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# "Flow" Transcranial Direct Current Stimulation (tDCS) for Depression Treatment in a Community Mental Health Team (CMHT) Service: Depression, Functioning, and Health-Related Quality of Life Outcomes

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## Abstract

Background: People who experience severe mental illness (SMI) have a high prevalence of depression symptoms, which is linked to worse functioning and quality of life. Research evidence indicates that transcranial direct current stimulation (tDCS) can reduce symptoms of depression. Flow FL-100 is a transcranial direct current stimulation (tDCS) device self-administered by a patient at home in combination with a software application that delivered wellbeing behaviour therapy training. Purpose/Aim: This study investigates if Flow can be introduced to a Community Mental Health Team (CMHT) service and the impact of Flow in treating depression. The study addresses the questions: "what are the depression reliable improvement and remission rates?" and "can Flow significantly reduce depressive symptoms and improve real world functioning (everyday, social and occupational functioning) and health-related quality of life?". Methods: An open-label patient cohort design with no control group. Pre-intervention and 6-week follow-up intervention assessments using the participant self-report measures: Patient Health Questionnaire (PHQ-9), Work and Social Adjustment Scale (WSAS), and EuroQol five-dimension (EQ-5D-5L). Participants were 31 CMHT patients, 15 males and 16 females, with an age range of 21 to 64 years, and average age of 42 years. Results: PHQ-9 reliable improvement and remission rates were 51.61% and 12.9%, respectively. PHQ-9 scores significantly improved, from 20.9 (*SD* 5.55) to 14.6 (*SD* 7.33) at 6 weeks, with large effect size. WSAS scores improved from 31.3 (*SD*

6.02) to 22.5 (*SD* 11.43) at 6 weeks, with large effect size. EQ-5D-5L results showed significant improvements in the health index score, and three EQ-5D-5L dimensions ("mobility", "self-care", and "pain"). Conclusion: Flow tDCS treatment was integrated into a CMHT service and was found to be beneficial in terms of improving functioning and quality of life and reducing depression symptoms. Flow FL100 tDCS and wellbeing behaviour therapy training could be offered through all CMHT services to people with SMI to treat depression, enable better functioning, and improve quality of life.

## Keywords

Depression, Quality of Life, Functioning, Transcranial Direct Current Stimulation (tDCS), Schizophrenia

## 1. Introduction

Severe mental illnesses (SMI) are psychological problems causing severe functional and occupational impairment and include diagnoses such as psychosis, schizophrenia, personality disorder, and bipolar disorder; the prevalence of SMI in England in adults is 0.9%, i.e., over 400,000 people (Public Health England, 2018). Depression is experiencing a low mood and loss of pleasure or interest in activities, and can include symptoms such as poor concentration, feelings of low self-worth, hopelessness, suicidality, disrupted sleep, and fatigue (World Health Organization, 2023). In Great Britain (GB) around one in six (16%) of the general population experience depression and prevalence is higher in people experiencing SMI (Office for National Statistics, 2022). Depression symptoms can have a severe negative impact on everyday functioning and quality of life (Lépine & Briley, 2011; World Health Organization, 2023) and depression is the most common mental illness factor determinant of deaths by suicide (Vigo et al., 2016).

Many people with SMI have treatment resistant depression (TRD) (McIntyre et al., 2023). TRD can be defined as no response to at least two consecutive courses of antidepressant medication (Berlim & Turecki, 2007). A systematic review of evidence of tDCS for TRD found favourable evidence that tDCS is clinically effective as measured by response, symptom improvement and remission in comparison to sham treatment (Li et al., 2024).

Depressive symptoms are important factors associated with and interacting with the experience of schizophrenia (van der Gaag et al., 2006; Lehoux et al., 2009). Major depressive disorder (MDD) is a common comorbidity in schizophrenia (Bosanac & Castle, 2012), with a lifetime prevalence up to 75% (Siris, 2000; Siris & Depression, 2003) and a pooled prevalence of 32.6% (Etchecopar-Etchart et al., 2021). Depressive symptoms can occur across the schizotypy continuum (Monsonet et al., 2022) and comorbid depression is a negative prognostic factor linked to detrimental functioning, quality of life and psychosocial outcomes (Gardsjord et al., 2016; Alessandrini et al., 2016; Upthegrove et al., 2017). Evidence

indicates that schizophrenia and MDD share transdiagnostic impairments at a neurobiological level (Goodkind et al., 2015; Han et al., 2019; Wu et al., 2017; Chang et al., 2018; Ma et al., 2020; Zhuo et al., 2021).

