

# An integrated computer-based system to support nicotine dependence treatment in primary care

Anna M. McDaniel, Philip L. Benson, G. H. Roesener, Julie Martindale

[Received 14 June 2004; accepted 3 November 2004]

**The purpose of this study was to develop, implement, and evaluate the feasibility of an integrated computer-based system for tobacco-user identification and smoking cessation intervention for primary care patients in a medically indigent, managed care population. Interactive voice response (IVR) technology was used to screen for tobacco use prior to scheduled primary care visits at two inner-city clinics. The IVR system placed calls to 2,039 patients scheduled for clinic visits, and 1,086 (53%) patients completed the automated tobacco-use question set. Current smokers were identified in 421 (39%) of the calls. Computer-generated reminders for clinicians that incorporated information obtained from the automated calls were placed on all smokers' encounter forms. In a postvisit interview of 120 smokers, 58 participants (48%) reported that they discussed smoking cessation with their provider. Some 71% of participants agreed that use of the IVR system to obtain information was a "good way for patients to give information about their health to doctors." Automated capture of patient-reported data via IVR technology is a potentially useful strategy for tobacco-use screening in primary care.**

## Introduction

The prevalence rate for cigarette smoking is over 35% for individuals with incomes below the poverty level (Centers for Disease Control and Prevention [CDC], 2003). Current trends indicate that smokers below the poverty threshold are significantly less likely to quit smoking than are those at or above this threshold (Flint & Novotny, 1997). The well-documented burdens of smoking are even greater among these low-income Americans.

Physician advice to quit smoking, even as brief as 3 minutes, can increase the odds of quitting by as much 30%–70% (Fiore et al., 2000; Silagy, 2001). It is estimated that 70% of all smokers visit a primary care provider annually (CDC, 1993), yet some studies report that as few as 25% are advised to quit during primary care visits (Doescher & Saver, 2000; Jaen, Crabtree, Zyzanski, Goodwin, & Strange, 1998;

Robinson, Laurent, & Little, 1995; Thorndike, Rigotti, Stafford, & Singer, 1998). Moreover, the odds of receiving advice to quit are significantly lower for uninsured smokers (Doescher & Saver, 2000; Parnes, Main, Holcomb, & Pace, 2002).

Primary care providers play a critical role in health promotion, yet preventive care activities, such as smoking cessation education and counseling, are often overlooked, in part because of the competing demands of the care delivery environment (Jaen et al., 2001). Even when competing demands are low, physicians often fail to address smoking cessation during primary care visits (Jaen et al., 2001). Strategies to increase compliance with recommended preventive care guidelines have been tested, including diverse interventions such as physician education and training, financial incentives, and organizational quality improvement programs (Hulscher, Wensing, van der Weijden, & Grol, 2001). Prompts to physicians to perform specific clinic activities, such as simple chart stickers or more systematic computer-based reminders, have been examined extensively and shown to increase preventive care behavior by 5%–24% (Hulscher et al., 2001). The use of computerized reminders in the primary care setting has been shown to improve provider intervention with outcomes such as immunization rates (Shaw, Samels, Larusso,

---

Anna M. McDaniel, D.N.S., R.N., Indiana University School of Nursing, Indianapolis; Philip L. Benson, M.H.A., Wishard Health Services, Indianapolis, IN; G. H. Roesener, R.Ph., TeleHealth Systems, Greenwood, IN; Julie Martindale, R.N., M.S.N., Indiana University Medical Group—Primary Care, Indianapolis, IN.

Correspondence: Anna M. McDaniel, D.N.S., R.N., Associate Professor, Indiana University School of Nursing, 1111 Middle Drive, NU483, Indianapolis, IN 46202 USA. Tel: +1 (317) 274-8095; Fax: +1 (317) 274-2411; E-mail: [amcdanie@iupui.edu](mailto:amcdanie@iupui.edu)

& Bernstein, 2000), cancer screening (Burack & Gimotty, 1997), cardiovascular risk reduction (Lowensteyn et al., 1998), and completing advance directives (Dexter et al., 1998). A meta-analysis by Shea, DuMouchel, and Bahamonde (1996) found a combined odds ratio of 1.77 (95% *CI*=1.38–2.27) for computerized reminders for preventive care practices.

One of the most promising applications of computer-based reminders is in the treatment of nicotine dependence. Systematic identification and documentation of smoking status has a significant impact on provider intervention for smoking cessation, nearly doubling the intervention rate (Fiore et al., 2000). Although paper-based reminders to trigger screening and intervention (e.g., “vital signs” stickers) have been shown to be useful for increasing smoking cessation advice and counseling in primary care (Ahluwalia, Gibson, Kenney, Wallace, & Resnicow, 1999; Fiore et al., 2000; Robinson et al., 1995), an automated system for identifying and treating tobacco dependence has several distinct advantages. First, once programmed, computer-generated reminders will execute systematically, independent of human assistance or maintenance. Furthermore, by using if-then programming logic that incorporates information on multiple variables present in the electronic medical record database, computer reminders can be generated on the fly and modified according to patient-specific information (McDaniel, 2000). Finally, in an integrated clinical information system, data about delivery of and compliance with reminders can be captured and stored electronically, increasing the ability of such information to be used for tracking outcomes and evaluating quality improvement initiatives.

