ATLAS.ti version 6.0 was used for data organization and management during analysis. After initial coding was completed, the resulting set of codes was applied to the transcripts, code categories were developed, and emergent themes were identified. The preliminary results of the analysis process were reviewed by research team members to assess their evocativeness, thoroughness, and comprehensiveness.¹⁵ Throughout the analysis, new findings were continually checked and compared with the rest of the data to establish new codes, themes, or patterns.¹⁶

RESULTS

DATA QUALITY RESULTS

Data quality assessments revealed that practices that initiated recall had error rates of 1%–6%, whereas practices that did not initiate recall had error rates of 2%–44% (Table).

PRACTICES' CHOICES ABOUT RECALL

Eight months after training, only 4 of the 11 practices had voluntarily initiated provider-based recall using CIIS at least once. Three practices initiated recall for children

≤2 years old and one practice recalled adolescent girls for human papillomavirus vaccine. Of the 11 practices that participated in the training, 7 had error rates of ≤10%, including the 4 practices that initiated recall. The method of recall varied: 3 practices telephoned families about overdue immunizations, and one practice sent letters, with assistance from their local health department.

BARRIERS TO INITIATION AND SUSTAINABILITY

Three recall initiation barriers were reported by both implementers and nonimplementers: lack of awareness of baseline immunization rates; distrust of the data; and reluctance to recall older children as a result of perceived difficulties. Four practices were able to overcome these barriers using strategies described in the next section.

One barrier discussed by both recall implementers and nonimplementers was their lack of awareness of baseline immunization rates. Most practices expressed an inability to assess practice-level rates autonomously, and 2 practices received immunization assessments from their local health department. Many participants reported the impression of “pretty high” overall immunization rates in their practices; however, actual immunization rates were not calculated. When participants were asked what they would do if an assessment revealed that their immunization rates were lower than the national average, nearly all responded that they would initiate recall or implement some other strategy to improve rates.

The most significant barrier reported by interviewees from all 11 practices was a general distrust of the data generated by the CIIS recall function. Practices reported commonly finding inaccuracies both with patient contact information and immunization data in CIIS. Practices often reported that patient contact information was not routinely updated in CIIS, only in the patient charts or electronic medical record (EMR). They also described frustration with perceived conflicts in the immunization algorithms between CIIS and the practice. For instance, a practice may use a broader age range for determining whether a child is late for immunizations, which may be inconsistent with the default minimum Advisory Committee on Immunization Practices recommendations in CIIS. Occasionally there were perceptions about mistakes in the CIIS algorithms and the practice would have to manually review the information. One nurse reported: *I get a lot of frustration with Hep B...there needs to be 16 weeks between [dose] 1 and 3...if I look and count out the weeks [in the patient chart] it's 16 weeks, [but the patient] is still on the [CIIS recall] report.*

This distrust of the data was further expanded upon by implementers. These interviewees expressed risk aversion to using only the information in CIIS to recall patients, despite having relatively good data quality on immunizations (≤6% error rates). One practice reported that they consistently cross-referenced the CIIS recall report with the immunization data in their patient EMR. As that practice's administrator put it, *If you are trying to do recalls just with the information that's in [CIIS], I think you would be wasting a lot of time...100% of the data doesn't*

[transfer from our EMR to CIIS]...maybe [only] 98%. Another administrator commented on the need to check with CIIS and their scheduling software: I don't want to do a recall on somebody who is coming in tomorrow...because then I look incompetent...if you want to look like a very thorough professional, [recall] is a very time consuming task.

Participants also discussed barriers to initiating recall with older children and adolescents. Interviewees from 9 practices thought that older children and adolescents are important to recall because of the infrequency of their visits. As one physician said, *Recalls are more useful in [the adolescent] population because it is a population that is not necessarily thinking about their kids' checkups.* However, participants anticipated the difficulties of identifying active adolescent patients and overcoming the obstacle of inaccurate contact information. Several participants also conveyed their belief that parents of older children would be less compliant to recall notices compared to parents of younger children. As one nurse relayed: *My own opinion is that with adolescents, they are so much busier than our little toddlers where mom can just pick them up and bring them in.* Additionally, the age parameters for adolescents offered in the CIIS include a large cohort (ie, 11–12-year-olds). This could generate a very long list of patients, which practices believed would be too time-consuming to review.

