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Computer Reminders Improve On-Time Immunization Rates

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OBJECTIVES. This study examines the effectiveness of computer-generated telephone reminders in improving infants receiving on-time immunizations. A computer called parents at home, reminded them of their child's visit, and asked if they could keep the appointment. If parents either canceled or failed to honor the appointment, the computer called back a few days later and asked them to reschedule.

METHODS. A medical assistant recruited 124 consecutive mothers to receive automated computer reminders. These mothers' infants were younger than 6 months, were being seen at an outpatient clinic for a first visit, and were patients of three attending physicians and three nurse practitioners. These infants were compared to 89 infants from the same clinic, in the same age range, who were being seen for the first time during the same period by the same providers but not contacted by the medical assistant. Subjects were selected from mothers who brought their infants for their first visit in an outpatient urban clinic that serves predominantly minority clients. A research assistant reviewed patients' medical records and collected the infants' birthday, mothers' age, race, source of payments, and the immunization record of the infants. Immunization was considered to be late if, at the time of the first visit, it was more than 30 days past due for any of the recommended immunizations of the American Academy of Pediatrics, except for Hepatitis B vaccine which was not recommended at the time of the study. The dependent variable was on-time immunization. The independent variables were age of the mother at baseline, age of the child at baseline, and membership in either the comparison or the experimental group. Chi-square tests and logistic regression were used to analyze the data.

RESULTS. The participation rate for appointments for the experimental group was 82%, as compared to a 69% overall participation rate for the clinic providers. The on-time immunization rate for experimental subjects was 67.8%, whereas the comparison group had an on-time immunization rate of 43.4% (differences were significant at alpha levels less than 0.01).

CONCLUSIONS. Computerized reminders sent to the parents led to an increase in participation rate at the clinic and an increase in on-time immunization for their infants.

Key words: computer applications, telecommunication aids, electronic networks, health education, pediatric care, immunization, patient compliance, computer reminders, prevention. (Med Care 1996;34:OS45–OS51)

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The Healthy People 2000 project has established the goal of complete immunization of 90% of 2-year-old children living in the United States.[1] Current data from the National Health Interview Study conducted by the Centers for Disease Control indicate that only 64% of children ages 19 to 35 months have completed a combined series of vaccinations.[2] This figure falls below 50% in many inner cities.[3]

The problem follows national trends in Cleveland. The on-time immunization rate for children in Cleveland is 37% and the rate for affluent suburbs is not much better (Department of Health, State of Ohio, 1994). These data raise the critical question, "Why are children not immunized?"

A recent study showed that parents consider the major reasons for failing to seek immunization to be: (1) cost, (2) lack of insurance coverage, (3) office waits that are too long, (4) immunization not given because of child's cold or fever, (5) lack of time, (6) inconvenient office hours, (7) lack of child care for other children, and (8) a host of less frequently mentioned other reasons.[4] Parents did not mention "forgetting" as a reason for missing immunizations. But in the same study physicians and health department personnel reported that the two main reasons for missing appointments are that parents forget or parents do not know when immunizations are required. This view is also supported by other, albeit older, studies of parents' reasons for failing to keep appointments.[5] In addition, data show that longer intervals between appointments lead to more missed appointments, presumably because the appointment is forgotten.[6] Thus, it seems probable that forgetting an appointment is a key reason why appointments are missed.

The National Vaccine Advisory Committee standards for pediatric immunization practice stress the importance of aggressive reminder and recall programs to keep children in the health-care system.[7] Recent advances in computer technology have prompted the use of automated immunization reminders to increase immunization visit compliance.

Dini et al evaluated the effectiveness of computer reminders in increasing kept appointment rates in a public health setting. They reported that computer reminders improved kept appointments by 19.5%, but they provided no data regarding the impact of these improvements on immunization of infants.[8]

Linkins et al used a computer to remind parents of 4,636 children who were late or due for immunization. Of those contacted by the computer, 36% visited a public health clinic within the next 30 days, as compared to 28% of the 3,366 parents in the comparison group. A simple call-out system was able to increase immunization rates by 8% in populations with access to a telephone.[9]

A comparable study by Stehr-Green et al described the effectiveness of such reminders in households with telephone numbers listed in the clinic directory.[10] These authors found that reminders improved the on-time immunization rate by 11.6% compared with patients not reminded.

