Evaluation of Telephoned Computer-Generated Reminders to Improve Immunization Coverage at Inner-City Clinics

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Synopsis

The authors evaluated the effectiveness of computer-generated telephoned reminders used to raise the rates of on-time immunization among preschool-age children in two public clinics in Atlanta, GA. The overall effect of the intervention on immunization levels appeared to be minimal (crude relative risk = 1.07, 95 percent confidence interval = 0.78, 1.46), in part because only about 80 percent of children in both the randomly selected intervention group and in the control group were members of a household with a telephone number listed in clinic records.

However, logistic regression analysis indicated that 36 of 68 children (52.9 percent) in the intervention group whose households were reached were vaccinated within 30 days of their due dates, compared to 31 of 75 children (41.3 percent) in the control group whose household telephone numbers were recorded but not called (adjusted odds ratio = 2.12, 95 percent confidence interval = 1.01, 4.46). This analysis indicates that telephoned reminders demonstrated a level of effectiveness in improving immunization levels at inner-city clinics that recommends further trial and study.

HEALTH OBJECTIVES FOR THE YEAR 2000 establish the goal of completing basic immunization by 2 years of age for at least 90 percent of children (*1*).

The basic immunization series recommended for children younger than 2 years consisted, at the time of our investigation, of four doses of diphtheria-tetanus-pertussis (DTP) vaccine, three doses of oral polio vaccine (OPV), and one dose of measles-mumps-rubella (MMR) vaccine (*2*). However, the most recent nationwide immunization survey available at the time of the investigation, in 1985, indicated that vaccination coverage among this group was only 54 percent for three doses of OPV, 33 percent for four doses of DTP, and 61 percent for one dose of MMR (unpublished data, Centers for Disease Control, National Center for Prevention Services, Division of Immunization, Data Management Branch, 1986).

Recent studies have confirmed that the problem of low vaccination coverage of inner-city preschoolers still exists (*3–5*). More intensive studies are needed of the underlying problems that affect demand for vaccination and the delivery of vaccination services, particularly in view of the resurgence of measles in inner-city areas (*6*). We describe a controlled evaluation of the use of computer-generated telephoned reminders, a new and relatively inexpensive technology, in improving levels of on-time vaccination (defined as vaccinations received within 1 month of due dates), among children attending public clinics in Fulton County, GA, which contains the City of Atlanta.

Patients and Methods

The evaluation was conducted at two public health clinics in southwest Fulton County. The clinics are the principal sources of primary health care for members of poor, minority populations. We reviewed immunization records of children

younger than 2 years who had previously been vaccinated at either of the clinics and who were listed in the clinic's file of current patients. Children were eligible who were due to receive DTP, OPV, or MMR during the study's 6-week enrollment period in February and March 1990. Each child was assigned at random to either the intervention group that received the telephoned reminder, or to the control group that received no reminder of any kind. Information was abstracted from patients' charts on date of birth, sex, race, ethnicity, date and type of previous immunization, telephone number, and other services received at the health center.

Children in the intervention group, and for whom telephone numbers were available, were called by using a Telecorp System 606 Telecomputer *(A)* that had been programmed by staff members of the Fulton County Health Department. The text of the standard message, which was delivered in a normal human voice, was:

"This is the Fulton County Health Department calling to remind you that your child is due for an immunization or 'shot' this month. Please call the health center for an appointment or bring your child in to the health center any day this week, Monday through Friday, between 8:30 a.m. and 4 p.m. Immunizations are important to protect your child from certain diseases, such as whooping cough, measles, and polio. They are also required for day care or school attendance."

Calls were made during 5 days, beginning the day before the child became due for his or her immunization. A maximum of nine attempts (not counting wrong numbers, nonworking numbers, or misdials) were made to each child's home, until an answer was obtained; at least five of the calls were to be made between 6 and 9 p.m. Calls not answered, responses by an answering machine (for which no reminder message was left), hang-ups within 10 seconds, and busy signals were classified as missed attempts.

