



Original article

## Comparison of Reminder Methods in Selected Adolescents With Records in an Immunization Registry


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 A B S T R A C T

**Purpose:** The aim of this study was to assess the effectiveness and cost efficiency of three reminder/recall methods for improving adolescent vaccination rates using the San Diego Immunization Registry.

**Methods:** Parents of 5,050 adolescents whose records indicated they lacked one or more adolescent vaccines were identified from the San Diego Immunization Registry and contacted by telephone. Based on their preference, consenting participants were enrolled to receive either postal mail (n = 282), e-mail (n = 963), or text (n = 552) reminders for vaccination. The intervention groups were sent a series of up to three reminders. The vaccination completion rate was compared between the intervention groups and two control groups—the enrollment phone call—only group who declined to participate and a no contact group—using logistic regression.

**Results:** The participants who received any reminder were more likely (24.6% vs. 12.4%;  $p < .001$ ) to become up-to-date (UTD) than those in the enrollment phone call—only group. At the conclusion of the study observation, UTD status was reached by 32.1% of text message recipients, 23.0% of postcard recipients, and 20.8% of e-mail recipients compared to 12.4% for the enrollment phone call recipients. Only 9.7% of nonintervention adolescents became UTD.

**Conclusions:** All three reminder interventions were effective in improving adolescent vaccination rates. Although postal mail reminders were preferred by most participants, text messaging and e-mail were the more effective reminder methods. Text messaging and e-mail as reminder methods for receiving vaccinations should be considered for use to boost vaccination completion among adolescents.

**IMPLICATIONS AND CONTRIBUTION**

This study reinforces the effectiveness of vaccine reminders and shows that using text or e-mail messages in conjunction with an immunization registry database may be an efficient way to improve immunization coverage rates among adolescents.

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Adolescence is a crucial period for immunization. The following three vaccines are recommended for routine administration during adolescence: human papillomavirus vaccine

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(HPV), tetanus-diphtheria-acellular pertussis vaccine (Tdap), and meningococcal conjugate vaccine (MCV). Among adolescents, vaccine coverage for Tdap and MCV is approaching Healthy People 2020 goals but coverage for three doses of HPV is low [1–3]. In a recent study, 53.8% of adolescent girls had received one dose of the HPV vaccine and only 33.4% had received all three doses. Among adolescent boys, only 20.8% and 6.8% had received one and three doses of HPV vaccine, respectively [4].

Evidence-based methods exist for improving immunization. Reminders and recalls for vaccine appointments have been found by many studies to be well-received and effective methods to

improve immunization rates [5]. Reminder/recall methods include postal mail, phone, e-mail, and text messages, with text message being the most recently implemented method [6–9]. Immunization registries, sometimes called immunization information systems or IIS, are computerized databases of patient immunization records managed by public health agencies. Many registries contain a built-in reminder system that generates immunization reminder notices. The ability to use the immunization records in these population-based systems would allow additional parents to receive reminders for immunization. These reminders would provide prompts for parents whose medical care providers do not provide this service or supplement the existing reminders from their child's medical provider. As technology improves and costs to implement reminder systems decrease, it becomes more feasible for medical clinics and public health immunization registries to implement reminder/recall systems. The use of mobile technology is consistently on the rise. More than 75% of U.S. adults and more than 70% of teenagers own a mobile phone, and of those users, more than 75% have text messaging capabilities [7]. In recent studies, parents were generally found to be receptive to text messaging [8–11]. The cost of implementing a text message reminder system has been shown to be much lower than telephone or postal mailing system reminders, and therefore, it is more likely to be a desirable option for those sending reminders [12]. Because of the rising acceptance of text messaging and the low cost of text distribution, text messaging could prove to be a most efficient reminder method.

Although text messaging has garnered the most attention lately, e-mail and postal mail are still thought of as reliable contact methods, especially for those who are not comfortable with newer technology. It is important to evaluate which methods of reminder/recall are most popular, efficient, and cost-effective. This study compares the popularity, effectiveness, and cost of text, e-mail, and postal reminders among adolescents who have records in a public health immunization registry information system.

