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# Monitoring daily affective symptoms and memory function using Interactive Voice Response (IVR) in outpatients receiving electroconvulsive therapy

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## Abstract

**Objective—**Recently there has been a gradual shift from inpatient-only electroconvulsive therapy (ECT) toward outpatient administration. Potential advantages include convenience and reduced cost. But providers do not have the same opportunity to monitor treatment response and side effects as they do with inpatients. This can obviate some of the potential advantages of outpatient ECT, such as tailoring treatment intervals to clinical response. Scheduling is typically algorithmic rather than empirically based. Daily monitoring through an automated telephone, interactive voice response (IVR), is a potential solution to this quandary.

**Methods—**To test feasibility of clinical monitoring via IVR, we recruited 26 patients (69% female, mean age 51 years) receiving outpatient ECT to make daily IVR reports of affective symptoms and subjective memory for 60 days. The IVR also administered a word recognition task daily to test objective memory. Every seventh day a longer IVR weekly interview included questions about suicidal ideation.

**Results—**Overall daily call compliance was high (mean=80%). Most participants (96%) did not consider the calls to be time-consuming. Longitudinal regression analysis using Generalized Estimating Equations revealed that participant objective memory functioning significantly improved during the study ($p<.05$). Out of 123 weekly IVR interviews, 41 reports (33%) in 14 patients endorsed suicidal ideation during the previous week.

**Conclusion—**IVR monitoring of outpatient ECT can provide more detailed clinical information than standard outpatient ECT assessment. IVR data offer providers a comprehensive, longitudinal picture of patient treatment response and side effects as a basis for treatment scheduling and ongoing clinical management.

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### Keywords

electroconvulsive therapy (ECT); interactive voice response (IVR); automated monitoring; memory function; mood disorders

## INTRODUCTION

In recent decades, there has been a shift from the use of inpatient-only electroconvulsive therapy (ECT) to outpatient services.[1,2,3,4] Outpatient ECT has significant advantages, for example it minimizes or eliminates the high cost of hospitalization and allows patients to receive treatment with less disruption to normal life routines.[5–7] Outpatient ECT also offers the potential for more flexible scheduling of treatments linked to treatment response. However, a significant disadvantage of outpatient delivery is that the opportunity to closely monitor treatment response and side effects is reduced in comparison to inpatient treatments. Typically with outpatient ECT, assessments of mood and treatment side effects, such as memory functioning, are conducted at the time of each outpatient treatment.[8,9] This does not give as detailed a picture of a patient's treatment response compared to the daily monitoring available on an inpatient service and may not provide sufficient clinical information for optimal treatment scheduling.[6] Further, retrospective reports of symptoms may be distorted by anxiety or distress associated with the scheduled ECT treatment. Lisanby et al.[10] recently proposed a treatment scheduling algorithm based on symptom monitoring via intensive case management.

Daily monitoring through interactive voice response (IVR) telephone technology is a potential solution to this problem. IVR systems allow patients to report mood and related symptoms via automated telephone interviews. Several investigations have examined the use of IVR and other automated systems for patients with severe mood disorders to monitor daily psychiatric symptoms,[11] treatment response,[12] screen for depression,[13,14] and for computer-based adjunctive treatment.[15] Daily monitoring of ECT treatment response and side effects via IVR can provide a more detailed picture of mood and cognitive functioning, which could be useful to ECT providers for assessing treatment response, determining additional treatment needs, and tracking key symptoms such as suicidal ideation, all of which could enhance clinical decision-making.

### Purpose

The aims of the current study were three-fold: 1) to test the feasibility of monitoring ECT patient mood and anxiety symptoms, suicidal ideation, and both objective and subjective memory function via daily IVR reports, 2) to elicit qualitative feedback from patients about the IVR-based daily monitoring and 3) to develop a report form of patient IVR responses for ECT providers, referring psychiatrists, and other appropriate clinicians.

