Distant mood monitoring for psychiatric disorders: A systematic review

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Abstract

Background: Whilst electronic self-monitoring and intervention programmes for mood disturbances in psychiatric disorders may promote self-management and patient empowerment, some level of interaction with professionals (such as clinicians, counsellors, and researchers) coupled with support is still positively valued by patients. This can allow for a more personalised approach, improve the efficiency of treatment, and adverse events can be managed in a time-appropriate manner, thereby mitigating some of the risks associated with mood fluctuations.

Methods: This systematic review synthesises quantitative and qualitative evidence on the effectiveness and feasibility of daily/weekly/monthly remote mood monitoring by distant supporters (clinicians, lay counsellors, and researchers) (or with regular feedback by distant supporters in cases where mood monitoring was self-assessed), in participants with any psychiatric disorder. Effectiveness was defined by the change in depression and/or mania scores. Feasibility was determined according to completion/attrition rates and participant feedback. Studies were assessed for quality using the Mixed Methods Appraisal Tool (MMAT) version 2018.

Results: Eight studies met our inclusion criteria. Distant mood monitoring was effective in improving depression scores but not mania scores. Feasibility, as measured through compliance and completion rates and participant feedback, varied.

Conclusion: Distant mood monitoring with feedback is an appealing intervention, particularly in low resourced settings; however, further studies are needed to better understand the utility, feasibility, and effectiveness of these interventions in routine clinical care.

Introduction

Broadening our knowledge of the longitudinal course of mood symptoms in psychiatric disorders is central to our understanding of patterns of chronicity, episodicity, relapse, and recurrence. Temporal changes in mood symptoms are a cardinal feature of depressive and bipolar disorder (Proudfoot et al., 2014; Sadock & Sadock, 2007).

Persistent mood symptoms are often accompanied by a variety of other symptoms (e.g. anxiety, cognitive, and functional disturbances) (Iosifescu, 2012). Additionally, persistent mood symptoms have been documented in patients with other psychiatric disorders including schizophrenia, anxiety, post-traumatic stress, and substance use disorders (Sadock & Sadock, 2007). Mood symptoms in these disorders have consistently been shown to impact on treatment outcomes, function, and prognosis (Strejilevich et al., 2013). Investigation of the longitudinal course of mood symptoms can contribute to knowledge of pathophysiological mechanisms of chronicity, episodicity, relapse, and recurrence; assist in guiding and optimising treatment (e.g. dose, duration) (Glasziou, Irwig, & Mant, 2005); and inform the development of novel and more effective treatments (van der Watt, Suryapranata, & Seedat, 2018).

Previous research indicates that patients with psychiatric disorders readily engage in the use of information technology (IT) platforms such as telemonitoring (Ure et al., 2011) and mobile technology (Bopp et al., 2010; Miklowitz et al., 2012) for mood assessment, monitoring, and treatment. These technologies allow for more regular data collection to track mood symptom trajectories. A systematic review of the validity of electronic self-monitoring of mood using IT platforms in adults with bipolar disorder found evidence for their validity when compared to clinical rating scales for depression (Faurholt-Jepsen, Munkholm, Frost, Bardram, & Kessing, 2016). Furthermore, weekly telemonitoring or text messaging has been shown to improve access to professional care in patients with bipolar disorder (Depp et al., 2015; Wenze, Arney, & Miller, 2014). Additionally, bipolar patients endorsed lower levels of illness experienced during facilitated integrated mood management (Miklowitz et al., 2012). Telemonitoring and text messaging to monitor patients' mood fluctuations, whilst not cost-free, are far less expensive methods than traditional clinical interviews (Miklowitz et al., 2012; Wenze et al., 2014). These interventions can also assist in increasing adherence to treatment which is of benefit as non-adherence is a major, and costly, concern in the treatment of psychiatric disorders (see for example Wenze et al., 2014).

Whilst electronic self-monitoring and intervention programmes may promote self-management and patient empowerment; keeping some sort of interaction underpinned by professional support (such as with clinicians, lay counsellors, and researchers) is positively valued by patients (van der Watt, Roos, Beyer, & Seedat, 2018). Additionally, it provides a more personalised approach, improves efficiency of treatment (Newman, Szkodny, Llera, & Przeworski, 2011; Proudfoot et al., 2014; Todd, Jones, Hart, & Lobban, 2014), and allows for adverse events to be managed in a time-appropriate manner, thereby mitigating some of the risks associated with mood fluctuations (Newham & Martin, 2013).

