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Direct Messaging to Parents/Guardians to Improve Adolescent Immunizations

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A B S T R A C T

Purpose: To study the impact on adolescent immunization rates of direct messages to parents/guardians.
Methods: Electronic health record rules identified adolescents needing an immunization. Parents/guardians of adolescents were messaged via a single vendor using automated text, prerecorded voice, and/or postcard.
Results: Parents/guardians of 3,393 patients, ages 11–18 years, with one or more primary care visits in the prior 2 years, identified as needing (average of 2.04 years) a vaccination (meningococcal conjugate, human papillomavirus, or tetanus, diphtheria, and pertussis vaccines) were messaged (mean age, 14 years; 50% male; 38% African-American; 23% white; 19% Hispanic; and 79% public health insurance). A total of 7,094 messages were sent: 3,334 automated voice (47%), 2,631 texts (37%), and 1,129 postcards (16%). After the first message, 865 adolescents (25.5%) received at least one vaccine. Within 24 weeks of messaging 1,324 vaccines (745 human papillomavirus; 403 meningococcal conjugate; and 176 tetanus, diphtheria, and pertussis vaccines) occurred in 959 visits (83.8% physician visits and 16.2% nurse visits). Average visits generated $204 gross reimbursement for $1.77 in messaging expenses per vaccine given. No differences in immunization completion rates occurred by age, gender, race/ethnicity, or insurance type. At 24 weeks, one message was more effective than two or three messages (35.6%, 19.4%, and 24.1% effectiveness, respectively; $p < .0001$). Texts and postcards correlated with more vaccination visits (38.8% and 40.1%, respectively) than phone calls (31.5%; $p = .04$). More vaccines due led to increasing message effectiveness.
Conclusions: Automated texts, voice messages, and postcards had a significant positive effect on vaccination rates in adolescents needing vaccination and required minimal financial expenditure.

IMPLICATIONS AND CONTRIBUTION

As electronic health records and communication technology become more prolific, the opportunities to identify vaccination opportunities and communicate them directly to parents, guardians, and patients increase. Using automated technology (voice calls, texts, and postcards) to directly communicate vaccination opportunities with parents/guardians can help increase adolescent vaccine completion rates by more than 25%.

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Centers for Disease Control and Prevention surveys show that adolescents are significantly underimmunized: of the adolescents, 15% have not received the recommended tetanus, diphtheria, and acellular pertussis (Tdap) vaccine, 26% have not received the meningococcal conjugate vaccine (MCV), 46% of females and 79% of males have not received any doses of human papillomavirus

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(HPV) vaccine, and 67% of females and 93% of males have not completed their HPV vaccine series [1]. Adolescents below the poverty line have immunization rates 1%–10% less than the adolescents at or above the poverty line [1]. In addition, depending on the vaccination, immunization completion rates differ between 1% and 24% on the basis of racial and ethnic differences, with Caucasians (female HPV) or Hispanics (Tdap, MCV, and male HPV) having the highest rates of immunization completion and African-Americans having the lowest rates of immunization completion [1]. Improving overall adolescent vaccination rates and reducing vaccination disparities are goals of the Healthy People 2020 [2].

Results of previous immunization reminder studies in low-income populations were mixed, with most demonstrating the limited impact of mail and telephone reminders [3–18]. A meta-analysis of 41 studies determined that reminder calls, postcards, and letters were modestly effective in increasing vaccination rates in children from 5 to 20 points [15]. However, many studies have highlighted the challenges of such interventions including incorrect addresses, wrong telephone numbers and for some studies, high cost per patient intervention [7,10,11]. Recently, cell phones have been shown to have a high penetrance in low-income communities and may be more stable than address or landlines [19]. In a recent survey of 190 parents at an academic medical center in the Midwest, 92% of the low-income families had cell phones, 96% of those were able to receive texts, and 87% would prefer an immunization reminder one week before the vaccine was due [20]. Focus groups with parents found them to be more receptive to text messages than phone calls or mail reminders [21]. In another national survey of parents, more than half were willing to register their cell phone number with their child's health care provider to receive immunization reminders [22]. Hence, text messaging may prove to be a more effective reminder method than traditional mail and/or telephone reminders.