Some interviewees also reported that school requirements and corresponding notices sent by schools to parents often serve as a de facto recall notice for older children. One nurse at a nonimplementation site said s/he did not feel there was a need to do recall among older children for this very reason: *The schools are definitely doing [recall] for [children in older] age brackets...Certainly if it was an issue and the schools weren't doing it, we'd be doing it.*

Finally, recall implementers reported high expectations for responses to recall efforts, which was a barrier to sustainability when expectations were not met. Realistic recall response rates were never discussed with participants attending the recall training, but nevertheless, recall implementers had opinions about how many patients should respond to recall notices. As one nurse noted, *In this office we probably had about 20% come back [for shots]...Which I don't think is really good...I would have hoped I would have gotten like 80% or 90%.*

STRATEGIES THAT FACILITATED RECALL INITIATION

Interviews with recall implementers indicated 2 successful strategies for IIS recall initiation. First, all 4 implementers had at least one staff person with dedicated time (at least 1 day a week) that could be directed towards recall activities, rather than caring for patients. These dedicated staff had the ability to evaluate data quality as well as coordinate telephone calls or letters to families. Second, 3 of the 4 implementers performed recall on children ≤ 2 years old. Participants considered this age group to be most accessible for recall both because younger children are routinely seen by their pediatricians and thus have the most accurate

contact information, and because parents of this age group were believed to be compliant to recall notices: *We would [recall] the 2, 4 and 6 month olds...because so many vaccines are given in such a short time...[and] usually under [age] 2 [parents] are pretty compliant.* Because of the default age parameters provided in CIIS, children ≤ 2 years old often generated a relatively short list of patients who needed to be recalled.

RECOMMENDATIONS FOR ALTERNATIVE RECALL METHODS

All interviewees were asked their opinions about and recommendations for alternative recall methods. We first asked interviewees their opinions about a population-based recall that might be conducted by a public health entity. Twenty-one of 24 participants had positive or neutral opinions about this approach. Some in particular were relieved at the thought of someone else doing all the work and paying for it. Some practices who had more transient patient populations liked the idea because it would let patients decide where to get their immunizations. One physician stated: *I would encourage that 100%. If they would do that and then it would be the patient's responsibility to choose [where] to go...if we sent out a card and [they go to a different] doctor, then we look like...we have ulterior motives.* Some felt that a population-based recall would also reach patients that did not have a medical home. However, other practices predicted that parents would respond better to notices that came directly from their practice, because of the personal relationships involved. As one physician explained: *Well, I don't have any ethical or other such problem with [a population-based recall]...I think probably the desire to reach the maximum number of people, going through a central [recall] might be the best. In terms of getting the best percentage response I think coming from the practices might be the best.* Many providers and staff also wanted to provide input into the wording of a postcard or phone call that would go out to patients. Generic language that referred patients to their provider for questions was preferred over more specific wording.

Providers and staff were also asked how they thought parents would perceive recall notices sent from schools rather than a public health entity. Twenty-three interviewees reported that parents would have a very positive view of notices from the schools because parents have an established personal relationship with the school system. One physician summarized: *My sense is [parents] would be more open to [notices sent from the schools]...[parents] seem to be really receptive to it...Whereas with a third party [like the health department] they don't really know, or maybe not trust.*

DISCUSSION

Despite the effectiveness of provider-based recall, few practices nationally utilize this approach for increasing immunization rates within their practices.⁶ IIS offers a tool to facilitate provider-based recall, yet little has been reported about providers' attitudes or practices using

the recall function. This qualitative analysis sheds light on initiation and sustainability issues in provider-based recall. The finding that only 4 of the 11 practices initiated recall over an 8-month period suggests that challenges to provider-based recall exist even among this sample of highly motivated, well-organized practices. Barriers to initiation and sustainability of recall were indicated by both implementers and nonimplementers and included lack of awareness of immunization rates, distrust of data generated in CIIS, perceived difficulties recalling adolescents, and unrealistic expectations for recall response. These barriers led practices to focus on younger children for recall efforts and favor alternative methods of recall, including recall conducted by public health entities and schools.

Although some of these barriers have also been suggested in other research, few previous studies have specifically reviewed recall using IIS. Tierney and colleagues found that lack of time, funding, and a simple way to identify children at a specific age presented barriers for practices.⁶ Others have found that poor patient contact information, inaccurate immunization data, and no-shows for appointments were barriers for recall in an academic teaching clinic.⁷ In this study, practices had a tool that enabled them to identify patients within specific age parameters needing immunizations; however, practices spent significant time double-checking data. Most practices in this study did not explicitly state that a lack of funding was a barrier to recall, although having personnel with dedicated time for recall activities implies funding was essential.

