Automated Telephone as an Adjunct for the Treatment of Chronic Pain: A Pilot Study
Magdalena R. Naylor,* John E. Helzer,* Shelly Naud,† and Francis J. Keefe‡

Abstract: The objective of this study was to test whether Interactive Voice Response (IVR) can be used to enhance the therapeutic outcome of patients receiving group cognitive behavioral therapy (CBT) for chronic pain. Ten subjects with chronic pain syndromes participated in 10 weeks of group CBT followed by 4 months of Therapeutic Interactive Voice Response (TIVR). Our specially designed TIVR is based on a computerized telephone system in which callers are asked questions and respond by using the telephone keypad. It was created to reinforce pain coping skills and to provide messages for relaxation, sleep induction, and emotional support that can be accessed by patients on demand. Within-subject analysis showed that maximum positive change for nearly all outcome measures was observed at the post-TIVR point. For some measures, improvement compared to baseline was significant after TIVR despite the fact it had not been significant after CBT. Measures showing this pattern included SF-36 Mental Health Composite Score (P < .0004), McGill Pain Questionnaire pain (P < .01), Coping Strategies Questionnaire Catastrophizing (P < .0006), Treatment Outcomes in Pain Survey Total Pain Experience (P < .03), and Perceived Family/Social Disability (P < .02). Our preliminary results suggest that TIVR can be used to improve coping skills adherence and to prevent relapse into pain behavior.

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Key words: Chronic pain, IVR, automated telephone, cognitive behavioral therapy.
Interactive Voice Response (IVR). Interactive Voice Response is essentially a method for interaction between an individual and a computer through the medium of a telephone. A toll-free number connects the user to the IVR, a recorded voice asks scripted questions following a branching logic format, and the caller inputs responses by using the telephone keypad.

**Automated Technologies**

During the past decade there has been considerable growth in automated (computer mediated) technologies for assessment and treatment. In part this is a response to the dramatic expansion of and general familiarity with personal computers during the past few years.⁹,²¹ Many options are available including desktop computers, palmtops, IVR, interactive televideo, and even wearable devices such as the Transdermal Alcohol Sensor.⁵¹ Automated technologies for assessment and treatment offer many potential advantages. For the patient these include 24-hour accessibility, the convenience of remote access, and a high level of comfort in reporting even sensitive material.⁵,³³ Caregiver/investigator advantages include reduced cost of data collection, greater standardization of clinical information, a high level of data validity due to patient comfort in reporting candidly,³³ and immediate access to data for analysis. In addition, electronic data collection offers particular advantages for monitoring clinical variables on a daily basis. Jamison et al¹⁸ used palmtops for daily monitoring of pain. They found that patients preferred the electronic format and showed much higher rates of compliance and satisfaction during a 1-year trial.

For clinical assessment, several well-known rating scales are available for computer administration. These include the Hamilton Depression Rating Scale,¹ the Hamilton Anxiety Scale,³³ the Liebowitz Social Anxiety Scale,²⁴ the Yale-Brown OCD Scale,³ the Clinical Interview Schedule,³⁶ and the Addiction Severity Index.⁹ Recently Mundt et al⁴⁰ have published an IVR-based tool for dementia screening. The latter was developed by the group at Healthcare Technology Systems, a clinical research and technology company specializing in clinical IVR systems for the pharmaceutical and health care industries that are available commercially.

In the area of treatment, automation has been particularly popular in substance cessation programs. Automated technologies have been used to enhance personal confidence,¹² to deal with setbacks and to maintain momentum,¹⁶ to increase comfort in disclosing information,⁴⁶ and to ascertain real-time data on the role of environmental cues in relapse.⁵⁰ To better understand the points at which intervention might be optimal, Shiffman et al⁴⁹ used palmtop computers to examine the situational association between drinking and smoking. Schneider et al⁴⁷ programmed a computer to interact directly with callers via the touch-tone telephone in a smoking cessation program. The system automatically composed messages to fit the needs, expectations, and progress of each caller and interacted at the preparation, quitting, or maintenance stage as appropriate. Intervention trials have also been published for IVR-assisted treatment of obsessive-compulsive disorder⁴ and major depression.⁴¹

In this study, we tested whether an IVR-based intervention we developed called Therapeutic Interactive Voice Response (TIVR) could increase treatment compliance and adherence in chronic pain patients and improve outcome at follow-up. The TIVR (see Methods for a description) was designed to enhance group CBT by providing automated access to self-monitoring, didactic review of coping skills, guided behavioral rehearsal of skills including prompts for regular practice, and personalized encouragement and reinforcement. To our knowledge, this trial is the first attempt at using automated technology for intervention in chronic pain. Although not specifically tested in this study, TIVR shares with other automated technologies the potential of reducing health care utilization costs.

