Automated Telephone Reminder Messages Can Assist Electronic Diabetes Care

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Summary

Telephone reminder systems have been used to assist in the treatment of many chronic diseases. However, it is unclear if these systems can increase medication and appointment adherence in patients with diabetes without direct patient–provider telephone contact. We tested the feasibility of using an automated telephone reminder system (ATRS) to deliver reminder messages to 253 adults with diabetes enrolled in a randomized controlled trial. Eighty-four percent of the patients were able to register using voice recognition and at least one reminder was delivered to 95% of registered patients over a period of 7.5 months. None of the demographic features studied predicted a patient's ability to enroll or to receive reminder calls. At the end of the study, 63% of patients indicated that they wished to continue to receive ATRS calls. The level of system use as determined by the number of received reminder calls was not associated with a change in the number of physician visits or diabetes-related laboratory tests during follow-up. The clinical benefits and sustainability of ATRS remain unproven, but our results indicate that an automated reminder system can be effective for providing messages to a large group of older patients with diabetes.

Introduction

Effective diabetes management requires encouraging patients to take a proactive role in their own care, consulting their providers (i.e. family physician, specialist, nurse, nutritionist) for advice as needed. This is known as 'shared care'.[1] However, the best way of motivating patients to improve their own care is not known. Research suggests that regular reminders directed at patients are more effective then infrequent educational lectures.[2]

Telephone support systems have been reported to have positive effects on the self-care of diabetes, through improved weight and glucose monitoring, lower serum glucose levels and more patients with normal HbA1c levels.[3,4] However, systematic reviews of telephone-based health interventions have concluded that the evidence for the effectiveness of telephone support in improving diabetes management as reflected by HbA1c levels is not strong.[5] In addition, the literature is confounded by the inclusion of nurse follow-up calls in otherwise automated interventions.[3,4,6] It is uncertain whether the benefits were the result of the automated system or if the contact with the nurse was responsible for improved self-care.

A literature search of Medline and EMBASE, to May 2006, revealed no studies focused on automated telephone systems employing voice recognition technology to improve diabetes self-care. We have conducted a study of an automated telephone reminder system (ATRS) to assess its value in a diabetes research trial.

Methods

Patient Enrolment

COMPETE II was a randomized controlled trial of the use of a complex intervention including a web-based and paper-based individualized diabetes tracker shared by patients and physicians,

designed to improve the processes and outcomes of diabetes care. The trial was approved by the appropriate ethics committee. Participants were enrolled from the practices of 47 physicians from central, northern and eastern Ontario, Canada. All practices used one of six electronic medical record products.

Patients with a diagnosis of diabetes who were over 18 years old, cognitively intact, fluent in English and had access to a telephone were deemed eligible to participate in the COMPETE II study and, after completing informed consent, were randomized with concealed allocation to intervention or control groups. Control patients continued to receive their usual medical care.

ATRS

Part of the intervention included the ATRS, which was designed to keep the patient apprised of forthcoming physician appointments, laboratory tests and pharmacy renewals/refills. The automated telephone reminder system, developed in collaboration with Tagge Medical Solutions Inc., used speech recognition software (Nuance, Burlington, Massachusetts, USA). The software employed built-in grammar (collections of words, phrases and/or sentences the system expects the patient to say) to communicate with individuals. The grammar was continually updated by a trained linguist.

At baseline, contact information and the expected schedule of visits, laboratory tests, and pharmacy renewals and refills of intervention patients were uploaded to the ATRS. Registration telephone calls were initiated by the telephony server starting at 09:00. If contact was not made, follow-up attempts were scheduled at four-hour intervals, continuing until 21:00, then beginning again at 10:00 the following day and continuing every four hours, until contact was made. Once contact was made, a pre-recorded female voice speaking at a rate of 190 words per minute identified itself as the COMPETE II study and attempted to imprint the patient's voice by asking them to repeat their 10-digit telephone number (registration). The imprinted patient voice was saved to a Speech Recognition Server. The patient was asked at what time of day they would like to receive reminder calls and this information was saved. Participating physicians also registered their voices so that their personalized voice was part of each reminder received by their patients.

