# Improving the Efficiency of Patient Recruitment with an Automated Telephone Screening System in a Client-Server Environment

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An automated telephone screening system was implemented at the Baltimore VA Hospital on a Local Area Network (LAN) to evaluate older adults for the GRECC research program. Using the system for decision support, a registered nurse (RN) placed 117 phone calls to older adults in the Baltimore community over a 3 month period. The modular design of the system allowed tracking of inclusion and exclusion criteria which was shared by clinicians and researchers. The design goal of the telephone screening system was to reduce time and personnel costs and increase the effectiveness of screening for recruitment for a major research project. Effectiveness is defined as avoiding under - or over - screening. Using the telephone system, it is estimated the research team saved over $6,000.00 in unnecessary medical evaluation in a 3 months period. As the system develops, the process by which older adults are assessed for research programs in the Geriatrics Service at the Baltimore VAMC will provide additional cost efficiencies.

## INTRODUCTION

Evaluating appropriate subjects for research projects is a difficult, costly, and time-consuming task [1]. This process is further compounded when subjects are older because: 1) their medical

histories are more complicated and evaluations are more time-consuming, 2) finding suitable subjects requires the implementation of costly screening procedures, and 3) older people tend to have more difficulties with functional loss, transportation services and other factors which contribute to lower attendance rates for use of medical services and participation in research studies.

Often, preliminary data are collected by telephone [2]. However, without appropriate decision support, these telephone surveys may not be cost-effective. Data obtained during the telephone interview are often not transferable to the medical record. Consequently, if the subject does qualify for a research program and attends a medical/research clinic for further evaluation, the same information must be recollected. This kind of redundant data collection is frustrating not only to subjects, volunteering their time to participate, but also to the investigators.

The GRECC program at the Baltimore VA Medical Center has designed a strategic automated telephone screening system for their program. This system is used to obtain health histories via the telephone and determine the appropriateness of an older person to attend the research clinic. Data have been successfully collected on 117 potential candidates. The program has proven to be a reliable support system to researchers and, has the potential to significantly reduce the cost of clinic evaluation

procedures for the research project. This paper describes the development and results of implementing and using the telephone screening system. The design goal of the telephone screening system was to reduce time and personnel costs and increase the effectiveness of screening for recruitment for a major research project. Effectiveness is defined as avoiding under - or over - screening.

## BACKGROUND

The primary focus of the GRECC research program is to determine the effectiveness of exercise, diet and smoking cessation on older veterans at risk for the development of cardiovascular complications [3]. This presents a unique problem with regards to recruitment. The older veterans must have some risk factors for cardiovascular disease to be an eligible candidate for one or more of the studies. For example, one protocol requires the subjects to have a history of smoking and have a sedentary life style. However, if they have too many risk factors or they are too healthy, they will be excluded from participating in a specific intervention protocol. The goal was to exclude inappropriate candidates over the telephone before they were invited to the medical/research clinic for a complete evaluation by having a registered nurse use an automated decision support system to perform a preliminary evaluation.

In previous evaluation efforts, almost every subject (except those with very obvious exclusion criteria) were examined in the medical/research clinic. These evaluations can take up to 2.5 hours and require expensive clinic resources (both human and laboratory). The cost of the initial evaluation in the VA system is approximately of $163.00, with the cost of the complete two visit evaluation totaling $326.00. Investigation into the "reasonable and customary" charges for equivalent services in the private sector would be approximately $250.00 and $375.00 respectively [4].

The research team was interested in determining whether an automated telephone screening system could be used by a registered nurse (RN) to exclude more candidates likely to be unacceptable for the research protocol and reduce the number of unnecessary and costly clinic evaluations. The telephone screening system was constrained by the fact that 'over screening' could potentially reduce the success of the research program (due to a lack of subjects being evaluated in the clinic) and 'under screening' would prove to be too costly to the research program. Thus, it was very important that 'expert-level' screening information was acquired and used within a flexible programming environment to accommodate the user's requirements. It was also very important that any data collected during question-and-answer sessions with the telephone screening system could be stored in an automated medical record and used to schedule visits to the medical/research clinic [5]. The need to share recruitment information among the study staff is also strongly supported by investigators [6].