This systematic review evaluates the effectiveness and feasibility of distant mood monitoring involving clinicians, lay counsellors, and researchers, in individuals with psychiatric disorders.

Objectives

We synthesised quantitative and qualitative evidence on the effectiveness and feasibility of daily/weekly/monthly remote mood monitoring in participants with any psychiatric disorder by clinicians, lay counsellors, and researchers (hereafter referred to as distant supporters), or where regular feedback was provided by distant supporters in cases where mood states were self-assessed. Assessment of effectiveness was based on the change in depression and/or mania scores. Feasibility was determined according to completion/attrition rates and participant feedback. Studies were assessed for quality using the Mixed Methods Appraisal Tool (MMAT) version 2018.

Methods

This review has been registered on PROSPERO (CRD42017057227).

Literature search

The following data bases were searched by the first author to identify eligible articles:

- i. Academic search premier—EBSCOhost
- ii. PubMed—Medline
- iii. SAGE journals

Additionally, the reference lists of included studies were searched to identify potentially relevant studies that may have been missed by electronic searches (Greenhalgh, 2005). After the first phase of the screening process (see Figure 1), relevant articles to which we did not have full text access were flagged. These articles were requested through an inter-library loan process at Stellenbosch University. The full text of one article (Whalen et al., 2006) could not be accessed and was excluded.

Search strategy

The following keywords (and MeSH terms) were used in searching for relevant literature:

Telephonic OR telephone OR mobile phone OR cellular phone OR cell phone OR smartphone OR computer OR telecommunication OR electronic OR Skype or Pen-and-Paper or Paper-and-Pencil AND Psychiatric Disorder OR mental disorder AND Monitoring OR remote monitoring OR distant monitoring OR no contact monitoring AND Clinician OR lay counsellor OR researcher OR therapist OR counsellor OR psychiatrist

Eligibility criteria

Only peer reviewed studies published in English between 01 January 2000 and 31 March 2019, were considered for the review. Inclusion criteria were not limited to study setting or location. Thus, all studies from low-, middle-, and high- income countries were eligible for inclusion. For a study to be eligible, it had to primarily focus on the effectiveness of daily/weekly/monthly, distant mood monitoring of participants diagnosed with a psychiatric disorder as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM: American Psychiatric Association, 2000, 2013) or the International Statistical Classification of Diseases and Related Health Problems (ICD: World Health Organization, 2018).

Study design

All quantitative studies were included as well as studies that qualitatively assessed participants' perceived effectiveness of distant mood monitoring offered by distant supporters. Systematic reviews and commentaries were excluded. Studies that had been included in

systematic reviews that met our inclusion criteria were included, but not the systematic reviews themselves.

Method of monitoring

Only studies in which the mood monitoring was done *distantly* were included, and the monitoring had to take place without any face-to-face contact (i.e. physical presence) between the patient and the person conducting the distant mood monitoring. Thus, studies where mood monitoring took place via telephone, internet, smartphone, e-mail, and/or pen-and-paper methods were included. This monitoring had to be done by a distant supporter. Studies where mood monitoring was done by the patient him/herself, were only included if a distant supporter provided feedback upon the patient completing a self-monitoring assessment.

Studies that focused only on participants' self-monitoring of mood states were excluded. Additionally, we excluded studies where mood monitoring was not conducted by a distant supporter, but by the patient him/herself, and where feedback was only computer generated without the assistance of a distant supporter. The decision to focus on mood monitoring conducted by a distant supporter (or which at least included some feedback by a distant supporter) was based on research indicating the effectiveness of participants being listened to (Billsborough et al., 2014) or simply talking to a researcher who is interested in what they have to say (Lowes & Paul, 2006). As such, mood monitoring which involves contact, albeit distant, with a distant supporter may have therapeutic benefits in and of itself (van der Watt, Roos, et al., 2018). Moreover, research has indicated that participants often take part in research studies, such as mood monitoring, in order to gain the aforementioned therapeutic benefits (Patel, Doku, & Tennakoon, 2003).