Computer-generated reminders depend on the availability of reliable and valid data. Patient-derived data are particularly difficult to collect and enter into an electronic medical record system. One potential mechanism to obtain and document patient-derived data is through the use of interactive voice response (IVR) technology. This technology uses a computerized system of automated telephone calls to collect and store patient data. Automated telephone communication has been shown to be acceptable and efficacious for patient education (Krishna, Balas, Boren, & Maglaveras, 2002). IVR technology is a feasible and cost-effective method for patient follow-up and disease management in chronic illness (Cordisco, Benjaminovitz, Hammond, & Mancini, 1999; Friedman et al., 1996; Piette, Weinberger, & McPhee, 2000), psychological assessment (Kobak, Greist, Jefferson, Mundt, & Katzelnick, 1999; Osgood-Hynes et al., 1998), and monitoring drug and alcohol consumption (Searles, Helzer, Rose, & Badger, 2002; Searles, Helzer, & Walter, 2000). Most

IVR applications in health care have been in inbound (patient-initiated) calls, appointment reminders, and treatment compliance. The use of outbound IVR technology to collect survey data is common in business but has been limited in health care (Corkey & Parkinson, 2002). No published studies have systematically evaluated the effect of an IVR system for tobacco-use screening and documentation prior to a primary care visit.

The purpose of the present study was to develop, implement, and evaluate the feasibility of an integrated computer-based system for tobacco-user identification and smoking cessation intervention for primary care patients in a medically indigent, managed care population. The specific objectives of this project were to (a) design an automated tobacco-user identification system that interfaces with the electronic medical record for primary care patients served by a network of hospital-based community health centers, (b) develop computer algorithms to deliver reminders in real time, at the point of care, to primary care providers to offer brief tobacco dependence treatment for all patients who smoke, (c) conduct a pilot test of the integrated system, and (d) evaluate the feasibility and outcomes of these system changes.

## Method

### *Phase 1: System development*

During the first phase of this project, we developed and implemented system changes to support treatment of tobacco dependence. The first step in developing a computerized decision support system for treatment of nicotine dependence was to design a brief tobacco-use assessment tool that could be administered via IVR technology. We conducted a literature search to identify a set of questions to assess patient-derived data elements essential for brief physician intervention for smoking cessation. For example, Prochaska and DiClemente (1983) recommend assessing readiness to quit smoking using brief standardized questions that can be answered in a simple yes or no format (i.e., Are you intending to quit smoking in the next 6 months? Are you intending to quit smoking in the next month?). Candidate questions included items that measure current and past tobacco use (history of  $\geq 100$  lifetime cigarettes), motivation to quit (Prochaska & DeClemente, 1983), and level of tobacco dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). The investigators and key members of physician leadership groups examined the items for reliability, validity, and suitability for use in the patient population served by the health care system. The entire question set is included in Table 1.

**Table 1.** Automated tobacco use screening tool.

“To help your doctor better take care of you, we would like to ask you a few, short questions that you can answer using the numbers on your telephone. Please listen to each question carefully before responding. If the answer to the question is yes, press one. If the answer to the question is no, press zero. If you need to have the question repeated press the ‘star’ key located at the bottom lefthand corner of your telephone keypad. Remember to answer the questions by pressing the keys on your telephone, not by talking.”

1. Do you smoke cigarettes? Press one if yes, zero if no.

If “yes”, go to question #2

If “no”, go to question #8

2. Please indicate how *many* cigarettes you smoke on a typical day using the following answers:

- a. Press one if you smoke a ½ pack or less per day
- b. Press two if you smoke between ½ and 1 pack per day
- c. Press three if you smoke between 1 and 1½ packs per day
- d. Press four if you smoke between 1½ and 2 packs per day
- e. Press five if you smoke more than 2 packs per day

3. How soon after you wake up do you smoke your first cigarette? Use the following answers:

- a. Press one if you smoke your first cigarette within 5 minutes after you wake up
- b. Press two if you smoke your first cigarette in 6–30 minutes after you wake up
- c. Press three if you smoke your first cigarette in 31–60 minutes after you wake up
- d. Press four if you smoke your first cigarette more than an hour after you wake up

In the past 12 months, has your doctor or other health provider advised you to quit smoking? Press one if yes, zero if no.

5. Do you intend to quit smoking in the next 6 months? Press one if yes, zero if no.

If “yes”, go to question #6

If “no”, go to end

6. Are you planning to quit smoking in the next 30 days? Press one if yes, zero if no.

If “yes”, go to question #7

If “no”, go to end

7. Would you like for someone from the Wishard Health Services Stop Smoking Program to call you? Press one if yes, zero if no.