**Materials and Methods**

**Subject Recruitment and Screening Procedure**

The University of Vermont Institutional Review Board approved the research protocol, and informed consent was obtained from each subject. Subjects for this study were a consecutive sample of patients referred to the MindBody Medicine Clinic (MBMC) at the university medical center during the period of study. In general, referrals are made by specialists from the university Pain Management Clinic, rheumatologists, primary care and other physicians. The eligible population for this study were those referred for treatment of chronic, non-neuropathic pain who met the following inclusion/exclusion criteria.

**Inclusion Criteria**

These criteria included at least 6 months of musculoskeletal or other non-neuropathic pain such as back pain, osteoarthritis, or headaches; ongoing standard pain management (typically involving oral medication and physical therapy, with or without anesthetic or steroid injections); age 18 years or older; and a touch-tone phone in the home.

**Exclusion Criteria**

These criteria included a diagnosis of severe personality disorder or any psychotic disorder; patients awaiting a pain-related surgical procedure or involved in pain-related litigation. We did not exclude patients with pain-related disability but did exclude those involved in pursuing settlement of a disability claim, because this or pain-related litigation might influence their perception or reports of pain sensitivity.

The overall study design is illustrated in Fig 1. The recruitment protocol was as follows. The psychiatrist or a staff psychologist contacted each MBMC referral by phone to explain the pain management program and to
determine the patient’s interest in CBT group participation. Initial assessment questionnaires (listed below) were sent, followed by an initial in-person evaluation with the psychiatrist or a staff psychologist.

There were 13 eligible subjects, 11 of whom agreed to enroll in the study. Enrollees were all white, 10 were women, and the mean age was 47 years. All 11 subjects finished the 10 weeks of group CBT and completed the subsequent 4 months of TIVR. One subject did not return the last follow-up evaluation questionnaire and thus was dropped from the analysis. The demographic characteristics of the 10 remaining study subjects appear in Table 1. Table 2 shows baseline values in this sample compared to selected normative values.

**Interventions**

**Group Behavioral/Cognitive Therapy**

Cognitive behavioral therapy was delivered in ten, 90-minute weekly group sessions. The treatment model was based on the gate control model of pain as a complex experience affected by thoughts, feelings, and behaviors by Melzack and Wall. The CBT intervention for pain management was designed to (1) change cognition and decrease maladaptive catastrophizing, (2) enhance patients’ ability to use attention diversion, and (3) change activity patterns to better control pain.

Below are the 5 treatment areas emphasized in our program and the associated cognitive-behavioral interventions to achieve the goals described above.

**Table 1. Sample Characteristics**

<table>
<thead>
<tr>
<th>SUBJECT NO.</th>
<th>AGE (YR)</th>
<th>SEX</th>
<th>MARITAL STATUS</th>
<th>EDUCATION (YR)</th>
<th>OCCUPATION</th>
<th>PAIN DURATION (YR)</th>
<th>DIAGNOSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>F</td>
<td>M</td>
<td>12</td>
<td>Disabled</td>
<td>6</td>
<td>S/P neck, shoulder injury</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>M</td>
<td>M</td>
<td>13</td>
<td>FT, logging</td>
<td>20</td>
<td>Neck, shoulder, low back</td>
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<tr>
<td>3</td>
<td>42</td>
<td>F</td>
<td>S</td>
<td>13</td>
<td>FT, office manager</td>
<td>3</td>
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<td>4</td>
<td>43</td>
<td>F</td>
<td>M</td>
<td>14</td>
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<td>12</td>
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<td>20</td>
<td>Fibromyalgia, HAs, abdominal pain</td>
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<td>6</td>
<td>61</td>
<td>F</td>
<td>M</td>
<td>14</td>
<td>Disabled</td>
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<td>Repetitive motion injury (shoulder, hand)</td>
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<td>7</td>
<td>34</td>
<td>F</td>
<td>S</td>
<td>16</td>
<td>FT, marketing</td>
<td>12</td>
<td>Tension and migraine headaches</td>
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<td>8</td>
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<td>Foot pain secondary to sprained ankle</td>
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<td>9</td>
<td>52</td>
<td>F</td>
<td>M</td>
<td>16</td>
<td>FT, RN</td>
<td>30</td>
<td>Headaches</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>F</td>
<td>M</td>
<td>12</td>
<td>Disabled</td>
<td>2</td>
<td>Low back pain of unknown etiology</td>
</tr>
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Mean, N = 10