There are complex issues associated with the treatment of depression in schizophrenia: use of antidepressants has limited effects (Helfer et al., 2016; Gregory et al., 2017) and there can be increased risks of drug interactions and reduced tolerability (van Rooijen et al., 2019). Therefore, alternatives to medication to reduce depressive symptoms for people living with schizophrenia are needed (Lisoni et al., 2024).

Transcranial direct current stimulation (tDCS) is a non-invasive brain stimulation by weak electrical currents (0.5 - 2.5 mA) (Grycuk et al., 2021). Electrode placement for treating depression is typically with the anode over the left dorsolateral prefrontal cortex (DLPFC) (F3) and cathode over the right DLPFC (F4) (Fregni et al., 2021). tDCS mechanisms of action include significant gray matter increases in brain regions functionally connected with the stimulation target, including the bilateral DLPFC, bilateral posterior cingulate cortex, subgenual anterior cingulate cortex, the right hippocampus, thalamus and left caudate brain regions; tDCS leads to neurostructural changes at predetermined brain targets in depression, and plasticity effects may propagate over brain networks (Jog et al., 2023).

Meta-analyses of the results of randomised sham-controlled trials show tDCS can significantly improve depressive symptoms and clinical response, with remission being significantly better than placebo sham stimulation (Mutz et al., 2018; 2019; Moffa et al., 2020; Razza et al., 2020). tDCS is effective as a standalone treatment or in combination with other anti-depression treatments (Razza et al., 2020). tDCS is safe (Razza et al., 2020) and generally reported by patients as acceptable and well-tolerated, with mild and transient physical sensations that usually do not prevent use: burning sensations (16.2%), skin redness (12.3%), scalp pain (10.1%), itching (6.7%), and tingling (6.3%) (Chhabra et al., 2020; Grycuk et al., 2021; Gordon et al., 2021).

A meta-analysis found a significant reduction of depressive symptoms when bilateral-bipolar prefrontal tDCS was delivered to people with a schizophrenia diagnosis (Tseng et al., 2022). A double-blind sham controlled randomised controlled trial (RCT) found bilateral bipolar-nonbalanced prefrontal tDCS (left DLPFC [F3] and the right orbitofrontal region [Fp2]) delivered five times a week for three weeks (15 sessions: 2 mA for 20 min)—significantly improved depression (with medium-to-large effect size) compared to sham in people with a diagnosis of schizophrenia (Lisoni et al., 2024). This positive result aligns with three previous RCTs which applied a bilateral bipolar-nonbalanced prefrontal electrode placement (Palm et al., 2016; Narita et al., 2017; Jeon et al., 2018). The total number of stimulation sessions could influence clinical outcomes (Tseng et al., 2022): the effect sizes seen were larger when using 15 sessions over three weeks (Lisoni et al., 2024) compared to 10 sessions over five three weeks (Palm et al., 2016;

Narita et al., 2017; Jeon et al., 2018) suggesting a dose-effect relationship (Lisoni et al., 2024). Recommendation has been made for evidence of the impact of a longer period of treatment and use of dedicated measure of functioning (Lisoni et al., 2024), both of which are addressed in this current study.

A meta-analysis of RCTs indicated that bilateral tDCS (F3 + F4) significantly improved depressive symptoms for people diagnosed with bipolar disorder (Hsu et al., 2024). A systematic review found studies consistently document the efficacy of tDCS, with a reduction in depression scores ranging from 18% to 92%, and that the RCT with the largest sample showed a significant superiority of active stimulation over sham (D'Urso et al., 2023). A recent open-label treatment study of clinical outcomes, acceptability and adverse events using the Flow FL-100 device to deliver tDCS (F3 anode, F4 cathode, 2mA, for 30 minutes, for 6-week trial, 21 sessions) found a significant improvement in depressive symptoms, clinical response was 77.3% and clinical remission was 47.7%, participant acceptability, and no participants developed mania or hypomania (Ghazi-Noori et al., 2024). A literature review concluded that tDCS is effective for depressive symptoms in bipolar disorder but may require additional maintenance sessions to prevent relapse (Nikolin et al., 2023).

