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Social Sciences (BMS)**

**Technology in Treatment  
of Patients with Bipolar Disorder  
- a Scoping Literature Review**

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### Abstract

**Introduction:** Most technological interventions for bipolar disorder (BD) serve as psychoeducational adjunctive care which involve self-monitoring under support of health caregivers. While recent technologies mostly target symptom reduction little is known about the effect on well-being. To improve technologies for BD incorporating not only symptom reduction but also patients' well-being, an updated version of a literature review is required to provide insight into current intervention characteristics and effect on patients' mental health. **Methods:** A scoping literature review was conducted collecting papers from the databases Scopus and PsycINFO. Keywords m-health, web-based, and bipolar disorder were used. **Results:** 392 potential entries matched the search criteria. After a thorough manual review, 22 trials pertaining to 19 different interventions, specifically focusing on technological interventions for patients with bipolar disorder, were selected. Common technological features were psychoeducational modules, mood monitoring and a red flag system for early symptom detection. Some trials measured the effect on well-being. However, the results were inconsistent and development of these applications is still in the early stages. **Discussion:** Considering the diversity of the initiatives, novel technological features are already integrated in existing interventions. Further, some interventions could be identified incorporating well-being not only as an intervention characteristic but also as an outcome measure. While some applications hold potential to provide help, the evidence base is still scarce. Recommended focal points like self-management and detection of early symptoms were exclusively addressed as study objective and intervention feature, respectively.

*Keywords:* technologies, web-based treatment, bipolar disorder, detection of early symptoms, self-management, well-being

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Since mobile and eHealth constitute common tools in the technology driven treatment of BD, new and modified technologies are regularly released. Considering the emerging amount and questionable effectiveness of interventions an updated review is necessary. Aim of this review was to assess the current characteristics of technologies in the treatment of BD and to assess the interventions' effect of self-management, detection of early symptoms and well-being. E-Health provides a promising opportunity to develop standardized psychological treatments that overcome some of the burdens of face-to-face treatments. For example, web-based interventions are constantly available and accessible to remote target groups (Van Gemert-Pijnen, 2018). In addition, such intervention programs offer the opportunity for clients to monitor and regularly assess their mood (depressive and manic symptoms) as well as other parameters such as sleep or physical and social functions (Rajagopalan et al., 2017). Furthermore, online interventions facilitate mutual feedback between patients and providers (Fitriani & Suryadi, 2019). These types of interventions facilitate early intervention for sub-syndrome symptoms for relapse prevention and help clients gain more awareness for their illness. This allows patients to improve their lifestyle with their chronic condition and timely treatment of symptoms. However, due to ever emerging technological innovations, there is a lack of standardized definitions. Furthermore, diverging frameworks are in use and variables are inconsistent. Therefore, it is complicated for clinicians who are unfamiliar with the technological domains, to fully comprehend the present and future benefits and challenges of incorporating these new technologies into clinical practice.

Since linking behavioral sciences and current technologies is usually not self-evident for many clinicians, the main purpose of this paper is to provide a review of published studies using technologies, particularly aimed to deliver evidence-based psychological interventions for patients with BD. Therefore, characteristics of each intervention and their effectiveness concerning self-management, detection of early symptoms and well-being will be described. This will further be compared and discussed with regard to the advantages and limitations of technological interventions as potential adjunctive care for BD and what future directions will result from this insight.

### **Bipolar Spectrum Disorders**

BD is a chronic affective disorder marked by episodes of mania, hypomania, and alternating or intertwining episodes of depression (Grande, Berk, Birmaher, & Vieta, 2016). It is a lifelong episodic illness with a fluctuating course that often produces functional and cognitive impairment and a decrease in quality of life (QoL). According to a WHO survey the prevalence of BD is 1-2% (Alonso et. al, 2011). Findings from a worldwide mental health survey showed that the prevalence of BD was equally frequent across cultures and ethnic groups (Merikangas et al., 2011). Regarding gender, men and women are equally frequent affected by BD I while bipolar II disorder is most common in women

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(Nivoli et al., 2011). With regards to the prognosis and progressive course of the disease patients experience periods of remission as well as reoccurrence, especially when compliance to treatment is low. Bipolar disorders are associated with substantial neurocognitive deficits across all mood states, but also physical impairment is likely to occur. For example, cardiovascular disorders, diabetes, and obesity are highly comorbid (Grande et al., 2016). All in all, bipolar disorder can be considered as a mental health disorder with severe effects on both mental and physical health.

### **Treatment Methods for Bipolar Disorder**

The major form of treatment includes pharmacological therapy to ensure the safety of the patient and their related parties to achieve stabilisation. For acute management mood stabilizers and antipsychotics are available. A previous review conducted by Geddes & Miklowitz (2013) describes that acute manic and depressive episodes of the disease are conventionally treated pharmacologically. Thus, following an episodic care model, patients receive adjusted pharmacological treatment if an upcoming episode occurs. For the long-term, pharmacological treatments are combined with psychological treatments. Among the adjunctive psychological interventions are individual and group psychoeducation, family-focused interventions and functional remediation (Reinares, Sanchez-Moreno, & Fountoulakis, 2014). Psychological treatment, usually delivered face to face, aims for behavioral change. That means these forms of treatment do not allow a constant symptom monitoring to detect a relapse in time. Thus, with the conventional treatment resources relapses often cannot be prevented and happen as a natural course of the disease. This lack of continuous monitoring and relapse prevention indicates a deficiency in the current state of treatments available to patients with BD.

Despite new psychological treatments for BD, about a third of the patients with BD receiving adequate pharmacotherapy have enduring and impeding sub-threshold depressive symptoms after a major depressive episode. This comes along with social and occupational impairment and increased psychosocial impairment which again is associated with earlier recurrences (Geddes, & Miklowitz, 2013). The authors Geddes and Miklowitz (2013) point out that "early detection combined with helpful self-management and targeted psychosocial and drug treatment promises substantial benefits" (Geddes & Miklowitz, 2013, p. 9). Additionally, they suggest online based protocols that monitor mood and sleep cycles provide real-time information which can add substantial improvement to prevent relapse (Geddes, & Miklowitz, 2013).

The limited capacities of face-to-face treatments and the constraint impact of pharmaceuticals leads to the agreement among researchers that the shortcomings of the conventional model of episodic care are insufficient for alleviating BD. Therefore, in line with findings of Geddes & Miklowitz (2013), there are emerging ambitions to explore new technology-driven therapeutic methods.

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Internet-supported/mobile interventions as a substitute method to prevent relapse might serve as an appropriate tool to detect symptoms.

This paper applies the definition of internet-support therapeutic interventions by Barak, Klein & Proudfoot (2009) explained what is meant with internet-supported therapeutic interventions:

A primarily self-guided intervention program that is executed by means of a prescriptive online program operated through a website and used by consumers seeking health- and mental-health related assistance. The intervention program itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive web-based components. (p. 5)

Internet-supported therapeutic interventions also include applications on mobile phones and wearables as a medium for self-tracking. This can be particularly useful to monitor the sleep rhythm and mood changes (Mohr, Zhang, & Schueller, 2017).