Children were followed for a 1-month period beginning on the date that they became due to receive their immunization; children who came for immunization before the due date were excluded from the analysis. At the end of the study, information on immunizations given was abstracted from clinic records.

Results

Of the 229 children who met the eligibility criteria for entry into the study, 6 were lost to followup (that is, clinic records could not be located after their followup period), and 1 was deferred from receiving further vaccinations, pending medical evaluation. Of the remaining 222 children (97 percent), 112 had been assigned at random to the intervention group and 110 had been designated as controls. Average ages of children in the two groups were similar, 9.2 ± 4.8 months for children in the intervention group and 8.7 ± 4.9 months for children in the control group. There were equivalent proportions in the two groups of children who were black or Hispanic and children whose household telephone numbers were recorded in their charts (table 1).

'Of the 68 children in the intervention group whose homes were reached successfully, 36 (52.9 percent) were vaccinated on time, compared to 31 (41.3 percent) of the 75 children in the control group with recorded telephone numbers for whom no reminder was given.'

Compared to children in the intervention group, children in the control group were slightly younger, were more likely to be female, were more likely to attend clinic A (the larger of the two study sites), were more likely to be due for DTP and OPV-1,2 or DTP-3, and were less likely to participate in other services offered by the two clinics. None of these differences was statistically significant. Children in the control group (14 of 110, or 12.7 percent) were slightly more likely than children in the intervention group (11 of 112, or 9.8 percent) to have returned for vaccination before their due date ($P > 0.05$). Those 25 children were excluded from further analysis.

The homes of 68 (67.3 percent) of the 101 remaining children in the intervention group were reached by telephone. Of the 33 children whose households were not reached, no telephone number had been recorded in clinic records for almost two-thirds of those households (21 children, or 63.6 percent). No systematic attempt was made to locate children for whom the telephone had been disconnected or for whom the telephone number recorded in clinic records was incorrect. Of the 68 children whose homes were reached, 51 (75.0 percent) were reached on the first attempt; an additional 12 (17.7

Table 1. Demographic characteristics of study groups in evaluation of computer-generated telephoned reminders of vaccination due dates, Fulton County, GA, 1990

Characteristic	Intervention group (N = 112)		Control group (N = 110)	
	Number	Percent	Number	Percent
Mean age in months (± standard deviation)	9.2 ± 4.8	...	8.7 ± 4.9	...
Female	58	52.3	49	45.0
Black	100	90.9	93	90.3
Hispanic	3	2.8	3	2.8
Attending clinic A	68	60.7	73	66.4
Receiving other services:				
Well-child care	70	93.3	59	83.1
WIC	54	70.1	43	58.9
EPSDT	45	61.6	39	54.9
Due for DTP and OPV–1,2 or DTP–3	88	78.6	92	83.6
With recorded telephone number	90	80.4	87	79.1

NOTE: Sample sizes for demographic strata vary because of missing data. No difference was statistically significant ($P < 0.05$). WIC = Special Supplemental Food Program for Women, Infants, and Children. EPSDT = Early and Periodic Screening, Diagnosis, and Treatment Program.

Table 2. Frequency of on-time immunizations in evaluation of computer-generated telephoned reminders of vaccination due dates, Fulton County, GA, 1990

Cohorts	On time		Relative likelihood	95 percent CI
	Number	Percent		
	Combined groups			
Sex:				
Female	44	45.4	1.06	0.77,1.43
Male	42	42.9	...	...
Race:				
Black	76	44.4	1.14	0.63,2.09
Other	7	38.9	...	...
Ethnicity:				
Hispanic	4	66.7	1.54	0.86,2.79
Non-Hispanic	79	43.2	...	...
Vaccine due:				
DTP and OPV–1,2 or DTP–3	76	48.4	1.75	1.04,3.03
DTP–4 and OPV–3 or MMR	11	27.5	...	...
Clinic attended:				
Clinic A	62	48.8	1.37	0.95,1.90
Clinic B	25	35.7	...	...
	Study groups			
Intervention group	46	45.5	1.07	0.78,1.46
Control group	41	42.7	...	...
Due DTP and OPV–1,2 or DTP–3:				
Intervention group	40	51.3	1.13	0.81,1.56
Control group	36	45.6	...	...
Due DTP–4 and OPV–3 or MMR:				
Intervention group	6	26.1	0.89	0.32,2.43
Control group	5	29.4	...	...