## MATERIALS AND METHODS

From July 2011 to July 2012, ECT providers from our University Psychiatry Service recruited patients to participate. Inclusion criteria comprised: 1) starting or currently receiving ECT for a mood disorder[16] and 2) participant able to complete daily telephone calls. Inpatients were invited to participate if they were expected to continue ECT after hospital discharge. The only exclusion criterion was not having consistent access to a touch-tone phone; candidates were not excluded for suicide risk. Five patients declined to participate. Patients who consented (N=26) were contacted via telephone by the study Research Assistant (RA) one to three days post-consent who collected demographic information and conducted a 10-minute orientation to the study and IVR. Patients completed

their first IVR call as a conference call with the RA who provided instructions and answered questions during the IVR interview. Participants were then asked to complete daily IVR calls on their own for the next 60 days except for days they received ECT. Participants were not compensated for participating. All participants provided written, informed consent approved by the University Institutional Review Board.

## Interviews

Six days a week, participants completed an IVR interview that included two questions about mood and two about anxiety adapted from the Patient Health Questionnaire-4 and PHQ-9 respectively.[17,18] To assess subjective memory, callers were asked three questions about memory functioning taken from the Squire Subjective Memory Questionnaire (SSMQ).[19] The questions selected were those with the highest loading scores in a psychometric study of the instrument.[20] Participants also completed an objective memory test during each call that assessed the recognition of unstructured word lists, found to be strongly affected by ECT treatment.[21] Words were chosen as high frequency four to five letter nouns from the MRC Psycholinguistic Database[22] which were read aloud by a single female voice for daily tests and a male voice for weekly tests. These voices remained consistent across the study. The words were placed into a standard recognition memory task.[23] Six words were presented at the beginning of the IVR call. Participants were then asked to identify the six words from a list of 12 at the end of the call. Participants were asked to not write the words down. In addition participants were instructed to repeat each word aloud and immediately press any key to continue. We hoped this would serve as a distractor and make it less likely for subjects to notate the words. Words used in the memory test were one and two syllable nouns. Words were not used more than once per two weeks.

Every seventh day, participants completed a longer IVR interview that included five additional affective questions from the PHQ-9, 5 additional anxiety questions from the GAD Inventory-7,[24,25] and five additional subjective memory items from the SMMQ.[19] At this interview, phrasing was changed to index the past week. The weekly interview also asked participants how frequently they had thoughts of suicide in the past week. Any positive response triggered a second question asking whether they were suicidal at the time of the call. If they answered “yes,” the caller received a prompt to call the Suicide Prevention Hotline and was given the telephone number. Weekly interview data were reviewed daily by an RA and any “yes” responses to feeling suicidal at the time of the call were sent to the ECT study physician (TR). Patients were asked permission to inform providers of suicidal ideation and all agreed. We chose not to ask about suicidal ideation on a daily basis as it seemed to us that such frequency would be intrusive and burdensome. Suicidal ideation is typically only asked when patients attend for ECT treatments or when they see their health care provider. Thus, asking about suicidal ideation weekly goes beyond current practice.

Following the 60-day study period (or earlier for those who stopped calling) participants completed a live, telephone-based final interview with the RA gathering feedback about the study. If participants completed ECT before the 60-day study period, they were asked to continue making the IVR reports for the full 60 days so as to track clinical progress post-ECT.

## Report Graphs

Graphs of participant self-reported mood, anxiety, subjective memory and the objective memory test results for each 30-day period in the study were constructed and distributed, with patient permission, to the ECT team. Sample graphs with simulated data were also given to other Psychiatry Department clinicians during a faculty meeting for informal, collective feedback. Once a final graph template was agreed upon, monthly graphs were

sent, with participant permission, to all ECT and community providers involved in the patient's care.

### IVR Method

Due to limited funds at the beginning of the study, an RA simulated an IVR by calling participants and reading the IVR script. After enrolling 13 participants, the study gained resources to permit programming an IVR. In particular, the study gained a graduate student research assistant (RA) who was able to program the IVR for free. All subsequent participants used this automated IVR, which was available 24/7 and accessible from any telephone. A toll-free number allowed patients to make calls from any area code in North America. If participants missed two consecutive calls to the IVR, they received a reminder call from the RA.

