

Interactive Voice Response Systems in the Diagnosis and Management of Chronic Disease

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Abstract

Objective: To assess the feasibility, reliability, validity, and potential clinical impact of interactive voice response (IVR) systems in the diagnosis and management of chronic disease.

Study Design: Literature review.

Results: Interactive voice response assessment systems have been implemented in the treatment of patients with chronic health problems such as heart failure, diabetes, hypertension, and mental health disorders. The information patients report during IVR assessments is at least as reliable as information obtained via structured clinical interviews or medical record reviews. Patients often are more inclined to report health problems to an IVR system than directly to a clinician. The few outcome evaluations of IVR-supported chronic illness management services indicate that they can have moderate impacts on some health and health behavior outcomes.

Conclusions: Future research should evaluate the extent to which IVR assessment data can improve the prediction of clinical problems over and above

what is possible using data usually available to primary care providers. Studies also should evaluate the outcomes of IVR-supported chronic disease management and the use of IVR assessments to measure variation in patient-centered treatment outcomes.

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Quality clinical information is the foundation of chronic disease management. The timeliness of such information is crucial because chronic illnesses often are characterized by day-to-day fluctuations in health status, periodic episodes of acute illness, and a gradual increase in disease severity. Patients' need for self-care management support and training also should be assessed continually because it varies over time depending on patients' disease course, treatment regimen, and contextual factors such as social support.

Most patient monitoring occurs in ambulatory care settings, although the information that is collected often is insufficient for the comprehensive, coordinated service delivery that characterizes effective chronic disease management.¹ Patients who are clinically unstable, newly diagnosed, or lacking in social support may need weekly or even daily monitoring. However, this usually is impossible through outpatient centers. Few healthcare organizations have the integrated information systems needed to trigger a standardized assessment when patients seek care through different entry points (eg, an emergency department; a pharmacy; or urgent care, primary care, and specialty care clinics). Even when outpatient assessment systems are optimized, the information on which clinicians depend often is lim-

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ited because many patients fail to keep scheduled office visits,² and others face barriers to accessing ambulatory care.^{3,4}

Because of these inadequacies in clinical information systems, chronic disease treatment plans often reflect patients' historical problems more than their current needs. Opportunities to prevent health crises are missed, and educational efforts lack the timeliness needed for them to be most effective. Ambulatory care visit schedules for chronically ill patients usually reflect a one-size-fits-all approach determined more by providers' practice styles than patients' characteristics.⁵ Information about the experiences of groups of similar patients rarely is available in any organized fashion.⁶ As a consequence, quality improvement efforts suffer, and patients must select providers based on anecdotal experiences rather than evidence of their relative quality.

We reviewed studies addressing the potential utility of interactive voice response (IVR) as a strategy for improving chronic disease management through systematic patient assessments between face-to-face visits with clinicians. Using IVR systems, patients receive recorded messages and report clinical information using their telephone's touch-tone keypad or voice response technology. We focus on IVR-assisted monitoring because it can be implemented rapidly without requiring specialized communication platforms such as the Internet, which often are unavailable to patients who have a low income, live in rural areas, or belong to ethnic minorities.⁷ Several large, randomized trials have demonstrated definitively that IVR reminder systems can improve medication adherence,⁸ vaccination rates,⁹⁻¹³ and clinic attendance rates.¹⁴ Here, we examine the somewhat more complex application of IVR to gather information repeatedly from chronically ill patients between outpatient visits to improve clinical decision making and evaluate treatment quality from the patient perspective. (For a more general review of distance medical technology, see Balas et al.¹⁵)

...METHODS ...

We reviewed the English-language, peer-reviewed medical literature to identify empirical studies of IVR interventions designed to assess patients' status between face-to-face clinical encounters. Studies published between 1985 and 1999 were identified through MEDLINE using keyword searches for the terms "automated assessment," "automated tele-

phone," "interactive voice-response," "IVR," and "computerized telephone." We conducted additional MEDLINE searches using the names of key researchers and collected other articles cited in the reference lists of identified studies. We also included several empirical studies of IVR-supported diabetes care that have been conducted by our own research team and published in peer-reviewed medical journals. Studies of IVR reminder systems, studies with few details regarding the IVR intervention or its evaluation, and conceptual descriptions of interventions without empirical evaluation data were examined but are not described explicitly.¹⁶⁻²⁰

...RESULTS ...