8. Have you ever smoked at least 100 cigarettes in your entire life? Press one if yes, zero if no.

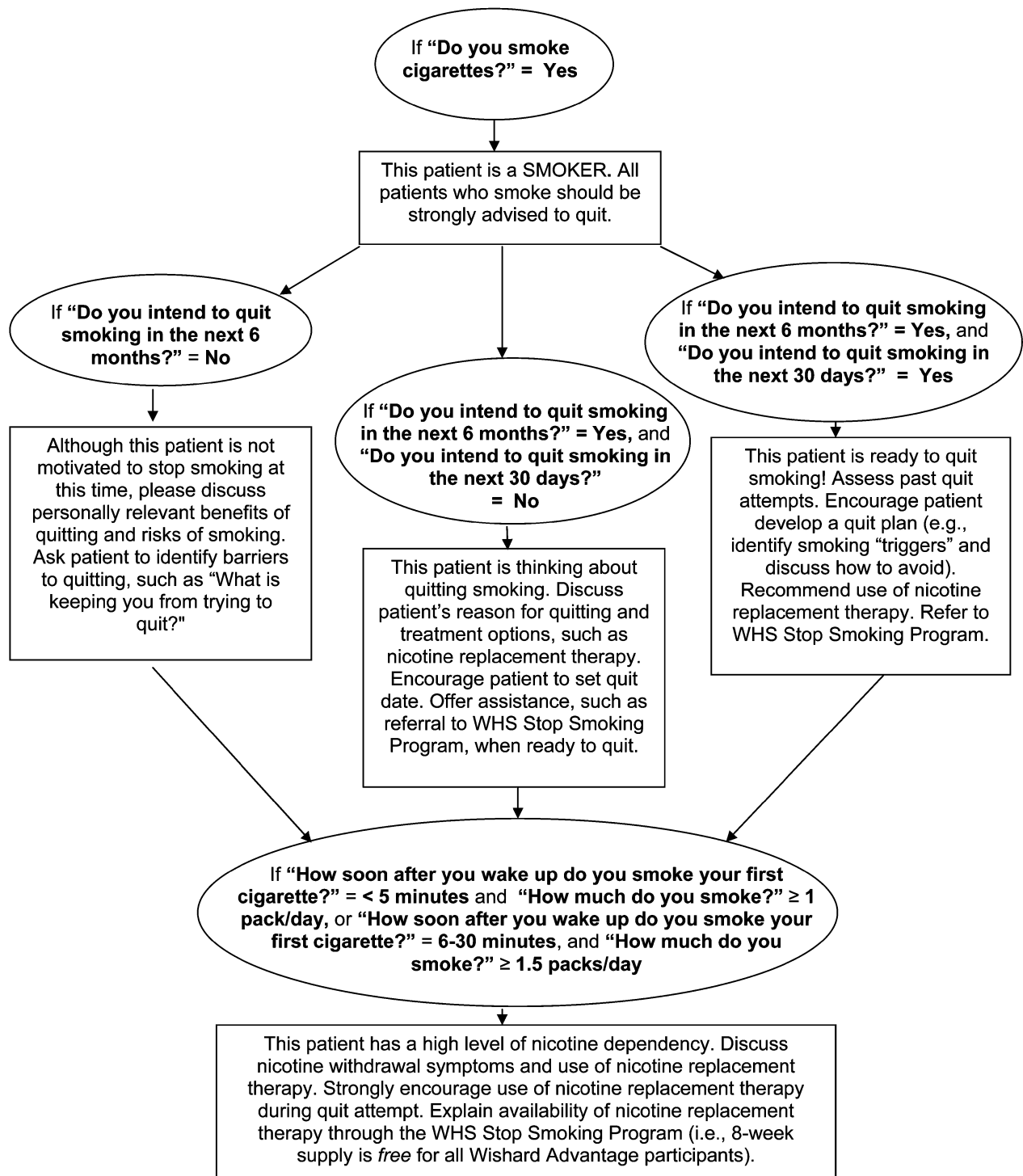
Next, we customized the automated telephone call system used to prospectively collect data on tobacco use for patients scheduled for primary care visits at Wishard Health Services (WHS), in Indianapolis, Indiana. TeleHealth Version 4.0 software was developed by Clinitech International to incorporate user-designed questions to collect data from patients via a telephone keypad. A script including instructions for using the IVR system and the tobacco-use screening questions were recorded in audio files and loaded into the computer program. The system was programmed to place calls at predetermined times and intervals the week prior to the scheduled clinic visit. Participant responses were recorded by the system and saved to a computerized database.

The next task was to create an interface to link tobacco-use data with the electronic medical record. The present study was conducted in affiliation with WHS, home to the Regenstrief Medical Record System (RMRS), one of the oldest and most complete electronic repositories of clinical data in the United States (McDonald et al., 1999). The data system has been used in research to improve health care by optimizing the capture, analysis, content, and delivery of the information needed by patients, their providers, and policy makers, and in interventional studies designed to measure the impact of the system on the efficiency and quality of health care (McDonald, 1999; McDonald & Tierney, 1986; Murray et al., 2003; Tierney & McDonald, 1991; Tierney, Miller, Hui, & McDonald, 1991). Data

captured and stored in the IVR system was transmitted to the project manager for manual entry into the RMRS prior to the patient visit. The RMRS used this data to generate reminders to primary care providers for smoking cessation intervention.

Content of the computerized reminders to primary care providers was based on the U.S. Public Health Service clinical practice guideline (Fiore et al., 2000). The reminders were printed on the primary care visit encounter documentation form, along with corollary information. The reminders incorporated clear, strong quit messages and prompted physicians to offer assistance for all patients who smoked. Content of the corollary information, called tidbits, was tailored to the patient based on data obtained via IVR assessment. Tidbits were printed on a separate sheet of the patient record, located immediately behind the current visit encounter form.

RMRS uses the CARE programming language for performing queries and alerts through the clinical information system (Overhage et al., 1995). CARE “rules” are written as logical statements to include conditions and actions according to specified inclusion or exclusion criteria. Algorithms for the CARE rules and content of the reminders are displayed in Figure 1. Before being implemented in the clinic setting, the CARE rules and reminders were tested and debugged in the prototype system for research and development of the RMRS using simulated patient data.



**Figure 1.** Algorithm and content for physician reminders on patient encounter form.

*Phase 2: Pilot test*

**Setting.** A pilot test of the system changes was conducted at two community health centers that are part of WHS in Indianapolis. WHS is the public-supported health care system affiliated with Indiana University School of Medicine that provides services to predominantly indigent, inner-city residents of Indianapolis. Over 50% of the WHS primary care

clinic patients are eligible for WHS’s health care assistance program known as Wishard Advantage, an innovative managed care program that has provided quality medical care and services to the uninsured since 1997 (Felland & Lesser, 2000).