NOTE: Children were considered to have received vaccinations on time if they visited the clinic within 1 month after the vaccinations were due, based on current age-specific recommendations and clinic vaccination policies. Children were excluded from the study who came to the clinic for immunization before their due date. CI = 95 percent confidence interval.

percent) were reached on the second attempt; on average, 1.4 attempts were required per successively completed call; at most, 7 attempts were needed.

Overall, girls were slightly more likely than boys to have been vaccinated on time. Blacks, Hispanics, and children attending clinic A were slightly more likely to have been vaccinated on time than whites, non-Hispanics, and children attending clinic B ($P > 0.05$). Young children due to receive DTP and OPV-1,2 or DTP-3 were much more likely to have been vaccinated on time than were older children who were due to receive DTP-4 and OPV-3 or MMR (table 2). A somewhat higher proportion of children in the intervention group was vaccinated within 1 month after they were due, compared with control group children. Of the 46 children in the intervention group who received their vaccinations on time, 34 (73.9 percent) did so within 1 week after their due date (median interval = 2.5 days), compared with 25 (61.0 percent) of 41 controls (median interval = 4.0 days); none of those differences was statistically significant.

Among children who were due for DTP and OPV-1,2 or DTP-3, those in the intervention group were slightly more likely to have been vaccinated on time than those in the control group, with the opposite association observed for children due for DTP-4 and OPV-3 or MMR (table 2). When sex, race, ethnicity, clinic attended, and type of vaccine due were controlled in a logistic regression model, children in the intervention group were somewhat more likely to have been vaccinated on time (adjusted odds ratio [aOR] = 1.13, 95 percent confidence interval [CI] = 0.61, 2.08).

Of the 68 children in the intervention group whose homes were reached successfully, 36 (52.9 percent) were vaccinated on time, compared to 31 (41.3 percent) of the 75 children in the control group with recorded telephone numbers for whom no reminder was given (crude relative risk = 1.28, 95 percent CI = 0.90, 1.82). When the potentially confounding factors were controlled using logistic regression, the children whose homes were reached appeared to be significantly more likely to have been vaccinated on time (aOR = 2.12, 95 percent CI = 1.01, 4.46).

Discussion

The results are more optimistic than previous reports, which have shown that fewer than one-third of children attending public clinics returned for vaccination within 30 days of their due date (*7–9*). While our results seem to suggest that the

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effect of computer-generated reminders is minimal, the actual impact on people's behaviors may have been underestimated. One-fifth of the children in the intervention group did not have telephone numbers recorded in clinic charts; for others, the recorded number may no longer have been correct (especially among older children for whom a longer period had elapsed since their last clinic visit), thereby introducing a misclassification error and diluting the apparent impact of the intervention. Furthermore, some of the telephoned-reminder recipients may not have been the child's parent, resulting in overestimation of the number of households that were effectively reached. From an operational perspective, that inability to reach a significant proportion of the subject population represents a potentially major impediment to the effectiveness of that type of reminder-recall system.

Nonetheless, if clinic records can be kept up-to-date with current locating information, the chances of influencing parents to get their children vaccinated, thereby improving on-time vaccination rates, will be enhanced for any type of reminder-recall system, including the method evaluated in our study. Indeed, when we limited the analyses to include only children for whom telephone numbers were available and children in the intervention group whose households were successfully called, the results suggested that a single computer-generated telephoned reminder may have been effective in increasing rates of on-time vaccination by approximately twofold.