Feasibility Studies

Interactive voice response systems have been used to assess the status of patients with chronic illnesses such as depression,²¹ cancer,^{22,23} heart failure,²⁴ and diabetes²⁵ (Table 1). For example, Baer et al.²¹ used IVR assessments to administer a standard, multi-item survey to identify individuals with depression. They found that of the 1812 callers, 88% completed the entire 20-item questionnaire. Importantly, more than one third of callers met criteria for "moderate," "marked," "severe," or "extreme" depression; and most of those who were identified as depressed had received no prior treatment.

We conducted 2 randomized trials in which we evaluated the impact on diabetes treatment outcomes of biweekly IVR assessments with telephone follow-up by a nurse. Based on a combined dataset representing 12 months of follow-up for intervention patients from both studies (n = 252 patients), we found that most patients completed the majority of their IVR assessments and one fourth completed 91% or more.²⁶

When asked how they felt about the IVR calls, the majority reported that the calls were easy to understand, 82% reported that they would be more satisfied with their healthcare if IVR assessment calls were available to patients, and 76% reported that they personally would choose to receive such calls if they were offered.

Reliability and Validity of Information Obtained by IVR Assessment

Studies indicate that IVR patient reports provide reliable and valid information (Table 2). In a study of 229 managed care patients with low-back pain,³² investigators found that scores on the SF-12 Health

Status Survey³⁷ were similar among patients using IVR reporting and those reporting information during a live telephone interview. Interactive voice response assessments also have been used to obtain psychiatric diagnoses that are comparable to those obtained by clinicians using a structured clinical interview.^{29,30} Other investigators found that IVR assessments of patients' preferences for cancer treatment identified important disparities in understanding between the patients and their clinicians.³⁶ Frequent IVR reports regarding drug²⁷ and alcohol use may be more accurate than retrospective recall over extended periods and may be especially useful for evaluating the drinking patterns of patients with alcohol abuse disorders.^{34,35} Interactive voice response assessments of frail elders can be a useful screening tool for detecting functional decline, although they identify fewer problems than in-home assessments by a case manager.³¹

In our 2 trials of IVR-supported diabetes care, nurse educators systematically verified patients'

assessment responses during follow-up telephone calls. Overall, the nurses verified 4400 IVR-reported problems. Eighty-five percent of these reports were affirmed by the patient (ie, the patient indicated that the key-entered response was what he or she had intended). Ninety-eight percent of reports of fair or poor general health were affirmed, and 98% of reports of fair or poor glycemic control were affirmed.

We also found that IVR assessment data identified groups of patients with diabetes who were at heightened risk of developing health problems.²⁶ For example, compared with patients who reported a self-monitored blood glucose level of <120 mg/dL during an IVR assessment, patients who reported a self-monitored blood glucose level of >200 mg/dL were more than twice as likely to have a glycosylated hemoglobin (H_{gA_{1c}}) level of >8%, more than twice as likely to have a history of diabetic complications, and more than 3 times as likely to report symptoms of hyperglycemia during a live interview. At least in