**Procedures.** The institutional review board of Indiana University Purdue University Indianapolis

approved all study procedures. For a 19-week period, a list of all Wishard Advantage patients over age 18 years who were scheduled for primary care visits at the two clinics was generated from the appointment and registration database of the hospital information system 3 weeks in advance. Next, a letter from the community health center clinic was sent to these patients approximately 12 days prior to the scheduled appointment informing them that they would receive an automated telephone call from WHS. The letter explained the nature and purpose of the telephone call and that participation was voluntary. In compliance with institutional review board requirements, patients were instructed to contact the principal investigator if they did not wish to receive a call. Patients' names and telephone numbers were then uploaded into the IVR system to generate calls the week prior to the scheduled appointments. The system was programmed to call up to five times in 1 day or until a response was received. Incomplete calls were carried over to the next day, and five additional attempts were made at a different time of day. If the intended respondent was not reached after 2 days, the call was considered incomplete and no further attempts to contact the patient were made. Patient-derived smoking data captured by the IVR system were entered manually into the medical record system, which generated reminders to provide treatment for nicotine dependence on the paper-based encounter forms for all clinic visits. Clinic personnel were oriented to the study procedures during a weekly staff meeting. The medical staff was informed about the study, and reminders were included in a letter distributed by the clinic's lead physician and site manager. In addition, all physicians in the WHS system received a pocket-sized reference guide incorporating the clinical practice guideline recommendations (Fiore et al., 2000) and information about the WHS smoking cessation program.

Each week of the pilot study, we created a list of all self-reported smokers and their scheduled clinic visit times, based on the IVR response data. Immediately following the clinic visits, a research assistant approached identified smokers and invited them to participate in a brief follow-up interview. After obtaining informed consent, the research assistant asked participants 11 yes-no questions and 1 open-ended question (see Table 3) about whether their providers discussed smoking and advised them to quit during the clinic visit. Other outcome measures obtained at the postvisit interview included the following: asked to set a quit date, given a follow-up appointment, provided with printed self-help materials, offered/discussed pharmacological treatment for nicotine dependence, and referred to WHS smoking cessation program (Lancaster, Silagy, &

Fowler, 2000). In addition, data on prescriptions for pharmacological therapy for nicotine dependence (i.e., bupropion or nicotine replacement therapy) were extracted from the medical records of participants for 6 weeks postvisit.

## Results

### *Automated tobacco-user identification system*

Feasibility of using IVR technology for obtaining tobacco-use information was evaluated by quantifying the proportion of calls received to calls placed and the proportion of calls answered (i.e., data entered) to calls received. A total of 2,421 unique patient appointments were obtained from the patient registration database. Of those, 121 names and telephone numbers (5%) were removed, either at the patients' request or due to ineligibility for the study (e.g., scheduled for nutritional consult rather than primary care visit). Some 261 calls (11%) were placed to disconnected numbers. After removal of invalid telephone numbers, 2,039 calls were attempted. Of the calls initiated, 1,117 (55%) were answered (i.e., patients responded to the automated tobacco-use question set). Incomplete data were recorded for 31 cases (3%); the final sample consisted of 1,086 (53%) usable responses.

The prevalence of smoking was high in this sample, with 421 patients (39%) reporting current smoking (i.e., answered yes to "Do you smoke cigarettes?"). Of the 665 nonsmokers, 300 (28% of sample) were former smokers (i.e., answered no to "Do you smoke cigarettes?" and yes to "Have you ever smoked at least 100 cigarettes in your entire life?"). Subjects reporting current smoking were asked a series of questions regarding smoking rates, intention to quit, and the like. These results are listed in Table 2. Overall the results indicate the group

**Table 2.** IVR survey results for self-reported smokers ( $N=421$ ).

Variable	<i>n</i>	Percent
Cigarettes per day		
1/2 pack or less	219	53.4
>1/2 to 1 pack	119	29.0
>1 to 1-1/2 pack	47	11.5
>1-1/2 to 2 packs	18	4.4
>2 packs	7	1.7
First morning cigarette		
Within 5 minutes of awakening	156	38.6
6-30 minutes after awakening	138	34.2
31-60 minutes after awakening	66	16.3
More than 1 hour after awakening	44	10.9
Provider advice to quit in past year	299	71.0
Stage of change		
Precontemplation (not planning to quit)	159	37.8
Contemplation (plan to quit within 6 months)	130	30.9
Preparation (plan to quit within 30 days)	130	30.9

**Table 3.** Postvisit follow-up patient interview.

Interview question	<i>n</i>	Percent
During your clinic visit today, did your doctor/primary care provider:		
Talk with you about quitting smoking?	58	48.3 <sup>a</sup>
Advise/tell you to quit smoking?	35	64.8 <sup>b</sup>
Offer to help you quit smoking?	30	55.6 <sup>b</sup>
Ask you to set a quit date?	11	20.4 <sup>b</sup>
Ask you to make a clinic appointment to help you quit smoking?	4	7.4 <sup>b</sup>
Give you a pamphlet or reading material about quitting smoking?	9	16.7 <sup>b</sup>
Discuss medicines to help you quit smoking?	21	38.9 <sup>b</sup>
Refer you to the Stop Smoking Program?	14	26.9 <sup>b</sup>

Note. <sup>a</sup>Percentage based on 120 subjects completing postvisit interview. <sup>b</sup>Percentage based on 54 subjects who responded to question. (Of the 58 who discussed quitting smoking with provider, 4 subjects had missing data.)

consisted of somewhat light smokers; more than 53% reported smoking 10 or fewer cigarettes per day. However, 73% of the smokers reported smoking within the first 30 minutes of awakening, which indicates a relatively high level of nicotine dependence.

#### *Follow-up interview*

Of the 421 smokers identified by the IVR automated assessment, 120 participated in the follow-up clinic interview; 8 patients refused to participate in the interview, 30 deferred participation during that visit due to time constraints, and 16 patients left the clinic before being approached (29% overall recruitment rate). Failure to keep the clinic appointment was common (378 “no shows”). [Note. Because this value reflects repeated attempts to approach patients on subsequent clinic visits, the total is greater than 421.]

The mean age of participants was 49.1 years ( $SD=12.1$ ). The sample was 67% female. Some 59% of participants were White, and 41% were Black. Medical data, extracted from the electronic medical record, were typical of a low-income, smoking population; 83% of the sample ( $n=100$ ) had a diagnosis of hypertension, and 46% ( $n=55$ ) had a diagnosis of reactive airway disease. A total of 73 participants (61%) had two or more comorbid medical conditions.