Screening process

Articles identified through the search were exported to Rayyan (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016) where the first and second author independently assessed their eligibility, using the blind function in Rayyan. As indicated in Figure 1, the screening process consisted of three phases: (i) Removing duplicates; (ii) Title and abstract screening; and (iii) Full text screening. After each phase, the blind function was turned off in order to resolve conflicts between the screeners.

The quality of included studies was independently assessed by the first and second author using the Mixed Methods Appraisal Tool (MMAT) version 2018 (Hong, Gonzalez-Reyes, & Pluye, 2018; Pace et al., 2012). However, since two of the included studies [blinded] were authored by the first author, a third independent researcher was asked to assess the quality of these two studies. A summary is presented in Table 3. Overall, the included studies were deemed to be of acceptable quality.

Of the 43 full text articles screened, 35 articles were excluded due to: lack of full text access ($n = 1$); monitoring/feedback taking place in person ($n = 2$); review papers ($n = 2$) or protocol papers ($n = 1$); lack of feedback to participants ($n = 6$); studies of participants without any psychiatric diagnosis ($n = 8$); and studies that did not report on mood outcomes ($n = 15$).

Figure 1 Screening Process

Data collection

The first author extracted the relevant information from the included studies, and the second author corroborated the information. The data extracted included study design, setting, sample, psychiatric disorder, method of monitoring, any additional information deemed important, and study findings.

Outcomes

The two main outcomes for which the data were sought were (i) effectiveness, and (ii) feasibility of daily/weekly/monthly quantitative remote/distant mood monitoring by distant supporters of participants with psychiatric disorders.

Results And Discussion

Eligible papers

Eight articles (Cole et al., 2006; Faurholt-Jepsen, Vinberg, et al., 2015; Gensichen et al., 2009; Rosen et al., 2013; Ross, Tenhave, Eakin, Difilippo, & Oslin, 2008; Timko, Harris, Jannausch, & Ilgen, 2019; van der Watt, Roos, et al., 2018; van der Watt, Suryapranata, et al., 2018) met the inclusion criteria for this systematic review. Mood monitoring studies were conducted in South Africa (van der Watt, Roos, et al., 2018; van der Watt, Suryapranata, et al., 2018), the United States (Cole et al., 2006; Rosen et al., 2013; Ross et al., 2008; Timko et al., 2019), Germany (Gensichen et al., 2009), and Denmark (Faurholt-Jepsen, Frost, et al., 2015). Details regarding study designs and monitoring procedures are presented in Table 1. Details regarding outcome measures, effectiveness, adverse events, and completion rates are presented in Table 2, while information on Population, Intervention, Comparison, Outcome, and Time (PICOT) is embedded in Table 1 (P, I, C, T) and Table 2 (C, O).

Table 1 Description of study designs and monitoring procedures

Table 2 Descriptions of outcome measures, effectiveness, adverse events, and completion rates