Table 1. Studies Evaluating the Feasibility of IVR Assessment

Investigators	Sample	Study Design	Findings
Baer et al (1995) ²¹	1812 community volunteers; mean age = 37 y	Cross-sectional study of a 2-wk calling period; participants completed an IVR version of the 20-item Zung Depression Scale and reported demographic information as well as their satisfaction with the calls	88% of callers completed all questions; 38% met criteria for "moderate" to "extreme" depression; 75% of those completing the screening reported that the call had been at least "moderately" helpful
Christ and Siegel (1990) ²²	92 adults with cancer receiving outpatient chemotherapy; 82% ≥ 45 y	Patients received 3 IVR assessments of their needs and unmet needs for concrete services such as transportation and housekeeping	Patients responded to the IVR as readily as to calls by a social worker but reported somewhat more social service needs during IVR assessments
Patel and Babbs (1992) ²⁴	3 heart failure patients ≥ 50 y	Patients completed weekly IVR assessments for 8-10 wk; reports were faxed to their cardiologists	Patients used the system without problems; a clinically significant increase in 1 patient's weight was detected and medication was adjusted
Piette and Mah (1997) ²⁵	65 patients with diabetes; 77% ≥ 55 y; 95% men	Patients completed up to 4 weekly IVR assessments over a 1-mo period	95% of patients completed more than 1 assessment, and 57% completed all 4; patients reported a variety of health and self-care problems; 98% reported that they thought the calls were helpful; 98% reported no difficulty completing the assessments

IVR = interactive voice response.

Table 2. Studies Evaluating the Reliability and Validity of IVR Assessment Information

Investigators	Sample	Study Design	Findings
Alemi et al (1994) ²⁷	42 recovering patients with drug and alcohol abuse disorders; mean age = 38 y	Patients were asked to call the IVR system weekly for 5 mo and report information about their substance use; IVR reports were compared with responses to mailed surveys; IVR-predicted relapse risk was verified against poststudy patient reports and (among drug users) hair samples	IVR reports were consistent with patients' mailed survey responses; the IVR assessments predicted patients' poststudy relapse reports 92% of the time; too few patients submitted hair samples to verify IVR reports reliably
Gonzalez et al (1997) ²⁸	32 English speakers and 23 Spanish speakers	Participants completed IVR and face-to-face versions of the CES-D depression screener administered in random order along with the Beck Depression Inventory and a short acculturation scale	IVR CES-D administrations were psychometrically equivalent to face-to-face interviews, reliable, and valid in both languages
Kobak et al (1997) ²⁹	200 adult volunteers from primary care and mental health clinics, and community controls	IVR assessments were used to determine psychiatric diagnoses; IVR diagnoses were compared with diagnoses obtained over the phone by clinicians using the SCID; a sub-sample of patients completed assessments via a clinician-administered version of the IVR scripts	Rates of psychiatric disorders were similar when measured via IVR (60%) and SCID (59%); rates of specific diagnoses were similar, although patients reported more alcohol abuse using the IVR (15%) than either the SCID (8%) or clinician-administered IVR scripts (8%); overall agreement (κ) for any diagnosis was 0.67 for the IVR-administered assessment
Kobak et al (1997) ³⁰	51 adult outpatients from a community mental health clinic	IVR-reported mental disorders were compared with disorders identified using a desktop computer, clinician interview, and chart diagnoses	Mean number of diagnoses per patient was 4.3 for IVR, 4.4 for desktop computer, and 4.4 for clinician interview; more cases of dysthymia and obsessive-compulsive disorder were identified by IVR than by other methods; fewer cases of panic disorder were identified by IVR (45%) than by clinician interview (65%)
Mahoney et al (1999) ³¹	20 patients with functional disabilities enrolled in a home care program; all \geq 60 y	Within a 72-h period, each patient received, in random order, 2 IVR and 1 live telephone functional assessment as well as an assessment conducted by a case manager during a home visit	Findings from the IVR and live phone assessments were similar, but neither method captured as many impairments as the case manager's home visit
Millard and Carver (1999) ³²	229 adult managed care patients undergoing assessment for low-back pain; mean age = 60 y	Partial-random assignment to IVR or live telephone administration of the SF-12; patients with cognitive, speech, or hearing problems all were assigned to the live calls	Mean SF-12 scale scores were similar in the 2 groups, although IVR patients reported more mental health problems and that their overall health was worse; correlations between SF-12 scores and other clinical variables were similar across administration modalities
Mundt et al (1998) ³³	367 adults; 18-79 y	Cross-sectional comparison of an IVR version of the Hamilton Rating Scale for Depression and a face-to-face version administered during a structured clinical interview	Both an 18-item version and a 6- to 8-item version of the IVR assessment correlated with the face-to-face assessments

(Table continues)

Table 2. Studies Evaluating the Reliability and Validity of IVR Assessment Information (*Continued*)