In this article, we report the results of a computer reminder system for parents of patients of an inner-city, urban, pediatric clinic. We reminded parents to make appointments for well child visits and to keep appointments for sick visits. The computer called the mother and reminded her of the appointment. If the mother wished to cancel the appointment, or if the mother did not show for a scheduled appointment, the computer called back in a few days and asked her to make a new appointment (see Figure 1 for a flow of activities).

This intervention is different from those previously documented in the literature because (1) the household does not need to have a telephone because messages are delivered to a voice mail box accessible through a toll-free number from any pay

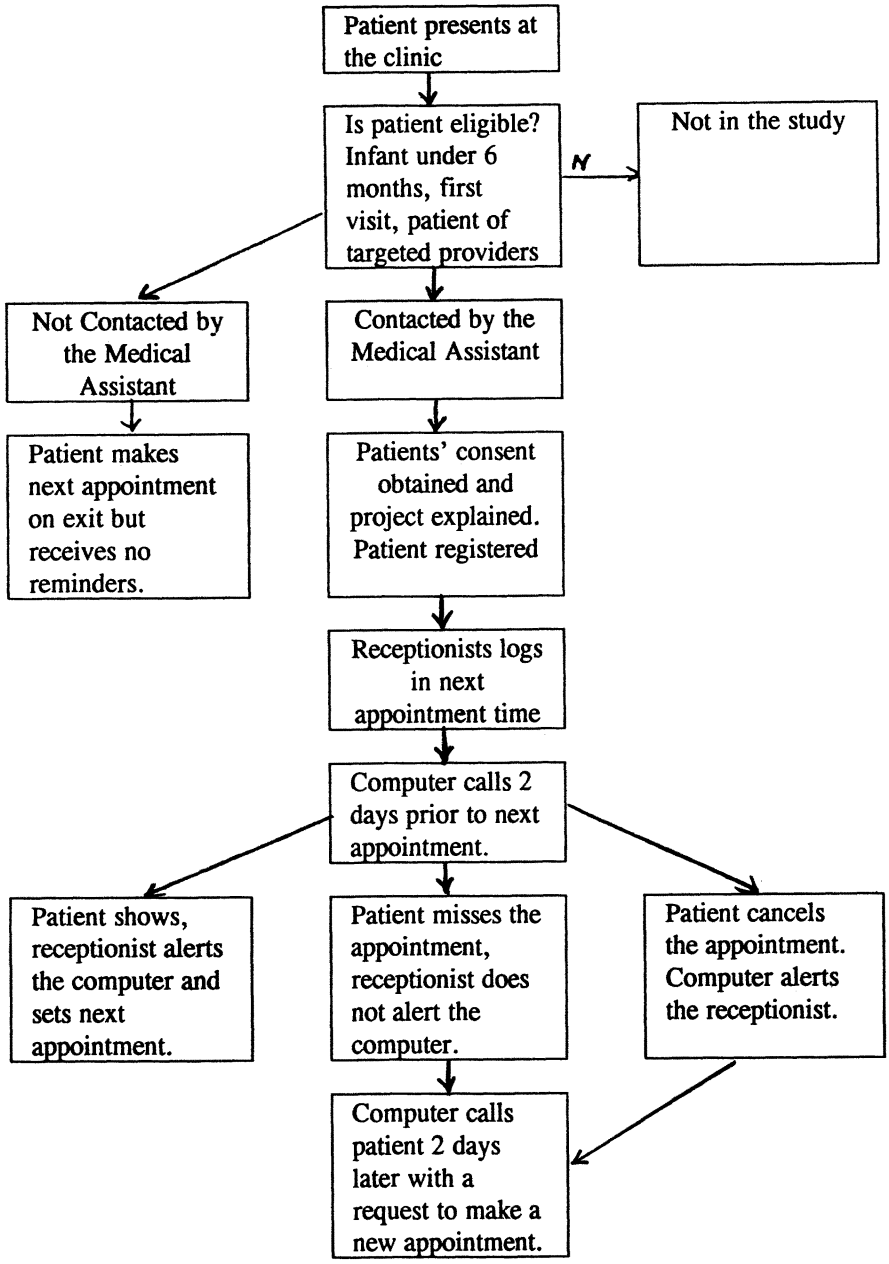

FIG. 1. A process diagram showing function of reminders.

phone, and (2) reminders were sent to parents to schedule as well as keep appointments. In this article, we report the impact of the reminder system on children's immunization rates.