The results here also suggest how much additional time practices are willing to take to ensure high levels of data quality. Among practices that chose to implement recall, data quality assessments were within an acceptable range (1%–6%); however, all recall implementers cross-referenced the information in CIIS to verify immunization data, contact information, or whether patients had an upcoming appointment. This time-consuming process was a burden on staff resources and time, but several practices suggested that not taking this important step would present a significant risk. Several administrators suggested that calling patients who do not need to be recalled might compromise their reputation as health providers because they would appear incompetent or unprofessional. This sort of risk aversion to other forms of preventive reminders has not been previously documented.

Issues with IIS data quality and accuracy have been recognized nationally.^{11,17} In recent years, the CDC has had to prioritize increasing the numbers of adolescents and adults on IIS, rather than focusing on data quality.¹⁷ The CDC measures data quality in 2 ways: timeliness of record creation, and completeness of core data elements and proportion of children up to date on childhood immunizations. In 2008, 67% of immunization data were uploaded within 30 days of vaccine delivery, and >90% of IIS records contained 6 of 17 core data elements. However, the concerns regarding data quality that emerged in the current study center on how accurately information in patient charts match CIIS information. One solution to

improving data accuracy is to increase provider participation and to increase automatic uploads to IIS from provider billing data and/or electronic health records. The CDC continues to work with the American Immunization Registry Association to develop best practices to improve data quality in these areas.¹⁷ In the meantime, data quality issues remain a deterrent from initiating the recall process, even though recall offers the opportunity to actually improve data quality.

Implementers of recall also described high expectations regarding the responses they expect to see among their patient population. A meta-analysis concluded that reminder/recall increased immunization rates by 5–20 absolute percentage points.³ However, implementers in this study expected that their efforts would yield a bigger return on their investment (ie, updating 80%–90% of those needing immunizations). Most practices reported a much smaller response rate and thus found it difficult to justify the cost and time for sustaining recall.

One successful strategy identified in this study was conducting recall on children ≤ 2 years old. Younger children are clearly perceived to be the low-hanging fruit within the practice setting. Providers felt more confident that younger children had more accurate contact and immunization data, and that the recall reports would be more manageable to work through. Unfortunately, this study also highlights the difficulties that practices may face when initiating recall for adolescents. This finding is timely given several new and recommended vaccines for adolescents.¹⁸ Interviewees overwhelmingly indicated that school-aged children and adolescents should be given priority for recall efforts as a result of the infrequency of their health care visits and the belief that parents put less priority on preventive health of older children. However, the perception of poor data quality among this age group in CIIS discouraged practices from focusing on them. Because adolescents are seen less frequently than younger children, practices have difficulty identifying active patients, are less sure of their contact information, and are less confident that their immunization data are accurate. This inability to accurately identify active adolescent patients, together with CIIS's large age parameters for older children (ie, 11–12-year-olds or 13–14-year-olds) may discourage recall for these age groups.

Due in part to such difficulties, most practices were receptive to generic recall notices sent from the public health entities or schools. Providers were generally quite receptive to this idea. Some thought that parents would respond better to a note sent from their pediatrician but also acknowledged a population-based approach would have a positive effect on public health overall. This population-based approach frees practices from conducting recall, although it is possible that practices could also be burdened by helping parents determine the accuracy of recall notices. Also, most interviewees thought that recall notices sent by schools would be well received by parents; however, schools would likely only promote school-mandated immunizations, rather than recommended vaccines (eg, human papillomavirus).

KEY LIMITATIONS

The major limitation of this study is that it only included the opinions and expertise of highly motivated, well-organized pediatric practices within one metropolitan area. Further, the selection of these practices was subjective, based on CIIS interactions with practices. Nevertheless, the themes discussed in this paper highlight challenges that would likely be even more problematic for less motivated practices. We are also unable to know the practice characteristics for practices that refused to participate in the recall training. It is possible that the off-site training session was a barrier for practices who did not attend. Future studies might examine whether on-line trainings would result in improved participation rates. Finally, the qualitative nature of this study prevents the formal testing of specific hypotheses. Instead, it offers a glimpse into the complex real-world issues some practices face when doing recall.