Table 3 MMAP quality appraisal of included articles

Description of participants, assessments, and outcomes

As indicated in Table 1, participants mainly comprised patients with mood and/or anxiety disorders ($n = 6$ studies Cole et al., 2006; Faurholt-Jepsen, Frost, et al., 2015; Gensichen et al., 2009; Ross et al., 2008; van der Watt, Roos, et al., 2018; van der Watt, Suryapranata, et al., 2018); only studies by Rosen and colleagues (2013) and Timko and colleagues (2019) included patients with comorbid psychiatric disorders (viz., depression, anxiety disorder, substance use disorder, schizophrenia, or bipolar disorder). The proportion of females across the studies ranged from 6.7% (Ross et al., 2008), to 89.2% (van der Watt, Roos, et al., 2018). The age ranges varied widely (see Table 1) indicating towards the usefulness of such interventions across age groups. The ethnicity of participants was only reported by Rosen and colleagues (2013: Caucasian = 65%, African American = 21%), Ross and colleagues (2008: white = 43.1%), Van der Watt, Roos and colleagues (2018: white = 43.2%, coloured = 51.4%), and Van der Watt, Suryapranata and colleagues (2018: African/black = 3.3%, white = 44.3%, coloured = 50.8%). Only four studies (Rosen et al., 2013; Timko et al., 2019; van der Watt, Roos, et al., 2018; van der Watt, Suryapranata, et al., 2018) specified the exact time at which mood monitoring commenced (1 week, or 2 weeks post-discharge). Other studies merely indicated that outpatients were recruited. As such, mood monitoring commenced at various stages of the illness. Depression outcome measures included the Patient Health Questionnaire 9 (PHQ-9: Cole et al., 2006; Gensichen et al., 2009; Ross et al., 2008), the Hamilton Rating Scale for Depression (HAM-D-17: Faurholt-Jepsen, Frost, et al., 2015), the Center for Epidemiologic Studies Depression Scale (CES-D: Rosen et al., 2013), the Mini-International Neuropsychiatric Interview (MINI: Ross et al., 2008), and the Quick Inventory of Depressive Symptomatology (QIDS: van der Watt, Roos, et al., 2018; van der Watt, Suryapranata, et al., 2018). Timko and colleagues (2019) did not specify the measure used, simply stating the “psychological problems” were recorded. Mania outcome measures included the Young Mania Rating Scale (YMRS: Faurholt-Jepsen, Frost, et al., 2015), and the Altman Self-Rating Mania Scale (ASRM: van der Watt, Roos, et al., 2018; van der Watt, Suryapranata, et al., 2018).

Effectiveness

We defined effectiveness (or lack thereof) in terms of an increase and/or decrease in depression and/or mania scores on a rating scale. Based on this definition, two studies (Faurholt-Jepsen, Frost, et al., 2015; Rosen et al., 2013) reported no significant improvement in depression and/or mania scores over the course of the study. Whilst Ross and colleagues (2008) at first reported lower depression scores and a lower rate of diagnoses for their intervention group, as compared to the control group; at study completion this difference was not significant.

Three studies (Cole et al., 2006; Gensichen et al., 2009; van der Watt, Suryapranata, et al., 2018) reported significant improvement in depression scores over the course of the study. In addition, one study (van der Watt, Roos, et al., 2018) reported that participants qualitatively reported mood monitoring to be effective. Furthermore, Timko and colleagues (2019) indicated that psychological problems decreased over time. However, mood monitoring did not appear to be effective in improving mania scores for either of the studies that reported on mania scores (Faurholt-Jepsen, Frost, et al., 2015; van der Watt, Suryapranata, et al., 2018).

Feasibility

For the purpose of this systematic review, feasibility was determined based on compliance and completion rates, and on feedback provided by participants. Completion rates ranged from 45.9% (van der Watt, Suryapranata, et al., 2018) to 86% (Faurholt-Jepsen, Frost, et al., 2015) for the intervention groups. This is similar to the completion rate of distant self-mood monitoring which did not include contact with (or feedback from) a clinician/lay counsellor/researcher (Faurholt-Jepsen et al., 2016). Specifically, in their systematic review of distant self-mood monitoring, Faurholt-Jepsen and colleagues (2016), reported completion rates of between 42.1% (Depp et al., 2010) and 93.9% (Bauer et al., 2004; Whybrow et al., 2003).

In the present review, the only study that included subjective qualitative reports (van der Watt, Roos, et al., 2018), indicated high acceptability of distant mood monitoring. However, it should be noted that the subjective qualitative findings reported by van der Watt, Roos, and colleagues (2018) mostly included participants who completed the study, with only a few participants who dropped out of monitoring reporting their experiences. As such, these findings should be interpreted with caution.

Conclusion And Recommendations

This systematic review focused on the effectiveness of distant mood monitoring offered by clinicians, lay counsellors, or researchers, to patients with psychiatric disorders. Patient (self-) assessments were also included, provided that feedback was distantly provided by distant supporters. Mood monitoring was not specifically compared to other interventions. Only eight studies were found to be eligible for inclusion. The majority of studies were conducted in patients where mood disorder was the primary or co-morbid diagnosis. The studies used varying methodologies. Given the differences in sample characteristics, methodology, and outcome measures it is difficult to draw comparisons across the studies.