Methods and Data Collection

We asked mothers presenting for their child's first appointment at the outpatient clinic of Rainbow Babies and Children Hos-

pital of Cleveland to participate in the study. This clinic is a hospital-based, urban, pediatric practice that serves predominantly minority clients. Services include well child care, immunization, and illness management. The patient volume is more than 28,000 visits per year.

The project began enrolling children in April of 1993. The study ended in September of 1994. Subjects were not assigned randomly to comparison and experimental groups because of clinic management issues and difficulty in training individuals for recruitment of the subjects. Instead, a medical assistant at the clinic was trained to recruit the parents for the experimental group and parents not contacted by this assistant were part of the comparison group. To improve the comparability of the experimental and comparison groups, we set the following eligibility requirements for both the comparison and the experimental groups:

1. Infants should be younger than 6 months. Because immunization is age-dependent, enrolling infants of different ages could bias the results because there will be either fewer or more occasions to miss well child visits.

2. Infants for whom this is the first visit to the clinic should be enrolled. Infants who already have had a second or third visit were not enrolled because they are more likely to show for future well child visits.

3. Infants should be patients of one of the participating three attending physicians and three nurse practitioners. Patients' participation rates may be affected by the treatment and care they receive from their providers.

Among the people contacted by the medical assistant, 98% agreed to participate and signed a consent form allowing the computer to call them and remind them of their next visit. People who refused to participate were also excluded from the comparison group. This method of recruitment led to 124 infants in the experimental and 89 in the comparison group that met the three eligibility requirements.

Comparison and experimental group patients who received regular care elsewhere, had moved out of the area, or whose immunization data were requested by another clinic, were excluded from the analysis after the completion of data collection. A total of one experimental and four comparison patients were excluded because of these reasons. In addition, data on four medical records (two experimental and two comparison) were not available at the time of review.

A research assistant reviewed medical records and collected patients' birthdays, race, and immunization data; mothers' ages; and source of payments. The age of the oldest infant reviewed in September was 23 months; the youngest infant was 4 months old. Immunizations were considered to be late if the child was more than 30 days past due on any immunization schedule of the American Academy of Pediatrics, except for the Hepatitis B vaccine. At the time of the study, the Academy had not yet recommended this vaccine.

The dependent variable was on-time immunization. On-time immunization was defined as either the parent keeping the initial appointment or the parent making and keeping the follow-up appointment within 30 days of recommended immunization date. The independent variables were age of the mother, age of the infant, and membership in the comparison or the experimental group. Data were analyzed using chi-square tests and logistic regression.

Results

There were no statistically significant differences in race and insurance status of infants between the comparison and experimental groups at alpha levels lower than 0.05 (Tables 1 and 2).

There was a significant difference in age of mothers. The mean age of the mothers in the experimental group was 21.6 years (standard deviation = 5.9 years) whereas the mean age

TABLE 1. Race of Infants in the Study

Race of Infant	Experimental Group No. (%)	Comparison Group No. (%)
Black	106 (87.6)	67 (80.7)
White	5 (4.1)	4 (4.8)
Unknown	10 (8.3)	12 (14.4)
Total	121 (100.0)	83 (100.0)

TABLE 2. Health Insurance Status of Infants in the Study

Insurance Status	Experimental Group No. (%)	Comparison Group No. (%)
Medicaid	94 (77.7)	58 (69.9)
Private/other	5 (4.1)	3 (3.6)
Unknown	22 (18.2)	22 (26.5)
Total	121 (100.0)	77 (100.0)

of the mothers in the comparison group was 24.1 years (standard deviation = 6.0 years).

There were no statistically significant differences in the age of infants between the experimental and comparison groups. The mean age of infants, at the time of chart review, in both the experimental and the comparison groups, was 15.5 months, with standard deviations of 3.1 and 4.0 respectively.

