

Depression Self-Management Assistance Using Automated Telephonic Assessments and Social Support

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Objective: To understand patient participation in interactive voice response (IVR) depression monitoring and self-management support calls and estimate the workload from clinical alerts based on patients' IVR reports.

Study Design: Observational study from program implementation in 13 community- and university-based primary care practices.

Methods: Patients with depression were identified using electronic records and enrolled by telephone. Patients were asked to complete IVR assessments weekly; those with significantly improved symptoms had the option of completing assessments monthly. Patients could enroll with an informal caregiver who received automated feedback based on patients' IVR reports. Clinicians received alerts regarding significant changes in the scores on the Patient Health Questionnaire 9-item depression measure, antidepressant adherence problems, or suicidal ideation.

Results: A total of 387 patients were followed for 12,042 weeks. More than half (59%) opted to participate with a caregiver. Patients completed 68% of 7912 attempted IVR assessments. Assessment completion was unrelated to patients' depressive symptoms and was higher among those who participated with a caregiver, were married, had more comorbidities, or reported missing a prior appointment. Assessment completion was lower when patients received monthly versus weekly assessment attempts. Clinical alerts were generated during 4.9% of follow-up weeks; most represented medication adherence problems (2.8%). Alerts indicating suicidal ideation were rare (0.2% of patient-weeks).

Conclusions: IVR support calls represent a viable strategy for increasing access to depression monitoring and self-management assistance in primary care. These programs generate a manageable number of alerts, most of which can be triaged with limited physician involvement.

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Roughly 7% of Americans have major depression each year,¹ and depression is expected to be the second-most burdensome disease worldwide by 2030.² Individuals with depression are more likely to have serious medical conditions,³ have twice the mortality rate as nondepressed people,⁴ and incur greater healthcare costs.⁵ Depression is common among primary care patients,⁶ especially those with chronic medical illnesses.⁷ Comorbid depression impairs self-care and worsens medical outcomes.⁷

Effective depression management is impeded by inadequate provider training, limited visit time, and few resources to monitor and support self-care.⁸ Cognitive-behavioral therapy is effective, but limited by the small number of providers and program cost.⁹ Antidepressant medications can reduce symptoms and recurrence risk, but adherence is often poor.¹⁰ For these reasons, routine depression screening is of little benefit without formal systems for follow-up.¹¹ Evidence-based depression care typically includes telephone care management to enhance recovery. While such programs may be cost-effective,^{12,13} they can be unattractive to decision makers because of the sheer number of undertreated patients, staffing requirements,¹⁴ and frequent contact many patients need.^{15,16}

Mobile health services including interactive voice response (IVR) calls address these barriers to effective depression care management. Patients with a variety of chronic conditions will respond to IVR calls¹⁷ and provide valid and reliable clinical information.¹⁸⁻²² Given their efficacy in other chronic diseases, IVR-based interventions may improve mental health outcomes.^{23,24}

Another strategy for improving depression management is to enhance patients' social support. In 1 trial, trained laypersons led to a 65% remission rate for depressive symptoms compared with usual care (39%).²⁵ Patients with greater social support have fewer depressive episodes²⁶⁻²⁸ and lower symptom severity, and most attribute their depression to insufficient support.^{29,30} However, spousal caregivers are at risk for burnout from competing demands,³¹⁻³⁴ and few informal caregivers have the tools needed to systematically monitor patients' mood and support their self-care.

Here, we describe the implementation of a primary care-based intervention in which depressed patients completed weekly IVR mood and self-care telephone assessments, and received tailored messages related to antidepressant adherence, mood monitoring, and behavioral activation. The intervention also

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enhanced linkages between patients and primary care, and with informal caregivers. We examined variation in program engagement as defined by completion of IVR calls and the frequency and types of clinical alerts sent to primary care.