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<td>AGE</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>11.2</td>
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<tr>
<td>SD</td>
<td>7.5</td>
<td>2.4</td>
<td></td>
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</tbody>
</table>

S/P, status post; FT, full time; HAs, headaches; SD, standard deviation.

**Figure 1.** Study design.
Relaxation Techniques and Cognitive Coping Strategies. Although there is no definitive list of adaptive coping strategies, there is an agreement that relaxation techniques,22,23 cognitive restructuring, and diverting attention29 are helpful in dealing with chronic pain. On the other hand, catastrophizing and other negative thoughts have been shown to be maladaptive coping strategies28 and need to be challenged to achieve improvement. Because catastrophizing is an automatic, reflexive process, patients do not recognize it but are only aware that their mood drifts downward and pain level rises. Thus, a therapeutic goal we emphasized was to help the patient recognize catastrophizing, to challenge negative thoughts, and to replace them with positive self-statements. In addition to cognitive restructuring and problem solving techniques, we taught other adaptive coping skills such as communication skills, cognitive distractions, activity pacing, and a variety of relaxation techniques (progressive relaxation, autogenic training, meditation, and guided imagery). During the program, therapists demonstrated examples of each coping strategy and guided patients in trying them out. Patients were then encouraged to practice each strategy as homework assignments. Audiocassette tapes were given to each patient to practice relaxation techniques at home daily.

Challenging Pain Beliefs. Patients’ understanding of or beliefs about their pain influence their motivation to engage in behavioral tasks and pain treatment modalities.19,20 In our program we used a variety of techniques to change maladaptive pain beliefs and to improve feelings of patient self-efficacy. These included cognitive distraction, relaxation techniques, and time-contingent behavioral pacing skills. We also encouraged patients to work on increasing pleasant activities, social opportunities, and feelings of self-worth.

Setting Treatment Goals. At the beginning of CBT program we explained the necessity of all patients deciding on a set of specific treatment goals. Patients set their own goals with our guidance so that they were realistic but challenging. At the end of the group CBT program, patients reviewed their goals and possible obstacles in maintaining them.

Pain Diaries as a Self-Education Tool. Patients were encouraged to keep a paper and pencil daily pain diary during the 10 weeks of CBT. Pain diaries enabled the therapists to monitor treatment progress and provided a tool for patient self-education. Patients were taught to recognize connections between their life events and the daily fluctuations in their pain. Use of the patient’s own self-reported information helped to emphasize the importance of cognitive appraisal and emotion. Pain diaries also showed the relationship of overexertion or underexertion and exacerbation of pain.

Enhancing Social Support. Spouses or significant others were invited to attend the week-eight session. In this study, 8 of the 10 partners attended. The purpose of this was to educate partners about the program, to provide the opportunity for them to ask questions, to obtain collateral feedback regarding patients’ progress, and to share their experiences with the other patients and partners. Social learning theory suggests that changes in behavior and thoughts can result from observing models in the world around us, such as peers or family members.5,8

We believe that this “Social Support” session helps shift the frame of thinking so as to generalize from the group to other important aspects of life (eg, the partner). It facilitates the process of associating the group with an important person from the outside of group. We think that this session also deepens patients’ own emotional experience, which may also promote a longer-lasting influence.

TIVR

The TIVR is based on a computer-driven system in which a prerecorded human voice asks a series of questions and callers respond by using the telephone keypad. The dedicated, toll-free phone number is active throughout the continental United States and Canada so calls can be made when traveling, while on vacation, or even if the subject moves out of the area. We created the TIVR as
an extension of CBT group therapy elements that utilize a relapse prevention model of behavior change.\textsuperscript{17} The TIVR has 4 components.