From the above findings, we tentatively conclude that distant mood monitoring may be effective in improving depression scores, but not mania scores. Feasibility, as measured through compliance and completion rates and participant feedback, varied. These findings are based on eight studies only, of which one included a placebo-control group and four a treatment-as-usual control group. Additionally, effectiveness and feasibility were loosely defined across studies. Changes in depression and mania scores may not necessarily correlate with improvement in quality of life or functioning. Furthermore, the present study is limited by the fact that only the first author located relevant studies through a systematic search of limited databases. Important databases such as PsychInfo could not be accessed since the study university did not have access to it. An additional independent systematic search would have been preferable. This, however, was not possible due to resource constraints. Yet, the use of a second, blinded, author in the screening process did add rigour to the study.

Distant mood monitoring with distant supporter feedback is an appealing intervention, particularly in low resource settings; however, further studies are needed to understand the role of these interventions and confirm their feasibility and effectiveness in routine clinical care across different settings. This includes a better understanding of the effectiveness and feasibility of this form of monitoring in different psychiatric disorders with and without comorbidity, the timing of the intervention in terms of the phase of illness, the potential harmful effects of regular mood monitoring with feedback, and barriers to the use and implementation of such monitoring systems.

More rigorous mood monitoring studies are needed to draw more definitive conclusions. These studies should provide more detail on (i) the mechanisms of monitoring (for example what the feedback entails), (ii) mood trajectories (e.g. at different time-points instead of only at baseline and endpoint), (iii) adverse events related/unrelated to the mood monitoring itself, (iv) the experiences and perceptions of participants during mood monitoring, and (v) the quality of life impact of treatment.

List Of Abbreviations

AD Anxiety Disorder

ASRM Altman Self-Rating Mania Scale

BD Bipolar Disorder

BHS Behavioural Health Specialist

CESDS Center for Epidemiologic Studies Depression Scale

CHF Congestive Heart Failure

DSM Diagnostic and Statistical Manual of Mental Disorders

HAMD–17 Hamilton Rating Scale for Depression

ICD International Statistical Classification of Diseases and Related Health Problems

IT Information Technology

MDD Major Depressive Disorder

MMAT Mixed Methods Appraisal Tool

Ms months

NA Not Applicable

NS Not Specified

PHQ Patient Health Questionnaire

PICOT Population, Intervention, Comparison, Outcome, and Time

PTSD Posttraumatic Stress Disorder

QIDS Quick Inventory of Depressive Symptomatology

RCT Randomized Controlled Trial

SD Standard Deviation

SUD Substance Use Disorder (incl. Alcohol Use Disorder)

TAU Treatment as usual

Tel Telephonic

Ws weeks

YMRS Young Mania Rating Scale

Declarations

Ethics approval and consent to participate

No ethics approval was required for this systematic review, nor consent to participate.

Consent for publication

No individual person's data is included in the present study. As such, consent for publication is not needed.

Availability of data and materials

No original data was included in this review.

Competing interests

We have no financial or non-financial competing interests to declare.

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Authors' contributions

AvdW conducted the literature search, the screening process, the quality check, data extraction, and writing of the article. WO served as second review during the screening process, quality check and data extraction. WO also contributed to writing the article. KL contributed to writing the article. SS contributed to writing the article.