METHODS

Patient Eligibility and Recruitment

Patients were enrolled between March 2010 and January 2012 from 13 university-affiliated and community-based primary care practices. Eligible patients had to have 2 primary care visits in the previous 2 years and 1 in the previous 13 months, and either an active depression diagnosis or an antidepressant prescription plus billing diagnosis of depression. Patients with schizophrenia, psychosis, delusional disorder, bipolar disorder, or dementia were excluded. Potential participants were mailed an introductory letter followed by a telephone call. After providing written informed consent, patients were mailed additional program information, including materials describing effective communication with informal caregivers and clinicians. Caregivers provided oral consent to receive feedback and suggestions based on their patient-partner's IVR assessments. The study was approved by the university human subjects committee.

Program Features

INTERACTIVE VOICE RESPONSE CALLING SYSTEM

The intervention provided (1) patients with IVR monitoring of depressive symptoms and medication adherence, including tailored information about self-care and when to seek health services; (2) clinical teams with actionable feedback about IVR-reported problems; and (3) informal caregivers with feedback about patients' status plus guidance on supporting self-management. Each week an assessment was scheduled (ie, call-week), the system made up to 3 call attempts on up to 3 patient-selected day/time combinations. Call contents were developed with input from psychiatrists, primary care providers, and experts in IVR design and health behavior change. Details about the call contents and flow can be obtained by contacting the authors.

After patients verified their identity, their depression symptoms were assessed using the Patient Health Questionnaire 9-item depression measure (PHQ-9).³⁵ Medication adherence was assessed using a standard item: "How often during the past week did you take your depression medication exactly as prescribed?" Additional questions asked about days in bed due to mental health symptoms and perceived general health.

Take-Away Points

We found that an interactive voice response (IVR) monitoring and self-management program for depressed patients was a viable strategy for increasing access to depression management services in primary care.

- Most patients opted to participate with an informal caregiver, who received automated feedback based on the patient's IVR reports.
- Patients completed 68% of 7912 attempted IVR assessments. Completion rates were similar regardless of patients' depressive symptoms and were higher among those participating with a caregiver.
- The program generated a manageable number of alerts, most of which could be triaged by allied health professionals with limited physician oversight.

Calls used tree-structured algorithms to present recorded queries and information, and lasted between 5 and 20 minutes. Weekly assessments were scheduled for weeks 1 through 6. Thereafter, patients with mild depressive symptoms (3 consecutive PHQ-9 scores of <10) were automatically given the option to reduce the frequency to 1 call-week per month. Patients were automatically given the option to revert to weekly calling whenever their PHQ-9 scores were 10 or higher.

ENHANCED SOCIAL SUPPORT

Patients could participate with a family member or friend (ie, an informal caregiver) and completed the Norbeck Social Support Questionnaire³⁶ to identify the best candidate. Eligible caregivers needed to be at least 18 years old, to report no history of psychosis or cognitive impairment, and to agree to participate. Caregivers automatically received structured e-mails based on information reported during the patient's IVR calls, with feedback about the patient's status and tailored self-management support advice.

CLINICIAN ALERTS

As part of a series of meetings to gain input and review the IVR call contents, clinicians (physicians and nurses) in primary care and psychiatry defined thresholds for alerting primary care teams about urgent patient reports. Alerts were designed to be actionable, have low false-positive rates, and efficiently use human resources for follow-up. The following 3 conditions triggered alerts: suicidal ideation, poor medication adherence, and increase in depressive symptom severity.

Suicidal Ideation. Alerts were generated if patients reported they "had made a specific plan to harm [themselves] or end [their] life," or that it was "somewhat likely" or "very likely" they would "harm [themselves] or end [their] life sometime over the next few days." Patients reporting suicidal thoughts were instructed to talk with their doctor or mental health professional as soon as possible and were told that their clinician would be alerted by fax. Patients automatically received a toll-free 24-hour suicide hotline number and could transfer there

immediately. Finally, patients were informed that their caregiver (if applicable) would receive automated information by phone about assisting the patient in getting help.