### Outcome Variables and Analyses

Outcome variables included call compliance; changes in depressed mood, anxiety, subjective and objective memory test scores during the 60-day study period; and qualitative feedback about the IVR. Changes in mood and anxiety were evaluated from the daily IVR reports. For the daily objective memory test, we changed from using three to six words half-way through the study, because of ceiling effects with three words. Six-word data for all participants were available from the beginning on the weekly interview and thus were used for objective memory analysis. We analyzed weekly subjective memory reports to retain the same time measurement as the objective memory analysis. We also evaluated whether our two interview types, live or IVR, predicted call compliance.

For objective memory, we computed d-prime scores by subtracting the z-score of the proportion of incorrectly identified words from the z-score of the proportion correctly identified.[26] The d-prime scale for the 6-word test during the study ranged from −1.934 to 1.934.

Change in quantitative variables over time was modeled using the SPSS[27] general linear model environment with generalized estimating equations (GEE).[28] GEE allows for a user-defined within-ID correlation structure to account for associations among daily reports within participants. We determined that an exchangeable correlation structure best fit the data based on the Quasi-Likelihood under the Independence Model Criterion (QIC).[29] Data were clustered by unique identification number and sorted by time (in days) consecutively from one to 60. SPSS uses pairwise deletion of missing data. Number of ECT sessions received during the study was included in all models as a covariate because we anticipated number of ECT sessions may influence depressive symptoms, anxiety and memory. We also evaluated call modality (live interviewer vs. IVR interview) as a potential covariate, but did not include it because 1) modality did not significantly predict any of the outcome variables and 2) adding modality did not change the beta values nor p values in our models. A 95% confidence interval was used for all GEE analyses.

## RESULTS

### Participants

The study sample consisted 26 participants, 69% female, 96% Caucasian, and mean age was 51 ± 12 years. Psychiatric diagnoses included major depressive disorder (n=18), bipolar disorder (n=7), and bipolar disorder with psychotic features (n=1). Sixteen participants started the study while receiving acute ECT treatment (2 or 3 ECT treatments per week) and 10 participants started the study while receiving maintenance ECT (1 treatment per week n=3, 1 treatment biweekly n=5, monthly treatments n=2). Most participants (88%; N=23)

began the study as outpatients, 3 (12%) began as inpatients and transitioned to outpatient. Seventeen patients were treated using the ultrabrief pulsewidth (i.e., Columbia) protocol[30] when they started the study and 9 patients were treated using the Duke protocol.[31] At the time participants enrolled in the study, electrode placements used in the treatment protocols were right unilateral (n=17), bitemporal (n=3), bifrontal (n=3), or left anterior/right temporal (n=3).[31] One of four ECT induction agents were used at the time participants entered the study: etomidate, ketamine, methohexital, or propofol.

### Participant Retention

Two of the acute ECT inpatients (8%) failed to engage in the study defined as making no or only one call to the IVR, and were dropped. Of the remaining 24, six stopped calling the IVR within the first month (n=4 in acute ECT, n=2 in maintenance ECT). The remaining 18 completed the full 60 days. All 24 participants completed final interviews.

### Feasibility

Call compliance was high (M=80%; range = 30–100%) while participants were engaged in the study. Mean daily interview call length was 4.3 ± 0.9 minutes and mean weekly interview call was 8.5 ± 1.6 minutes. While call compliance for both daily and weekly interviews was high, call compliance for weekly interviews was actually higher (93%) than compliance with daily interviews (83%). Participants preferred to call during the day; 72% of calls were made before 5:00 P.M. Most participants (96%) did not consider the interviews to be time-consuming. For the six patients who stopped calling, the most common reason for discontinuation was difficulty remembering to call. Mean call compliance for the participants who completed the full 60 days was 87%. Several participants completed IVR reports on holidays including Thanksgiving, Christmas Eve, and New Year's Eve.