Hidalgo-Mazzei et al. (2015) conducted a literature review about internet-based psychological interventions for BD. They concluded that up to that point of time, there was no evidence supported technological interventions targeting BD. However, the authors emphasized the high potential of web-based interventions considering the reported high rates of retention and adherence of the interventions. Furthermore, they stressed the tremendous potential that mobile technologies offer. They stated the applications serve as valuable opportunities to detect and quantify human behaviour through the large number of embedded sensors. Those can deliver more personalised information of behaviour. Hence, this can be of significant importance to timely intervene and possibly save lives (Hidalgo-Mazzei et al., 2015).

In the discussed studies by Hidalgo-Mazzei et al. (2015) most interventions included interactive psychoeducational-CBT, self-monitoring of different parameters, feedback mechanisms, as well as the support given by either the mental health caregivers or by patients' peers. The authors stated, key priority in the development of new technologies should not only be relapse prevention but also focus on patients' quality of life, psychosocial functioning and well-being (Hidalgo-Mazzei et al., 2015).

Considering the limitations of available treatment methods and the findings of Hidalgo-Mazzei et al. (2015) and Geddes & Miklowitz (2013), *self-management* and *well-being* appear to be aspects deserving more attention in both web-based and conventional treatment of BD. A study conducted by Loric et al. (2001) confirmed a positive effect of a self-management program on patients with chronic disease. The participants experienced statistically significant improvements in health behaviors, self-efficacy, and health status (fatigue, shortness of breath, pain, role function, depression, and health distress) and had fewer visits to the emergency unit. With regard to the value of self-management, Murrey and her research team (2011) outlined which self-management strategies are of main importance: Managing sleep, diet, rest and exercise; ongoing monitoring; reflective and meditative practices; understanding BD, educating others, connecting to others and enacting a plan

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to attain a goal. As previously outlined, the current episodic care for BD is not quite sufficient for addressing these strategies, but self-management could be an aspect incorporated by technologies.

With regards to the importance of well-being, Bird et al. (2014) emphasised the concept of personal recovery as meaningful for people with BD. Personal recovery considers a patients' ability to live a satisfying life even within the limitations caused by the illness, taking into account this disease is chronic. Especially within the treatment of patients with BD personal recovery is highly applicable as it includes development of new meaning and purpose in life, build-up hope, engagement in society and control over care (Slade, 2009). The CHIME framework developed by Slade et al. (2011) describes an approach to personal recovery relevant to BD that includes connectedness, hope and optimism about the future, identity, meaning in life and empowerment (CHIME) These are processes inevitable for personal recovery of patients with BD. Next to well-being, self-management requires an extra appraisal in the context of BD treatment as patients constantly need to manage pharmacological compliance, self-awareness for early symptoms and taking control over well-being as aspects to prevent relapse. Based on the previous, this review will particularly examine the technological characteristics of current interventions to understand how detection of early symptoms, accomplishment of self-management and increase of well-being is performed among internet-supported therapeutic interventions for BD.

### **Objective**

So far, less scientifically researched (but equally relevant for the adjunctive care of patients with BD) are technologies targeting BD. In particular, little research has been conducted on the well-being and self-management approach as supplement to usual psychotherapeutic routine care among technological interventions for BD. A focus on well-being interventions should serve as an extension to the existing reviews.

The aim of this review was to update the knowledge on current technological interventions, to review what technical features are integrated and investigate in how far interventions serve the purpose of detection of early symptoms, self-management and well-being. Accordingly, the following research questions guide the literature review of this paper.

1. What are the characteristics of technological interventions designed for people with bipolar disorder?
2. What are the effects of technological interventions designed for people with bipolar disorder on well-being, the detection of early symptoms, and self-management?

## Methods

### Search Strategy

Eligible studies were searched in two databases: Scopus and PsycINFO. On May 1<sup>st</sup> 2020 the first literature search was conducted. Selected terms used for the literature review were:

(technology\* OR "World Wide Web" OR online OR web-based OR internet\* OR "computer assisted" OR e-health OR network OR "Web Services" OR "compassionate technology" OR internet OR app OR wearable OR m-health OR "eMental health") AND (autonomy OR "Personal recovery" OR self-management OR empowerment OR "mindfulness based" OR "mental health" OR well-being) AND (bipolar OR "Affective disorder" OR "Episodic illness" OR manic OR bi-polar) AND ("feasibility studies" OR "Study protocol" OR efficacy OR performance OR result OR outcome OR "Pilot study" OR usability OR "focus group") AND (RCT OR "randomized control trial\*" OR effect\*).

The scoping literature review was reported according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. In this review, various kinds of studies were included in which technology played a central role during the intervention. To the included studies counted both effectiveness studies as well as feasibility studies of an intervention. Excluded from the study were web-based assessment tools for BD as diagnostic tools as these papers did not contribute to the research question of this review, which focused on intervention characteristics and effectiveness.

### Selection of Studies

Duplicates were removed from the identified studies and title and abstract were screened. Remaining records published in full-text and German or English language were checked for eligibility. In the next step, studies meeting the inclusion criteria were included for the review. First, the study population had to concern people with BD. The second inclusion criteria concerned whether the conducted intervention was electronic, or web-based. Next, the studies were screened with regard to its effectiveness on therapeutic level. Here, it was evaluated whether the intervention was measured on at least one of the previously named outcomes measures (well-being, self-management or early symptoms). Blended forms of eMental Health interventions with psychological treatment were also included. Whether an intervention was in line with the concept of eMental health was assessed by the author, guided by the definition of internet-based therapeutic technology provided above by Barak, Klein & Proudfoot, (2009) and Mohr, Zhang, & Schueller, (2017). Considered suitable for this review were not only RCT study designs but also quasi-randomized controlled trials (QRCTs), controlled before-after studies (CBA\*s), and interrupted time series (ITS\*s). Besides, feasibility and pilot studies were included to collect the latest innovations present in the current literature and to see which



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variables they used. Trials with secondary analyses were also included, whereas studies that solely reported implementation results (e.g. preferences and use of information channels on BD) were excluded. During the screening phase, studies with study population targeting general severe mental illness were also excluded, as no specific differentiation to people with BD could be made. Some of the interventions have been available for a long time and have been thoroughly examined. However, there have been some newly published studies on existing or new interventions since the latest review was conducted by Hidalgo-Mazzei in 2015. Those newly published interventions and the according studies will be discussed in more detail when answering the first research question about intervention characteristics.

### Data Extraction

For each study, the following data was extracted: First, the *Population characteristics* were collected, including author and year of publication, country, gender and age of participants if available. Second, the *intervention features* were gathered, including type of intervention, form of delivery, number of sessions and duration (in weeks). Third, *Methodological features*, which included study design, type of control group, measurement moments (before, after, follow-up) and outcome measures were accessed. Finally, the key findings of the studies were recapitulated. Thus, the specific study characteristics (PICOS) according to the Prisma statement were extracted. The elementary aspects addressed included participants, interventions, comparisons, outcomes, and study design (PICOS). The data was collected, analyzed and reported by a single researcher.