The primary outcome of the pilot study was patient report of any discussion of quitting smoking with their primary care provider. In the postvisit interview, only 58 participants (48% of identified smokers) reported they discussed smoking cessation with their provider. Some 35 participants reported that the provider had advised them to quit smoking during the current visit, although 71% of the 120 patients interviewed reported they had been advised to quit smoking by a provider in the past 12 months. A total of 21 participants reported that their provider discussed medications to help them quit smoking.

Data on prescriptions for pharmacological therapy for nicotine dependence (i.e., bupropion or nicotine replacement) were extracted from the medical record for 6 weeks postvisit; 9 participants (7.5%) had prescriptions for treatment of nicotine dependence filled during that time period. Wishard Advantage patients receive medications, including nonprescription nicotine replacement therapy, at the health care system pharmacy, when ordered by their primary care provider, at greatly reduced cost (US\$5.00 or less copay). Smokers in the present study would have been unlikely to obtain medications for nicotine dependence from another more costly source. Results of the follow-up clinic interview are presented in Table 3.

In addition to eliciting information about smoking cessation intervention during the visit, the follow-up interview also asked subjects their opinion of the IVR system. The majority of respondents (71%) indicated that using the computerized calling system was a “good way for patients to give information about their health to their doctors”; however, 34 subjects (29%) reported they did not receive a call from the automated system. Comments solicited by open-ended questions converged into three themes: technical problems with the system, such as hang-ups or long pauses ( $n=10$ ); preference for talking with a real person ( $n=12$ ); and efficiency for doctor-patient communication ( $n=5$ ). Other comments voiced included dislike of forced-choice options (e.g., wanted more opportunities to express themselves,  $n=4$ ) and perceived intrusiveness of tobacco-use questions ( $n=1$ ). Several subjects who expressed a strong motivation to quit described the automated system as a “good thing” to help people quit smoking.

#### **Discussion**

The present study indicated that IVR technology is a feasible method for identifying tobacco users prior to scheduled clinical encounters but not without limitations. A majority of patients found the system to be acceptable and efficient for collecting health-risk data, although at least one patient felt the system was intrusive. The completed call rate of 53% also supports feasibility of this method as compared with labor-intensive in-person telephone contact. The few studies that have used outbound IVR applications to collect survey data have reported similar completion rates, ranging from 7% to 49% (Havice, 1989, 1990; Troutman, Murray, & Norlander, 1990). Typically, IVR technology has been used in health care for monitoring progress and patient follow-up (Cordisco et al., 1999; Friedman et al., 1996; Kobak et al., 1999; Osgood-Hynes et al., 1998; Piette et al., 2000; Searles et al., 2000). The present study used the IVR system

prospectively to collect data prior to patient encounters, when the information has the greatest potential to affect care decisions.

One potential benefit of using IVR technology is the relatively high self-report rates for health-risk behaviors such as binge drinking (Bardone, Krahn, Goodman, & Searles, 2000), possibly due to higher perceived confidentiality and lower social desirability in response to nonhuman questioning (Corkey & Parkinson, 2002). This aspect of IVR technology may be particularly valuable when dealing with disadvantaged patients who are sensitive to social pressure and may distrust the health care system (Smedley, Stith, & Nelson, 2003). This conjecture might account, in part, for the high prevalence rate for smoking reported in the present study (39%) compared with national estimates for the population below poverty level (31.4%; CDC, 2003).

The reliability of the IVR system for collecting patient-reported data is a concern. Almost one-third of patients interviewed after visiting their primary care provider reported they did not receive an automated call prior to their appointment. In addition, 20 patients (5% of identified smokers) approached for recruitment for the follow-up interview reported they did not smoke, although six of those had quit smoking only recently. The study was designed so that only patients identified as smokers by the IVR system were contacted for the postvisit interview, which calls into question the reliability of the tobacco-use data. A significant limitation of the IVR system used in the present study was the lack of ability to ascertain the identity of the respondent, as opposed to another member of the household. Methods to verify the identity of telephone respondents, such as requiring users to enter an identification number on the telephone keypad or including the intended call recipient's name in the telephone message via speech-generating software, are available with some IVR systems, although the complexity of using such measures would likely decrease compliance with the system. Current Health Insurance Portability and Accountability Act regulations were not in effect at the time the present study was conducted. Institutional privacy policies may preclude including identifying information in the inbound message.

The effect of the computer-based chart reminders on smoking cessation intervention by primary care providers is difficult to determine. Fewer than 50% of the smokers in the present study reported that their primary care provider had discussed smoking cessation during the clinic visit, which is lower than the 72.6% rate of physician advice to quit reported by current smokers in Indiana (CDC, 2004). However, rates of primary care provider smoking cessation intervention among underinsured smokers, similar to

the population in the present study, have been reported to be as low as 25% (Parnes et al., 2002) to 40% (Doescher & Saver, 2000). Computerized decision support systems have demonstrated benefit in increasing preventive care practices (Hunt, Haynes, Hanna, & Smith, 1998), although absolute changes achieved with physician reminders vary (Hulscher et al., 2001). Boyle and Solberg (2004) found that adding smoking status as a vital sign did not increase smoking cessation advice by primary care providers in a managed care organization. However, their findings are different from a number of studies that have found that including smoking status identification in a medical record significantly increases physician advice to quit (Ahluwalia et al., 1999; Fiore et al., 2000; Fiore et al., 1995; Piper et al., 2003; Robinson et al., 1995).