## Methods

### Participants

Participants were selected randomly using SPSS 20 (IBM Corp., Armonk, NY) computer-based randomization from records in the San Diego County Immunization Registry (SDIR). The SDIR is a Web-based voluntary immunization information system managed by the County of San Diego Health and Human Services Agency's Epidemiology and Immunization Services Branch. Forty-one percent of San Diego County adolescents aged 11–17 years have at least two or more adolescent immunizations recorded in SDIR. Of the eligible adolescents, 16.6% were randomly chosen to be contacted for the study. The sampled population included all adolescents with complete demographic information and at least one vaccination in SDIR. To qualify, the adolescent had to have received at least one vaccine other than H1N1 influenza within the past 3 years, have no documentation of medical contraindication to vaccination or personal exemption from vaccination requirements, a phone number in San Diego County documented in SDIR, and not be up-to-date (UTD) on at least one of the recommended adolescent vaccines. The adolescent vaccines included in the criteria for being UTD were MCV4 (one dose for those aged <16 years; two doses for those aged ≥16 years), Tdap (one dose), HPV (three doses), and varicella (two doses).

A documented history of varicella was accepted as being UTD for varicella vaccine. Parents of adolescents of ages 11–17 years were recruited from September 2012 to February 2013. Adolescents who were found to be UTD during the recruitment process were excluded. The study end date was September 12, 2013, which allowed all those enrolled adolescents sufficient time to receive the full series of recommended adolescent vaccines.

Parents of eligible adolescents were contacted by phone through the systematic randomization and asked to participate in the study. If they agreed to participate in the study the participant was given a choice of reminder type. Only one child from each household was enrolled. Interviews were conducted using computer-assisted telephone interview using WinCati 5.0 (Sawtooth Technologies, Inc., Northbrook, IL). Recruiting was completed by trained bilingual (Spanish and English) research staff.

Data collected from SDIR included the names of the adolescents and of their parents/guardians, date of birth, gender, phone numbers, home addresses, and immunization status of the four vaccines. Telephone interviews were conducted to verify the information obtained from SDIR and to obtain consent and choice of receiving e-mail, postcard, or text message reminders. Interviews were terminated if the teens were no longer living in the county, there was a mismatch of the respondents' birth dates, names were not a match with the SDIR information, the respondents were not the adolescent's guardians, or if the adolescent's immunizations were determined to already be UTD. If the subject declined to participate, they were placed into the primary control group. This group is referred to as the enrollment phone call–only group. A secondary control group was made up of adolescents who met the criteria for inclusion but were not contacted by phone. Both the primary and secondary control groups were assessed using SDIR data at the beginning and conclusion of the study on September 12, 2013.

### Measures

The initial recruitment phone call served as the first reminder to the eligible participants. Any household receiving this initial recruitment call but declining follow-up reminders was placed in the enrollment phone call–only group and not contacted again. Those participants who consented to receiving one of the reminder methods but who obtained the vaccines necessary to become UTD (as documented in SDIR) before initiation of reminders were also placed in the enrollment phone call–only group.

Three follow-up reminder phases were used to send messages addressed to the parents of adolescents who chose to be included in the intervention group. The first reminder was sent 2 weeks after the initial telephone enrollment and reminder. If the participant did not become UTD with vaccines, the second reminder consisted of a pair of reminders, sent 2 weeks apart, 3 months after the first reminder was sent. The final reminder was two reminders, sent 2 weeks apart, 3 months after the second set of reminders. The postcard reminder option was capped at 300 participants because such systems have already been thoroughly studied and are not as cost-effective as electronic reminder methods. When this number was reached, the postcard option was eliminated and participants chose between e-mail or text reminders. The content of the postcard included the name of the adolescent, a reminder to vaccinate, and a phone number for the participants to contact to report that they had

become UTD or to opt out of receiving further postcards. The postcards were printed in both English and Spanish. Both text messages and e-mails were sent using Voicent, automated messaging software (Voicent Communications, Mountain View, CA). The content of the e-mail and text messages included the participants' names, a reminder to vaccinate, and steps on how to report becoming UTD or to unsubscribe from the reminder service. The reminders were sent in either English or Spanish depending on the recipient's preference. None of the reminders specified which vaccines were needed. Participants were tracked throughout the study period and removed from receiving reminders if they became UTD through the registry or parental self-report or if they unsubscribed from the reminder service.