GEE analysis revealed that call compliance was significantly higher (84%) at the start of the study when a live interviewer was initiating the calls, compared to when participants had to initiate the IVR calls (72%) (b=−.09, p=.04, 95% CI −.08, −.01). This was not surprising since the main reason given for non-compliance was forgetting to call the IVR.

### Qualitative Feedback

During the final interview, participants provided qualitative feedback about the IVR. Most (89%) of the 18 who completed the study reported the IVR monitoring made them more aware of their mood and emotions and several suggested adding more memory tests. Common suggestions for improvement included programming the IVR to make outbound calls and including patients on the distribution list for the monthly report summaries.

### Mood, Anxiety and Memory Symptom Changes Across Time

Although the current study was a test of feasibility, we conducted exploratory analyses to evaluate change in daily mood, anxiety, and subjective and objective memory in the 18 participants who completed the study period using GEE.[26] Our first model used study days (1–60) as a predictor of daily depressive symptoms scores, while controlling for the number of ECT sessions received (see Table 1). Results indicated a trend towards decreased depressive symptom severity during the study (b=−.01, p=.06, 95% CI=−.02, .00). Results were similar for anxiety (b=−.01, p=.08, 95% CI=−.02, .00). Participants had a statistically significant improvement in memory functioning as measured by the weekly IVR objective memory test (b=.10, p<.05). With a scale range from −1.34 to 1.34, participants increased an average of .10 points each study week. Objective memory scores for the 6 participants who stopped calling could not be calculated due to inadequate data. Participant subjective memory ratings did not significantly change (b=.05, p=.32).

### Risk Situations Detected via the IVR

Of 123 weekly reports, 41 (33%) in 14 patients revealed suicidal ideation over the prior week and thus were asked whether they were suicidal at the time of the call. If the answer was “yes”, the RA immediately notified the ECT study doctor (TR) per study protocol. Several risk situations were identified by the IVR that led to rapid notification of treatment providers and changes in patient treatment. For two participants, reports of past week suicidal ideation plus additional data on daily depressive symptoms aided in the decision to report this information to the study physician (TR). The study physician contacted the participants and their referring psychiatrists and in both cases, changes were made in the patients’ treatment regimen.

A third participant had stopped ECT against medical advice due to side effects but continued daily IVR reports. On the first weekly IVR interview post-ECT discontinuation, the participant reported that suicidal ideation at the time of the call and was prompted by the IVR to call the Suicide Prevention Hotline. During a follow up clinical interview conducted by the ECT study physician, the patient reported this IVR recommendation also prompted her to call her treating psychologist. As a result, the participant was hospitalized and re-started on ECT, which led to a decrease in depressive symptoms, as evidenced by subsequent IVR reports. The participant expressed gratitude for the IVR intervention and for the coordination between the ECT team and her psychologist, which maintained her safety and resulted in an improvement in her mood.

### Graphs of Participant IVR Reports for Treatment Providers

A final study goal was to develop a monthly ECT report form that could be sent to all providers. Based on informal, iterative feedback from the ECT team and departmental clinicians, we developed a simple monthly report graph format (see Figures 1 and 2). The graphs displayed daily depressive symptoms (Figure 1) or daily objective memory test scores (Figure 2) with a rolling mean to provide a visual representation of patient progress over time. The rolling mean was used to smooth curves and allow for visual representation of trends. The graph was also utilized when a participant reported being suicidal (as described previously) during an IVR call. The graph was sent to the ECT physician (TR) and the participant’s psychologist and aided them in determining the participant’s immediate treatment needs.