Previous studies have looked at immunization reminders in the pediatric population, such as influenza vaccine and other adolescent vaccines [11,12]. However, the comparative effect of multiple modes of immunization reminders, including texting, on all three routine adolescent vaccinations (HPV, MCV, and Tdap) has not been well studied. In addition, prior reminder studies have not compared the efficacy and cost-effectiveness of different messaging modes and messaging frequencies in adolescent population. In this study, the authors aim to evaluate the effectiveness of different messaging types on the completion of needed vaccines in a socioeconomically, racially, and ethnically diverse adolescent population.

Methods

Subjects

This study was conducted in a large academic, tertiary, public health care system located in Northeast Ohio. Inclusion criteria were as follows: (1) age between 11.0 and 18.0 years; (2) at least one ambulatory primary care encounter (in either an adolescent or general pediatric clinic) within the last 2 years; and (3) needing at least one of the following vaccines: HPV, MCV, or Tdap.

Materials

To determine if a patient needed an immunization, a suite of rules was configured in our Epic (Epic Systems Corporation, Verona, WI) electronic health record (EHR). The rules were on the basis of the Advisory Council on Immunization Practices immunization guidelines [23], took into account immunization data available in the EHR, and identified all adolescents due for HPV, MCV, and/or Tdap. This information was used in two ways: (1) to alert pediatric providers that the patient needed one or more recommended immunizations as part of a face-to-face patient encounter and (2) to provide data for direct parent/guardian messaging.

Procedure

A list of eligible adolescents was extracted from the EHR and downloaded every 2 months via secure file transfer protocol to our telecommunications vendor (TeleVox Software Inc., Mobile, AL). The extracted data included the first and the last name, address, all phone numbers available, e-mail address, medical record number, and year of birth.

Messaging via any of the several modalities was directed to the parent/guardian of the adolescent patient on the basis of contact information available within the EHR. A stepwise messaging cascade was defined to minimize cost. If an e-mail address was available, an e-mail was sent. If no e-mail address was available, phone numbers were examined by the telecommunications vendor to determine if they could receive text messages. If any of the available phone numbers for a patient were capable of receiving a text message, a text message was sent. If none of the available phone numbers could receive a text message, an automated recorded voice message was delivered. If no working phone numbers were available, a postcard was sent. All messaging scripts (Figure 1) were developed by the study team and transmitted or printed and sent to the parent/guardian by the telecommunications vendor. One coinvestigator (M.S.), an adolescent provider, recorded the voice message for use by the vendor.

Before the study, our health care system's annual notice of privacy practices and consent for treatment forms were updated to inform patients/parents/guardians that multiple modes of messaging, including text messaging, may be used to communicate health related information. Except in emergency situations, these forms are required by our health care system to be reviewed/signed by patients/parents/guardians before receiving medical services. Because of the Federal Communications Commission regulations, text messages were only sent to parents/guardians of patients with whom we had an ongoing relationship. An ongoing relationship was defined as having had a visit anywhere in our health care system within the prior 18 months. Before texting any immunization message, each textable phone was sent a one-time text inviting the recipient to opt out of receiving further text messages from our health care system. If a parent/guardian opted out of texting, they were messaged via recorded voice message or postcard. This opt-out approach minimized costs for those parents/guardians whose mobile phone plans charge by-the-message fees for text messages.

The messaging scripts instructed parents/guardians to call a scheduling line for appointments and questions. When the patient called, the nurse followed a defined protocol to handle the call. The nurse reviewed the patients' EHR, and depending on the length of time since the child had been seen for a well-child visit and other issues the parent/guardian wanted to be addressed at the visit, scheduled the patient for one of the following: (1) a well-child visit; (2) a nurse immunization visit; or (3) a non–well-child visit (i.e., "sick" visit). To avoid exceeding the capacities of telephone system and clinics, messaging was limited to not more than

MetroHealth: Records show your teen born in YYYY may be late for a recommended vaccine shot. Please call 216-xxx-xxxx to schedule. Txt STOP to stop txt msgs.