IMPLICATIONS AND NEXT STEPS

This study provides details on provider-based recall using an IIS, an approach that has been endorsed by immunization experts. The information collected from this study is important for understanding the reasons why so few practices utilize provider-based recall. Only one article has explored some of these issues. For provider-based recall to be sustainable, more efforts are needed to improve data quality within the system and within practices. In addition, practices should be given realistic expectations about the response rates from provider-based recall. Widespread implementation of new technologies may help to overcome some of the hurdles that private practices face in initiating and sustaining provider-based recall.¹⁹ The Health Information Technology for Economic and Clinical Health sections of the American Recovery and Reinvestment Act of 2009 on automated recall functionality are likely to have particular impact because of their inclusion of EMR benchmarks, such as the capacity for EMR systems to submit electronic data to immunization registries. Given the difficulties that providers encounter, they were open to alternative approaches to recall, including recall conducted by public health entities and/or schools. Currently, there is no research comparing the effectiveness of provider-based versus population-based recall. Such research is recommended because it is likely to be helpful in determining the best methods to recall children.

ACKNOWLEDGMENT

We thank the staff from the CIIS for their assistance identifying practices and offering reminder/recall training to practices as part of this research project. We also thank the pediatricians, nurses, and practice administrators who participated in interviews for this study.

This investigation was funded by a grant from the Centers for Disease Control and Prevention 3U01IP000129-02W1 to the University of Colorado Denver. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for

Disease Control and Prevention or the US Department of Health and Human Services.

REFERENCES

1. Task Force on Community Preventive Services. Recommendations regarding interventions to improve vaccination coverage in children, adolescents, and adults. *Am J Prev Med.* 2000;18(suppl 1): 92–96.
2. Briss PA, Rodewald LE, Hinman AR, et al. Reviews of evidence regarding interventions to improve vaccination coverage in children, adolescents, and adults. The Task Force on Community Preventive Services. *Am J Prev Med.* 2000;18(suppl 1):97–140.
3. Jacobson VJ, Szilagyi P. Patient reminder and patient recall systems to improve immunization rates. *Cochrane Database Syst Rev.* 2005;(3): CD003941.
4. Szilagyi PG, Bordley C, Vann JC, et al. Effect of patient reminder/recall interventions on immunization rates: a review. *JAMA.* 2000; 284:1820–1827.
5. LeBaron CW, Lyons B, Massoudi M, Stevenson J. Childhood vaccination providers in the United States. *Am J Public Health.* 2002;92: 266–270.
6. Tierney CD, Yusuf H, McMahon SR, et al. Adoption of reminder and recall messages for immunizations by pediatricians and public health clinics. *Pediatrics.* 2003;112:1076–1082.
7. Kempe A, Lowery NE, Pearson KA, et al. Immunization recall: effectiveness and barriers to success in an urban teaching clinic. *J Pediatr.* 2001;139:630–635.
8. Department of Health and Human Services, Centers for Disease Control and Prevention. *Immunization Program Operations Manual.* July 2009. Available at: <http://www.cdc.gov/vaccines/vac-gen/policies/ipom/>. Accessed August 18, 2010.
9. Colorado Department of Public Health and Environment, Colorado Immunization Information System. *Colorado Annual Immunization Progress Report for CY2008, Section IX—Immunization Information Systems.* Denver, Colo: Colorado Department of Public Health and Environment; September 1, 2009.
10. O’Leary S, Lowery E, Armon C, Todd J. Vaccine-preventable diseases in Colorado’s children, 2007. State of the health of Colorado’s children. 2008;5(1). Available at: <http://www.thechildrenshospital.org/pdf/Vaccine-Preventable-Diseases-Colorado-Children-2007.pdf>. Accessed August 11, 2010.
11. American Immunization Registry Association. Reminder/recall in immunization information systems. April 2009. Available at: http://www.immregistries.org/pdf/AIRA_MIROW_RR_041009.pdf. Accessed August 18, 2010.
12. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today.* 2004;24:105–112.
13. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res.* 2005;15:1277–1288.
14. Stemler S. An overview of content analysis. *Practical Assessment, Research and Evaluation.* 2001;7[17]. Available at: <http://PAREonline.net/getvn.asp?v=7&n=17>. Accessed October 28, 2010.
15. Teddlie C, Tashakkori A. *Foundations of Mixed Methods Research Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences.* Thousand Oaks, Calif: Sage Publications; 2009.
16. Charmaz K. *Constructing Grounded Theory.* London: Sage; 2006.
17. Progress in immunization information systems—United States, 2008. *MMWR Morb Mortal Wkly Rep.* 2010;59:133–135.
18. American Academy of Pediatrics. Recommended immunization schedules for children and adolescents—United States, 2007. *Pediatrics.* 2007;119:207–208.
19. Hogan SO, Kissam SM. Measuring meaningful use. *Health Aff (Millwood).* 2010;29:601–606.