Several lessons learned from the present study have implications for feasibility of the use of IVR systems and computer-generated reminders. First, the chart reminder alone may have not have been sufficiently robust to prompt behavior change. Prior to implementation of the computerized reminders, a pocket reference guide incorporating U.S. Public Health Service guidelines was distributed to all providers in the health care system, but no additional motivational strategies were used. Additional research of multicomponent or more intense interventions to increase provider adherence to nicotine treatment guidelines is warranted. Another concern raised in the present study is the potential for "reminder fatigue" due to multiple prompts and alerts to providers. RMRS features a complex decision support system that generates a number of reminders for preventive care, medication contraindications, and laboratory tests, among others. Multiple reminders during the context of a busy primary care visit may exceed the provider's capacity to respond (Weiner et al., 2003). In addition, the integrated system developed for the present study was not fully automated. Electronic data transfer from the IVR system to the electronic medical record could be achieved through use of Health Level 7 (HL7) messages. HL7 is the standard for electronic data exchange used in health care applications (Beeler, 1998). However, the programming necessary to develop this mechanism was cost-prohibitive for this relatively small pilot study; thus, the system relied on manual data entry, which would be too labor intensive for widespread use.

The present study had several limitations. The low recruitment rate (29%) for the postvisit interview is of concern. A large number of eligible subjects were not enrolled in the study due to the high rate of no-show behavior; as many as 50% of identified smokers failed to keep appointments. Although multiple attempts to recruit patients on subsequently

scheduled visits were made, the overall recruitment rate was lower than anticipated. Of the patients who were approached to participate in the postvisit interview, 38 (22%) refused. The extent to which the 120 subjects recruited for the follow-up study are representative of the overall smoking population at the clinic is unknown. According to clinic personnel, the appointment failures observed in the present study were not atypical. Lower socioeconomic status is associated with higher rates of missed appointments (Bean & Talaga, 1992). Dini, Linkins, and Chaney (1995) found that automated telephone reminders were effective for increasing the rate of kept appointments in a public health clinic. The IVR calls in the present study served in a sense as a reminder to all clinic patients of their upcoming appointments, but whether the calls had any impact on kept appointments cannot be determined.

Additional limitations of the study design have implications for further research. The lack of a comparison group restricts the interpretation of the results. However, the purpose of the present study was to demonstrate feasibility of the approach rather than to establish efficacy, and results should be considered in light of that purpose. Further studies to test the efficacy of computerized smoking intervention reminders should include baseline provider intervention rates or a control group for comparison. Another design issue is the validity of patient self-report to assess provider intervention. Patient report of smoking cessation counseling has 72% sensitivity and 98% specificity, whereas provider documentation of smoking cessation intervention in the medical record has 41% sensitivity and 99% specificity when compared with direct observation of patient visits (Stange et al., 1998). Nevertheless, provider documentation of smoking cessation intervention might be valuable as a means to verify patient self-report. Ideally, with an electronic medical record that is fully integrated with a computerized reminder system, these data could be captured at the point of care and stored electronically.

Several features of the design of the system limit the findings of the present study. First, IVR technology depends on the use of valid telephone numbers to reach intended recipients. Only 11% of telephone numbers recorded in the electronic medical record were vacant or disconnected. We were not able to determine how many of the patients we attempted to reach lack access to any telephone service, which is a concern in a low-income population, although national estimates indicate that 95% of U.S. households have telephones (Anderson, Nelson, & Wilson, 1998). A small number of patients ( $n=3$ ) had rotary-dial telephones, which are incompatible with IVR technology. In this pilot study, the telephone script was recorded in English, which was

the predominant language of all but a few of the patients served in the clinic sites included in the study. Changing demographics among the Wishard Advantage population indicate a growing number of Spanish-speaking patients. IVR technology has the capability of recording scripts in any language, yet few studies of the use of IVR systems with non-English speakers have been reported. The IVR system contacted patients 1 week prior to scheduled visits based on registration data obtained from the hospital information system 3 weeks in advance. Thus, patients being seen for acute care services, whose visits were scheduled less than 3 weeks in advance, were excluded from the present study. This constraint limited the delivery of physician reminders to all smokers who should be advised to quit by their primary care provider. However, the 3-week advance period was necessary to comply with institutional review board requirements allowing for patients to be notified of procedures to opt out of receiving IVR calls. The IVR system has the technical capability to be programmed as little as 1 day prior to scheduled visits if such a system were deployed as a screening tool in clinical practice rather than in the research setting.

In conclusion, the use of technology to support evidence-based treatment of nicotine dependence presents challenges. Computerized decision support systems depend on reliable and valid data. Obtaining patient-reported data about health-risk behavior for inclusion in the medical record is difficult. IVR technology is one potential technology to address this difficulty. Low-tech cueing systems to remind providers to ask about tobacco use and to intervene with smokers in diverse settings may be more appropriate for disadvantaged populations.

### Acknowledgments and disclosure

This study was supported by grant 044166 from The Robert Wood Johnson Foundation's Addressing Tobacco in Managed Care program. The authors would like to acknowledge Susan Perkins and Rong Qi for their assistance in preparation of this manuscript and Lisa Harris for her commitment to improving the quality of patient care. G. H. Roesener, as president of TeleHealth Systems, Inc., has a financial interest in the IVR technology used in the study.