The UTD status of the participants in the reminder intervention groups was compared with the enrollment phone call-only and no contact control groups. For the reminder groups, final UTD status was determined 2 weeks after the third reminder. For those in the primary and secondary control groups, final UTD status was determined on the last day of data collection. The recruitment and intervention process is illustrated in Figure 1.

*Data analysis and ethical approvals*

All analyses were conducted using IBM SPSS Statistics 20. Descriptive analysis was used to compare frequency of data and proportions by UTD status and the time to UTD status. The McNemar test was used to test for significance of increased coverage levels between the groups at the beginning and end of the study. Odds ratios were used for the likelihood of UTD comparing the three different reminder types to the two control groups. The rates were calculated using logistic regression, adjusted by age and gender variables. One-way analysis of

variance was also used to test the difference in mean values of time to UTD status between the different intervention and control groups. The University of California San Diego Institutional Review Board granted approval for the study (2012/120328).

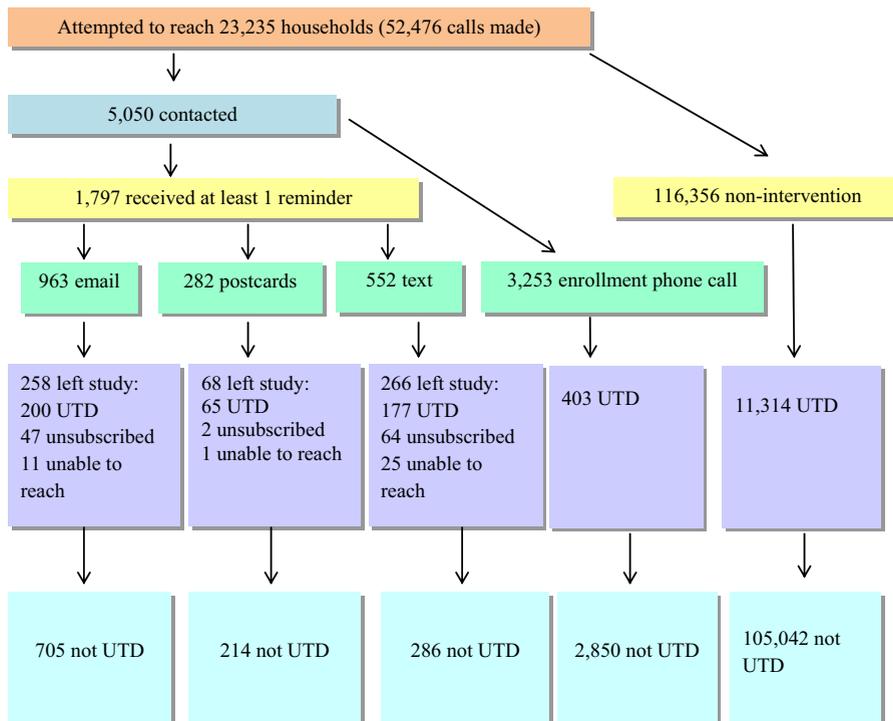
**Results**

*Enrollment*

A total of 52,476 contact attempts were made to 23,235 households. Of the 5,050 households contacted, 1,797 were enrolled in one of the reminder systems and received at least one reminder and 3,253 declined to participate in the reminder program and were placed into the enrollment phone call-only control group. The remaining 116,356 eligible but nonsampled households were placed in the no contact control group. Among parents who chose to participate in the reminder intervention, the top choice was postcard reminders. E-mail, the next most popular option, was two times more likely to be chosen than text messaging. After placing eight participants who voluntarily disenrolled from the study before the first reminders were sent and 200 participants who were to receive reminders but became UTD before the beginning of the study into the enrollment phone call-only group, 1,797 participants remained in the intervention group; the breakdown of participants was as follows: 282 postcard reminders (15.7%), 552 text message reminders (30.7%), and 963 e-mail reminders (53.6%; Figure 1).