Investigators	Sample	Study Design	Findings
Perrine et al (1995) ³⁴	30 male alcohol users; median age = 36 y	Patients reported daily alcohol consumption via IVR; reports were validated against daily breath and saliva samples and against reports by a cohabitating partner	IVR alcohol reports correlated with blood alcohol content ($r = .72$) and collateral reports ($r = .89$)
Piette et al (1999) ²⁶	252 diabetes patients; mean age = 58 y	Patients received IVR assessment and self-care education calls with nurse follow-up for 12 mo; trends in use over time were examined along with the reliability of patient responses; the validity of IVR reports was evaluated using medical record data, laboratory test results, and responses during live interviews	50% of patients completed at least 77% of their assessments, and 50% reported self-monitored glucose readings during >86% of completed assessments; patients' responses were consistent within assessments and identified subgroups with more health problems
Searles et al (1995) ³⁵	51 volunteer men; median age = 28 y; 98% were white	Patients used IVR to report daily alcohol intake during 4 1-mo periods; IVR reports were compared with reports gathered using 2 common retrospective recall procedures	IVR reports correlated with recall, but consistently identified more alcohol use; participants with higher average consumption had the most underestimated use when comparing recall with IVR
Temple et al (1998) ³⁶	26 pairs of newly diagnosed breast cancer patients and their surgeons recruited soon after a postbiopsy consultation	Patients and their surgeons called the IVR system and responded to parallel questions about patients' preferences for treatment, shared decision making, and time for discussion	Surgeons and patients were in agreement about what the treatment plan was most of the time (88%); however, they often disagreed about who made the decision, how much input the patient wanted, and how well the patient understood the rationale for the treatment choice

IVR = interactive voice response; CES-D = Center for Epidemiologic Studies Depression Scale; SCID = structured clinical interviews for the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV)*; SF-12 = 12-Item Short Form Health Status Survey.

concept, these differences could be used to allocate resources more effectively based on patients' needs rather than their ability to seek care.

A potentially important characteristic of IVR assessments is that they often identify more health problems than typical modalities for gathering patient information. Patients were more likely to report alcohol abuse during IVR assessments than during live interviews, both in the study by Kobak et al²⁹ and the study by Searles et al.³⁵ In another study, Kobak et al³⁰ found that mental health patients were more likely to report psychiatric symptoms during IVR assessments than during clinical interviews. Millard and Carver³² found that more

patients with low-back pain reported psychiatric symptoms during an IVR administration of the SF-12 Health Status Survey than patients who completed the SF-12 Health Status Survey during a live telephone call. Such findings have precedent in earlier research. Studies dating back to the 1970s have demonstrated that patients are more apt to report mental health problems and other problems during a computer assessment than during an in-person interview.³⁸⁻⁴² Some patients report that they are less embarrassed when reporting sensitive information to a computer than to a clinician.⁴³ A more detailed review of this issue is provided by Kobak et al.⁴⁴