## DISCUSSION

Results from the current study indicate that daily IVR monitoring of ECT outpatients’ depressive symptoms, anxiety, subjective and objective memory function, and suicidal ideation is feasible and well accepted by patients. We recruited patients in both acute and maintenance ECT and found that clinical monitoring via IVR appears to be feasible in both acute and maintenance ECT for outpatients. Compliance with daily calls was surprisingly high, given that participants presented with severe depression, had to initiate the IVR calls, and in some cases had memory impairments. In addition, there was no financial incentive for participating in the study or completing the calls. Our feasibility findings support the use of IVR monitoring in patients receiving outpatient ECT. Our findings are in accordance with other studies in the literature that found using IVR or other automated systems are feasible to monitor daily psychiatric symptoms,[11] treatment response,[12,32] and to screen for depression.[13,14]

One factor that may have contributed to high call compliance may be that participants actually liked reporting their symptoms and progress to the IVR, knowing that the information would be shared with the ECT team. In participants’ final interviews, many

made statements to support this point. Further, some participants reported they felt comforted knowing if their symptoms worsened, the information they provided the IVR would reach the ECT team quickly. Call compliance may also have been high because calls were brief, toll-free, and could be made from any landline or cell phone. Participants had 24-hour access to the IVR, thus were able to call when most convenient. Our feasibility results indicate that participants tolerated the very brief (less than five minutes average) daily calls and the longer (mean of about nine minutes) weekly interview once per week, as evidenced by their call compliance. Future research is needed to determine a daily call time limit that participants would be willing to tolerate. This will help in understanding how to balance call length with gathering important clinical information. While call compliance was actually higher for the weekly interview compared to the daily, we caution that participants may not be willing to complete a longer interview every day, hence further research is needed.

An interesting finding was that participants' objective memory function significantly improved over the course of the study, as evidenced by the IVR word recognition tests. There are several possible explanations for the observed memory improvement. First, participant memory function may have improved as depressive symptoms were alleviated by ECT treatment. This is consistent with previous research findings that patients with major depression often exhibit cognitive deficits, including memory impairment[33] and that following ECT treatment, memory function returns to or surpasses baseline memory functioning.[21] Many participants had more intensive ECT treatment schedules at study entry compared to compared to later, thus it is also possible that memory function improved as intensity of treatments decreased. Due to our small sample size, we were not able to further explore this speculation by stratifying analyses based on acute or maintenance ECT. Finally, it is possible that the memory tests themselves served as a daily exercise to strengthen recognition memory skills. Importantly, memory test results did not differ by call modality (live interview vs. IVR interview). Sharing results of the objective memory testing directly with patients might also have a positive impact on subjective perceptions of memory. This could be important since subjective memory impairment is a common complaint among patients receiving ECT.

A principal benefit of IVR daily monitoring is that clinical information, including changes in depressive symptoms, side effects, and suicidal ideation can be monitored more frequently than is possible in a typical outpatient setting. On several occasions the IVR detected changes in mood and suicide risk that would not likely have been detected in the absence of an IVR. Thus, the IVR provided important clinical information that enhanced provider knowledge of patient symptoms and led to more rapid and more specific changes in patients' treatment with an overall improvement in outcomes. Patient care could be further optimized if the IVR was programmed to identify thresholds for changes in depressive symptoms and patient suicide risk and immediately sent an alert to treatment providers.

As a research tool that could be translated to clinical practice, the IVR was both cost and time efficient for us to develop and maintain. While time and effort was required initially for programming and testing, the IVR was easy to maintain once it was running. Once programmed, IVR systems run autonomously and seldom require technical maintenance.

Several limitations of this study should be noted. First, live interviewers were used in place of the IVR at the beginning of the study due to limited project resources; the study switched to using a full IVR partway through recruitment. In addition, the live interviewers called participants, while IVR-only participants had to initiate IVR calls. One benefit of this change in protocol is that it provided an opportunity to detect the higher call compliance rate when patients did not have to initiate the daily calls. With a sufficient budget, the IVR can be programmed to make outgoing calls to participants.

A second limitation is that the recognition memory test has not been validated for IVR administration. Further, our simplified IVR program did not include an algorithm to take into account age and education effects in the memory testing. There is some chance that on the memory tests, participants notated the words. However, if this were the case we would expect memory scores to start out high and remain high throughout the study. On the contrary, we found a statistically significant improvement in objective memory test scores during the course of study. We asked all participants at the final interview if they wrote down the memory words as they were being administered. All denied ever doing so.