### Quality Assessment

According to the PRISMA guidelines a quality assessment of the collected studies within a scoped literature was not mandatory. Nevertheless, on some studies a quality assessment was performed. This solely applied to RCT studies as these were composed of the appropriate features assessable during a quality check. This assessment was conducted to make a more valid interpretation of these specific trials as the research questions required specific information about variables and effectiveness of these studies. To determine the quality of the retrieved papers the checklist for the assessment of the methodological quality of both randomised and non-randomised studies of health care interventions by Downs and Black was used (1998). Notably, when assessing the collected papers for quality according to the Downs and Black checklist, following categories were used, as reported by an another study by Hooper, Jutai, Strong, & Russell-Minda (2008): excellent (26-28); good (20-25); fair (15-19); and poor ( $\leq 14$ ) whereas item 27 was rated whether the study did or did not perform a power calculation. Thus, the maximum score was 28 instead of 32.

The recommended review protocol for scoping literature reviews (PRISMA-ScR Checklist)

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was used for this review. This research was registered 2020 within the framework of a university degree at the University of Twente. The studies were selected under the specified selection criteria stated above. The results were synthesized by evaluation of study design, study objective, participants, the intervention characteristics, outcome measures and main findings. The evidence examined was documented both in a table and in narrative form. No funding for this research took place.

### Results

The overall study selection process is depicted in the flow diagram in Figure 1, p. 12. First, the numbers of studies identified was 392. After initial screening of the title and abstract of the identified papers and removal of duplicates, 49 studies remained. The reasons for exclusions at this stage can be seen in the flow diagram. After more comprehensive screening of the full text, another 26 articles were removed. In particular, implementation studies, treatments targeting relatives, comorbid patients and reviews were excluded. Finally, 22 studies remained for review.

#### Current Interventions

The final 22 articles included 19 different projects or interventions. As already mentioned, all selected studies aimed at BD, specifically at the patient including his treating clinician. The majority of studies emphasized the following reasons why internet-based interventions are particularly useful: The constant presence of smartphones in our everyday life to collect data, the fast transfer of data (Proudfoot et al., 2007) and the possibility to reach otherwise hard to reach target groups, as for instance 32% of the participants lived in rural areas in trial of Gliddon et al. (2019).

The majority of interventions were available on both PC and smartphone (Lengvenyte et al., 2020; Gliddon et al., 2019; Fletcher et al. 2018; van den Heuvel et al., 2018; González-Ortega et al. 2016; Lobban et al., 2015; Barnes et al., 2014; Todd et al., 2014; Todd et al., 2012; Poole et al., 2012; Proudfoot et al., 2007; Barnes et al., 2007). Most of the interventions followed an iterative development strategy to optimize the intervention (Fletcher et al., 2018; Hidalgo-Mazzei et al., 2015; Todd et al., 2012). For this purpose, the technological elements were mostly refined and adapted to make the intervention more user-friendly taking the results from case studies, focus groups and pilot studies, before eventually tested out in randomized controlled trials. In some trials, the patients themselves were involved in the design process as a collaborative partner to meet their specific needs (Hidalgo-Mazzei et al., 2015; Fletcher et al., 2018).

For the greater part, the interventions were intended as adjunctive care to usual treatment in order to prevent relapse. This was facilitated by *detection of early symptoms* as a main tool. This was usually made possible by providing the patients with a personal health record (PHR) where they could

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indicate the severity of their symptoms. Close monitoring of the PHR assisted the patients in recognizing early warning signals of relapse. If detected early enough by themselves, patients could see a doctor and adjust the treatment plan in time. To the most common variables collected in the PHR belong *mood monitoring (MM) tools, medication adherence, sleep wake rhythm and alcohol consumption*. Among the reviewed trials the PHR was electronically provided and the collected data was made available for further examination by the user and in some cases also by a clinician or the device itself.

The reviewed studies used different terms for the same concept of *detection of early symptoms* as one of their main features. Most often, the authors referred to either *detection of early symptoms* or *early warning signs (EWS)*. The meaning of the different terms is intervening in time and averting an upcoming episode by identifying subsyndromal symptoms indicating an upcoming episode. More advanced technologies send out automated warning messages to the patient or clinician, referred to as red flag system, setting off an alarm when certain thresholds are exceeded. To the studies which used the red flag system belong Mondéjar et al. (2019), Gliddon et al. (2019), Fletcher et al. (2018), Mühlbauer (2018), González-Ortega et al. (2016), Hidalgo-Mazzei et al. (2015) Barnes et al. (2014), Faurholt-Jepsen et al. (2013), Barnes et al. (2007).

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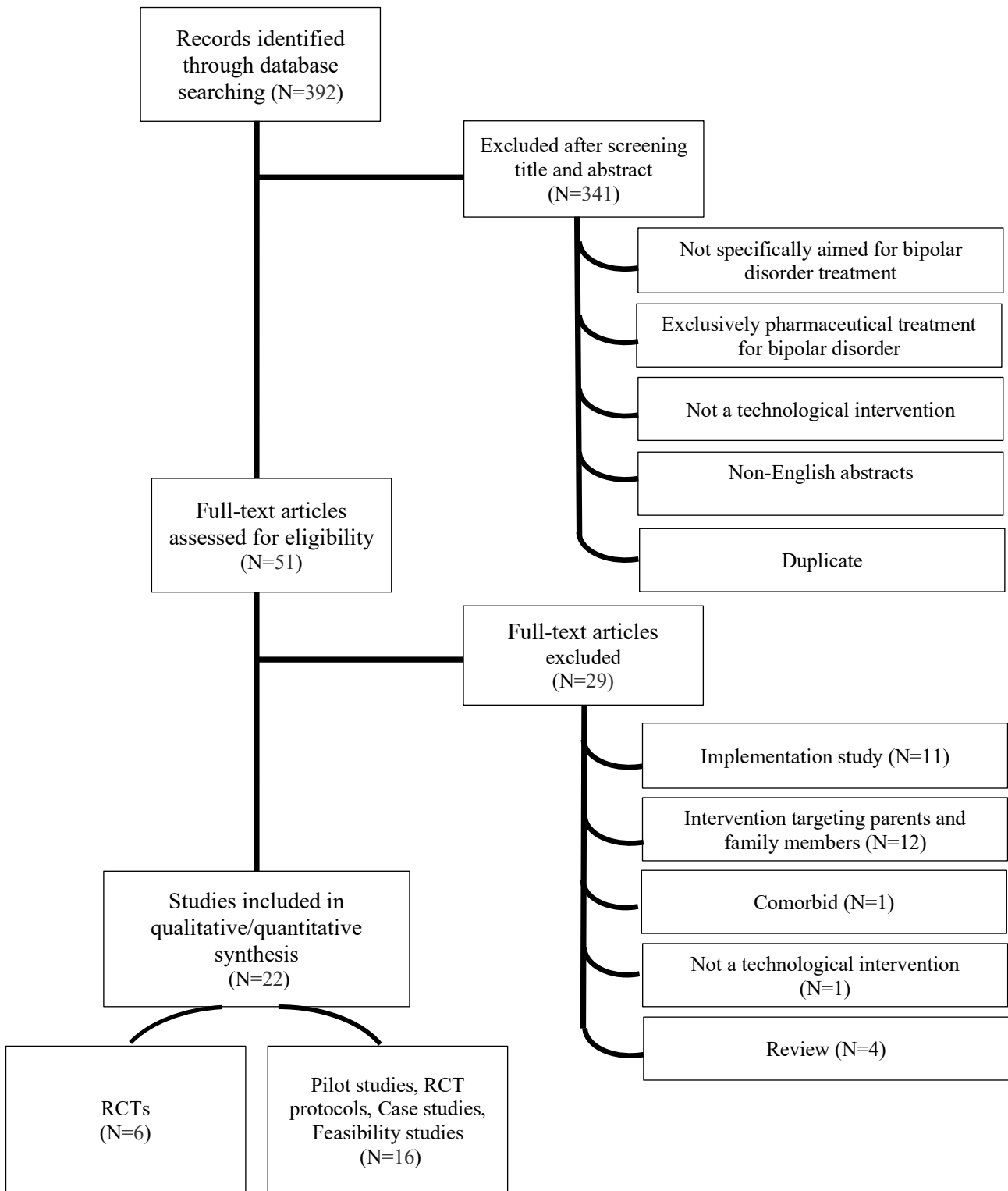


Figure 1. Flow diagram of selected studies.