Table 3. Studies Evaluating IVR Assessments Linked to a Clinical Response

Investigators	Sample	Study Design	Findings
Alemi et al (1996) ⁴⁵	179 pregnant women who had used cocaine during their pregnancy; mean age = 27 y	Randomized trial, patients followed until 6 mo after the birth; intervention patients accessed clinical assessments, peer support, and health education via IVR	More intervention than control patients used formal drug treatment services 3 or more times a week (83% vs 55%; $P < .05$); no differences were observed in patients' health status, drug use, or health service use
Friedman et al (1996) ⁴⁶	267 poorly controlled hypertensive patients; mean age = 76 y	Randomized trial with 6-mo follow-up; intervention patients received weekly IVR assessments focusing primarily on hypertensive medication adherence; IVR reports were sent to physicians	Antihypertensive medication adherence improved more in the intervention group than the control group (18% vs 12%; $P = .03$); mean diastolic blood pressure decreased more as well (5 mm Hg vs 0.8 mm Hg; $P = .02$)
Meneghini et al (1998) ⁴⁷	184 patients with diabetes; 94% insulin users	Pre-post study with a 1-y follow-up; patients called the IVR to report self-monitored glucose readings, symptoms, and health behaviors; some patients could access decision-support for insulin dose adjustment	At follow-up, episodes of hyperglycemia and hypoglycemia decreased ($P < .05$); among patients with available data ($n = 30$), HgA _{1c} decreased 0.9% ($P = .04$)
Osgood-Hynes et al (1998) ⁴⁸	41 patients from 2 US sites and 1 UK site; mean age = 42 y	Pre-post study of a 12-wk self-help intervention for depression that included 11 IVR assessments with patient-specific recommendations, a videotape, and informational booklets	At follow-up, patients' scores on the Hamilton Rating Scale for Depression and the Work and Social Adjustment Scale improved ($P < .001$); expectation of effectiveness and time making IVR calls correlated positively with improvements
Piette et al (2000) ⁴⁹	248 diabetes patients; mean age = 54 y; 64 patients spoke primarily Spanish	Randomized trial with self-care behaviors, perceived glycemic control, and diabetic symptoms measured at 12 mo via live telephone interview; glycemic control measured via laboratory tests of HgA _{1c} and serum glucose	Compared with controls, intervention patients at follow-up reported more frequent glucose monitoring, foot care, and weight monitoring (all $P < .03$); 48% of intervention patients reported medication adherence problems compared with 69% of controls ($P = .003$); compared with controls, intervention patients had somewhat lower HgA _{1c} levels (8.4% vs 8.1%; $P = .1$) and lower serum glucose levels (221 mg/dL vs 180 mg/dL; $P = .04$); intervention patients reported fewer symptoms of hyperglycemia and hypoglycemia ($P < .01$)
Piette et al (2000) ⁵⁰	Same study as above	Patient-centered outcomes measured via live telephone interviews	Compared with controls, intervention patients at follow-up reported fewer depressive symptoms, greater self-efficacy and satisfaction with care, and fewer days in bed due to illness (all $P < .05$); no impact on anxiety or health-related quality of life
Siegel et al (1992) ²³	239 cancer patients receiving outpatient chemotherapy; mean age = 59 y	Quasi-randomized trial with 6-wk follow-up; intervention patients received 3 IVR assessments of their needs for concrete services such as	Among patients with service needs, intervention patients reported fewer unmet needs than controls, although the study was underpowered to identify any

HgA_{1c} = glycosylated hemoglobin; IVR = interactive voice response.

Impact of IVR Assessments with Clinical Follow-up

There have been few peer-reviewed evaluations of the impact on patient outcomes of IVR-supported chronic disease management. However, those that have been conducted indicate that some outcomes can be moderately improved (Table 3). Alemi and colleagues randomized 179 pregnant cocaine-using women to usual care or to usual care supported by an IVR-based intervention that included clinical assessments, mutual support, and health education.⁴⁵ They found that patients used the IVR system frequently and that it increased their use of drug treatment services. However, at 6 months postdelivery, there were no differences between intervention and control patients in health status, drug use, or use of medical care.

In another important study, investigators randomized hypertensive patients to usual care or weekly IVR monitoring with feedback of their assessment data to physicians.⁴⁶ After 6 months, antihypertensive medication adherence improved among intervention patients compared with control patients receiving usual care, and diastolic blood pressure decreased more in the IVR group than in the control group. Among patients with the poorest baseline medication adherence, diastolic blood pressure decreased among IVR users but increased slightly among patients receiving usual care.

In a pretest-posttest study, patients with diabetes used an IVR system to obtain health information, report changes in their glycemic control, and access a decision-support system for making insulin dose adjustments.⁴⁷ At follow-up, investigators observed a 3-fold decrease in diabetic crises and a 0.8% average decrease in HgA_{1c} levels. In a randomized trial of IVR-supported diabetes care, intervention patients at follow-up reported greater improvements in self-care and fewer symptoms of poor glycemic control than patients receiving usual care.^{49,50} Compared with patients receiving usual care, patients receiving the intervention also reported fewer symptoms of depression and days in bed due to illness, greater self-efficacy to perform self-care activities, and higher levels of satisfaction with their healthcare. Endpoint HgA_{1c} and serum glucose levels among intervention patients were lower than they were among controls, and more than twice as many intervention patients had follow-up HgA_{1c} levels within the normal range (17% vs 8%; $P = .04$). Analyses are under way of a similar intervention conducted among patients with diabetes treated in Department of Veterans Affairs clinics. Preliminary findings indi-

cate that impacts on patients' glycemic control, symptoms, and satisfaction with healthcare are similar to those found in the study just described.