Poor Medication Adherence. Alerts were generated if the patient reported “rarely or never” taking their antidepressant as prescribed, or that they had considered reducing their medication or stopping medications due to side effects in the past week.

Increase in Depressive Symptom Severity. Alerts were generated if patients’ PHQ-9 scores increased by at least 5 points since the preceding assessment, or increased from lower than 15 to 15 or higher.

Data Collection and Analysis

We analyzed data at the patient-week level (ie, 1 record for each week an assessment was attempted). At baseline we collected data on patients’ sociodemographic and clinical characteristics including PHQ-8³⁷ (the PHQ-9 without the suicidality item), the number of comorbid medical conditions (hypertension, cardiovascular disease, hyperlipidemia, stroke, arthritis, chronic lung disease, and low back pain), scores on the Medical Outcomes Study Short Form 12 (SF-12),³⁸ hospitalizations, and missed outpatient visits in the prior year.

We examined differences in characteristics of patients who did versus did not enroll with a caregiver. We used 2 multivariable logistic regression models to examine patients’ probability of completing assessments as a function of their demographic characteristics, measures of baseline vulnerability (missed appointments, hospitalizations, depressive symptoms, SF-12 physical and mental functioning scores), and weeks of follow-up. With the exception of patients’ baseline depression scores, coefficients in the full model with *P* values greater than .15 were dropped from the final model. Based on model coefficients we used the *prgen* command in Stata version 11.2³⁹ to plot the probability of assessment completion by patients’ baseline depressive symptom scores. We fit a second logistic model to identify whether assessment completion rates were affected by whether the patient elected to receive monthly versus weekly calls. Because reporting 3 successive PHQ-9 scores lower than 10 was a criterion for monthly calls, patients who did not complete calls regularly would be less likely to be represented in the monthly call data. We minimized that bias by including only patient call-weeks for which the prior assessment was successfully completed. Both models corrected coefficient standard errors for clustering of person-weeks within patients.

Finally, we examined the frequency of clinical alerts per 100 patient-weeks of program participation. We used logistic regression to identify systematic variation in the probability of each alert type across groups of patients defined by their

baseline depressive symptom severity and controlling for sociodemographic covariates. In the subset of patients enrolled from the university-affiliated clinics, we reviewed medical records to characterize clinicians’ response to alerts generated based on reports of suicidal ideation.

RESULTS

Patient Characteristics

A total of 1330 potentially eligible patients were contacted, of which 387 primary care patients from 13 university-based (81%) and community-based (19%) clinics were enrolled. Participants tended to be female (80%) and white (90%), to have more than a high school education (80%), and to be married (62%; **Table 1**). There were a broad range of ages, with 31% being 21 to 45 years old and 12% being 66 years or older. At baseline, 52% reported at least moderate depressive symptoms and 26% reported at least moderately severe symptoms. Two-thirds of patients (66%) reported missing 1 or more primary care appointments in the prior year, and 24% reported being hospitalized in the prior year. Patients reported a mean of 2.1 comorbid medical conditions, with the most prevalent being arthritis (48%), hypertension (47%), back pain (39%), and chronic lung disease (31%).

Most patients enrolled with a caregiver (59%), and these patients had significantly lower incomes, more severe baseline depressive symptoms, a greater likelihood of having been hospitalized in the prior year, and more comorbid chronic conditions (**Table 1**). Compared with patients who did not enroll with a caregiver, those with a caregiver were more likely to have hypertension (52% vs 40%), chronic lung disease (34% vs 26%), and chronic back pain (42% vs 34%) (each *P* < .05).