### Characteristics of New Interventions Published since 2015

The first objective of this review is to describe the characteristics of technological interventions designed for people with BD. An overview of the reviewed studies and the according characteristics can be found in Table 1 in Appendix A. In sum, from the 11 studied technologies for BD, published since 2015, 10 follow a psychoeducational and self-management approach to prevent

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relapse. One study investigated a more neurological approach in the area of working memory training (Lengvenyte et al., 2020). Apart from that, to the most frequent shared characteristic of the latest studied technologies for BD, count psychoeducation (N=7), mood monitoring (N=6), red flag system (N=5), relapse prevention plan (N=3), reminder messages to do the program (N=3). Less frequent features were positive psychological exercises (N=2), sharing the data with a clinician (N=2), discussion forum (N=2), sleep and physical movement (N=2) and medical adherence (N=1).

With regards to mood monitoring two programs, *BraPolar* (Mondéjar et al., 2019) and *True Colors Platform* (Bilderbeck et al., 2016), use passive data measurement to track sleep rhythm and physical movement/acoustic changes. This novel approach relates to the model proposed by Mohr, Zhang, & Schueller (2017) as particularly useful tools to monitor mood changes. Yet, the number of studies integrating passive data collection is still small.

To exemplify the various characteristics of the interventions mentioned above, individual interventions integrating these features are discussed below. With regard to the first frequent feature, *psychoeducation*, it is usually provided in modular form as for instance on the *BPTM platform* (of nine weeks) (González-Ortega et al., 2016). PE is addressed with topics like: What is bipolar disorder?; symptoms of the disorder; course and prognosis of the disorder; pharmacological treatment for the disorder; relapse prevention: Risk and protective factors; What can be done about a relapse?; Healthy lifestyle; Toxic habits; What can I do to improve my condition?. The intervention also contains various other elements such as mood monitoring, professional feedback and reminder messages. This intervention is equipped with the red flag system discussed earlier. However, the RCT about this intervention is still in progress, so no results are available yet.

With regard to the second frequent feature, *mood monitoring* (MM) was usually measured by taking depressive symptoms and manic symptoms into account as these aspects compose the main symptoms of BD. Only recently, an intervention with a 12 months period of daily MM, was assessed in a pilot study by van den Heuvel et al. (2018). Like many of the other trials manic and depressive symptoms were measured through self-rating by the clients as for instance with the Altman Self-Rating Mania Scale (ASRM) (Altman et al., 1997) and the Inventory of Depressive Symptomatology Self-Rating Scale (IDS- SR). Similar to the study about MoodSwings 2.0 (Gliddon et al., 2019) this study provides first effect sizes over a longer intervention period. Next to treatment as usual this intervention, which is called ‘Self-management and Dialogue in Bipolar Disorder’, incorporated self-management, EWS, symptom reduction, improving QoL and sharing data with the clinician. However, with regards to the results, no significant changes from baseline to post measurement could be detected on affective symptoms. Qualitative evaluations still showed a frequent utility of MM, improved communication between clinician and participant with BD and, increased insight in mood fluctuation. Besides, an improved communication between patient and clinician resulting in

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an enhanced therapeutic alliance was found. A lately published RCT protocol about the intervention SBAA-BD (BipoLife\_A3) targets among other aspects also MM (Mühlbauer, 2018). Beyond that, this study aims to assesses the long-term effect after a 21 months intervention period of daily mood monitoring. With this time frame the study constitutes the longest intervention period assessed among the collected studies.

Regarding the *red flag system*, this feature is also integrated in the ongoing intervention ORBIT investigated by Fletcher et al. (2018). During the trial, the red flag alarm will go off as soon as immediate risk of harm emerges (e.g., forum posts or coach emails suggesting active suicidality, scoring high on suicide items). Here, the trial staff was comprehensively trained on protocol procedures how to react if such a case of emergency occurs. Besides, the RCT trial will investigate the effects of ORBIT on self-management and QoL for late stage BD and therewith focuses on a particular subgroup of patients with BD.

Considering the fourth frequent feature, *relapse prevention plan*, an RCT study examining the *True colors platform* intervention in 2016 (Bilderbeck et al., 2016), provided the option to create a prevention plan together with the treating doctor. This 12-week intervention study, of good quality, compared a short therapist-facilitated with a self-directed psychoeducational intervention for BD. Symptoms of the 121 outpatients with BD were measured in both groups on a daily basis. The two experimental groups turned out to be equally effective with good adherence to the intervention. However, there was no significant difference between groups on the primary outcome (depressive symptoms), which makes it difficult to say which form of delivery was more effective.

A similarly often used feature, namely *reminder messages* to do the program was integrated for instance within the study by Lobban et al. (2015) who is was studying a long-term intervention *ERPonline*, another intervention for the detection of early symptoms and strengthening coping strategies over the period of 48 weeks. Similar to the ORBIT study (Fletcher et al., 2018), this intervention trial also targeted people with late stage BD having already a certain prior knowledge about the illness.

*Positive psychological exercises* were a less often used feature. It concerned exercises based on Acceptance and Commitment therapy and self-compassion as in the *ORBIT* trial by Fletcher and her colleagues (2018) or on Mindfulness based Cognitive Therapy in the study by Murry (2015). Among the trained skills were self-awareness, mindfulness as a tool for emotion regulation, identifying personal values as a guide to action, acceptance of negative experiences, creating distance from destructive thoughts, emotions and sensations and building self-compassion in the context of ongoing symptoms (Fletcher et al., 2018).

A further less frequent used tool was *sleep and physical monitoring*. A recent case study about the intervention *BraPolar* (Mondéjar et al., 2019) incorporated technological innovations such as

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sensors allowing detection of data without the active input of the user. Among the variables detected passively were sleep wake rhythms, physical movement and acoustic parameter. To the actively collected data counted MM, QoL, psychosocial interaction and specialized assistance. The intervention was available in two modes, one for the patient and one for the clinician. Hence, both modes could monitor the health status and intervene timely. Goal of the intervention was to encourage self-recognition, self-awareness and detection of early warning signs (EWS). The duration of the intervention was three months. A striking outcome of this study was that people indicated they felt uncomfortable in viewing their passively collected data stored on their device. Above that, the authors raised awareness to the aspect of phone dependence as important measurement to evaluate the effectiveness of sensors. Phone dependence means how many hours a person is on their phone. The authors were concerned that recorded patterns of health behaviors were largely determined by the users' recorded time spend on their phone which thus, influenced the interpretation of data.