About a third (31%) of the study sample either stopped calling the first month (n=6) or failed to engage in the study (n=2). Most of these participants were in acute ECT treatment and the most common reason for stopping calls was difficulty remembering to call. A potential solution to these issues would be to program an IVR to call participants at their requested time. This was not done in the current study due to limited project resources, but would be feasible with a study budget sufficient to retain a professional programmer for the initial IVR programming.

Finally, participants with any mood disorder, including those with psychotic symptoms, were included, as well as participants in any phase of ECT. Such variations in our sample may have made it more difficult to observe changes in symptoms. This may be the case particularly with depressive symptoms. Our results showed a trend toward decreased depressive symptoms, but results were not statistically significant. Participants started the study in different phases of ECT treatment, so it is likely that participants had wide variation in depressive symptom severity at the start of the study. Further, participants may have differed in change in depressive symptoms from the start of the study to the end. These factors may have made it difficult to detect changes in depressive symptoms over time for the entire group. In addition, our study was only powered to detect the largest effects. A corresponding advantage of our heterogeneous study group is that our sample allows for broader generalizability of our feasibility results.

### Implications

IVR daily process measurement can improve monitoring of outpatient mood and anxiety symptoms and memory function and provide more detailed clinical information than is generally available with standard outpatient ECT. Giving ECT providers a more detailed picture of patient treatment response may enhance the quality of outpatient ECT treatment by allowing providers to see trends in response and side effects and to adjust treatment accordingly. This may lead to enhanced patient safety, improved treatment adherence and decreased treatment side effects due to early detection. IVR monitoring could be tailored to the specific interests of clinic providers or standardized to allow for easy dissemination to multiple ECT clinics. In addition, IVR monitoring could be expanded to include periodic reports from participating care-givers to provide ECT physicians a broader perspective on the patient's functioning and treatment response. In future research we plan to expand upon IVR monitoring to incorporate IVR initiated calls to participants, automated risk management, care-giver reporting, and protocols to reduce or help patients cope with possible memory impairment and other potential ECT-related side effects. In addition, we plan to explore ways to facilitate the implementation and use of IVR monitoring for outpatient ECT.