*Intervention versus control groups*

Intervention and control groups have similar characteristics as seen in Table 1. As a whole, the participants who received a



**Figure 1.** Flow chart for study by intervention and control groups.

**Table 1**  
Demographics of intervention and control groups

	Intervention groups (%) (N = 1,797)	Enrollment phone call–only group (%) (N = 3,253)	Nonintervention group (%) (N = 116,356)
Gender			
Female	49.5	47.7	43.0
Male	50.5	51.4	47.0
Unknown	0	.8	10.1
Age, years			
11	10.6	11.3	10.6
12	13.0	14.3	12.6
13	15.0	15.9	16.0
14	14.6	14.0	15.3
15	13.8	14.5	15.9
16	18.0	16.1	14.9
17	13.3	13.8	14.7

repeated reminder were more likely (24.6% vs. 12.4%;  $p < .001$ ) to become UTD when compared to those in the enrollment phone call–only group. Overall, 23.0% of postcard recipients, 32.1% of those who received text reminders, 20.8% of e-mail recipients, and 12.4% of enrollment phone call–only recipients became UTD. Only 9.7% of nonintervention control subjects became UTD (Figure 1). Table 2 displays coverage rates and the percent change from baseline by vaccine for intervention or control group. Of the three different interventions, text message recipients had the highest percentage of participants brought UTD. Table 3 displays odds ratios for becoming UTD comparing reminder methods to each of the two control groups.

Because the UTD status was ascertained using registry data and parental response, an analysis was performed to determine the extent of any discrepancy between the two sources. This analysis (not shown) showed that 3.0% of the e-mail recipients, 1.4% of postcard recipients, and 7.6% of text message recipients reported UTD status that was not reflected in the registry database. The difference in UTD status between registry data and self-reported data is 4.2% across the three reminder intervention groups.

**Table 2**  
Vaccination coverage rates and improvement from beginning to the end of study by vaccine and reminder group (among all participants)<sup>a</sup>

	Intervention and control groups percent increase in vaccination rate (coverage rate at the end of study)				
	E-mail (%)	Postcard (%)	Text (%)	Enrollment phone call–only (%)	Nonintervention (%)
HPV female					
≥1 dose	9.7 (70.2)	10.3 (81.5)	11.5 (79.2)	6.7 (65.0)	4.9 (63.1)
≥3 doses	13.6 (30.8)	15.0 (39.0)	21.6 (33.5)	8.7 (24.9)	6.2 (27.6)
HPV male					
≥1 dose	20.6 (50.4)	17.6 (48.5)	29.1 (64.0)	16.3 (42.2)	10.9 (40.3)
≥3 doses	10.0 (13.3)	9.5 (13.2)	16.1 (17.8)	8.6 (10.7)	6.4 (10.0)
MCV dose 1	8.6 (83.4)	11.0 (83.7)	10.5 (83.9)	7.1 (77.7)	5.6 (73.7)
MCV dose 2 <sup>b</sup>	17.7 (26.5)	19.8 (33.6)	22.7 (31.9)	12.0 (24.3)	9.1 (20.3)
Tdap	2.7 (95.0)	2.1 (95.7)	2.6 (96.6)	2.3 (93.4)	2.3 (94.1)
Varicella dose 1 <sup>c</sup>	.4 <sup>d</sup> (93.2)	.8 <sup>d</sup> (94.3)	.4 <sup>d</sup> (90.4)	.2 <sup>d</sup> (88.5)	.1 <sup>d</sup> (90.0)
Varicella dose 2 <sup>c</sup>	2.0 (75.1)	4.5 (75.1)	2.2 (78.0)	1.9 (69.7)	1.2 (66.8)
Varicella (history of disease)	12.3	10.6	10.9	5.9	7.7
Varicella (history of disease or received ≥ two doses)	1.5 (78.0)	4.0 (77.7)	2.7 (80.5)	1.8 (71.5)	1.3 (69.4)

HPV = human papillomavirus vaccine; MCV = meningococcal conjugate vaccine; Tdap = tetanus-diphtheria-acellular pertussis vaccine.

