



## Original article

# Remote mood monitoring for adults with bipolar disorder: An explorative study of compliance and impact on mental health service use and costs



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## ABSTRACT

**Background:** Remote monitoring of mood disorders may be an effective and low resource option for patient follow-up, but relevant evidence remains very limited. This study explores real-life compliance and health services impacts of mood monitoring among patients with bipolar disorder in the UK.

**Methods:** Patients with a diagnosis of bipolar disorder who were registered users of the *True Colours* monitoring system for at least 12 months at study assessment were included in this retrospective cohort study ( $n = 79$ ). Compliance was measured as the proportion of valid depression and mania scale messages received in comparison to their expected numbers over the first 12 months of monitoring. Mental health service use data were extracted from case notes, costed using national unit costs, and compared 12 months before (pre-TC period) and 12 months after (TC period) patients' engagement with monitoring. Associations with relevant patient factors were investigated in a multiple regression model. **Results:** Average compliance with monitoring was 82%. Significant increases in the annual use and costs of psychiatrist contacts and total mental health services were shown for patients newly referred to the clinic during the pre-TC period but not for long-term patients of the clinic. Psychiatric medication costs increased significantly between the pre-TC and TC periods (£ 235,  $P = 0.005$ ) unrelated to patients' referral status. **Conclusions:** Remote mood monitoring has good compliance among consenting patients with bipolar disorder. We found no associations between observed changes in mental health service costs and the introduction of monitoring except for the increase in psychiatric medication costs.

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## 1. Introduction

Bipolar disorder is a chronic illness characterised by episodes of depression and excessive elation. It represents a spectrum from mild mood episodes to severe mood disorders with psychotic symptoms. Bipolar disorder is often associated with other psychiatric disorders (e.g. substance abuse, personality disorder) or physical co-morbidities (e.g. diabetes, cardiovascular disease), and often results in poor social and physical functioning of the patients [1–3].

The lifetime prevalence of bipolar disorder is estimated to be between 1 and 6% in European countries [4]. Worldwide, it is one of the leading causes of disability with more years of life lost due to premature death and disability than asthma, heart attack, epilepsy

and dementia [5]. People with bipolar disorder are frequent users of health and social care services. In 2007, an estimated 1.14 million people suffered from bipolar disorder in the UK [6]. For the same year, the total societal costs of bipolar and related disorders were calculated at £ 5.2 billion with total service costs (health and social services and informal care) being £ 1.6 billion [6]. A more recent estimate by Young et al. [7] for the annual UK National Health Service (NHS) cost of bipolar disorder was £ 342 million at 2009/10 prices. Hospitalizations accounted for 60%, outpatient and community mental health for 26.7%, and medication in primary care for 7.4% of the overall direct costs of care [7]. A recent review suggests that costs in the UK are comparable with other European countries: cost estimates for the USA are much more variable [8].

The main objectives of bipolar disorder management are stabilization of mood thereby preventing acute episodes, unwanted hospital admissions and suicides, and improving quality of life by

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optimising social and physical functioning. Recent guidelines [9] have emphasized the potential for improving care by more expert clinical service provision. Specialist care reduced the risk of re-admission to hospital in bipolar disorder in comparison with generic care in Denmark [10] and this finding can probably be generalized to other developed countries. Monitoring of symptoms should be an essential component of bipolar disease management because it can track the effectiveness of interventions and facilitate early intervention when fluctuations in symptoms are identified to prevent or minimise the impact of episodes [11]. Timely access to specialist care is, however, often limited due to human, financial or geographical constraints resulting in waiting lists, suboptimal treatment and lost opportunities for early intervention or prevention.

Several attempts have been made to implement regular, remote mood monitoring for bipolar disorder to improve clinical outcomes and optimize access to specialist services at low direct intervention costs [12–17]. However, none of the relevant studies provided information on patients' real-world achievable compliance with monitoring or investigated the broader impact of monitoring on other costs to the mental health services. Moreover, currently there is no agreement whether remote mood monitoring increases mental health service use due to stricter follow-up or reduces service use as the consequence of less frequent visits and better health outcomes. With the growing number of such services worldwide, it is important to gain more insight into the real-life feasibility and acceptability of remote mood monitoring and to establish its likely wider economic impact on the mental health services. In order to explore these aspects and fill the relevant gaps in evidence, we conducted a retrospective cohort study of bipolar patients' compliance with monitoring and their mental health service contacts and costs before and during their first year engagement with the *True Colours* monitoring system at Oxford Bipolar Disorder Research Clinic in Oxford, UK (<https://truecolours.nhs.uk>).