Component 1 (self-monitoring) is a 21-item daily questionnaire. Subjects are asked to rate for the previous 24 hours their level of pain, mood, stress, use of pain medication, and a variety of other parameters. This daily self-monitoring provides a convenient means of reporting not only symptoms but also target behaviors, frequency of use of coping skills, and coping efficacy.

For this pilot study we suggested completing the Component 1 questionnaire daily, but to see what the spontaneous call frequency would be, we did not make this a condition of study participation. Patient calls were monitored, and reminder calls were made only during the first week of the study, as we have done in previous work.\textsuperscript{48} To compensate for their time, subjects were paid $0.70 for each day they called the daily questionnaire.

The daily questionnaire could be answered only once every 24 hours. After participants completed the daily self-monitoring component of TIVR, they could branch to one of the other components or make separate calls for the other components as often as they liked.

Component 2 (didactic skills review) permits patients to access a verbal review of 8 different pain management skills learned during the 10 weeks of CBT, such as reappraisal of pain, activity pacing, cognitive restructuring, relaxation response, self-talk, and others. Each review is 1 to 4 minutes in length. Having ongoing access to the rationale for and instruction in pain coping skills can be useful in enhancing patients' understanding of these techniques. As emphasized in the relapse prevention model,\textsuperscript{17,32} access to didactic review of such coping strategies is particularly useful in reminding patients that they have multiple options for coping with pain.

Component 3 (guided behavioral rehearsal of pain coping skills) is a set of eight 2- to 10-minute verbal messages for relaxation, sleep induction, cognitive restructuring, and other skills. The therapist verbally guides the patient through the pain coping skills they had previously learned during the group CBT. Patients are encouraged to use this component to reinforce their practice efforts and to help them deal with challenging situations (eg, pain flares, emotionally or physically demanding life events) that might lead to coping setbacks. In the relapse prevention model, guided behavioral rehearsal is especially useful in enhancing the patient's sense of self-efficacy in learned coping skills.\textsuperscript{32,37}

Component 4 (monthly therapist feedback) of the TIVR intervention is a personalized message from the group therapist recorded once a month for each subject summarizing progress and offering suggestions. This message contains a summary of the patient's daily reports to the TIVR for the past month; insight into possible relationships between reported pain, stress, mood, anger, and use of coping skills; suggestions for other pain management tactics; and verbal encouragement. This regular feedback also simulates and extends the weekly feedback provided during the initial CBT training. The relapse prevention model maintains that periodic therapist feedback is quite useful in helping patients to gauge their progress and to recognize successes as well as problems in coping with challenging situations.\textsuperscript{37}

All subjects participated in a 90-minute group TIVR training session for which they were reimbursed $20. This session was held 1 week before the end of CBT group program so that patients had an opportunity to practice using the TIVR before finishing CBT and to ask any questions before starting the 4-month TIVR trial. Each subject was given a detailed but user-friendly instruction manual. Subjects were assigned a unique identification number and selected their own numeric password to ensure security of their personal data.

Calls for the 4-month TIVR trial began the day after training; however, the first post-CBT week was designated for system practice, and the data for that week were not analyzed. If a subject missed a daily TIVR call on 2 successive days during this first week, we called them to inquire about any difficulties. There were no call reminders after the first week of the TIVR trial. The computer was programmed to monitor patient calling records, and then daily reports were generated for the therapist's monthly message.

### Assessment Instruments/Questionnaires

#### Intake Assessment Questionnaire

This is a general information questionnaire created for the MBMC to obtain demographic data including sex, age, marital status, occupation, employment status, and educational level. In addition, a history of the patient's pain and related treatment, health perception and habits, roles and relationships, coping skills, and other areas are explored. This questionnaire was completed only at the time of initial enrollment. No psychometric data are available for this instrument.

All participants were asked to complete the following self-report instruments at the time of enrolment and at the 2 follow-up evaluations.