Once registered, patients began receiving monthly automated calls that reminded them to schedule physician appointments, complete their laboratory tests prior to attending medical appointments, and to renew and refill medication prescriptions as required. Each reminder message identified itself as calling from the COMPETE II diabetes study and attempted to confirm the patient's identity by asking them to repeat their 10-digit telephone number. If a match was made with the patient's previous recording, then they received the message body sent on behalf of the study and their physician (the patient's physician's voice was part of the message). If the ATRS was unable to confirm a patient's identity or there was no contact with the patient on the first attempt, the system attempted to contact the patient in four-hour cycles as for registration. If the individual's telephone was busy at the time of the call, the ATRS was programmed to call back 30 minutes later. Reminder messages were delivered monthly.

The outcome, time and date of each call was saved to the database server, which was monitored regularly for problems (for example, calls sent inappropriately at early hours in the morning), with patients identified by ID numbers only. Although the ATRS operated automatically, an operator was called if patients exceeded the maximum number of retries while interacting with the system.

Outcomes

Patient outcomes were collected at baseline and 6 months later via Computer Assisted Telephone Interviewing (CATI) and by chart review, including an ATRS evaluation

questionnaire, demographics and health resource utilization. Physicians completed a written version of an ATRS evaluation questionnaire.

Statistical Analysis

Factors identified as potential predictors of response – age, gender, living arrangements, education, duration of computer use, and frequency of computer and Internet use – were analysed using independent t-tests (for interval/ratio variables) or chi-squared tests (for nominal variables) to determine differences between the enrolled/not enrolled population.

The influence of any of the above seven factors on the number of received reminders, as well as the influence of the number of reminders on the number of completed physician visits and laboratory tests, was analysed using Poisson regression. The influence of the number of reminders on the patient rating of acceptability was assessed using binary logistic regression. Poisson regression analysis was conducted using SAS version 9.1 for Windows. All other analyses were conducted using SPSS version 14.

Results

Registration

Of the 253 patients randomized to the intervention, three patients (1%) withdrew and 21 (8%) did not have their contact information sent to the ATRS for logistical reasons. The remaining 229 (91%) patients had their contact information transferred to the reminder system for voice registration (Figure 1). A total of 193 patients (84%) were successfully registered over a period of nine weeks to receive reminders. In order to register all 193 patients, the ATRS initiated 1408 calls during the nine week period. The ATRS sent a mean of 4.2 calls (IQR 1.5–6.0) to obtain a successful registration. Ten patients required operator assistance to successfully register.

Of the 36 (16%) patients who did not successfully register their voice, 10 (4%) withdrew completely from the study, 10 (4%) did not want to receive reminder calls and withdrew through the ATRS operator, one (0.4%) could not be contacted due to the listing of a wrong number and 15 (7%) were lost due to the ATRS abandoning the registration attempt. The system made a mean of 21.1 registration call attempts (IQR 18.0–26.0) before declaring the 15 patients unreachable. In comparing the 193 successfully registered patients to the 60 who were not registered, no significant differences were found in age, gender, living arrangement, educational background, computer use or Internet use (Table 1). Although 1225 (87%) of the enrolment calls were unsuccessful, the majority of unsuccessful calls (65%) were because the patient was unreachable (e.g. busy signal, no answer) or were made at an inconvenient time (i.e. the patient requested ATRS to call back later).

Reminders

Since the study aimed to assess the feasibility of an automated system, reminders needed to be received without the help of a human operator for them to be considered successful. At the completion of the study, 184 of 193 intervention patients had received at least one successful ATRS reminder. This number represents 95% of those successfully registered, or 80% (184/253) of the original ATRS cohort. The mean number of successful reminders received by registered intervention patients was 4.3 (SD 2.0, with 81% (156/193) of registered patients receiving at least three successful reminders and 50% (97/193) receiving at least five (Figure 2). Poisson regression analysis revealed that no demographic factor was correlated with the number of reminders received.

A mean of 2.6 attempts (IQR 1.0–3.0) was required to successfully remind a patient and a mean of 8.2 (IQR 4.0–10.0) calls was made before abandoning an unsuccessful reminder attempt. The ATRS initiated a total of 3844 reminder calls, with 820 (21%) of them resulting in a

successful reminder. The success rate of ATRS reminders per quarter was relatively consistent (29% to the end of May, 17% to the end of August and 21% to the end of December).