Although this analysis provided insight into the potential impact of the intervention on people's behavior, part of the apparent effect may have been artifactual. For example, some children in the control group whom we did not attempt to contact could have moved from the study area, thereby lowering the on-time vaccination rate in the control group.

Different types of reminder-recall systems, using letters, postcards, personal phone calls, or home visits, have shown improvements in clinic attendance rates of about 50 percent (*7–10*), not unlike

the rates reported for this study. Furthermore, when coupled with financial and other incentives, some reminder-recall systems have raised immunization rates by almost fivefold (*7*). However, the principal drawback of the methods has been their relatively high cost, particularly for labor.

One of the advantages of a computer-generated reminder system is that it can attempt as many as 100 calls per hour, with minimal staffing requirements. As an illustration, at a clinic at which 160 children each month are due for immunization (similar to those in the present study), the estimated cost per child of introducing that type of reminder system would be about $1.16. If on-time vaccination rates among those children increased even modestly, from 33 percent to 50 percent as a result of the intervention, the cost per additional child vaccinated on time would be $6.83.

The estimates were made assuming that the $4,500 cost of the machine and its maintenance would be amortized during 5 years, that a clerical worker earning $10 per hour would spend 2 hours per week programming the machine, and that telephone charges were $0.15 per call. The per capita costs would be lower if more children were called, if the machine's useful life was extended, or if the increase in on-time vaccination rates was greater. The costs do not reflect savings in direct and indirect costs from prevention of disease.

Additional studies are in progress to evaluate more fully the use of the computer-generated reminder system. One of the major limitations of our pilot study was its small sample size, which limited our ability to discern differences among key subgroups, thereby limiting our ability to draw definitive inferences. Ongoing trials include sufficiently large sample sizes to adequately evaluate those associations. The trials are designed to evaluate the impact of the intervention method in a wider range of settings, such as with other ethnic groups and in rural areas; using vaccine-specific messages; and using different schedules of calls to improve compliance among older children. The usefulness of the method as a basis for recall systems is being examined with children who are past due for immunization, as well as for improving attendance for services other than immunization.

References

1. Public Health Service: Healthy people 2000: national health promotion and disease prevention objectives. DHHS Publication No. (PHS) 91-50212. Office of the Assistant Secretary for Health, Office of Disease Prevention and Health Promotion. U.S. Government Printing Office, Washington, DC, 1990.
2. Immunization Practices Advisory Committee. General recommendations on immunization. MMWR Morb Mortal Wkly Rep 38: 205-214, 219-227, Apr. 7, 1989.
3. Update: measles outbreak—Chicago, 1989. MMWR Morb Mortal Wkly Rep 39: 317-319, 325-326, May 18, 1990.
4. Measles vaccination among related groups of preschool-aged children—United States. MMWR Morb Mortal Wkly Rep 40: 36-39, Jan. 18, 1991.
5. Orenstein, W. A., and Bernier, R. H.: Surveillance: information for action. Pediatr Clin North Am 37: 709-734 (1990).
6. Measles—United States, 1990. MMWR Morb Mortal Wkly Rep 40: 369-372, June 7, 1991.
7. Yokley, J. M., and Glenwick, D. S.: Increasing the immunization of preschool children: an evaluation of applied community interventions. J Appl Behav Anal 17: 313-325 (1984).
8. Young, S. A., et al.: Effectiveness of a mailed reminder on the immunization levels of infants at high risk of failure to complete immunizations. Am J Public Health 70: 422-424 (1980).
9. Moore, B. J., Morris, D. W., Burton, B., and Kilcrease, D. T.: Measuring effectiveness of service aides in infant immunization surveillance program in north central Texas. Am J Public Health 71: 634-636 (1981).
10. Quattlebaum, T. G., Darden, P. M., and Sperry, J. B.: Effectiveness of computer-generated appointment reminders. Pediatrics 88: 801-805 (1991).

Equipment

A. Telecorp Systems, Inc., Norcross, GA.