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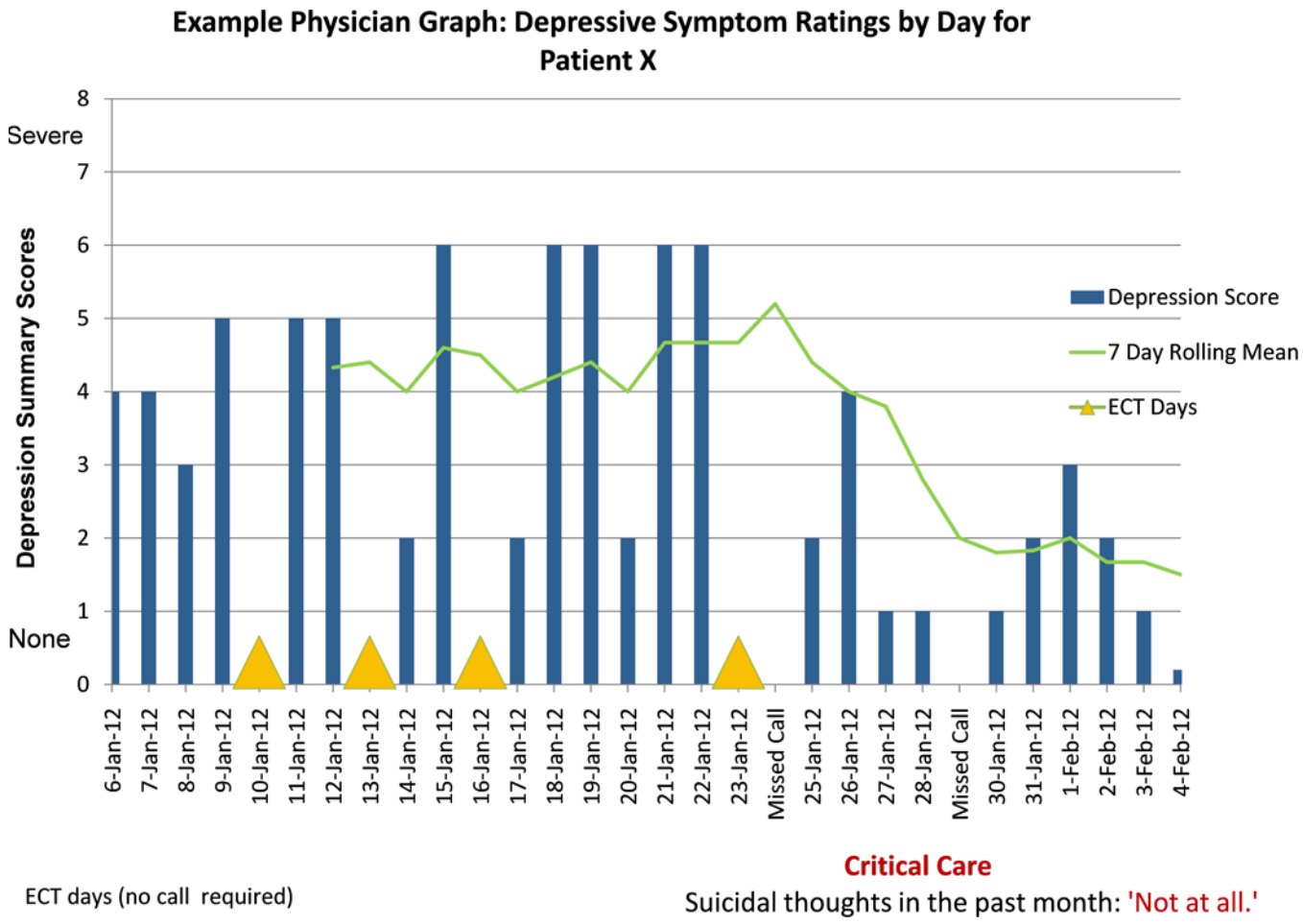


**Figure 1.**

The rolling mean was calculated as the mean of the past 7 study day depression ratings. For each day, scores previous 7$^{th}$ day were dropped and the most current day scores included to compute the mean.