## REVIEW OF THE LITERATURE

Eighty-five articles were found in a Medline Search from 1973 through 1993 where telephone programs had been used to acquired information from subjects. Out of 85 articles, only two articles reported the use of an automated decision support system to assist the interviewers [2,5]. None of the reports discussed how data collected during the telephone call could be stored in the subjects' medical record or how the data was used to support scheduling decisions.

## METHODOLOGY

### Analysis
An interactive software systems life cycle was used for this project. Rapid prototyping was extremely helpful because problems with the user interface design and logic were detected early in the design phase. Four prototypes were developed over a six month period and evaluated.

The analysis began by conducting knowledge acquisition sessions with the primary researchers. Classes of patient attributes used to identify and categorize appropriate and inappropriate subjects were obtained and validated. These attributes were then organized into several truth tables. The investigators were asked to identify heuristics within the tables that would identify appropriate and inappropriate subjects in the clinic. Even with intensive knowledge acquisition support, the rules governing the appropriateness of subjects were difficult to identify. Meta rules involving age, weight and veteran status were easy. However, due to the complexity of cardiovascular

risk factors, information on numerous medical conditions, the severity of those conditions, medications, and overall functionality needed to be obtained in order to avoid both over - and under - screening. If the subject's birth date was after 1932, then the subject was not old enough for the project and the telephone interview could be terminated (simple meta rule). If the subject were a diabetic, but the diabetes was well controlled and not requiring insulin, and was a smoker, then the person may still be an appropriate candidate for the clinic (complex screening rule). After several knowledge acquisition sessions, it became clear that a traditional rule-based system using backward chaining procedures might not only be too restrictive, but also might require very large rule sets to cover every possible combination of medical condition.

In conjunction with knowledge acquisition sessions, a traditional analysis was performed to determine how the telephone screening system would be integrated with external entities such as scheduling the subjects to the clinic and storing the results of the interview in an automated medical record. The requirements were such that all scheduling activities needed to be centralized and all data collected from the telephone interview shared with the researchers and clinicians. The data collected from the telephone interview would also be used to organize the subjects' first visit to the clinic so that all the appropriate tests (to further exclude the subject or verify inclusion) could be ordered and scheduled in a systematic fashion.

Most of the overall analysis was complete within the first two months. As each prototype was evaluated, the analysis was updated using the interactive system's model. This became an important element in the success of the program since the research protocols were evolving as the GRECC program was formalized.

**Design and Implementation**
The telephone system currently runs on a 486 file server on a Novell Local Area Network (LAN). The telephone system was written in Foxpro 2.0 (Healthcare Informatics Laboratory, University of Maryland at Baltimore). There are five modules with one module set aside as a controller for the user interface and the logic of the program. The other four modules are divided logically among

the events in the system including: 1) the random telephone list, 2) the beginning questions (to establish the subject's interest), 3) the inclusion criteria and exclusion criteria and, 4) the decision and schedule. This modular design provided easy updates to the logic within each module and allowed messages to be shared about the results stored in each module by both callers and GRECC investigators.

The user interface was organized according to the following five categories: scheduled call backs, information sent, call back (busy), new calls and updated client records. This design supports recording of the outcomes of attempted telephone calls and eliminates duplication of calls. Once data were entered about the status of a call, messages regarding the activity conducted on a subject were sent as updates. For example, if a subjects was listed in the 'call back busy' category and a new call was successfully completed, the subject's name was automatically removed from 'call back busy' and added to 'information sent'.

Tracking subjects according to recruitment resources they were derived helped the GRECC determine where recruitment efforts should be targeted [7]. Some subjects were obtained from random telephone lists and other from community recruitment programs. Both resources are expensive and need to be evaluated for their effectiveness.

In order to reduce interview bias, a script was written so multiple nurses could eventually use the system according to the same interviewing format. Each script allowed the interviewer the option to continue, postpone or cancel the interview.