Assessment Completion Rates

Patients participated for a median of 25 weeks (interquartile range: 21 weeks to 48 weeks), yielding 12,042 patient-weeks of follow-up (**Table 2**). Eleven percent dropped out in the first 6 months. Attrition was unrelated to baseline depressive symptoms and other clinical and sociodemographic characteristics. Interactive voice response assessments were attempted during 7912 call-weeks, with the remaining 4130 being protocol-driven “gap weeks” due to patients opting for monthly assessments or to temporary call suspension (eg, vacation). Patients completed assessments during 68% of the attempted call-weeks, yielding 5360 assessments.

Out of the 5360 completed assessments, 582 (10.9%) were assessments in which the patient was given the opportunity to switch from weekly to monthly calls because of 3 prior assessments indicating well-controlled depressive symptoms. During most of those calls (364/582; 63%), the patient opted

■ **Table 1.** Patient Baseline Characteristics

Characteristics	Total (N = 387)	Caregiver Present		P
		Yes (n = 227)	N (n = 160)	
Female, %	80.1	78.0	83.1	.21
White, %	90.4	92.5	87.5	.10
High school or less, %	19.9	19.8	20.0	.98
Income >\$30,000 per year, %	69.1	64.9	75.2	.03
Married, %	61.5	63.9	58.1	.25
Age, y, %				.50
21-45	30.8	31.7	29.4	
46-55	27.9	24.7	32.5	
56-65	29.5	30.4	28.1	
66+	11.9	13.3	10.0	
PHQ-8 score, mean ± SD	10.0 ± 6.1	10.6 ± 6.0	9.2 ± 6.1	.03
PHQ-8 score >10, % ^a	46.3	51.1	39.4	.02
≥1 missed appointments, % ^b	65.6	62.6	70.0	.13
≥1 prior hospitalizations, % ^c	24.0	27.8	18.8	.04
SF-12 MCS, mean ± SD ^a	36.7 ± 12.9	36.4 ± 12.0	37.2 ± 13.3	.56
SF-12 PCS, mean ± SD ^a	40.7 ± 13.4	39.7 ± 14.0	42.1 ± 12.4	.09
No. of comorbid conditions, mean ± SD ^d	2.1 ± 1.6	2.3 ± 1.6	2.0 ± 1.5	.05

PHQ-8 indicates Patient Health Questionnaire 8-item depression measure; SF-12 MCS, Medical Outcomes Study 12-Item Mental Composite Summary Score; SF-12 PCS, Medical Outcomes Study 12-Item Physical Composite Summary Score.
^aHigher scores indicate better functioning.
^bOne or more missed outpatient appointments of any type in the prior 12 months.
^cOne or more hospitalizations of any type in the prior 12 months.
^dHypertension, cardiovascular disease, hyperlipidemia, stroke, arthritis, chronic lung disease (either asthma or chronic obstructive pulmonary disease), and low back pain.

to continue with weekly calling. In 96 monthly assessments, the patient’s PHQ-9 depression scores were 10 or higher, and as a result, the patient was given the option of returning to weekly calling. Those patients chose to return to weekly calls 41% of the time (39/96). Overall, 19.2% of attempted call-weeks followed month-long gaps.

As shown in model 1 in **Table 3**, the odds of a completed assessment were greater when patients had a caregiver, were older, were married, and had a greater number of comorbid conditions. Completion rates did not vary significantly according to patients’ baseline SF-12 physical functioning scores, sex, income, educational attainment, or race (all *P* >.15), and these variables were dropped from the final model. The likelihood of assessment completion decreased over time. Importantly, completion rates did not vary significantly according to patients’ baseline depression symptom severity (**Table 3** and **Figure 1**).

Considering only call-weeks that followed a successfully completed assessment (**Table 3**, model 2), the odds of call completion were lower when eligible patients opted for monthly instead of weekly calls. This effect was not attributable to patients’ depressive symptom severity at baseline or during the preceding completed assessment.