### References

- Ahluwalia, J. S., Gibson, C. A., Kenney, R. E., Wallace, D. D., & Resnicow, K. (1999). Smoking status as a vital sign. *Journal of General Internal Medicine, 14*, 402-408.
- Anderson, J. E., Nelson, D. E., & Wilson, R. W. (1998). Telephone coverage and measurement of health risk indicators: Data from the National Health Interview Survey. *American Journal of Public Health, 88*, 1392-1395.
- Barbone, A. M., Krahn, D. D., Goodman, B. M., & Searles, J. S. (2000). Using interactive voice response technology and timeline follow-back methodology in studying binge eating and drinking



- behavior: Different answers to different forms of the same question? *Addictive Behaviors*, 25, 1–11.
- Bean, A. G., & Talaga, J. (1992). Appointment breaking: Causes and solutions. *Journal of Health Care Marketing*, 12, 14–25.
- Beeler, G. W. (1998). HL7 version 3—An object-oriented methodology for collaborative standards development. *International Journal of Medical Informatics*, 48, 151–161.
- Boyle, R., & Solberg, L. I. (2004). Is making smoking status a vital sign sufficient to increase cessation support actions in clinical practice? *Annals of Family Medicine*, 2, 22–25.
- Burack, R. C., & Gimotty, P. A. (1997). Promoting screening mammography in inner-city settings: The sustained effectiveness of computerized reminders in a randomized controlled trial. *Medical Care*, 35, 921–931.
- Centers for Disease Control and Prevention. (1993). Physician and other health care professional counseling of smokers to quit—United States, 1991. *Morbidity and Mortality Weekly Report*, 42, 854–857.
- Centers for Disease Control and Prevention. (2003). Cigarette smoking among adults—United States, 2001. *Morbidity and Mortality Weekly Report*, 52, 953–956.
- Centers for Disease Control and Prevention. (2004). State-specific prevalence of current cigarette smoking among adults—United States, 2002. *Morbidity and Mortality Weekly Report*, 52, 1277–1280.
- Cordisco, M. E., Benjaminovitz, A., Hammond, K., & Mancini, D. (1999). Use of telemonitoring to decrease the rate of hospitalization in patients with severe congestive heart failure. *American Journal of Cardiology*, 84, 860–862.
- Corkey, R., & Parkinson, L. (2002). Interactive voice response: Review of studies, 1989–2000. *Behavior Research Methods, Instruments, & Computers*, 34, 342–353.
- Dexter, P. R., Wolinsky, F. D., Gramelspacher, G. P., Zhou, X. H., Eckert, G. J., Waisburg, M., & Tierney, W. M. (1998). Effectiveness of computer-generated reminders for increasing discussions about advance directives and completion of advance directive forms: A randomized, controlled trial. *Annals of Internal Medicine*, 128, 102–110.
- Dini, E. F., Linkins, R. W., & Chaney, M. (1995). Effectiveness of computer-generated telephone messages in increasing clinic visits. *Archives of Pediatrics and Adolescent Medicine*, 149, 902–905.
- Doescher, M. P., & Saver, B. G. (2000). Physicians' advice to quit smoking: The glass remains half empty. *Journal of Family Practice*, 49, 543–547.
- Felland, L. E., & Lesser, C. S. (2000). Local innovations provide managed care for the uninsured. *Issues Brief*, 25, 1–6.
- Fiore, M. C., Bailey, W. C., Cohen, S. J., Dorfman, S. F., Gritz, E. R., Heyman, R. B., Holbrook, J., Jaen, C. R., Kottke, T. E., Lando, H. A., Mecklenbur, R., Mullen, P. D., Nett, L. M., Robinson, L., Stitzer, M., Tommasello, A. C., Villejo, L., & Wewers, M. E. (2000). *Treating tobacco use and dependence. Clinical practice guideline*. Rockville, MD: U.S. Department of Health and Human Services. Public Health Service.
- Fiore, M. C., Jorenby, D. E., Schensky, A. E., Smith, S. S., Bauer, R. R., & Baker, T. B. (1995). Smoking status as the new vital sign: Effect on assessment and intervention in patients who smoke. *Mayo Clinic Proceedings*, 70, 209–213.
- Flint, A. J., & Novotny, T. E. (1997). Poverty status and cigarette smoking prevalence and cessation in the United States, 1983–1993: The independent risk of being poor. *Tobacco Control*, 6, 14–18.
- Friedman, R. H., Kazis, L. E., Jette, A., Smith, M. B., Stollerman, J., Torgerson, J., & Carey, K. (1996). A telecommunications system for monitoring and counseling patients with hypertension. Impact on medication adherence and blood pressure control. *American Journal of Hypertension*, 9, 285–292.
- Havice, M. (1989). How response rates compare for human and digitized phone surveys. *Journalism Quarterly*, 66, 137–142.
- Havice, M. (1990). Measuring nonresponse and refusals to an electronic telephone survey. *Journalism Quarterly*, 67, 521–530.
- Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerström, K. O. (1991). The Fagerström Test for Nicotine Dependence: A revision of the Fagerström Tolerance Questionnaire. *British Journal of Addiction*, 86, 1119–1127.
- Hulscher, M. E., Wensing, M., van der Weijden, T., & Grol, R. (2001). Interventions to implement prevention in primary care (Cochrane Review). *Cochrane Database of Systematic Reviews*, 1, CD000362.
- Hunt, D. L., Haynes, R. B., Hanna, S. E., & Smith, K. (1998). Effects of computer-based clinical decision support systems on physician performance and patient outcomes: A systematic review. *The Journal of the American Medical Association*, 280, 1339–1346.
- Jaen, C. R., Crabtree, B. F., Zyzanski, S. J., Goodwin, M. A., & Strange, K. C. (1998). Making time for tobacco cessation counseling. *Journal of Family Practice*, 46, 425–428.
- Kobak, K. A., Greist, J. H., Jefferson, J. M., Mundt, J. C., & Katelnick, D. J. (1999). Computerized assessment of depression and anxiety over the telephone using interactive voice response. *MD Computing*, 16, 64–68.
- Krishna, S., Balas, E. A., Boren, S. A., & Maglaveras, N. (2002). Patient acceptance of educational voice messages: A review of controlled clinical studies. *Methods of Information in Medicine*, 41, 360–369.
- Lancaster, T., Silagy, C., & Fowler, G. (2000). Training health professionals in smoking cessation. *Cochrane Database of Systematic Reviews*, 3, CD000214.
- Lowensteyn, I., Joseph, L., Levinton, C., Abrahamowicz, M., Steinert, Y., & Grover, S. (1998). Can computerized risk profiles help patients improve their coronary risk? The results of the Coronary Health Assessment Study (CHAS). *Preventive Medicine*, 27, 730–737.
- McDaniel, A. M. (2000, March). *A computerized decision support system for inpatient smoking cessation intervention*. Washington, DC: Poster presented at the sixth annual meeting of the Society for Research on Nicotine and Tobacco.
- McDonald, C. J. (1999). Quality measures and electronic medical systems. *The Journal of the American Medical Association*, 282, 1181–1182.
- McDonald, C. J., Overhage, J. M., Tierney, W. M., Dexter, P. R., Martin, D. K., & Suico, J. G., et al. (1999). The Regenrief Medical Record System: A quarter century experience. *International Journal of Medical Informatics*, 54, 225–253.
- McDonald, C. J., & Tierney, W. M. (1986). Research uses of computer-stored practice records in general medicine. *Journal of General Internal Medicine*, 1, S19–S24.
- Murray, M. D., Smith, F. E., Fox, J., Teal, E. Y., Kesterson, J. G., Stiffler, T. A., Ambuehl, R. J., Wang, J., Dibble, M., Bengel, D. O., Betley, L. J., Tierney, W. M., & McDonald, C. J. (2003). Structure, functions, and activities of a research support informatics section. *Journal of the American Medical Informatics Association*, 10, 389–398.
- Osgood-Hynes, D. J., Greist, J. H., Marks, I. M., Baer, L., Heneman, S. W., Wensel, K. W., Manzo, P. A., Parkin, J. R., Spierings, C. J., Dottl, S. L., & Vitse, H. M. (1998). Self-administered psychotherapy for depression using a telephone-accessed computer system plus booklets: An open US–UK study. *Journal of Clinical Psychiatry*, 59, 358–365.
- Overhage, J. M., Mamlin, B., Warvel, J., Warvel, J., Tierney, W. M., & McDonald, C. J. (1995). A tool for provider interaction during patient care: G-CARE. *Proceedings—The Annual Symposium on Computer Applications in Medical Care*, 178–182.
- Parnes, B., Main, D. S., Holcomb, S., & Pace, W. (2002). Tobacco cessation counseling among underserved patients: A report for CaReNet. *Journal of Family Practice*, 51, 65–69.
- Piette, J. D., Weinberger, M., & McPhee, S. J. (2000). The effect of automated calls with telephone nurse follow-up on patient-centered outcomes of diabetes care: A randomized controlled trial. *Medical Care*, 38, 218–230.
- Piper, M. E., Fiore, M. C., Smith, S. S., Jorenby, D. E., Wilson, J. R., Zehner, M. E., & Baker, T. B. (2003). Use of the vital sign stamp as a systematic screening tool to promote smoking cessation. *Mayo Clinic Proceedings*, 78, 716–722.
- Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model. *Journal of Consulting and Clinical Psychology*, 51, 390–395.
- Robinson, M. D., Laurent, S. L., & Little, R. M., Jr. (1995). Including smoking status as a new vital sign: It works! *Journal of Family Practice*, 40, 556–561.
- Searles, J. S., Helzer, J. E., Rose, G. L., & Badger, G. J. (2002). Concurrent and retrospective reports of alcohol consumption across 30, 90 and 366 days: Interactive voice response compared with the timeline follow back. *Journal of Studies on Alcohol*, 63, 352–362.
- Searles, J. S., Helzer, J. E., & Walter, D. E. (2000). Comparison of drinking patterns measured by daily reports and timeline follow back. *Psychology of Addictive Behaviors*, 14, 277–286.