In order to avoid under - and over - screening errors, the developers proposed an acquisition format requiring two layers of interview data. In the first layer, only those conditions which exclusively eliminated a subject from the clinic were asked. Information on the excluding conditions were summarized in a total of 18 yes or no questions. In the second layer, question about the risk factors of interest to the investigators were posed to the subject. The subjects' Body Mass Index (BMI) was also calculated as the ratio weight/height 2 (kg/m2).

In the initial prototype, the first layer of questions were presented in such a way that if any one question were positive, the telephone call could be

terminated. However, formative evaluations conducted during the implementation process revealed the importance of completing both layers of questions and capturing subsequent data rather than automatically terminating the program. Therefore, the subjects were asked a total of 25 questions prior to the determination of suitability for the research studies. If any of the level one questions were answered as positive (exclusionary criteria) regardless of the answers to level two, then the subject was deemed inappropriate and the participant told of disqualification. If all answers in the level one series were negative and at least one question in the level two series was positive, the subject was deemed appropriate and the opportunity to schedule a clinic visit was offered. In order to access the centralized schedule, the interviewer will eventually be able to window into the automated scheduling program, confirm an appointment, and return to the telephone system to complete the call.

The architecture for the system included a client-server automated medical record (GERI) running on the LAN which will be integrated into the telephone system by rewriting the screening program in SQLWindows 4.0. Once the telephone systems' screening support has been thoroughly evaluated, the system will be integrated with GERI. GERI is written in SQLWindows and is running on SQLBase 5.1.2 (both are GUPTA products).

## EVALUATION

The most recent prototype of the telephone screening system has been successfully used to support an RN conducting telephone interviews.

The average time per phone call was 7 minutes. The average age of potential subjects was 68 years. There were 109 males and 8 females contacted. Out of 117 subjects, 12 were either not interested or unwilling to answer questions. Using the telephone system as a decision support tool, eight unnecessary clinic visits were avoided due to cardiovascular complications, 5 for strokes, 1 for medications, 1 for active seizure disorder, 1 for ETOH abuse, and 3 classified as masters athletes (too fit). A total of 19 (18.5%) subjects were eliminated saving approximately $6,194 in medical/research clinic resources. Of the remaining 86 subjects, only 5 were unwilling to schedule an appointment at this time. A total of

81 subjects were successfully recruited into the GRECC clinic during the time period of February 3 - April 5, 1993.

All 81 of the subjects accepted via the telephone screening system were seen in the medical/research clinic. Following the clinic evaluations an additional 26 subjects were rejected. Of the 26 rejected, 9 were too healthy, 2 had Parkinson's (one undiagnosed the other diagnosed), two took too many medications, two had uncontrolled diabetes, one had a psychiatric disturbance, and 10 had cardiac problems that were undiagnosed. All disqualified patients were referred to their private doctors for further evaluation and treatment.

## DISCUSSION

In a three month period, a total of $6,194.00 was saved because 19 potential subjects were not invited to the first 2 research visits (based on $326.00 VA cost). However, 26 subjects seen in the medical/research clinic were rejected from the research program. A total of $8,462.00 was still spent on subjects who could not be entered into a research protocol. Therefore, it appears as though this prototype of the telephone screening system 'under' screened too many subjects. However, further analysis has demonstrated a discrepancy between subjects' perceived health status (as self-reported) and actual health status (as determined after medical exams). This conundrum cannot be easily reconciled.

Interestingly, the eight potential subjects rejected due to cardiovascular complications did not report complications during the screening interview. These complications were diagnosed by performing an EKG. Those diagnosed with abnormal EKGs were referred for further treatment. The use of the telephone system is projected to help the investigators identify subjects attributes which should be collected via the telephone and those which should be obtained during face-to-face interviews and medical examinations.

To improve the screening support provided by the telephone system, changes to the user interface and the exclusion/inclusion module will be made to reduce under-screening activities. As the program evolves, the cost savings to the research team will hopefully continue to improve without

compromising the availability of subjects.

Over time, is anticipated that the telephone screening system will save the research team a significant amount of money, time and utilization of its resources. In addition, the reports obtained from the system will be used to identify correlations between conditions reported during telephone interviews and medical conditions documented in the patient record.

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