#### Augmented SF-36 (Treatment Outcomes in Pain Survey — TOPS)

The SF-36 was originally developed for the Medical Outcomes Study as a general instrument to evaluate health status in broad range of medical populations.\textsuperscript{54} Although brief, the SF-36 has considerable normative data and has been validated worldwide.\textsuperscript{14} The augmented version of SF-36 for pain (TOPS) is a 120-item, pain-enhanced version of the SF-36 that includes measures of 11 dimensions of pain and pain treatment response.\textsuperscript{44,45} The most comprehensive of these, the TOPS Total Pain Experience Scale, is a sum of 5 TOPS subscales: Pain Symptom, Functional Limitations, Perceived Family Disability, Objective Family Disability, and Objective Work Disability.\textsuperscript{45} TOPS Total Pain Experience is the scale that best discriminated individual changes within the populations used to norm the TOPS.\textsuperscript{45}
Subjects’ Use of the TIVR (Feasibility)  
All patients made regular use of the TIVR throughout the 4 months of study. Collectively the 10 research subjects called the daily self-monitoring questionnaire (Component 1) on 83% of the approximately 1200 reporting days. This mean was reduced by 1 subject who made only 45% of the daily calls. The daily calling rates of the remaining 9 subjects ranged from 70% to 99%, with a mean of 87%. There was a slight decline in the percentage of daily calls during the 4 months. On the other hand, 9 of the 10 subjects made 107 unremunerated calls (69% by 2 subjects) after the end of the study.

The didactic review of skills (Component 2) was variably used. Seven of 10 subjects used this component at least once. The group’s average frequency of use was 1.5 times a week across the 4-month trial. The highest level of use occurred in months 1 and 4 with a relative hiatus in months 2 and 3.

The guided behavioral rehearsals (Component 3) were used by all 10 of the subjects. Use by individual subjects ranged widely from a low of 3 times across the 4 months to a high of 83 times, ie, more than 5 times a week. Mean usage across the 10 subjects was more than once a week, and use was more consistent across the 4 months than it was for component 2. The most popular behavioral rehearsals were Body Scan Relaxation and Sleep Induction.

Every subject reviewed each new monthly therapist feedback message (Component 4) as soon as it was available. Many reviewed each monthly message more than once, and some even requested a hard copy.

Finally, we asked subjects to fill out a questionnaire about the TIVR at the conclusion of the study. These results indicated that all subjects found the TIVR to be helpful in a variety of ways. Most patients believed that the TIVR reinforced what they learned in the CBT group program. They reported that the TIVR enhanced their motivation to continue practicing the new skills they learned and provided structure so learned skills became a habit. We concluded that the 4-month duration of the TIVR was a reasonable length of follow-up to ensure patients are maintaining learned patterns, but not so long as to be burdensome to the patients or the clinician. Only one patient thought that 4 months of calling was too long; the others continued to call after the 4-month trial. One resumed calling 2 months after the trial ended during increased family stress associated with an increase of pain.

Treatment Outcomes After CBT and After TIVR  
This was a single group study in which patients’ progress after treatment and after TIVR was compared independently to their pretreatment baseline. Therefore, we analyzed the outcome data by using within-subject analyses.

Table 2 shows sample means for key study variables compared to baseline and normative values. The treatment outcome results summarized in Table 3 present variables from the SF-36, MPQ, and TOPS and 3 variables from the CSQ. Our minimum criterion for therapeutic success was that improvements obtained during CBT would be maintained during the 4 months of TIVR. However, for Mental Health Composite Score from TOPS and most of the pain measures, results were actually more positive than that; improvements continued to strengthen during the TIVR trial, ie, after CBT had been completed. For example as shown in Table 3, the maximum mean change from baseline for all reported measures except one CSQ variable (Ability to Decrease Pain) occurred at the post-TIVR point. For 3 measures, improvement compared to baseline was statistically significant at the post-TIVR point despite the lack of significance at the post-CBT point. These latter included the
SF-36 Mental Health Composite score, the current pain measure Pain Now on the MPQ, and the Total Pain Experience measure from the TOPS. Of the 22 variables we reviewed from these 4 instruments, the only variable that was significantly improved after CBT but no longer significant after TIVR was the CSQ measure Praying or Hoping, a so-called “negative” coping skill.

Two of the figures show the actual test scores at each assessment for key variables from Table 3. In Fig 2, we have shown 2 additional TOPS variables along with Total Pain Experience. Fig 3 illustrates the two SF-36 summary variables along with Catastrophizing scale from CSQ.

Discussion

In this small, within group, uncontrolled study, musculoskeletal pain patients who averaged 11 years of chronicity demonstrated statistically significant improvement in SF-36 Mental Health Composite, TOPS Total Pain Experience, CSQ Catastrophizing, and CSQ Ability to Decrease the Pain after receiving 4 months of a telephone-based treatment specifically designed for chronic pain. Although the treatment effect cannot be measured in the absence of a control group, it seems that the TIVR technology offers an option for self-directed treatment as an adjunct to behavioral group therapy to sustain some chronic pain patients.