A differing recent study sharing little characteristics with the other trials, relates to the intervention *COGMED*® (Lengvenyte et al., 2020) evaluated during a case study. This trial included 32 patients with BD and cognitive complaints. The intervention aims at working memory training with a total of 25 sessions, lasting between 30 and 45 min, five days per week for five weeks. A battery of interactive games is offered supported by weekly phone-based feedback. There is a progress index displayed allowing evaluation so the patients can evaluate their progress. The study found an increase in global functioning (autonomy, professional domain, cognitive domain, financial domain, interpersonal relationships, and leisure activities) after the working memory training program. Furthermore, scores of neuropsychological tests for cognitive complaints, as well as verbal and visuospatial working memory components were significantly increased after the intervention. However, subjective quality of life (QoL) and therapeutic compliance did not change. The researchers conclude the results have to be interpreted cautiously due to limitations considering the short treatment period and small power of the study sample.

The other studies, which were reviewed already in 2015 are also displayed in Table 1 Appendix A, including interventions like *Simple, Personalized Real-Time Intervention for Stabilizing Mood (PRISM)*, *Living with Bipolar*, *Health- Steps for Bipolar Disorder*, *Monarca*, *Beating Bipolar*, *BEP platform* and *Recovery Road*. All of them all put emphasis on the aspect of self-management which includes the detection of early symptoms to prevent relapse. Here, the acquisition of symptom insight is also mostly attained by psychoeducation.

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### Effect on Detection of Early Symptoms

One part of the second objective of this review was to describe the effect on the *detection of early symptoms* of technological interventions designed for people with BD. A great part of the trials, in particular 12 out of 22, describe *detection of early symptoms* as a key concept of their intervention (See which studies used detection of early symptoms in column “study objective” in Table 1 in Appendix A). Still, among the reviewed trials no intervention included *detection of early symptoms* as their primary outcome measure. This made it difficult to determine the effect of the interventions on detection of early symptoms in itself. Apparently, the feature is incorporated, while it is not assessed as an outcome.

The studies could, therefore, only be examined for whether they had integrated detection of early symptoms as a feature. Among the most prominent primary outcome variables pathological variables such as depressive or manic symptoms, functionality or quality of life. Detection of early symptoms was not among the primary outcome measures. Regarding the three RCT studies, which used *detection of early symptoms* as one of their intervention features, solely one study with an excellent quality found significant improvements for depressive symptoms (Depp et al., 2015).

*Detection of early symptoms* was integrated as one of their features was in a pilot study about ‘*Self-management and Dialogue in Bipolar Disorder*’ (van den Heuvel, 2018). It showed improved insight into factors of mood fluctuations. Another case study about the wearable technological intervention *PSYCHE Platform* could identify changes in affective symptoms. They could detect changes from milder to severe states with an accuracy of 97%, which also can be evaluated as increased ability to *detect early symptoms*, but only in proximate form (Valenza et al., 2013). Results from a case study about the intervention *Beating bipolar* (Poole et al., 2012), revealed an improved self-awareness which also can be interpreted as a positive effect *on detection of early symptoms* but also here only in a proximate form.

In sum, the large number of interventions incorporating *detection of early symptoms* as a feature, the promising results from the case studies and one significant result from an experimental study, show this feature is highly represented. Apparently, this feature is elementary within the treatment of BD but inferences about its effect size cannot be drawn yet as the studies lack according outcome measures.

### Effect on Self-management

14 out of 22 trials investigated an intervention incorporating *self-management* as one of their study objectives. However, this aspect is not assessed as an outcome measure. At least, the *PRISM* intervention (Depp et al., 2015) and *LWB* intervention (Todd et al., 2014) found significant improvements for depressive symptoms and increased well-being, respectively as proximate outcome



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measures. On the contrary, *Beating Bipolar* (Smith et al., 2011), *Health-Steps for Bipolar Disorder* (Barnes et al., 2014) and *True colors platform* (Bilderbeck et al., 2016) could not detect any significant improvement for mental health incorporating *self-management* as a feature. Nevertheless, a pilot study by Murray et al. (2015), featuring *self-management* found significant improvement on the primary outcome QoL. Thus, there was neither self-management assessed as an outcome measure nor were there consistent results about the effectiveness of technologies incorporating self-management as a feature. In sum, similar to the component *detection of early symptoms*, *self-management* was in fact addressed multiple times as an intervention characteristic but not as an outcome variable among the investigated trials.

### Effect on Well-being

Since 2015, 5 out of 22 trials include *well-being* as a primary outcome mostly in the form of measuring quality of life (QoL). Thus, almost a quarter of the studies examined, considered well-being as a suitable outcome measure (Murray et al., 2015; Hidalgo-Mazzei et al., 2015; van den Heuvel et al., 2018; Fletcher et al., 2018). A further study integrated *well-being* as a secondary outcome measure, also specified as QoL (Todd et al., 2014). In the particular cases of Fletcher et al. (2018) and Murray (2015), these trials assessed *well-being* not only as an outcome measure but also integrated this aspect as a technological feature. Apparently, assessing well-being as an outcome measure does not automatically implicate that well-being is incorporated as a technological feature.

Three of the six studies with effect on well-being already published findings about effectiveness. A first pilot study of Murray (2015) showed significant improvements of QoL. The accompanying RCT trial by Fletcher and her colleagues (2018) (ORBIT intervention) is still in progress. Todd et al. (2014) found improvement in psychological and physical domains of quality of life as a secondary outcome. The RCT conducted by Smith et al. (2011), using QoL as their primary outcome measure found no significant improvement compared with the control group. However, within the psychological subsection, there was a marginally significant improvement in the intention-to-treat group. Overall, even so the effect on well-being is inconsistent among the trials, some studies place value on the topic as a technological feature and multiple trials manifest well-being as an outcome measure.

## Discussion

### Main Findings

This literature review aimed at, first examining which existing technological features are incorporated in programs for BD and second, understanding how interventions influence detection of early symptoms, self-management and well-being. Considering the first aim, the most frequent

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characteristics of the examined technological interventions are psychoeducational elements, mood monitoring, and the integration of a red flag system. The interventions largely varied in number of technological features but had a similar function as psychoeducational adjunctive care.

The above stated characteristics of technologies are generally in accordance with Barak's' et al. (2009) description of internet-based interventions. Among the collected papers, the users are offered health related information and interactive components through websites and applications. Furthermore, as proposed by Barak et al. (2009), the interventions are primarily self-guided. Aside from BraPolar (Mondéjar et al. 2019), which offers as a specialized assistance, all of the other technologies take place under self-guidance, which conforms the definition of web-based interventions. An additional element exceeding the description of Barak et al. is the feature of mood monitoring. This feature goes beyond the distribution of diagnosis-specific information but requires the exact tracking of a PHR. At most, mood monitoring could be understood as an interactive tool and thus complement Barak's' et al. (2009) description of interactive components. This means the definition should be extended to include mood monitoring, to offer a comprehensive definition to also cover technologies targeting chronic diseases such as BD.