Figure 1. Examples of direct messaging used: Text message (*top*) and dual English/Spanish postcard (*bottom*).

500 messages per week. If the adolescent's immunization was not completed, parents/guardians were sent repeat immunization messages every 2 months for up to six messages during the duration of the study.

After each messaging date, the telecommunications vendor generated files indicating which messaging mode was used for each patient. These files were securely transferred to the research team via secure file transfer protocol. Additional data from the EHR including demographics, immunization status, and medical visits were obtained monthly for aggregation. All data were analyzed using logistic regression and analysis of variance (JMP 10.0; SAS Institute Inc., Cary, NC) with significance set at $p < .05$. Regression analysis was used to investigate variables associated with vaccine completion after messaging. Variables analyzed included age (at the time of the first message), gender, race, ethnicity, current insurance of adolescent, number of messages

Table 1
Study population characteristics

Characteristic (n = 3,393)	Mean (range) or % (n)
Age, years	14.4 (11.0–18.0)
Male	50 (1,691)
Race/ethnicity	
Black	38.4 (1,303)
White	23.1 (783)
Hispanic	18.5 (628)
Other	3.6 (122)
Unavailable	16.4 (557)
Insurance	
Public	78.7 (2,625)
Other[a]	21.3 (768)
Vaccination overdue	
HPV	85.4 (2,897)
MCV4	47.8 (1,623)
Tdap	31.6 (1,073)

HPV = human papillomavirus; MCV = meningococcal conjugate vaccine; Tdap = tetanus, diphtheria, and acellular pertussis

[a] 20% private insurance; <1% uninsured, or other nonpublic/nonprivate insurance.

sent, message mode (text message, recorded voice message, or postcard), and number of vaccines needed. These variables were chosen before any data analysis on the basis of a priori hypotheses for factors that may impact messaging effectiveness. This study was approved by the MetroHealth System Institutional Review Board.

Results

Using our suite of immunization rules in the EHR, 3,393 eligible patients were identified as needing at least one adolescent vaccine. Demographic characteristics of the patients are presented in Table 1. Patients had been in need of their vaccinations for a mean time of 2.04 years (HPV, 1.84 years; MCV, 1.53 years; and Tdap, 3.25 years). Their average age at the time of the first contact was 14.4 years (standard deviation, 2.1 years).

We sent parents/guardians of the eligible adolescents a total of 7,094 immunization messages, including 3,334 recorded voice messages (47% of messages), 2,631 text messages (37%), and 1,129 postcards (16%). We had 10 e-mail addresses on file for parents/guardians of adolescents needing immunizations and sent 12 e-mail messages. Because of the low frequency, e-mail messages were excluded from the analysis. Only 145 (4%) parents/guardians opted out of text messaging. Just less than one-third (924) of the parents/guardians responded to a single immunization message. Every 2 months, we obtained a current list of patients needing at least one immunization. If a patient continued to remain due, a repeat message was sent as follows: 1,231 parents/guardians (36%) received two immunization messages and an additional 1,238 parents/guardians (36%) received a third immunization message.

Within 24 weeks of the first contact, a total of 1,324 vaccines (745 HPV, 403 MCV, and 176 Tdap) were given to study patients in 959 visits. Of the visits, 83.8% were with a physician and 16.2% were with a nurse. Overall, 25.5% of the adolescents whose parents/guardians were messaged received at least one needed vaccine. Among patients needing a vaccine, 22.9% received an HPV vaccine, 24.7% received an MCV vaccine, and 24.3% received a Tdap vaccine. Patients needing the third dose of HPV vaccine were significantly more likely to get vaccinated (31.0%) than patients needing the first (16.9%) or second doses (26.3%) in the series ($p < .0001$). There was no significant difference in vaccination rates by dose among patients needing the MCV vaccine (first dose, 25.6%; second dose, 24.0%; $p = .46$). Among patients needing Tdap, messaging was 24.2% effective.