On the basis of consistency of patient use and their uniformly positive feedback, the feasibility of TIVR appears to be high. Subjects used the daily questionnaire (Component 1, self-monitoring) nearly every day throughout the 4-month trial. Participants were paid $0.70 for each of these daily calls, but in retrospect the payment was probably unnecessary. Half of the subjects refused payment, and 9 of the 10 continued to call after the end of the trial when there was no payment.

Self-monitoring is believed to be one of the most important components of maintenance enhancement.37 Relapse prevention models emphasize the utility of self-monitoring in helping patients identify early warning signs of setbacks in coping efforts, evaluate the effects of specific coping skills, and become aware of successes and problems in dealing with setbacks.32,37 In addition, pain diaries (Component 1) enabled the therapists to monitor treatment progress and to teach patients to recognize connections between their life events and the daily fluctuations in their pain. Use of the patient’s own self-reported information helped to emphasize the importance

**Table 3. Maximum Mean Changes and *P* Values for Assessment Scales at Baseline, Post CBT, and Post TIVR**

<table>
<thead>
<tr>
<th>Test</th>
<th>Maximum mean change*</th>
<th>Overall test P value</th>
<th>Post CBT</th>
<th>Post TIVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-36 Mental Health Composite (+)†</td>
<td>6.2 (2)</td>
<td>.04</td>
<td>NS</td>
<td>.0004</td>
</tr>
<tr>
<td>SF-36 Physical Composite Score (+)</td>
<td>2.1 (2)</td>
<td>NS</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>MPQ - Pain Now (−)</td>
<td>−1.20 (2)</td>
<td>.02</td>
<td>NS</td>
<td>.01</td>
</tr>
<tr>
<td>MPQ - Pain Typical (−)</td>
<td>−.80 (2)</td>
<td>NS</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CSQ - Catastrophizing (−)</td>
<td>−9.3 (2)</td>
<td>.0001</td>
<td>.0005</td>
<td>.0006</td>
</tr>
<tr>
<td>CSQ - Ability to Control Pain (+)</td>
<td>0.90 (1)</td>
<td>.01</td>
<td>.01</td>
<td>.08</td>
</tr>
<tr>
<td>CSQ - Ability to Decrease Pain (+)</td>
<td>1.20 (2)</td>
<td>.01</td>
<td>.04</td>
<td>.01</td>
</tr>
<tr>
<td>TOPS - Total Pain Experience(−)</td>
<td>−6.5 (2)</td>
<td>.01</td>
<td>NS</td>
<td>.03</td>
</tr>
</tbody>
</table>

N = 10 subjects. Huyn-Feldt Adjusted F Test was used for these analyses.

CBT, cognitive behavioral therapy; TIVR, Therapeutic Interactive Voice Response; NS, not significant.

*Number in parentheses indicates maximum change from baseline: 1, post CBT; 2, post TIVR.

†Sign in parentheses indicates the direction test results should go to satisfy expected outcome.

SF-36 Mental Health Composite score, the current pain measure Pain Now on the MPQ, and the Total Pain Experience measure from the TOPS. Of the 22 variables we reviewed from these 4 instruments, the only variable that was significantly improved after CBT but no longer significant after TIVR was the CSQ measure Praying or Hoping, a so-called “negative” coping skill.

Two of the figures show the actual test scores at each assessment for key variables from Table 3. In Fig 2, we have shown 2 additional TOPS variables along with Total Pain Experience. Fig 3 illustrates the two SF-36 summary variables along with Catastrophizing scale from CSQ.

**Figure 2.** Actual test scores on 3 TOPS measures in patients with chronic pain: (1) before starting 10 weeks of group CBT for pain management (Baseline), (2) after completing the 10 weeks of group therapy (Post CBT), and (3) after 4 additional months of an automated telephone intervention (Post TIVR). All P values are for comparisons to baseline.
of cognitive appraisal and emotion and the relationship of overexertion or underexertion and exacerbation of pain. We believe that this daily self-monitoring was one of the contributing factors in improvement of symptoms. However, the TIVR is more of an interactive process than just keeping a self-monitoring calendar. Simply by doing the questionnaire (Component 1), patients get a daily reminder of the adaptive coping skills they have been taught in CBT. Beyond that, extending self-monitoring for 4 months helps patients generalize coping skills training from a group setting to daily life (confirmed by the results of TOPS and SF-36) and enables patients to practice under expert guidance skills that they have not yet mastered during the formal CBT program.