Figure 1 Flowchart of ATRS use in patients randomized to receive intervention

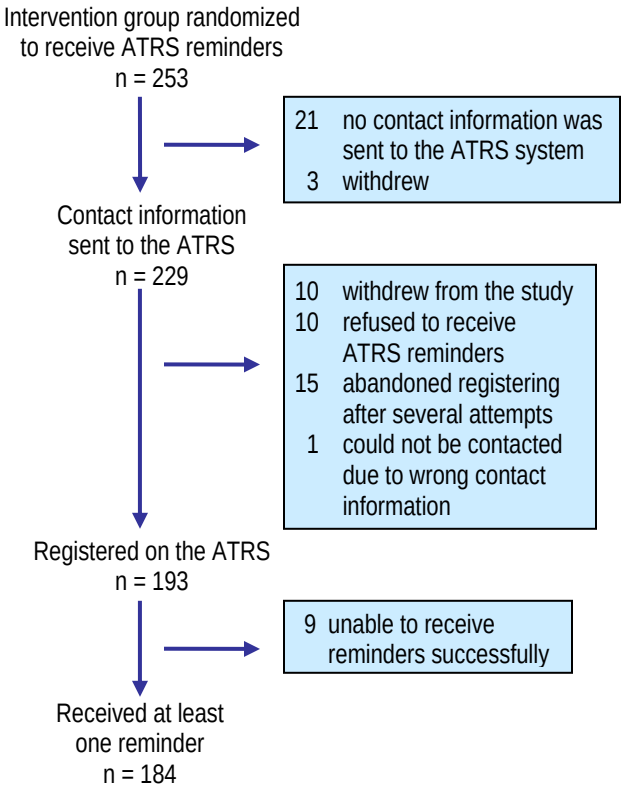


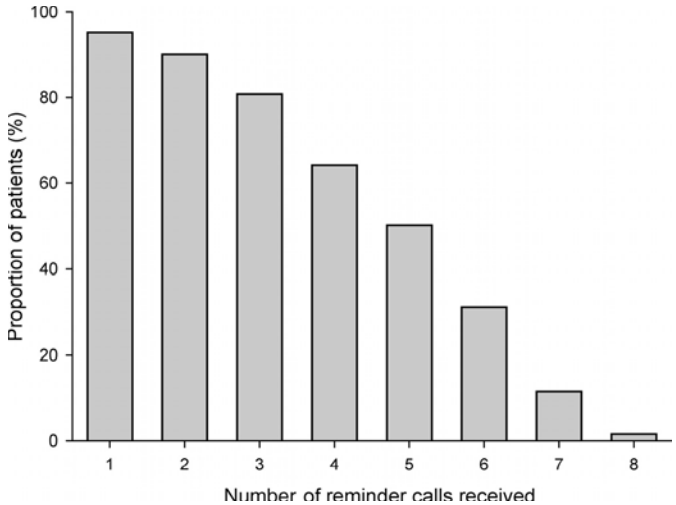
Table 1 Baseline characteristics of the subjects

	Enrolled	Not enrolled	P value*
Subjects (n)	191	57	
Mean age at enrollment (years) (SD)	60 (12)	62 (16)	0.295
Male: n (%)	91 (48)	30 (53)	0.509
Living arrangements: n (%)			0.75
Alone	36 (19)	9 (16)	
Family	110 (58)	37 (65)	
Extended family	1 (0.5)	1 (2)	
Friends	2 (1.0)	0	
Significant other	41 (22)	10 (18)	
Refused	1 (0.5)	0	
Education: n (%)			0.38
Some/completed elementary school	16 (8)	7 (12)	
Some/completed high school	85 (45)	27 (47)	
College/university education	76 (40)	22 (39)	
Professional/graduate degree	14 (7)	1 (2)	
Frequency of computer use: n (%)			0.113
At least once a day	83 (44)	18 (32)	
Several times a week	25 (13)	5 (9)	
Once a month or less	7 (4)	1 (1.8)	
Never	76 (40)	33 (58)	
First started using computers†: n (%)			0.398
In the past year	11 (10)	4 (17)	
In the past two years	5 (4)	2 (8)	
More than two years ago	99 (86)	18 (75)	
Frequency of Internet use†: n (%)			0.685
At least once a day	59 (51)	13 (54)	
Several times a week	29 (25)	5 (218)	
Once a month or less	11 (10)	1 (4)	
Never	16 (14)	5 (21)	

*'Age at enrollment' was analysed using an independent samples t-test (not assuming equal variances). All other significance values were obtained using Pearson's chi-squared test

†Patients who answered 'Never' under 'frequency of computer use' were not asked this question

Figure 2 Number of successful reminder calls received (n ¼ 193)



Despite the ability of the system to contact patients, the number of reminders received did not affect the number of physician visits or laboratory tests conducted during the one-year period after patient randomization.