<sup>a</sup> The McNemar pairwise test was used to determine if the percent change was significance. For each vaccine percent changes for baseline versus final rate differences were statistically significant ( $p < .05$ ), except where noted.

<sup>b</sup> Among adolescents eligible for the MCV2 vaccine.

<sup>c</sup> Among adolescents with no history of disease.

<sup>d</sup> Difference not significant.

## Retention

As seen in Figure 1, at the conclusion of the study, 1,205 adolescents from the three intervention groups were not UTD. During the study, 592 participants were removed from receiving reminders for the following reasons: became UTD (442 participants), declined further participation (113 participants), or lost contact (37 participants). A total of 89 of the 552 text participants (16.1%) left the reminder program early by declining further participation and did not become UTD. However, only 58 of the 963 e-mail participants (6.0%) and three of the 282 postcard participants (1.1%) left the reminder program by declining further participation.

## Time to UTD and cost efficiency

Among the adolescents who became UTD, the mean days to reach this status is displayed for each group in Table 4. Of the three different interventions, text message recipients on average required the least time to become UTD. Text messaging participants took an average of 110 days to be brought UTD, followed by e-mail with an average of 133 days and then postcards with an average of 151 days. All the reminder groups took a shorter time to reach UTD status than the control groups with the enrollment phone call–only group taking an average of 175 days to UTD status and the no contact group taking an average of 234 days to UTD status.

The mean costs for each type of reminder were \$4.65 per postcard, \$3.09 per e-mail, and \$3.09 per text message enrollees. The cost for postcard reminders included postage, printing, and processing. E-mail and text messaging incurred the same overhead cost which included purchasing the Voicent software (Voicent Communications), training personnel to use the software, and processing return messages from recipients (unsubscribe requests or UTD status updates). The cost per individual reminder, calculated by total cost divided by total number of reminders sent, was \$1.25 for each postcard sent and \$.80 for each text messages and e-mails sent. The average cost for each text recipient to become UTD was \$9.63 compared to \$14.86 per UTD e-mail

**Table 3**

Odds of becoming up-to-date for all recommended vaccines adjusted for age and gender

	Intervention groups versus enrollment phone call–only group	Intervention versus control groups <sup>a</sup>
	OR <sup>b</sup> (95% CI <sup>c</sup> )	OR <sup>a</sup> (95% CI)
E-mail (N = 963)	1.86 (1.54–2.25)	2.43 (2.07–2.85)
Postcard (N = 282)	2.33 (1.72–3.14)	3.07 (2.32–4.07)
Text messaging (N = 552)	3.34 (2.71–4.12)	4.37 (3.64–5.25)
Enrollment phone call–only (N = 3,253)	1.00 <sup>c</sup>	1.31 (1.173–1.45)
Nonintervention (N = 116,356)	NA	1.00 <sup>d</sup>

CI = confidence interval; NA = not applicable; OR = odds ratio.

<sup>a</sup> Control groups are the enrollment phone call–only and no contact groups.<sup>b</sup> The ORs were calculated using logistic regression adjusted for age and gender.<sup>c</sup> The enrollment phone call–only group as the reference group.<sup>d</sup> The no contact group as the reference group.

recipient and \$20.22 per UTD postcard recipient. These findings show that text messaging is the most cost-efficient of the three reminder methods.

## Discussion

Adolescent vaccine completion is of critical importance to disease prevention; improving vaccination rates is a major public health priority. Immunization registries are becoming more widely used, so finding a way to use these large databases to improve coverage rates is important. Previous studies have shown that reminders are effective in improving compliance with vaccinations [13–16]. We showed that all reminder methods, including the single phone call, proved more effective than not receiving a reminder at all.

The reminders seemed to be particularly effective in improving HPV vaccination rates, as seen in Table 1, which is an often targeted adolescent vaccine with a particularly low coverage rate [4]. When stratified by gender, the HPV coverage rates showed large improvements, especially among the males, with a large gain in both the first dose of HPV and the full HPV three-dose series.