With regard to the second aim, the interventions' effect on *detection of early symptoms* is not quantifiable as *detection of early symptoms* was no outcome measure, at most this aspect was integrated as a technological feature. The ways in which *detection of early symptoms* was usually technologically integrated was mood monitoring and the red flag system. Similar to this, *self-management* was also no outcome measure and still incorporated in more than half of the interventions as study objective. In particular, the examined interventions served the purpose of *self-management* mainly through psychoeducational features. Mostly this was facilitated in form of self-efficient management of various areas in life (E.g.: medication adherence, relapse prevention plan). Remarkable is that *well-being* was not only assessed as an outcome measure delivering some positive indications for mental health but it also served as characteristic of some of the reviewed trials. However, clinically significant results about this approach cannot yet be delivered yet because the present studies are inconsistent and involve ongoing trials that do not report results. In view of the number of studies that address well-being as a focus, one can say that there is at least a certain interest in the topic but more research is needed.

When comparing the effects of studies on the aspects of *detection of early symptoms*, *self-management* and *well-being*, *well-being* seems to be the best researched focus with regard to primary outcome measures. However, considering the intervention characteristics, well-being was with two interventions the least represented feature among the trials. Not being assessed as an outcome measure the aspect *detection of early symptoms* can be more understood as a technological feature and *self-management* more as a study objective compared to well-being which was mostly assessed

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as an outcome. From this, the hypothesis can be derived that *detection of early symptoms* is evaluated as means to an end influencing *well-being*. *Self-management* was used neither as a technological feature nor as outcome measure but more as a general goal of the intervention. Nevertheless, from the amount of interventions incorporating detection of early symptoms and self-management, it can also be seen that these aspects are pivotal for the outcome of the intervention. The connection between the discussed aspects will further evaluated in the following.

Based on these findings, many of the reviewed interventions aimed to have an ultimate effect on increasing well-being as a depending variable. Regarding, detection of early symptoms and self-management, it is possible that the role of mediators can be attributed to them in form of a serial mediation. Following this model, technology (independent variable) might have an influence on well-being (dependent variable), mediated by detection of early symptoms (first mediating variable) and self-management (second mediating variable) in a sequential manner (See Figure 2, p.20). Some support for this hypothesis can be derived from two existing studies. First, this would be in line with Schuurmans' et al. (2005) study on a self-report instrument for self-management who assumes self-management abilities contribute to sustainable well-being later in life. Secondly, Morriss (2004) confirms detection of early symptoms is presumed to be a component to achieve well-being.

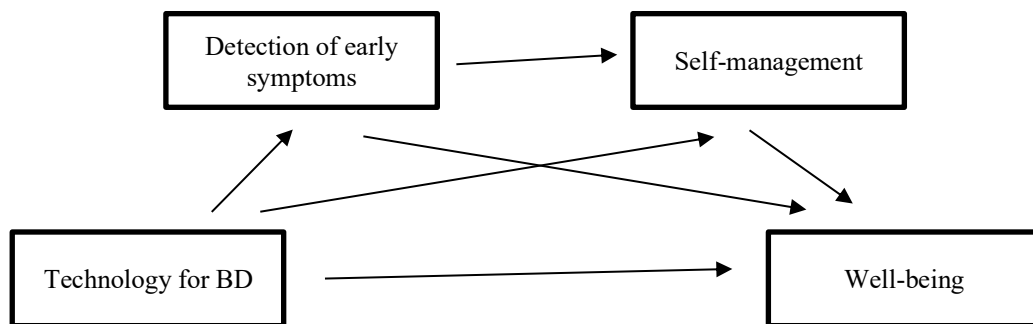


Figure 2. Serial mediation model.

In sum, the reviewed interventions can be described as internet-supported therapeutic interventions in concordance with the definition delivered by Barak et al. (2009). They are mostly of psychoeducational nature sharing intervention characteristics like psychoeducational elements, mood monitoring and a red flag system. Further, it can be said that the effort in technology development for DB in the recent years (in particular since 2015) is not only aimed at relapse prevention, but also focuses on patients' quality of life, psychosocial functioning and well-being, which corresponds to the recommendations of Hidalgo-Mazzei et al. (2015).

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### Potential and Limitations of Current Studies

Among the latest technological interventions for BD, *self-management* facilitated by psychoeducational modules remain an important factor in both currently studied interventions as well as prior ones. As *self-management* of chronic illness becomes growingly important and technological progress offers more and more interactive tools, features such as moderated discussion forums, professional feedback and reminder messages have been added. The technological advances also refer to the development of embedded sensors (E.g.: GPS tracking, measurement of social interaction) to collect ubiquitous data and use them to *detect early symptoms*. Having control over fluctuating mood and activity-patterns, detected by embedded sensors, is one of the outstanding great potentials of web-based interventions in addition to treatment as usual. Limited evidence is available, but first studies test out this potential (Mondéjar et al., 2019, Bilderbeck et al., 2016). This finding is in line with an earlier BD platform review which stated novel phenotypic markers providing objective data as revolutionizing prompt recognition and easy monitoring despite lacking large scale evidence base (Rajagopalan et al., 2017).

In particular, two technologies (BraPolar, True Colors Platform) can already be assigned to the concept of compassionate technology recently developed by Noordzij (University of Twente), yet for this term no proper definition is existing though. Nevertheless, compassionate technology aims to improve quality and access to mental healthcare. This technology has the advantage to detect human behavior passively and the user is unburdened as there is no need for self-report measures. This is particular helpful in chronic disease, demanding measurement of data over long time period. The technology makes the data quantifiable into diagnostic parameters allowing close monitoring. Here, the technology, as a constant companion might detect changes in pattern which might otherwise remain undetected but are a crucial sign of relapse. The detection of early warning signs is particularly beneficial as that they may be eventually ignored when symptoms are only recorded manually. The second advantage of this form of technology is when data is shared with the treating clinician, the patient can be contacted, and an upcoming episode or even suicidality can be averted. In addition to the embossed sensors, the early warning system with automated messages constitutes a more newly introduced characteristic of digital interventions in this field.

Not only a technological upgrade could be observed but also an extension to the existing pathological dimension towards well-being was found. As mentioned earlier, there is a recognizable increase of well-being approaches integrated into interventions but scientific evidence for its effectiveness is scarce. The evidence-base for this approach is only just beginning to emerge. Among the studies, it could be recognized, many interventions not only integrate well-being as an intervention approach but also as an outcome.

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With regard to the detected intervention characteristics, an interesting finding was that patients in very early stage of development of the disease as well as in late stage can both profit from some newly introduced customizable psychoeducation features, which allow an adjustable degree of detail among the educational modules. This might be beneficial as Van Gemert-Pijnen (2013) describes that eHealth technologies increasingly include personalization to accommodate the user preferences. This successful adaptation to prior versions, shows integration of the users' needs works well and it can encourage further collaborative development processes to provide psychoeducation to affected people of any age group.

Despite most of the interventions aim for a reduced involvement of clinicians, mainly to keep the cost low, many interventions still have a high degree of participation of trained supporters and clinicians to guide the patients through the psychoeducational modules. Among the studied interventions clinicians were mostly available on a very regular basis and even conducted weekly phone calls with the participants. The calls were usually relatively short compared to a referral hour in office. It got to be noted, an absolute independence is impossible due to necessary medical consultations in phases of relapse. This highlights the issue of indispensable lack of self-management of the disease, as involvement of others is always required to some degree. Certainly, this constitutes a limitation of the present technologies.