The didactic review of skills (Component 2) was used least frequently, but most use was in the first month. Presumably use rates fell after that as patients perfected the skills they had learned in CBT. There was some increased use again in the fourth month, after reminders in the third monthly message to subjects who had narrowed their skills repertoire. Components 3 and 4 were used regularly throughout the 4 months by all of the subjects. Patient feedback about the monthly message suggests that it was an especially important part of the TIVR. Patients appreciated the fact that it was personalized and recorded in the voice of the group therapist. They believed this demonstrated the ongoing interest of the therapist in their progress. We speculate that this belief increased their motivation to use the TIVR as a guide for their self-improvement.

Regarding the outcome data, for all the variables we examined except one (Ability to Control Pain), the maximum change from baseline occurred after the 4 months of TIVR rather than after the 10 weeks of CBT (Table 3). The fact that key variables continued to show improvement and that these improvements were often statistically significant despite a sample size of only 10 patients is also an encouraging preliminary outcome. This contrasts with the expected post-CBT outcome pattern for patients having persistent pain, ie, a plateau in therapeutic benefit after CBT is completed and sometimes a deterioration in improvement within a few months. We believe that coping strategies are skills that need to be practiced over time to be mastered. At the end of the group CBT, patients had learned about coping skills but had little experience in using them. The following 4 months of TIVR gave them opportunity to practice these skills daily so they became a helpful habit rather than just knowledge. We speculate that, when adherence to coping skills increases, the self-efficacy improves and relapse into pain behaviors decreases. However, without a control group we cannot rule out regression to the mean as an explanation for these findings. Patients may have been referred for CBT (and thus recruited for the study) at a time when their pain was above average in severity. Gradual improvement back to their own mean level of severity over time might then be interpreted as response to the therapy. We believe this is unlikely for 3 reasons. First is the magnitude of the improvement. Second is the fact that improvement continued for an extended period of time and actually strengthened as time went on. Third, spontaneous improvement was unlikely in this group because all of the subjects had long histories of pain and failure to respond to numerous prior trials of treatment. Two other possible explanations that we cannot rule out are (1) that the improvement we found is simply a manifestation of the fluctuations that are a part of the natural history of chronic pain and (2) a placebo effect, perhaps because of the near daily attention to the study protocol. The lack of a control group is mitigated to some extent by our use of within-subject analyses, in which each subject serves as his/her own control. This helps to minimize confounding by personality or other variables that may influence outcomes.

To our knowledge, no similar automated telephone-based intervention has been described in the pain literature. A significant advantage of this technology is that it facilitates self-directed management of chronic illness. For example, 1 subject who stopped using the TIVR at the conclusion of the trial resumed regular calling again a few weeks later when she began to lose control of her pain. She reported that this resumption helped greatly in regaining a sense of behavioral control and a reduction in pain symptoms.

Although these results appear promising, it is important to recognize the results are preliminary. Several lim-

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**Figure 3.** Results from the Catastrophizing subscale of the CSQ and 2 composite subscales from the SF-36 in patients with chronic pain: (1) before starting 10 weeks of group CBT for pain management (Baseline), (2) after completing the 10 weeks of group therapy (Post CBT), and (3) after 4 additional months of an automated telephone intervention (Post TIVR). All P values are for comparisons to baseline. NS, Not significant.
iterations of this study should be considered. First, although we had specific inclusion and exclusion criteria, the study group was heterogeneous as to the cause of the chronic pain. Consequently, it is unclear to what extent our results are generalizable to the treatment of patients with other pain disorders and to other clinical settings. Furthermore, the size of the study group was small. Clearly, additional studies are needed to validate our results.

We are cautiously optimistic about this technology at this point. We continue to explore the therapeutic potential of the TIVR and hope to mount a randomized controlled trial of TIVR in a group of patients with a specific disorder, chronic knee pain due to osteoarthritis, in the near future. We also plan to explore the relative contribution of each component to the positive outcome. For example, Component 4 was an individualized rather than an automated process and thus the most consuming of therapist time. If further study shows this could be automated or eliminated, the cost in personnel time associated with using the TIVR would be significantly reduced.

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