One of the strengths of the study is that the participants were recruited randomly from the registry database. The registry participants in San Diego County consist primarily of patients who receive vaccines in public health clinics and community

**Table 4**Mean days to becoming up-to-date (UTD) for all recommended vaccines by intervention groups<sup>a</sup>

	Average time of days to UTD	Brought UTD	Group total
	Number	%	Number
E-mail	133	20.8	963
Postcard	151	23.0	282
Text	110	32.1	552
Enrollment phone call–only	175	12.4	3,253
Nonintervention	234	9.7	116,356

<sup>a</sup> The start date for nonintervention is the date when the adolescent was identified as lacking one or more recommended vaccine in the registry on September 2012. The start dates for intervention and enrollment phone call–only groups were the dates of the recruiting phone call made.

health centers that primarily serve families of lower socioeconomic status.

By expanding reminders to text and e-mails, households have more options to receive reminders. The ability for the participant to choose between different reminder methods will likely increase compliance. A possible practical strategy for clinics and public health centers would be to send the families a message that their adolescent is not UTD and have an automated system to sign up for reminders on their own.

This study was focused on ascertaining the feasibility and effectiveness of personalized postcards, e-mail, and text message to prompt parents to vaccinate adolescents who are not UTD according to the registry data. The reminder interventions were all more effective than no intervention. Even a single recruitment phone call for families that did not volunteer for other reminders was also more effective than having no intervention. Our findings support the well-documented idea that reminders are effective in achieving UTD status in adolescents. Reminders can be used with relatively limited resources to increase chances of successful achievement of UTD status. Even for clinics and centers without the resources to send postcards, there are many inexpensive alternatives with robocalls and the text and e-mail systems.

This study demonstrated that when selected by the parent, text messaging is the most effective and cost-efficient reminder method. However, we also found that when given the choice, text messaging was the least popular option, with postcards being the most popular reminder type requested. Text messaging has been shown to be an effective reminder method; many studies find it to be popular in many geographic locations and for different age ranges, including senior citizens and those living in rural communities [17–20]. Although texting was the most efficient of the reminder methods studied, it also had the lowest retention rate among the three reminder types.

Although text message reminders appear to be the most effective option, there are also some drawbacks to text messaging. It was the least popular reminder method in our population. Another issue is that not all parents have access to text messaging or have cellular phone contracts without unlimited text messaging plans and would not want to acquire the cost of a text reminder. The overall best choice reminder method depends on the population and resources available. Because of variance in reminder preferences, future studies should examine the possible positive effect of using multiple reminders on the same household to improve adherence rates.

Our research design created several barriers to the intervention. Many parents did not want to complete the initial phone interview when contacted. There were 1,934 refusals (38.3% of all answered phone calls) which occurred before we were able to recruit the participants to receive reminders. However, of those who allowed us to interview and completely update their information during the recruitment phone call, only 1,111 (22% of all answered phone calls) refused to allow reminders, suggesting that a reminder intervention independent of a research project would be well accepted. We also recognize that because parents who chose a reminder option but became UTD were included in the same group with those who also received only a phone call but declined to participate, a bias could have been created in the enrollment phone call–only group between the two types of participants.

A limitation of the study was that the registry only represents a subset of the adolescent population of San Diego and because it is comprised of mostly public health centers and community clinics it may have limited generalizability. The cost estimation

was also limited because it did not include factors such as room rental, after hours cost, etc.

Another obstacle to recruitment was that the institutional review board approved only three recruiting calls per household. This limited opportunities to reach, interview, and enroll parents. To overcome this obstacle, the study interviewers began to leave voice messages. Although leaving voice messages generally did not lead to return calls to schedule an interview, the process did increase receptiveness to a future interview calls. Another barrier was that nearly half (52%) of the households were unreachable using the phone contact information that was provided in the SDIR. To overcome some of the inaccuracies, the use of two way interfaces between electronic health records in clinics and the registry should be examined.

This study adds to the current literature by ascertaining the feasibility and effectiveness of commonly available methods of targeted reminders in improving UTD status among the adolescent population. The study shows that the use of a registry combined with text messaging as an intervention could help public health departments reach people in a way in which they are comfortable and accustomed. The study also demonstrates that any form of reminder system used in conjunction with an immunization registry can be successful in improving the UTD status among adolescents.

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