With regards to limitations, with patients' risk management a legal issue appears. Most of the studied interventions are not available to the public yet. In careful consideration of legal issues with the delivery of web-based interventions with "therapeutic value", the interventions were specified as self-management programs with no claim to offer a psychological service. However, in order to improve and expand psychological services it requires health political legal changes to be also able to integrate more therapeutic tools. Finally, with regard to the efforts to integrate internet-based and e-mental health tools into the treatment strategy in order to treat more cost-effectively and faster (Emmelkamp et al., 2014), the numerous studies found can already be regarded as promising investigation of novel features with both symptom and well-being oriented outcome measures.

### **Intervention evolution.**

Based on the intervention characteristics, one can recognize a trend from a purely pharmacological treatment strategy towards a more autonomous self-management among the available treatment methods for BD. Since most interventions pursue their primary goal in psychoeducation, there are few therapeutic aspects among the available interventions. From the latest studies since 2015, 10 of 11 studies focused on a psychoeducational approach instead of behavioral change interventions to alleviate symptoms. Hence, there is a development to foster coping strategies and protective factors in the sense of positive psychology. Adding a well-being approach to the

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existing pathological approach (symptom oriented) broadens the spectrum of intervention possibilities. This development can be interpreted as a holistic movement, which perceives the integration of strengths and resources to already existing tools as beneficial.

### **Strengths and Limitations**

The current study provided insight into technological innovations for BD and could detect the latest developments in the research area due to a broad search process on two different databases. Therewith, not only intervention characteristics could be described but also inferences about the effect on detection of early symptoms, self-management and well-being could be drawn. This is valuable information for both research and clinical practice. The scoped review was able to inform future research practice, programs and policy. Furthermore, the RCT studies which were assessed for quality go beyond the usual reporting of a scoped literature review. This allows a more valid interpretation and further use of the results.

However, this review did not allow for answering the second research question to a great part as the examined studies did not include the intended primary outcomes except from *well-being*. Inferences about the effect on *detection of early symptoms* and *self-management* could not be drawn with regards to effect sizes.

### **Implication for Practice and Research**

Taking the limitations into consideration, future research could add an outcome measure for *detection of early symptoms* and a measure for *self-management* to allow inferences about the effect on these two aspects. From the findings of the current study, it can be seen that *well-being* could be identified as the only outcome parameter compared to the other two aspects of this research. As explained above, the two latter concepts may serve as mediators, to increasing *well-being*. This could be tested in further experimental research applying a mediation analysis.

With respect to the goal to provide effective interventions targeting BD, some technological interventions already go beyond symptom reduction as their main outcome measure by adding well-being as a parameter. The resulting evidence base is yet scarce and divergent. To improve that, the choice of outcome measures might need modification, specifically adding psychoeducation and self-management as parameters as these mostly compose the study objective in view of psychoeducational adjunctive care interventions. In a next step, if more elaborate conclusions about the effect on these aspects can be drawn also a factorial randomized controlled trial could be conducted to identify most efficacious technological features targeting symptom reduction, self-management and well-being.

Implication for clinical practice is a portrayal of current interventions and their effects on patients. Even though the interventions are not available yet to the public, clinicians can already

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follow the research progress in the area to possibly integrate them in their practice in future. Other stakeholders profiting from the findings might be IT developers, encouraging them to further work on refining embedded sensors as these seem to play a fundamental role in mood and behavior monitoring in the treatment of chronic diseases, such as BD. Especially, for chronic diseases compassionate technologies constitute a preeminent advantage to traditional health care models and should therefore be put in focus by both intervention developers and researchers.

Concluding, this review could provide insight into the current state of technological interventions targeting patients with BD. The current interventions mainly aimed for psychoeducation and mood monitoring as adjunctive care to treatment as usual by under application of diverse technological features. However, the effect of the interventions was mainly measured with outcome variables of depressive and manic symptoms as well as well-being. Besides, the findings about the effect sizes were inconsistent. Beyond that, while the majority aimed for self-management as a study objective, this variable was not assessed as an outcome measure. A similar situation prevailed for detection of early symptoms, solely incorporated as an intervention feature.

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## EHEALTH IN BIPOLAR DISORDER

### Appendix A:

Table 1

*Characteristics of the current psychological interventions projects or programs delivered through technologies.*

| <b>Project/program</b> | <b>Authors (Year)</b>    | <b>Study objective</b>                                       | <b>Technological features</b>  | <b>When</b>              | <b>Type</b>  | <b>Control</b>   | <b>Primary outcome measure</b>                    | <b>Study findings</b>  |
|------------------------|--------------------------|--|--|--------------------------|--------------|--|---|--|
| COGMED                 | Lengvenyte et al. (2020) | Improved functioning   | WM   | Daily sessions, 5 weeks  | Case study   | preliminary naturalistic, prospective, monocentric, open, non-controlled study   | Global functioning                                | Improvement of global functioning (autonomy, professional domain, cognitive domain, financial domain, interpersonal relationships, and leisure activities) |
| BraPolar               | Mondéjar et al. (2019)   | Encourage self-recognition, self-awareness, detection of EWS | MM, QoL, psychosocial interaction, specialized assistance, sleep, physical movement, acoustic parameter, red flag system | Daily sessions, 12 weeks | Case study   | NA   | Data transmission of patient specific information | Application is satisfying and easy to use, some features need improvement for better end-user experience   |
| MoodSwings 2.0         | Gliddon et al. (2019)    | Psychoeducation, symptoms reduction                          | PE, DF, CBT interactive tools, monthly red flag system   | Daily session, 12 months | RCT          | 1) Discussion forum only. 2) Discussion forum plus psychoeducational modules 3) Discussion forum, psychoeducational modules, plus CBT-based interactive tools. | Decreased symptoms of depression and mania        | Reduction of depression  |
| ORBIT                  | Fletcher et al. (2018)   | Self-management, improve QoL                                 | PE, PF, DF, MM, PPIs (ACT, self-compassion), free choice of order, red flag system                                       | Daily sessions, 5 weeks  | RCT protocol | 1) Mindfulness 2) Psychoeducation  | Quality of life                                   | NA   |

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|  |                               |   |   |                           |              |  |   |   |
|--|-------------------------------|---|---|---------------------------|--------------|--|---|---|
| SBAA-BD (BipoLife_A3)                                | Mühlbauer (2018)              | Detection of early symptoms   | red flag system, MM   | Daily sessions, 21 months | RCT protocol | Without feedback   | Decreased symptoms of depression and mania  | NA  |
| 'Self-management and Dialogue in Bipolar Disorder'   | Van den Heuvel (2018)         | Self-management, EWS, symptom reduction, improve QoL                                    | MM, PE, relapse prevention plan, share data with clinician                                | Daily sessions, 12 months | Pilot study  | NA   | Feasibility of the personal health record, evaluate user experiences                  | Frequent utility of the mood chart modules, improved communication between clinician and participant with BD and, increased insight in influencing factors of mood fluctuations |
| Bipolar Patient Treatment Management (BPTM platform) | González-Ortega et al. (2016) | Symptom reduction, functional improvement, detection of early symptoms, self-management | PE, MM, PF, red flag system, reminder   | Daily sessions, 9 weeks   | RCT protocol | TAU  | Patients' illness awareness, symptoms, functionality, relapses and rehospitalizations | NA  |
| True colours platform                                | Bilderbeck et al. (2016)      | Symptom reduction, psychoeducation, self-management, detection of early symptoms        | PE, MM, reminder, share data with clinicians, sleep, med. adher., relapse prevention plan | Weekly sessions, 12 weeks | RCT          | Intervention group: facilitated; control group: manualized | Depressive symptoms   | No group differences  |
| MBI Orbit  | Murray (2015)                 | Symptom reduction, improve QoL, self-management   | PPIs (ACT, MBCT), QoL   | Daily sessions 3 weeks    | Pilot study  | NA   | Quality of life   | Significant improvement in quality of life  |
| ERPonline  | Lobban et al. (2015)          | Detection of early symptoms, strengthening coping strategies                            | PE (level of detail) free choice of order, relapse prevention plan, FAQ, reminder         | Daily sessions, 48 weeks  | RCT protocol | WCT  | Feasibility and acceptability   | NA  |