Patient Survey Results

A total of 171 patients were available for contact for the ATRS evaluation questionnaire and 144 (82%) completed all questions. Of the 171 intervention patients, 12% claimed to have used an automated telephone reminder system in the past. In general, the mechanics of the system were acceptable to most patients, with 77% of 147 patients reporting that the enrolment process took a reasonable amount of time, 64% of 165 patients claiming to have no problems in understanding or using the ATRS, and 67% of 144 patients claiming that they had no problems in receiving reminder messages. The most common problem concerned the sensitivity of the voice recognition software, resulting in the ATRS having difficulty in recognizing the voices of patients. This was more frequent in patients with accents or those who were ill at the time of the reminder. Confusion was also reported when the family of patients answered an ATRS call, with family members unsure how to respond to the system or acting in a manner that caused the ATRS to call back later. In addition, the ATRS left a series of messages on answering machines, filling an individual's inbox if they were away for extended periods of time.

The survey results were less conclusive regarding the overall perceived benefits of the reminder messages. Of the 144 patients, 51% claimed that the generic messages helped them keep appointments and 61% said that they felt the system was useful. Those who did not find the system helpful with appointment reminders felt that they did not require additional assistance. In the end, 63% of the 144 patients stated that they would continue to use the ATRS, with 33% commenting that they would rather not. Patient reports of system effectiveness and willingness to continue to use system were not related to the number of calls they received.

When the ATRS survey data were compared with actual call records, we found that patients generally were accurate in their estimate of call success. One hundred and fifty-five patients (91% of those surveyed) correctly identified that they were contacted by the ATRS to enroll them and 131 patients (80% of those surveyed) correctly identified whether or not they were enrolled.

Physician Survey Results

Analysis of the 38 returned physician surveys (81% of the 47 sent out) indicated that clinicians were not directly involved in the ATRS and most of their patients had not commented on it. However, 34% of physicians noted an increase in patient attendance for laboratory tests and appointments. Despite no direct contact with the ATRS itself, nearly one-half (47%) were interested in their patients continuing to use the system.

Discussion

The results of the study indicate that an automated telephone system can be effective for enrolling patients, including the elderly, and periodically providing basic health service reminders. In general, patients did not experience problems with the mechanics of the system and approximately 60% of the patients wished to continue to receive the generic reminders. None of the demographic characteristics measured predicted patient attitudes towards the ATRS or the ability to register and receive reminders. This suggests that the ATRS can be used to target a diverse patient group. However, we were unable to identify a relation between system exposure (as measured by the number of successfully received reminders) and the number of physician visits and laboratory tests. Thus it is difficult to determine if the ATRS had any clinical benefits.

Over a period of 7.5 months, the estimated monthly costs for the two telephone lines were $15,000. In addition, technical/personnel support to maintain the system cost another $15,000.

Lastly, if each long distance call cost $0.25/min, and the ATRS system spent approximately 2 minutes/call, then the 5252 calls made over the course of the study cost approximately $2626. This would result in a total cost of $32,626 to operate the ATRS system for 7.5 months, or an average cost of $32.21 for each successful enrolment or reminder.

This study had several limitations. First, while the number of reminders received did not correlate with visits, it is still possible that the system improved adherence compared to the control group and may have helped improve clinical outcomes. To properly assess the clinical benefits of the ATRS, it would have to be evaluated as a separate intervention (with an accompanying control group). Second, the eventual default to a single, generic message sent out every month probably decreased the effectiveness of the ATRS.[7] We had hoped to provide individualized physician appointment and drug medication renewal messages, but were not able to receive this information electronically. Third, the actual content and delivery of the message may have limited any clinical benefit. Literacy, word flow and repetition may all influence information retention.[8,9] Fourth, the reliability of voice recognition technology requires improvement as background noise and upper respiratory illnesses caused confusion. Fifth, accommodation of answering machines and interactions with other household members would improve the usefulness of the ATRS. Nonetheless, we believe that the results of the present study are encouraging and that additional trials of improved automated telephone systems would be valuable.

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