Clinician Alerts

Alerts were triggered at a rate of 4.9 per 100 person-weeks of participation (**Table 2**). More than half were triggered by poor antidepressant adherence (n = 349 alerts for 133 patients; ie, 2.8 per 100 person-weeks). Another 2.2 alerts per 100 person-weeks (n = 272 alerts for 137 patients) were triggered by increased depressive symptom severity, while a small number (n = 29 alerts for 19 patients; ie, 0.2% alerts per 100 person-weeks) were triggered by reports of suicidal ideation. As expected, clinical alerts triggered by poor medication adherence and suicidal ideation increased monotonically with baseline depressive symptom severity (**Figure 2**). In contrast, alerts triggered by increased depressive symptom severity had a curvilinear association with baseline symptom severity, with a peak in frequency when the patient’s baseline score was approximately 15.

We examined clinicians’ responses to 15 suicidal ideation alerts through chart review for patients who received care from university-affiliated practices. Clinician follow-up was documented for 13 (87%) of these incidents. Follow-up occurred on the same day for 8 incidents and within 3 days for 11 incidents. For 7 of these incidents, medical records documented that the patient reported on follow-up that he or she indicated

■ **Table 2.** Assessment Completion Rates and Clinical Alerts

Assessments/Clinical Alerts	Total (N = 387)	Caregiver Present	
		Yes (n = 227)	No (n = 160)
Weeks enrolled	12,042	7523	4519
Attempted weekly assessments	7912	4896	3016
Completed weekly assessments, n (%)	5360 (67.8)	3425 (70.0)	1935 (64.1)
Clinical alerts per 100 patient-weeks			
Any alert	4.9	5.1	4.5
Suicidal ideation	0.2	0.3	0.2
Medication adherence	2.8	2.8	2.8
Depressive symptoms	2.2	2.3	1.8
PHQ-9 exceeded 15	1.4	1.6	1.0
PHQ-9 increased by 7 or more	1.4	1.5	1.2

PHQ-9 indicates Patient Health Questionnaire 9-item depression measure.

■ **Table 3.** Logistic Regression Models Predicting Call Completion^a

Patient Variable	Model 1 ^b			Model 2 ^c		
	All Call Weeks			Weeks After Completed Assessment		
	AOR	95% CI	P	AOR	95% CI	P
Participating with a caregiver	1.54	1.11-2.12	.009	1.20	0.94-1.55	.15
Age^d	1.07	1.00-1.14	.05	1.08	1.02-1.14	.005
Married	1.44	1.07-1.94	.02	1.29	1.00-1.65	.05
Missed an appointment^e	1.35	1.00-1.89	.06	1.49	1.13-1.97	.004
No. of comorbid medical diagnoses	1.11	1.01-1.24	.03	1.07	0.98-1.17	.13
Baseline depressive symptoms^f						
Moderate	0.98	0.88-1.08	.65	0.91	0.68-1.20	.49
Moderate/severe	0.99	0.83-1.20	.95	0.91	0.63-1.31	.6
Severe	1.25	0.46-3.42	.66	1.02	0.60-1.73	.93
Depressive symptoms in most recent assessment^g						
Moderate	—			0.87	0.66-1.14	.3
Moderate/severe	—			0.73	0.50-1.07	.11
Severe	—			1.00	0.48-2.06	.99
Call week	0.96	0.94-0.97	<.001	0.98	0.97-0.99	.002
Long gap^h	—			0.30	0.25-0.37	<.001

AOR indicates adjusted odds ratio; CI, confidence interval.

^aAssessment completion rates did not vary significantly according to patients' sex, race, educational attainment, or baseline physical functioning (all *P* > .15); and these terms were dropped from the final models.

^bModel based on all 7912 attempted calling weeks.

^cModel based on 4951 attempted calling weeks for which patients completed their most recent attempted assessment and therefore had available data on recent depressive symptoms.

^dPer 5-year increase in age.