Key Issues Associated with IVR-Supported Diagnosis and Assessment

What Types of Patients Can Benefit from IVR Assessment? Studies described here suggest that IVR assessment may be a useful adjunct to care for patients with a variety of chronic physical and mental illnesses. However, it is likely that some patients may benefit more than others. For example, patients whose health is especially unstable either because of the nature of their underlying illness or because of a recent change in their treatment probably would benefit more than patients with a stable or slowly changing disease course. Given the same medical characteristics, some patients are better able to monitor their health without IVR and seek appropriate treatment when necessary. Other patients (eg, those who face barriers to self-monitoring such as lack of social support, poor English competence, poor health literacy, or mental health problems) may benefit more from the additional oversight afforded by periodic IVR assessments.

What Factors Motivate Compliance with IVR Assessment? Much needs to be learned about the factors that motivate patients to participate in IVR monitoring over an extended period of time. In our studies of IVR-supported diabetes care, we found that patients who frequently completed assessments and patients who completed them less frequently had similar sociodemographic characteristics. However, more frequent respondents tended to be somewhat healthier, as indicated by factors such as fewer symptoms and better health-related quality-of-life scale scores. Socioeconomic factors that can limit patients' access to glucose self-monitoring supplies were important in determining patients' rates of reporting self-monitored blood glucose data. In sum, it appears that there are few unique factors limiting compliance with IVR. Rather, factors that can influence patients' use of healthcare more generally also may contribute to their IVR assessment compliance.

Is IVR-Supported Chronic Disease Management Cost Effective? Although the cost implications of IVR-supported chronic disease management remain uncertain, the factors that determine its cost effectiveness are becoming clearer. Implementation costs include either the purchase of the IVR equipment or an ongoing service contract with an outside vendor. Both options have their advantages.⁵¹ Their relative

cost efficiency depends on factors such as the value an organization places on controlling the day-to-day operation of the system, the availability of in-house technical support staff, and the number of patients being managed.

Care supported by IVR may increase or decrease use of other health services. For example, it might increase compliance with treatment guidelines such as annual ophthalmologic examinations for patients with diabetes or increase pharmacy costs that result from improved adherence to medication regimens. These investments may yield decreased use of acute care at some point in the future, although they clearly will increase expenditures up front. Interactive voice response has the potential to decrease short-term treatment costs by increasing the time interval between face-to-face clinical encounters for patients who report no health problems via IVR or who access IVR-based self-care education. Identification of symptoms indicating a developing health crisis could lead to more rapid outpatient follow-up and decreased costs associated with emergency department or inpatient care. Although the long-term health implications of modulating visit schedules based on IVR assessment data are unknown, studies described here suggest that patient-specific visit intervals may be possible.

Agenda for Future Research

Increasing the Prognostic Significance of IVR Assessments. Studies have demonstrated repeatedly that IVR assessment information is reliable and clinically meaningful insofar as it corroborates contemporaneous information from face-to-face interviews and medical records. Still, without evidence regarding the *prognostic* significance of IVR assessments, appropriate clinical use will be limited. Providers who already are barraged with patient information may ignore IVR assessment reports. Conversely, other providers may overestimate the data's prognostic significance and make inappropriate changes to treatment plans. Still others may take a conservative approach, scheduling unnecessary in-person assessments and diagnostic procedures for patients whose IVR reports suggest even a remote possibility of a developing problem.