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Tables

Table 1 Description of study designs and monitoring procedures

	Study Design	Sample Characteristics (Population and Comparison)			Mood Monitoring Information (Intervention and Time)				
		Psychiatric Disorder	Sample Size	Mean Age (Range; SD)	Monitoring	Feedback	Frequency	Total Length	Start of monitoring
Cole et al., 2006	Observational	Depression with comorbid CHF	MDD: $n = 19$ Other depression: $n = 8$	MDD: 73.8 (61–93 years; NS) Other depression: 77 (73–80 years; NS)	Paper-and-pencil, telephonic	Telephone calls	At least monthly	24Ws	NS: Outpatient population
Faurholt-Jepsen et al., 2015[1]	RCT single blind	BD	Intervention: $n = 39$ Placebo-control group provided with mobile phone for daily use: $n = 39$	Intervention: 29.1 (NS; 7.5 years) Control: 29.5 (NS; 9.4 years)	Smart phone application	Contacted by nurse when necessary; graphic visualization	Daily	24Ws	NS: Outpatient population
Gensichen et al., 2009	Cluster RCT	MDD	Intervention: $n = 310$ TAU control: $n = 316$	Intervention: 51.7 (NS; 14.05 years) Control: 50.53 (NS; 14.32 years)	Telephonic	Telephonic	First month: twice a week Following 11 months: monthly	12Ms	NS: Outpatient population
Rosen et al., 2013	Multisite RCT	PTSD with comorbid depression, AD, SUD, schizophrenia, BD	Intervention: $n = 412$ TAU control: $n = 425$	Intervention: 50.2 (NS; 0.62 years) Control: 49.9 (NS; 0.86 years)	Telephonic	Telephonic	First 3 months: Bi-weekly	3Ms	Two weeks post-discharge
Ross et al., 2008	RCT	Minor Depression	Intervention: $n = 130$ TAU control: $n = 93$	Intervention: 59.8 (NS; 14.6 years) Control: 58.5 (NS; 17.7 years)	Telephonic	Telephonic	Weekly	8Ws	NS: Outpatient population
Timko et al., 2019	RCT	Depression, AD, PTSD, schizophrenia / schizoaffective disorder, BD, SUD	Intervention: $n = 207$ TAU: $n = 199$	Intervention: 45.1 (NS; 12.6) TAU: 45.2 (NS; 12.6)	Telephonic	Telephonic	Weekly	3Ms	1 week post-discharge
Van der Watt, Roos et al., 2018	Mixed-method	Mood Disorder, AD	Interviews: $n = 37$	Interviews: 35.76 (18–53; 10.8 years)	Telephonic	Telephonic	Weekly	26Ws	1 week post-discharge
Van der Watt, Suryapranata et al., 2018	Longitudinal	Mood Disorder, AD	$N = 61$	35.3 (18–53; 10.2 years)	Telephonic	Telephonic	Weekly	26Ws	1 week post-discharge

Note: AD = Anxiety Disorder; ASRM = Altman Self-Rating Mania Scale; BD = Bipolar Disorder; BHS = Behavioural Health Specialist; CESDS = Center for Epidemiologic Studies Depression Scale; CHF = Congestive Heart Failure; HAMD-17 = Hamilton Rating Scale for Depression; Ms = months; MDD = Major Depressive Disorder; NA = Not Applicable; NS = Not Specified; PHQ = Patient Health Questionnaire; PTSD = Posttraumatic Stress Disorder; QIDS = Quick Inventory of Depressive Symptomatology; RCT = Randomized Controlled Trial; SD = Standard Deviation; SUD = Substance Use Disorder (incl. Alcohol Use Disorder); TAU = Treatment as usual; Tel = Telephonic; YMRS = Young Mania Rating Scale, Ws = weeks

Table 2 Descriptions of outcome measures, effectiveness, adverse events, and completion rates

	Outcome Measures				Feasibility and Effectiveness	
	(Comparison and Outcome)				(Outcome)	
Authors	Depression scale/instrument	Mania	Frequency	AE reported	Completion Rate	Effective
Cole et al., 2006	PHQ	NA	6Ws, 12Ws, 6Ms	Use of a formal, structured suicide assessment instrument. Results NS	24/35 = 68.57%	Significant improvement in PHQ scores.
Faurholt-Jepsen et al., 2015[2]	HAMD-17	YMRS	Monthly for 6 months	Trained nurse contacted participant if deterioration in symptoms detected. Results NS	Intervention: 33/39 = 82.62% Control: 34/39 = 87.18%	No significant improvement in HAMD-17 or YMRS scores.
Gensichen et al., 2009	PHQ	NA	6Ms; 12Ms	NS	6 months: 84.8% 12 months: 84.2%	Significant improvement in PHQ scores.
Rosen et al., 2013	CESD	NA	4Ms; 12Ms	Serious suicidal ideation (6%), homicidal ideation (6%), and heavy alcohol/drug use (5%) reported in calls. Rehospitalisation within one year of discharge: 11% intervention group; 13% TAU group.	Intervention: 86%	No significant improvement in CESDS scores.
Ross et al., 2008	PHQ; MINI	NA	6Ms	Participants (37.7%) referred to BHS.	Intervention: 96/130 = 73.85% Control: 72/93 = 77.42%	Intervention group had less (not significantly) depression symptoms and diagnoses at 6-months follow-up than control group.
Timko et al., 2019	NS	NA	3Ms, 9Ms, 15Ms	Deceased participants indicated at 3Ms ($n = 2$); 9Ms ($n = 13$), and 15Ms ($n = 16$) follow-up. Relation to study NS. Incarcerated participants indicated at 3Ms ($n = 6$); 9Ms ($n = 5$), and 15Ms ($n = 2$) follow-up. Relation to study NS.	Intervention attrition indicated at 3Ms ($n = 32$); 9Ms ($n = 58$), and 15Ms ($n = 58$) follow-up. TAU attrition indicated at 3Ms ($n = 41$); 9Ms ($n = 57$), and 15Ms ($n = 50$) follow-up. Relation to study NS.	Psychological problems decreased over time, with no significant difference by condition or interaction of time by condition.
Van der Watt, Roos et al., 2018	QIDS	ASRM	26Ws	Participants reported negative (10.8%) and apprehensive (16.2%) experience of baseline assessment.	Interviews conducted regarding effectiveness: 60.7%	Majority of participants interviewed (86.5%) reported that they found the mood monitoring helpful.
Van der Watt, Suryapranata et al., 2018	QIDS	ASRM	26Ws	NS	45.9%	Significant improvement in QIDS scores. No significant difference in ASRM scores.