"Flow" combines tDCS (delivered by Flow FL-100 device) and software application wellbeing behaviour training (physical exercise, nutrition, mindfulness, sleep, and choosing actions). A randomised sham-controlled trial of Flow FL-100 in major depressive disorder (MDD) found significant improvement in depression symptoms following 10 weeks treatment, with clinical response of 58.3% and remission rate of 44.9% (Woodham et al., 2024). A "real world" health service open-label primary care patient study of Flow found depression reliable improvement and remission rates of 58.1% and 32.3%, and significant improvement in depression, everyday functioning, and quality of life (Griffiths et al., 2024a, 2024b). Qualitative studies undertaken on experience of Flow found most patients reported that Flow improved depression symptoms, was acceptable, and that they would recommend it to others (Rimmer et al., 2022; Griffiths et al., 2023; Griffiths et al., 2024c).

This open-label patient cohort study investigates if Flow FL-100 tDCS and behaviour change wellbeing training can be successfully introduced to the treatments offered by a Community Mental Health Team (CMHT) service. It assesses the impact of Flow in treating depression for people with SMI. The study addresses the questions: "what are the depression reliable improvement and remission rates?" and "can Flow significantly reduce depressive symptoms and improve real world functioning (everyday, social and occupational functioning) and health-related quality of life?"

## 2. Methods

### 2.1. Design

Open-label patient cohort design with no control group.

### 2.2. Approval

The project was undertaken from August 2023 to September 2024. Approval for the study was gained from the NHS healthcare trust in which the services were based (reference for approval: Flow-CMHT). The study was undertaken in accordance with the Declaration of Helsinki.

### 2.3. Setting

The sample was recruited from people in a Community Mental Health Team (CMHT) service within the United Kingdom's (UK) National Health Service (NHS). A Community Mental Health Team (CMHT) provides assessment, monitoring, support, and treatment for the full range of mental health conditions. CMHTs are accessible to individuals whose needs cannot be met in other services such as primary care or NHS Talking Therapies. CMHTs have a Multi-Disciplinary Team (MDT) model of care. Flow Neuroscience AB (manufacturer of Flow) provided CMHT staff with training.

### 2.4. Intervention

Flow FL-100 is a Conformite Européenne (CE) marked Class IIa medical device for the treatment of MDD and has United States (US) Food and Drug Administration (FDA) "Breakthrough Device" designation, indicating its potential to provide effective treatment. Flow can be purchased directly by anyone via the manufacturer's website in the European Union and other European countries. Flow has been used by >15,000 users in UK/EU and is offered by >70 private healthcare institutions.

In the treatment protocol, the patient remains awake and self-administers at home five sessions per week for the first three weeks and then three sessions per week for the following three weeks: 24 sessions, with a maximum of one 30-minute session per day. After the initial six-week period, patients can choose to self-administer up to 3 sessions per week for as long as they choose.

Flow treatment was concurrent with any current treatment, e.g., antidepressant medication, face-to-face psychotherapy, or any online psychotherapy. The anode was positioned over the left dorsolateral prefrontal cortex (DLPFC) (F3 on the international 10/20 EEG system) and the cathode over the right DLPFC (F4); stimulation is 2 mA for 30 min. On the Flow mobile phone software app, seven brief (around 20 minutes, pace of completion chosen by user) healthy lifestyle behaviour therapy training sessions are available for users to optionally engage with. These provide information about the links between behaviour and wellbeing and how to take actions to improve wellbeing and reduce depressive symptoms. They are titled: "The basics", "Choosing your actions", "Mindfulness meditation", "Exercise for your brain", "The anti-depression diet", "Therapeutic sleep", and "Looking back and planning ahead".

The Flow mobile phone software app is used to control the Bluetooth-connected Flow FL-100 tDCS headset via the user's smartphone. Flow also provides

depression symptom level tracking that enables users to monitor their progress/symptoms. This is done by the completion of the nine-question Montgomery-Åsberg Depression Rating Scale Self-report (MADRS-S) (Montgomery & Åsberg, 1979) via the user's smartphone prior to a tDCS session. Flow also provides an integrated platform for the patient's healthcare provider, with the ability to monitor patients, and customise protocols remotely. A patient can decide whether or not to allow their healthcare provider access to this information.