Prospective cohort studies that link IVR-reported clinical problems to subsequent health and service use outcomes are needed. By combining information reported within an individual IVR assessment and taking greater advantage of serial measurements

of a given health parameter (eg, heart failure patients' weight), it may be possible to identify prodromal signs of acute health crises early enough to intervene. It also would be important to evaluate the impact of IVR reports that summarize data for a provider's entire panel of chronically ill patients. Such reports could facilitate the introduction of population-based treatment principles into a provider's practice.

Identifying the Extent to Which IVR Assessments Improve Outcomes. There is likely to be no single answer to the question of whether IVR assessments improve patient outcomes. Rather, the utility of IVR probably will depend on the nature of the chronic illness, patients' sociodemographic characteristics (particularly those impacting access to care), and the healthcare system in which the system is implemented. Large-scale, randomized trials measuring the health impacts and cost effectiveness of IVR-based chronic disease management are badly needed.

The studies shown in Table 3 used different strategies for incorporating IVR assessments into patient care. For example, the study by Friedman et al⁴⁶ reported IVR data back to patients' physicians directly, while the model we examined used a centralized nurse to evaluate IVR assessment reports, make initial follow-up calls, and serve as the interface between the IVR monitoring system and patients' overall care.⁵² Other strategies for incorporating IVR assessments into patient care are possible and should be investigated. In particular, creative strategies for communicating IVR data to clinicians via electronic patient records and the Internet should be examined. Finer points about the process of IVR assessment such as the relative effectiveness of patient-initiated versus clinician-initiated assessment systems, the optimal length of such calls, and the use of random assessments to characterize health behavior patterns⁵³ also are important and should be evaluated in controlled studies.

Using IVR to Assess Treatment Quality from the Patient's Perspective. The patient's perspective frequently is left out of healthcare system evaluations,⁵⁴ and most patients select healthcare organizations without a clear basis for determining which providers are best for them and their families. Interactive voice response-based assessments could be used to obtain population-based estimates of patients' experience with treatment as well as patient-centered outcomes of care such as satisfaction, symptom burden, and health-related quality of life. As such, they could be used to compare

patients' experiences across clinics, health plans, and provider specialties. Such a system should be explored in future IVR research because it would respond to consumers' desire that patient-centered outcomes play a larger role in their care.⁵⁵

Ongoing Studies. Many unanswered questions regarding the role of IVR-based patient assessment are being addressed in ongoing studies. Our own research group is developing IVR assessment instruments that include measures of diabetic patients' physical health (eg, glycemic control), self-care behaviors (eg, self-monitored blood glucose, diet), and patient-centered outcomes (eg, satisfaction with care and health-related quality of life). We plan to use these data to develop statistical models that determine the extent to which IVR reports can improve clinicians' ability to predict outcomes over and above what is possible using information that typically is available to primary care providers. Based on these analyses, we will develop a clinician feedback system and evaluate its impact in a multi-center randomized trial. Because these studies will include patients from private managed care systems, county-funded healthcare systems, and Department of Veterans Affairs healthcare systems, we also will have the opportunity to determine whether IVR-reported outcomes can be used to measure the association between health system structures, processes of care, and treatment quality.

Other investigators are pursuing IVR research that will expand our understanding of potential chronic disease management applications. For example, one study will assess whether periodic IVR assessments can increase the maintenance of changes in self-care achieved through peer-led support groups. Another study will use IVR assessments before outpatient encounters as a method of assisting patients in articulating their treatment priorities so that communication with physicians can be more effective and adherence to self-care plans can be improved. A third planned study will combine IVR communication with an Internet-based diabetes management tool so that the widest possible audience can access health services and receive timely clinical intervention in the event of acute problems.

... CONCLUSIONS ...

Multiple studies have demonstrated that IVR assessment is feasible in chronically ill populations,

including populations of patients who have mental health problems, have low incomes, or cannot speak English. Patients report clinically meaningful information during IVR assessments, and some health problems can be identified more effectively through IVR assessments than through in-person interviews. Few studies have examined the outcomes of IVR assessment linked to a clinical response, but those that have been conducted indicate that some outcomes can be improved. Given the state of the evidence, further research is needed into the prognostic significance of IVR assessment data, the outcomes of treatment supported by IVR assessments, and the use of IVR data to measure treatment quality from the patient's perspective.

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