Eighty-two percent of the experimental subjects showed for their visits, whereas the rate for the comparison group was 72%. Table 3 provides the rates of immunization for comparison and experimental groups. The overall on-time immunization rate for the experimental group was 1.56 times higher than that for the comparison group, suggesting that subjects of the experimental group made many more appointments for well child visits and showed for these appointments.

Chi-square tests were performed to compare the immunization status of infants in the experimental group to the status of those in the comparison group. The on-time immunization rate for the experimental group was significantly higher than that for the comparison group (alpha < 0.01).

In addition to the previous analysis, we used logistic regression to control for the age of the mother. The dependent variable was on-time immunization. The independent variables were age of the mother, receiving reminders, and age of the infant. The age of the mother was not significantly related to on-time immunization. The older

TABLE 3. On-time Immunization Rates[a]

On-Time Immunization	Experimental Group No. (%)	Comparison Group No. (%)	Chi-Square *P*
No. of patients	121	83	0
Total series	82 (67.8)	36 (43.4)	12.01 (0.0005)
Diptheria-tetanus-pertussis vaccine	100 (82.6)	48 (57.8)	15.21 (0.0001)
Oral polio vaccine	87 (71.9)	44 (53.0)	7.64 (0.0057)
Measles, mumps, and rubella vaccine	59 (76.6)	33 (55.9)	7.14 (0.0075)
Hemophilus, influenza bacteria vaccine	102 (84.3)	52 (62.7)	12.47 (0.0004)

[a]MMR series was based on 77 patients in the experimental group and 60 in the comparison group who were eligible for MMR shots. Hepatitis B vaccine was not counted toward total series vaccination because it was not required at the time of the study.

the infant, the more likely that their immunization would not be on-time, presumably because there are more occasions in which immunizations may be missed. After controlling for the age of the mother, the differences in on-time immunization between comparison and experimental groups remained statistically significant at alpha levels lower than 0.05 (Table 4).

Discussion

The current study was not a randomized clinical study. The improvement in on-time immunization may be due to subject differences from the onset of the study. We matched subjects in the study by age of the infants, provider of the infants, and first visit of the infant to reduce potential differences. The two groups did not differ in source of insurance and race, but did differ in age of the mother. Age of mother was not related to on-time immunization. Furthermore, we statistically controlled for the age of the mother throughout our analysis. Despite these efforts, it is possible that factors not measured in this study could explain the differential rate of on-time immunization between the experimental and comparison groups. Hence, any generalization from this study should wait until additional studies confirm the findings.

The study found that infants older at time of review were less likely to be on-time than younger infants, presumably because older infants have more occasions for missing their immunizations. There were no statistically significant differences between the comparison and the experimental groups in age of the infants studied. Therefore, this variable cannot explain the observed differences between the two groups.

TABLE 4. Predicting On-Time Immunization[a]

Variable	Coefficient (SE)	*P*
Age of mother	0.05 (0.03)	0.13
Receiving reminders	0.73 (0.35)	0.03
Age of infant	-0.17 (0.05)	0.00
Constant	1.51 (0.97)	0.12

SE, standard deviation.
[a]The dependent variable was on-time immunization for 121 patients in the experimental group and 83 in the comparison group.

Comparing the experience of the experimental group to that of the comparison group suggests that parents, who are reminded by a computer, are more likely to make well child care visits to the clinic. As a consequence of the increased visits, infants' immunizations were more on-time.

The magnitude of improvement in on-time immunization was larger than with other computer interventions when parents were reminded to make a well child visit but were not reminded to keep a scheduled appointment. For example, Linkins et al reported an 8% improvement in immunization rates and Stehr-Green et al[10] reported an improvement of 11.6% in immunization rates. In the present study, computer reminders yielded a 24.4% improvement in on-time immunization rates. This increased magnitude of improvement may be due to the fact that we reminded parents about both making a well child visit and keeping a scheduled appointment.

Reminders to make an appointment are easy to organize because they are delivered a certain number of months after the birth of the child. As long as the computer is aware of the child's birthday, it could schedule the reminder. Reminders to keep an appointment, however, are indexed to an actual appointment day and time, and require someone to enter information about the appointment each time the patient is expected to visit the clinic. Reminders to keep an appointment require more personnel time, but may be more likely to lead to better care for the children. Furthermore, the increased personnel costs required for entering information about a patient's next appointment may be compensated by the positive economic impact of improved patient compliance.

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