- Shaw, J. S., Samuels, R. C., Larusso, E. M., & Bernstien, H. H. (2000). Impact of an encounter-based prompting system on resident vaccine administration performance and immunization knowledge. *Pediatrics, 105*, 978–983.
- Shea, S., DuMouchel, W., & Bahamonde, L. (1996). A meta-analysis of 16 randomized controlled trials to evaluate computer-based clinical reminder systems for preventive care in the ambulatory setting. *Journal of the American Medical Informatics Association, 3*, 399–409.
- Silagy, C. (2001). Physician advice for smoking cessation. *Cochrane Database of Systematic Reviews, 2*, CD000165.
- Smedley, B. D., Stith, A. Y., & Nelson, A. R. (2003). *Unequal treatment: Confronting racial and ethnic disparities in health care*. Washington, DC: National Academies Press.
- Stange, K. C., Zyzanski, S. J., Smith, T. F., Kelly, R., Langa, D. M., Flocke, S. A., & Jaen, C. R. (1998). How valid are medical records and patient questionnaires for physician profiling and health services research? A comparison with direct observation of patients' visits. *Medical Care, 36*, 851–867.
- Thorndike, A. N., Rigotti, N. A., Stafford, R. S., & Singer, D. E. (1998). National patterns in the treatment of smokers by physicians. *The Journal of the American Medical Association, 279*, 604–608.
- Tierney, W. M., & McDonald, C. J. (1991). Practice databases and their uses in clinical research. *Statistics in Medicine, 10*, 541–557.
- Tierney, W. M., Miller, M. E., Hui, S. L., & McDonald, C. J. (1991). Practice randomization and clinical research. The Indiana experience. *Medical Care, 29*, JS57–JS64.
- Troutman, W. G., Murray, L. L., & Norlander, B. (1990). An estimation of annual incidence of poisoning using automated telephone polling. *Journal of Toxicology, Clinical Toxicology, 28*, 193–202.
- Weiner, M., Callahan, C. M., Tierney, W. M., Overhage, J. M., Mamlin, B., Dexter, P. R., & McDonald, C. J. (2003). Using information technology to improve the health care of older adults. *Annals of Internal Medicine, 139*, 430–436.