Note: AD = Anxiety Disorder; ASRM = Altman Self-Rating Mania Scale; BD = Bipolar Disorder; BHS = Behavioural Health Specialist; CESDS = Center for Epidemiologic Studies Depression Scale; CHF = Congestive Heart Failure; HAMD-17 = Hamilton Rating Scale for Depression; Ms = months; MDD = Major Depressive Disorder; NA = Not Applicable; NS = Not Specified; PHQ = Patient Health Questionnaire; PTSD = Posttraumatic Stress Disorder; QIDS = Quick Inventory of Depressive Symptomatology; RCT = Randomized Controlled Trial; SD = Standard

Deviation; SUD = Substance Use Disorder (incl. Alcohol Use Disorder); TAU = Treatment as usual; Tel = Telephonic; YMRS = Young Mania Rating Scale, Ws = weeks

Table 3 MMAP quality appraisal of included articles

MMAP Quantitative RCT quality appraisal					
	Faurholt-Jepsen et al., 2015	Gensichen et al., 2009	Rosen et al., 2013	Ross et al., 2008	Timko et al., 2019
1. Is randomization appropriately performed?	Yes: Participants were randomized with a balanced ration of 1:1 to receive either an intervention Android smartphone (the intervention group) or a control Android smartphone (the control group) for a 6-month trial period.	Yes: The data safety and monitoring board stratified the practices according to the size of the city and performed computer-based randomization. Participant random assignment status was nested within the practice status.	Yes: Randomization by site, gender, and service in the recent wars in Iraq or Afghanistan was done centrally by Efron randomization by someone blind to participants' treatment histories.	Unclear: Consented clinicians were randomly assigned to either usual care or close monitoring. Randomization was stratified by clinic. However, it is unclear how participants were randomized.	Yes: After the baseline interview, participants were randomly assigned by the project manager to condition (usual care or usual care plus telephone monitoring) using permuted blocking whereby ID numbers to be given sequentially to patients were randomly preselected within different sized blocks to be assigned to each condition.
2. Are the groups comparable at baseline?	Yes: Randomization was stratified on age (<29 or ≥29 years) and former hospitalization (yes/no) since these were considered to be possible prognostic variables, and a fixed block size of 10 within each stratum was used.	Yes: See Table 2 in the article. There was no statistical difference between the two groups' characteristics at baseline.	Yes: See Table 1 in the article. There was no statistical difference between the two groups' characteristics at baseline.	Partial: See Table 1 in the article. At baseline the two groups statistically differed in terms of sex, finance, and the experience of a disturbing traumatic event.	Unclear: Baseline data is provided; however, no clear statement about statistically significant differences (or not) is provided.
3. Are there complete outcome data?	Yes: 82.62% of the intervention group data, and 87.18% of the control group data could be analysed.	Yes: 86.13% of the intervention group data, 91.14% of the control group data could be analysed at 12 month assessment.	Yes: 99.03% of the intervention group data, and 98.12% of the control group data could be analysed.	Yes: 72.31% of the intervention group data, and 77.42% of the control group data could be analysed.	Yes: 71.98% of the intervention group data, and 74.87% of the control group data could be analysed.
4. Are outcome assessors blinded to the intervention provided?	Partial: Due to the type of intervention, this trial was single-blinded since blinding of the participants, the clinicians, and the study nurse handling the intervention was not possible.	No: Because of the practice staff training required for the behavioural intervention, participants, health care assistants, family physicians, and researchers were not blinded to assignment once the trial was started.	No: Due to the nature of the intervention, blinding was not possible.	No: Due to the nature of the intervention, blinding was not possible.	Yes: Regarding follow-up, the research assistant, blinded to patients' condition assignment collected self-report data from patients by telephone at three months post-baseline, which was upon completion of the intervention for the group in the telephone monitoring condition.