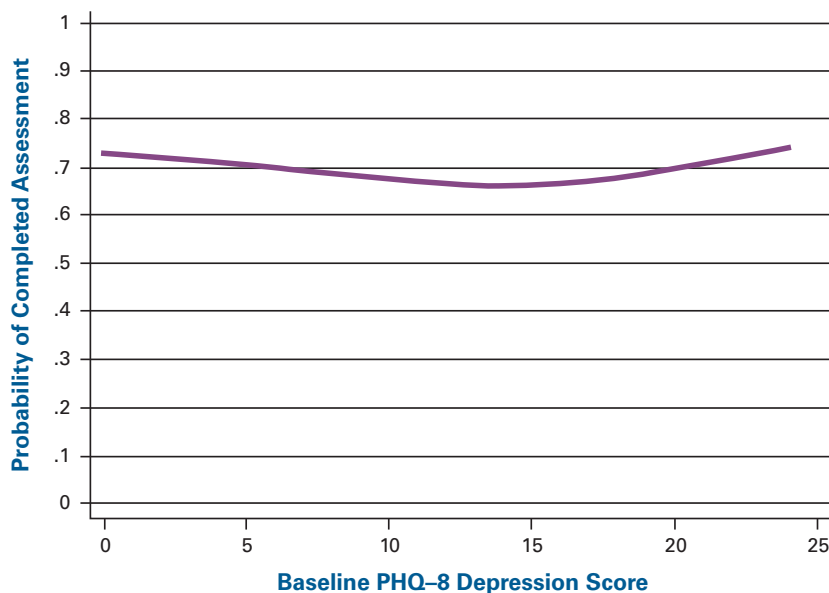
^eMore than 1 missed clinic appointments in the prior year.

^fBaseline Patient Health Questionnaire 8-item depression measure scores: moderate = 10-14; moderate/severe = 15-19; severe = 20+. Referent was <10.

^gPatient Health Questionnaire 9-item depression measure scores from the most recently completed assessment: moderate = 10-14; moderate/severe = 15-19; severe = 20+. Referent was <10.

^hFour weeks since most recent attempted assessment (vs 1 week).

■ **Figure 1.** Probability of Assessment Completion by Baseline PHQ-8 Score



PHQ-8 indicates Patient Health Questionnaire 8-item depression measure.

suicidal ideation accidentally. While the samples are too small for statistical comparisons, these 7 patients did not differ from the other 6 patients who reported suicidal thoughts in terms of either the internal consistency or test-retest correlation of their PHQ-9 responses. For all 13 patients who received clinical follow-up, the medical record indicated that the patient underwent review of symptoms, adherence, and psychosocial stressors; 5 notes documented review of medications and/or appointments with mental health providers. No reviewed records indicated that emergency intervention was required or that a suicidal attempt occurred.

DISCUSSION

Prior studies describe the use of IVR assessment and self-management support calls to monitor symptoms among patients with mental health and substance abuse disorders.⁴⁰⁻⁴³ However, most of these studies had small samples and relatively brief follow-up. Here, we demonstrated that an automated IVR service is a feasible long-term strategy to improve between-visit monitoring and self-management support of depressed primary care patients. Several important findings merit emphasis.