There were significant differences in outcome depending on the number of times the parent/guardian was messaged, the modality used, and the number of immunizations due. Patients whose parents/guardians received a single immunization message were significantly more likely to get vaccinated (35.6%) than those whose parents received two (19.4%) or three messages (24.1%; $p < .0001$) (Table 2).

Among patients whose parents/guardians received a single immunization message, those who received text messages and postcards were more likely to get vaccinated (38.8% and 40.1%, respectively) than those receiving phone calls (31.5%; $p = .04$). Messaging beyond the first message was less effective with odds ratios of .42 and .52 for the second and third messages, respectively (i.e., a third message to the same parent/guardian is more effective than the second but less effective than the first). Patients who were due for more than one immunization were approximately 1.3 (1.06–1.60) times more likely to receive the vaccination. In our regression analysis (Table 2), adjusted odds ratios for age at the first message, gender, race/ethnicity, and insurance at the first message, were not statistically different.

The cost was <$.10 per automated message for e-mail, text, and phone messages; the cost per postcard was approximately $1.50. The overall messaging cost per dose given (including patients who did not receive the needed vaccines) was $1.77. Messaging led to 959 face-to-face nurse and physician visits. Most (58%) visits were billed for well-child care (Table 3). Gross (not net) revenue from visits in which a needed immunization was given was $195,882 (average, $204 per visit). Comparing messaging cost against gross revenue, messaging cost was less than 1% of gross revenue.

Table 2
Factors associated with receiving human papillomavirus, meningococcal conjugate, and tetanus, diphtheria, and pertussis vaccines

Variable	Adjusted odds ratio (95% confidence interval)
Age at the first messaging	1.12 (.84–1.48)
Messaged	
one time	Reference
two times	*.42 (.35–.52)*
three times	*.54 (.45–.66)*
Gender	
Male	Reference
Female	.98 (.84–1.15)
Race/ethnicity	
Black	Reference
White	.98 (.79–1.21)
Hispanic	.90 (.72–1.12)
Other	1.21 (.78–1.96)
Unavailable	1.20 (.94–1.52)
Insurance	
Private	Reference
Public	1.12 (.92–1.37)
Number of immunizations due	
1	Reference
2	*1.29 (1.06–1.56)*
3	*1.31 (1.07–1.60)*

Italics indicates statistically significant variable.

Table 3
Visit types and payments from direct messages

Appointment type	Appointment number	Mean professional + technical payments
Evaluation and management of Common Procedural Terminology (CPT) codes	210	$195.57
99203	3	
99204	7	
99213	124	
99214	72	
99215	4	
Well-child CPT codes	556	$234.08
99383	3	
99384	26	
99385	1	
99393	92	
99394	415	
99395	19	
Nurse visit (99201 CPT code)	193	$130.52
Total	959	$204.25

Discussion

For several decades, researchers have been studying direct messaging to parents/guardians and measuring its impact on children's immunization rates and other preventative health metrics [5,7–9,15,17]. To our knowledge, this is the first known study to compare the impact of automated text, phone calls, and postcards sent to parents/guardians with the goal of increasing immunization rates among a socioeconomically, racially, and ethnically diverse group of teenagers who were in need of one or more of the recommended adolescent immunizations (HPV, MCV, and/or Tdap).

Overall, we demonstrated that, after needing at least one immunization for an average of about 2 years, more than 25% of the adolescents received at least one immunization within 6 months of messaging. In our diverse population, our interventions were equally effective across all groups analyzed. Age, gender, insurance status (proxy for socioeconomic status), and race/ethnicity did not impact message efficacy. The number of messages, mode of messaging, and overall number of due immunizations positively impacted message effectiveness. In the HPV series, but not the MCV series, messaging had an increased impact in the patients due for a subsequent dose in the series.

Other studies [4–11,13–17] have demonstrated that immunization reminders lead to 0%–20% improvement in immunization rates. Our 25.5% rate of the overall effectiveness may have been higher due to several factors. First, we were able to send text messages to many parent/guardians, and texting was demonstrated to be a very effective messaging mode in our population. Despite the fact that phone numbers that can receive texts are not specifically sought during the patient registration process and the relatively low socioeconomic status of our families, many of the parents/guardians had a textable phone number in our EHR database. We speculate that the availability of relatively low-cost wireless and text messaging services have been combined to make text messaging a favored modality among our socioeconomically diverse population. Furthermore, we speculate that the retrievability of texts and postcards made them more effective than the less easily retrievable content of recorded voice phone calls.