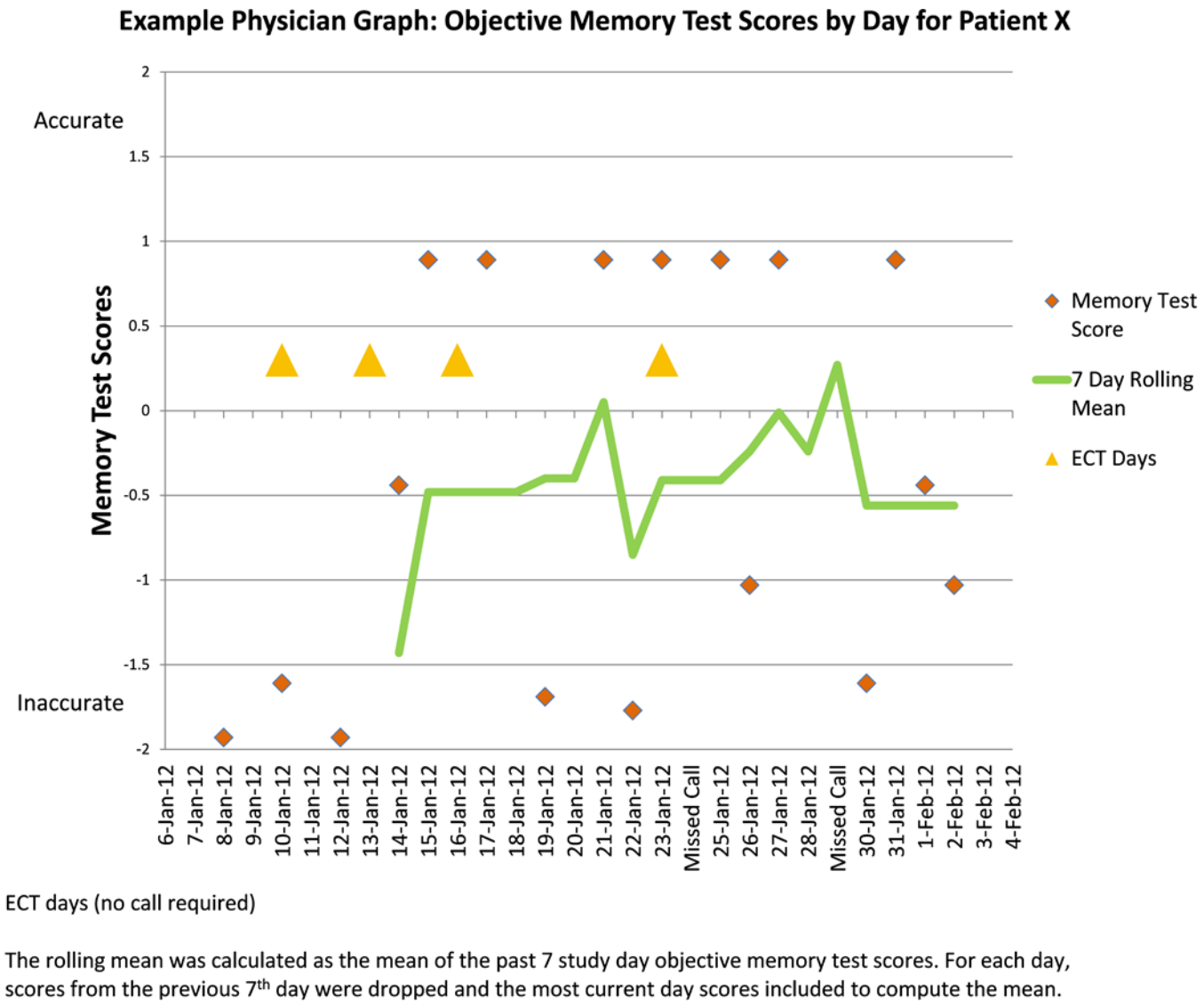


**Figure 2.**

The rolling mean was calculated as the mean of the past 7 study day objective memory test scores. For each day, scores from the previous 7th day were dropped and the most current day scores included to compute the mean.

**Table 1**

Effect of time in the study on daily depressive symptoms, anxiety, and memory.

| | *b* | SE | *p* | 95%CI (low, high) | |
|---|---|---|---|---|---|
| | DV: Daily objective memory test scores | | | | |
| Day in the study (1–60) | .10 | .04 | .05* | .00, | .16 |
| Number of ECT sessions[a] | .02 | .04 | .67 | −.07, | 1.01 |
| | DV: Daily subjective memory ratings | | | | |
| Day in the study (1–60) | .05 | .05 | .32 | −.04, | .13 |
| Number of ECT sessions[a] | −.05 | .03 | .15 | −.11, | .02 |
| | DV: Daily depressive symptoms ratings | | | | |
| Day in the study (1–60) | −.01 | .01 | .06 | −.02, | .00 |
| Number of ECT sessions[a] | .08 | .12 | .45 | −13, | .29 |
| | DV: Daily anxiety ratings | | | | |
| Day in the study (1–60) | −.01 | .01 | .08 | −.02, | .00 |
| Number of ECT sessions[a] | .16 | .07 | .03* | .01, | .30 |

*Note*. DV: dependent variable; *b*: unstandardized regression coefficient; SE: standard error; *p: p*-value; CI: confidence interval.

[a]Number of ECT sessions received during the study.

*Statistically significant at the .05 level or lower