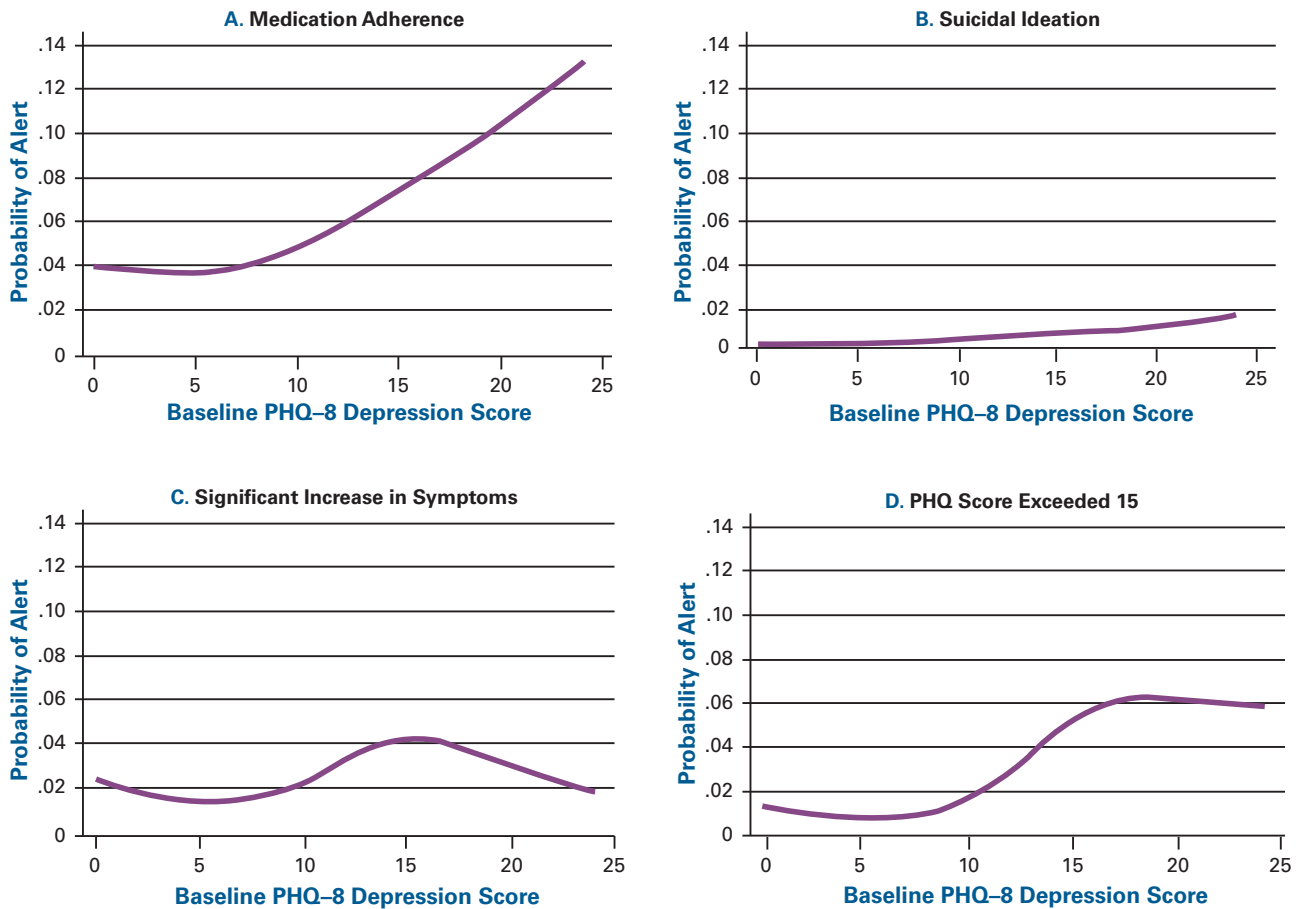
Given the option, most patients participated with a caregiver who received updates on the patient's status with targeted self-management support advice, suggesting that health systems should strive to balance privacy considerations with patients' preferences to engage social network

members. Although stronger social ties are associated with better health status,^{25,29,30,44-46} at baseline patients participating with a caregiver had more severe depressive symptoms, were more likely to have been hospitalized in the prior year, and reported more comorbid diagnoses compared with patients participating alone. This suggests that the social support option was most likely to be used by patients needing it the most. Despite their worse health status, patients participating with a caregiver were significantly more likely to complete IVR calls.

Call completion was unrelated to sociodemographic characteristics, suggesting that engagement is possible even among vulnerable patients. Call completion was also unrelated to baseline depressive symptom severity, even though patients with more severe depression struggle with low energy, social withdrawal, and low motivation. Call completion was at least as high among older patients and higher among patients with multiple chronic health conditions. These encouraging findings suggest that IVR may be useful for improving access to monitoring and self-care support among patients with depression and complex chronic conditions.