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|   |                               |   |   |                           |                        |                                     |   |   |
|---|-------------------------------|---|---|---------------------------|------------------------|-------------------------------------|---|---|
| Simple  | Hidalgo-Mazzei (2015)         | Self-management and psychoeducation                                 | MM, sleep, Med. adher., PE based on assessment, red flag system         | Daily sessions, 12 weeks  | RCT protocol           | SIMPlE + TAU; control: only TAU     | Affective symptoms, global functioning, biological rhythm, quality of life                        | NA  |
| Personalized Real-Time Intervention for Stabilizing Mood (PRISM). | Depp et al. (2015)            | Self-management, reduction of symptoms, detection of early symptoms | MM, generating coping strategies  | Twice per day, 10 weeks   | RCT                    | Paper-and-pencil mood monitoring    | Depressive symptoms   | Compliance was 65%, significantly greater reductions in depressive symptoms, effects were not maintained at 6-months follow up                |
| Living with Bipolar (LWB)   | Todd et al. (2014)            | Self-management   | PE, MM, DF, reminder, CBT   | Daily sessions, 6 months  | RCT, feasibility study | LWB + TAU; control: WLC             | Feasibility; secondary outcome: QoL   | High retention rates, LWB showed the most robust improvement in psychological and physical domains of quality of life, wellbeing and recovery |
| Health- Steps for Bipolar Disorder                                | Barnes et al. (2014)          | Self-management + optional CBT                                      | PE, MM, CBT, red flag system,   | Daily sessions, 12 months | RCT                    | Websites focused on 'healthy living | Reoccurrence: Depressive and/or hypomanic symptomatology and functional capacity, hospitalization | Completion rate 75%, no significant differences between the active and control treatment groups on any of the definitions of recurrence.      |
| Monarca   | Faurholt-Jepsen et al. (2013) | Self-management, detection of early symptoms                        | MM, sleep, red flag system, PF, cognitive problems, alcohol consumption | Daily sessions, 6 months  | RCT protocol           | Placebo                             | Depressive and manic symptoms   | NA  |

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|                     |                       |   |   |                                 |              |     |                                       |  |
|---------------------|-----------------------|---|---|---------------------------------|--------------|-----|---------------------------------------|--|
| PSYCHE Platform     | Valenza et al. (2013) | Mood monitoring, detection of early symptoms                                  | Wearable: T-shirt with monitoring system using autonomic nervous system related bio signals | 90 days                         | Case study   | NA  | changes in affective symptoms         | with an accuracy of 97% good affective state (euthymia) could be distinguished from severe clinical states and is lower in distinguishing euthymia from the milder states (accuracy up to 88%)   |
| Living with Bipolar | Todd et al. (2012)    | Self-management   | PE, MM, DF, reminder, CBT   | Daily sessions, 6 months        | RTC protocol | TAU | Feasibility and acceptability         | NA   |
| Beating Bipolar     | Poole et al. (2012)   | Psychoeducation, self-awareness, self-management, detection of early symptoms | PE, DF  | 2 weeks gap between each module | Case study   | NA  | Feasibility, acceptability and impact | Engaging, feasible to complete, 35 % attrition rate (due to concentration and motivation difficulties), interface was professional and clear, comprehensive, own pace and timing, lack of discussion moderator, lack of sociability, more in-depth drug review, impact for new or very recently diagnosed, improved self-awareness |
| Beating Bipolar     | Smith et al. (2011)   | Psychoeducation, self-management, detection of early symptoms                 | PE, DF reminder   | 4 months                        | RCT          | TAU | Quality of life                       | Compliance rate: 66.6% completed at least 75% of the program, no significant difference between the intervention and control groups, within the psychological subsection, there was a marginally significant difference  |



## EHEALTH IN BIPOLAR DISORDER

|                          |                         |   |  |                           |                                 |  |   |  |
|--------------------------|-------------------------|---|--|---------------------------|---------------------------------|--|---|--|
| Biped -> Beating Bipolar | Simpson et al. (2009)   | Psychoeducation, self-management, detection of early symptoms | PE, DF                                 | Daily sessions, 4 months  | RCT protocol                    | TAU  | Overall quality of life (physical health, psychological health, social relationships and environment) | NA   |
| BEP platform             | Proudfoot et al. (2007) | Self-management, psychoeducation                              | PE, free open access                   | Not applicable            | RCT protocol, feasibility study | (i) on its own, and (ii) with email support from informed supporters to establish and implement a wellbeing self-management plan | Representations of their illness, usage of the program  | 8000 visitors within first 6 months, predominantly female, 43.5% with bipolar disorder, majority (76%) completed sessions they commenced |
| Recovery Road            | Barnes et al. (2007)    | Self-management, detection of early symptoms                  | CBT, PE, MM, red flag system, reminder | Daily sessions, 12 months | RCT protocol                    | Receiving some relevant information (online attention placebo)   | Depressive and manic symptoms   | NA   |

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*Note.* PE=Psychoeducation, MM=Mood-Monitoring, DF=Discussion forum, PPIs= Positive psychological interventions, Med. adher.=Medication adherence, PF=Professional feedback QoL=Quality of life, EWS=Early warning signs, ACT=Acceptance and Commitment Therapy, MBCT=Mindfulness based cognitive therapy, CBT=Cognitive behavioral therapy, WCT= Waiting list control group, RCT=Randomized control trial, NA=Not applicable, TAU=Treatment as usual.

## EHEALTH IN BIPOLAR DISORDER

### **Appendix B:** Full electronic search strategy PsycINFO (EBSCOhost)

Search Alert: "(technology\* OR "World Wide Web" OR online OR web-based OR internet\* OR "computer assisted" OR e-health OR network OR "Web Services" OR "compassionate technology" OR internet OR app OR wearable OR m-health OR "eMental health") AND (autonomy OR "Personal recovery" OR self-management OR empowerment OR "mindfulness based" OR "mental health" OR well-being) AND (bipolar OR "Affective disorder" OR "Episodic illness" OR manic OR bi-polar) AND ("feasibility studies" OR "Study protocol" OR efficacy OR performance OR result OR outcome OR "Pilot study" OR usability OR "focus group") AND (RCT OR "randomized control trial\*" OR effect\*) Linked Full Text on 2020-05-04 11:41 AM"