Second, our study used a multiple messaging strategy whereas other studies sent only a single or at most two messages. We found that parents/guardians were heterogeneous in their responsiveness to messaging. For some, one message alone was effective. However, among parents/guardians who received more than one message, we found that three messages were more effective than two messages. We speculate that some parents who are resistant to a single message may exhibit an activation threshold which makes repeat messaging more effective.

Third, we do not think that language diversity played a major role. In our study, the postcards were bilingual (English/Spanish) but text and recorded phone messages were not. In our cohort study, 19% of the patients identify as Hispanic but only 4.6% of them specified Spanish as their preferred language (93.8% English and 1.6% other). The fact that an overwhelming majority of Hispanic patients identify English as their preferred language helps explain why our regression analysis failed to detect any significant decrease in effectiveness in patients of the Hispanic ethnicity.

Fourth, immunizations were needed (an average of 2 years), and there had been no prior concerted recall effort in this population. These factors may have increased parent/guardian responsiveness to a reminder. Finally, the impact of messaging has been shown to increase over time [10] and our study monitored the adolescents for a full 6 months to completion. Other studies that used a shorter measurement period may have underestimated the effects of the messages.

Our study also supports the findings of other reminder messaging studies that messaging to patients/parents disproportionately positively effects in HPV series completion [18]. The finding that, on average, vaccines were needed for at least 2 years and that messaging is more effective in patients with more vaccinations needed is consistent with Wong's observation that better systems, such as in-clinic reminders or recall reminder systems, need to be developed to decrease missed opportunities for vaccination [24]. Our findings also support the increased interest and ability for patients/parents/guardians to receive messages via cell/textable phone [22]. Finally, these results are consistent with others that show equal effectiveness of these types of reminders across racial and ethnic populations [10,11], but did not show differences across income levels [25].

This study has several limitations. First, the study design was a pre-post evaluation. We did not use methodology utilizing a separate control group or any type of randomization. It is not known what the ongoing rate of immunizations in the group needing immunizations would have been without the direct messaging. However, we suspect that because the average time of needing immunizations was more than 2 years, the background rate of immunization in the study cohort would have been small. Additionally, we note that the effect of messaging in this study is only slightly higher than other studies with different study designs [8,9,12].

A second weakness was that our study design did not allow us to distinguish the separate additive effects of the EHR alerts, or "smart" order sets, above and beyond the impact of the direct messaging. The messaging led to face-to-face visits; the alerts displayed to providers during those visits; and the order sets facilitated the placing of the correct immunization orders during those visits. All three initiatives would be expected to help improve adolescent immunization rates. Further study with control groups and/or a staged rollout of the functionality could help define the individual contributions of each part of the initiative.

A third weakness was that, because of the low numbers of available e-mails, this study was able to evaluate only the effect of automated text messaging, phone calls, and postcards. Further study of additional messaging modalities, such as e-mails and personal health record reminders, may demonstrate that a combination of modes is more effective than a single mode.

Finally, the financial analysis looked only at gross revenue and messaging costs. As such, it did not account for all significant nonmessaging costs of each visit (i.e., staff costs, facility costs, etc.). Nonetheless, the analysis showed that the cost of messaging is less than 1% of the gross revenue collected for a visit. This indicates that relatively inexpensive, direct, automated messaging can drive significant clinical business among adolescents needing immunizations, which can lead to significant revenue generation.

Textable mobile phones are becoming more prolific [19], and parents/guardians are interested in using these technologies to assist in their children's health care [26]. Many providers, however, have been reluctant to engage directly with their patients through texting [27]. Despite the many operational, privacy, security, and technology issues, this study demonstrates that a program of direct, automated messaging is feasible and that those messages are effective in a socioeconomically and diverse population. These efforts lead to improvements in both patient care and revenue [28].

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