As shown in Table 3, the likelihood of call completion substantially decreased when stabilized patients opted to change from weekly to monthly calls. This decrease was unassociated with recent depressive symptom severity. Future studies should weigh the respondent burden of weekly monitoring for relatively healthy patients against the possibility that less frequent monitoring may lead to reduced engagement.

■ **Figure 2.** Probability of Clinical Alerts per Completed IVR Assessment by Baseline PHQ-8 Score



IVR indicates interactive voice response; PHQ-8, Patient Health Questionnaire 8-item depression measure; PHQ-9, Patient Health Questionnaire 9-item depression measure.

Panel A: patients reported “rarely or never” taking their antidepressant medication as prescribed, or that they had considered reducing their medication or stopping medications due to side effects in the past week. **Panel B:** patients reported that they “had made a specific plan to harm [themselves] or to end [their] life” or that it was “somewhat likely” or “very likely” that they would “harm [themselves] or end [their] life sometime over the next few days.” **Panel C:** PHQ-9 depression score reported via IVR increased 7+ points relative to the most recently completed assessment. **Panel D:** PHQ-9 depression score reported via IVR increased from <15 to 15+ relative to the most recently completed assessment.

Although clinicians are understandably concerned about the additional workload generated from between-visit automated symptom monitoring, we found that only a modest number of clinical alerts were generated using the current algorithms. Importantly, reports of suicidal ideation were rare, and other alerts could be triaged by a nursing assistant. Alerts related to worsening depressive symptoms (Figure 2) were not necessarily distributed across patients in a predictable way according to baseline depression scores. Ongoing analyses of alert frequency and distribution remain important in order to clarify implications of these programs for clinical follow-up. Among patients reporting suicidal ideation where follow-up was documented, half indicated mistakenly reporting thoughts of self-harm. If true, this suggests that follow-up for erroneous suicide risks occurred at roughly 1 patient per

1000 patient-weeks of follow-up (ie, half the rate of suicide reports in Table 2). However, multiple studies have shown that IVR-reported psychiatric problems are as reliable as in-person reports,⁴⁷⁻⁵⁰ and analyses of data from this study suggest that patients who reported erroneous suicidal ideation had PHQ scores at least as reliable as those of other patients.

This study has several of those limitations. While the sample was heterogeneous in terms of age, depressive symptom severity, and primary care setting, the majority were white and female with at least some post high school education. Most potentially eligible patients (71%) did not enroll in this program, and unfortunately, due to human subjects restrictions we were not able to collect information allowing us to compare those patients’ sociodemographic and clinical characteristics with those of enrollees. Future work on understanding

the barriers to enrollment will be important, and a portfolio of options for improving depression self-care (eg, including peer support⁵¹) will likely be needed to meet other patients' needs. Alert rates shown in Figure 2 suggest that the total number of alerts generated will depend on the distribution of patients' depression severity on enrollment. Thus, the volume could be higher if patients with more severe depression were targeted. Other than the analyses of suicidal ideation alerts, we did not measure the impact on primary or specialty care providers of telephone or face-to-face encounters (resulting from the IVR alerts). Finally, patients had high rates of comorbid medical conditions, and the current IVR patient messages did not mention the importance of managing depression for health outcomes in general. Nevertheless, it would be important in future studies to determine the impact of these services on patients' overall health and functioning.

In conclusion, we found that implementing IVR assessment and self-management support for depressed primary care patients was feasible, was well accepted by patients and caregivers, and did not generate an unmanageable clinician burden. Patients' engagement was greater when they participated with a caregiver who received ongoing updates about their mood and functioning along with advice on how to support their efforts at depression self-management. Automated depression monitoring and self-management support programs may help fill the gap between what some patients need or want and what resource-constrained health systems can realistically provide.

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