5. Did the participants adhere to the assigned intervention?	Yes: A total of 3.7% of participant visits were missing (3.6% in the intervention group and 3.8% in the control group) due to participants not attending.	Unclear: Follow-up data is reported for 84.8% of the participants at 6 months and 84.2% at 12 months). However, it is not clear how many completed the weekly/monthly assessments.	No: Follow-up data is reported for 67% (4 months) and 62% (12 months) for the intervention group; and 70% (4 months) and 66% (12 months) for the control group. However, it is not clear how many completed the bi-weekly assessments.	Unclear: Follow-up data is reported for 75.3% (6 months) for the participants in general. However, it is not clear how many completed the weekly assessments.	Unclear: Follow-up data is reported for 84.54% (3 months), and 71.98% (9 months) for the intervention group; and 79.40% (3 months) and 71.40% (9 months) for the control group. However, it is not clear how many completed the weekly assessments.
MMAP Mixed Methods quality appraisal		MMAP Quantitative non-RCT quality appraisal			
	Van der Watt, Roos, et al., 2018		Cole et al., 2006	Van der Watt, Suryapranata et al., 2018	
1. Is there an adequate rationale for using a mixed methods	No: There is no rationale provided	1. Are the participants representative of the target population?	Yes: Possible patients with depression were identified through five different	Yes: Inpatients with a primary mood or anxiety disorder were recruited pre-discharge.	

design to address the research question?			methods. All patients with depression were offered participation in the initiative. The article clearly indicates why some patients approached did not take part.		
2. Are the different components of the study effectively integrated to answer the research question?	Yes: The qualitative and quantitative components complement each other and function well as a unified whole to answer the research question.	2. Are the measurements appropriate regarding both the outcome and intervention (or exposure)?	Yes: Depression was measured using the PHQ which is a reliable and valid measure of depression symptoms.	Yes: The intervention involved interepisodal telephonic mood monitoring and the outcomes were measured weekly for 26 weeks using established tools, the Altman Self-Rating Mania Scale (ASRM) and Quick Inventory of Depressive Symptomatology (QIDS).	
3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	Yes: The qualitative component provides detailed evidence for acceptability and perceived effectiveness of mood monitoring and reasons for participant drop-out. This information is effectively supported by quantitative data including baseline assessment and post-discharge assessment using established questionnaires.	3. Are there complete outcome data?	Yes: 68.57% of the data could be analysed.	Yes: Although the drop-out rate was quite high, results showed a significant decline in depression scores. ASRM scores were not indicative of significant mania and the authors also reported data for suicidality.	
4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	Unclear: There appears to be no mention of any divergence or inconsistencies between quantitative and qualitative results.	4. Are the confounders accounted for in the design and analysis?	Yes: A detailed description is provided on how the regression analysis accounted for variable.	Unclear: The authors collected data on traumatic childhood experiences but did not state if these were accounted for as confounders in the data analysis. No other confounders are mentioned.	
5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	Yes: It is reflected in the analysis and reporting of the data.	5. During the study period, is the intervention administered (or exposure occurred) as intended?	No: Because many patients reported difficulty with the IVR version of the HADS, this assessment tool was eliminated a few weeks into the trial.	Yes: Even though 54.1% of the participants dropped out of the study, the intervention was administered as intended.	

[1] Demographic data only presented for participants who completed the study.

[2] Demographic data only presented for participants who completed the study.

Figures

Figure 1

Screening Process

Supplementary Files

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