## 2. Methods

### 2.1. The *True Colours* system

Remote mood monitoring for adults with bipolar disorder has been successfully implemented at the Oxford Bipolar Disorder Research Clinic at the Warneford Hospital, Oxford, UK using the *True Colours* system since 2006. The clinic provides secondary (for referrals from central Oxford) and tertiary service for around 300 patients with bipolar disorder. The *True Colours* system combines simple, widely used, convenient and low cost means of communication by SMS/email/internet with sophisticated software engineering. It allows a real-time, remote monitoring of symptoms and clinical outcomes by patients self-rating their mood using validated self-report scales for depressive (the Quick Inventory of Depressive Symptomatology [QIDS-SR<sub>16</sub>]) and manic symptoms (the Altman Self-Rating Scale for Mania [ASRM]), and their communication by weekly mobile-phone text messages or email [18,19]. Patients using *True Colours* either receive and reply to two, weekly text messages separately for the monitoring of their QIDS and ASRM scores, or receive one prompting email and log in to the *True Colours* website via a secure link to enter their relevant scores directly. In case of no reply or faulty response, the system sends additional reminder SMS messages/emails. The chosen method of communication is the preference of the patient and can be changed. The system also produces a graph-based output in a user-friendly format accessible through the web for the patients and their clinicians/care teams, allowing them to track a patient's condition and identify early signs of relapse in a collaborative way. *True Colours* meets the requirements of patient confidentiality and security as it has been designed to enable compliance with the Data Protection Act 1998 and 2003 [20,21] and the NHS Information Governance Assurance Framework [22].

### 2.2. Patients and design

A group of 159 potential participants aged 18 and over was obtained from the patient lists of the three consultant psychiatrists initially implementing *True Colours* at the Oxford Bipolar Disorder Research Clinic. The status of these participants as current or previous *True Colours* users was confirmed by their responsible clinician and further authenticated through cross-referencing with the *True Colours* database. Screening of the cohort was conducted to identify: a clinician confirmed diagnosis of bipolar disorder I, II or Not Otherwise Specified (NOS) using the Structured Clinical Interview for DSM-IV (SCID); registration with the *True Colours* system for a minimum of 12 months; and accessible paper or electronic psychiatric notes covering the full 12-month periods prior to and after enrolment with *True Colours* (pre-TC and TC periods, respectively) as of 2010.

Compliance with remote mood monitoring was measured for each participant as the proportion of valid SMS/email messages received by the *True Colours* system in comparison to the expected number of weekly QIDS and ASRM scale messages over the first year monitoring period. Anonymised patient-level data on the number of messages sent and received by the *True Colours* system were extracted directly by the system manager for the relevant 12-month periods. Individual case notes were screened for contacts with various mental health care staff and psychiatric hospital admissions for the 12 months before and 12 months after engagement with remote mood monitoring by an independent research assistant. Written consent was sought from all participants. The study protocol was approved by the local Research Ethics Committee (Oxfordshire REC A, Reference: 10/H0604/13).

### 2.3. Analysis

The economic analysis had a before and after study design. Investigated resource use categories included mental health inpatient hospitalisations, face-to-face and phone contacts with psychiatrists (including trainees), psychologists, community mental care staff (community psychiatric nurse, community support worker, crisis team, occupational therapist, social worker) and psychiatric medications. Service costs were calculated in British £s for the last respective year of resource use using UK national-level unit costs [23,24]. For medications, we used average mg prices based on the British National Formulary [25]. Applied unit costs are listed in Table 1.

A frequency analysis of observed, patient-level mental health service use data and comparison of observed costs in the pre-TC and TC periods were carried out using t-test. In addition, mental health service costs were analysed in a multiple regression analytic framework [26–28] to explore the associations with age, gender, duration of illness and period of observation (pre-TC or TC), and to adjust for potential, a priori defined confounders such as the presence of significant manic and/or depressive symptoms at the time of engagement with *True Colours*, and patients' referral status to the Oxford Bipolar Disorder Research Clinic during the pre-TC period (newly referred vs. long-term patients). Statistical significance was considered at 5% (two-sided,  $P \leq 0.05$ ). All analyses were carried out in STATA 10 (StataCorp. LP, College Station, Texas, USA, 2007).

## 3. Results

### 3.1. Patients

Seventy-nine participants (33 male/46 female) aged 18 to 71 years (mean age = 39 years, SD = 13 years) fulfilled all of the specified inclusion criteria and consented to the study. Participants' history of bipolar I ( $n = 52$ ), II ( $n = 9$ ) or NOS ( $n = 18$ )

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