### 2.5. Inclusion/Exclusion Criteria

Participants were included if they were determined by CMHT staff to have symptoms of depression, were aged 18 or over, had the mental capacity to consent, provided informed consent, and had the ability to understand verbal and written English. Participants remained on any prescribed medication they were taking and continued any current psychological interventions.

Exclusion criteria comprised: epilepsy (or having a history of seizures), a defect in the neurocranium and/or an implant inside the skull, an active implanted medical device, a neurological condition, a history of hypomanic/manic episodes, and an open wound in the area of pad contact point on the forehead.

### 2.6. Procedure

Participants were selected if they met the inclusion/exclusion criteria and were provided with information about the treatment and evaluation. Participants stayed on the same medication and continued any current psychological interventions they were undertaking. Informed consent was obtained by their mental health practitioner prior to beginning treatment. Following informed consent, demographic, treatment, and health information was extracted from clinical records containing routinely collected data. Participants could withdraw consent or stop treatment at any point without the need to provide a reason. Following informed consent, participants were given the Flow device and instructions, and completed three self-report measures. Participants were informed about Flow Neuroscience AB's website which provides information, training on use, and email support. Compliance was monitored and assessed using a clinical portal web based dashboard of patient daily use of Flow and change in depression scores, this was available to patient's prescriber of Flow for patients who consented to share. Follow-up self-report measures were collected after six weeks of treatment.

### 2.7. Measures

The Work and Social Adjustment Scale (WSAS) is a self-report measure of functional impairment attributable to an identified problem (e.g., depression) (Marks, 1986). The five questions on impairment to work, home management, social leisure, private leisure, and close social relationships are each scored zero (not at all) to eight (very severely). The WSAS is a reliable, valid, and sensitive to change outcome measure (Mundt et al., 2002). Severe functional impairment is 20 and over

and scores below 10 are associated with subclinical populations; a score of 9 or below is the clinical (recovery) cut off (Hammond et al., 2012).

Patient Health Questionnaire-9 (PHQ-9) is a self-report measure of depression; it has good sensitivity and specificity for major depression as well as good internal consistency (Kroenke et al., 2001); scores for depression severity are: 0 - 4 none, 5 - 9 mild, 10 - 14 moderate, 15 - 19 moderately severe, and 20 - 27 severe (Kroenke et al., 2007). Remission is defined as a score of 9 or less, and reliable improvement is a drop of 6 points (Richards & Borglin, 2011). A score of 9 or below is the clinical remission cut off.

European Quality of Life Five Dimension (EQ-5D-5L) (EuroQol Group, 1990; van Hout et al., 2012) is a 5-item question and visual analogue scale (VAS) self-rated measure of health-related quality of life and overall health status developed by EuroQol group to provide a simple, standardised measure for a clinical appraisal (EuroQol Group, 1990). It comprises five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression), each of which is measured within five levels (no problems, slight problems, moderate problems, severe problems, and extreme problems). The digits from the five dimensions are combined to create a five-digit number measuring holistic health state. Each health state can be assigned an index score based on societal preference weights for the health state. Health state index scores 1 = the value of full health, with higher scores indicating higher health utility. The EQ VAS is a subjective measure of a participant's current health, ranging from 0 (worst health imaginable) to 100 (best health imaginable). The EQ-5D-5L has good construct validity and is sensitive to change in patients with depression and anxiety (Peasgood et al., 2012). The EQ-5D-5L is a validated measure of health status widely used in national health surveys in worldwide and in clinical trials of health interventions (Brooks, 1996; Herdman et al., 2011), and EQ-5D is recommended by the UK's National Institute for Health and Care Excellence (NICE) to estimate health state utility weights for quality-adjusted life year (QALYs) (NICE, 2019).

### 2.8. Analysis

Data were analysed using the statistical software package SPSS Statistics 26.

## 3. Results

### 3.1. Participant Characteristics

Thirty-one participants completed a six-week Flow treatment. Their average age was 42.06 years (age range from 21 to 64 years). 16 (51.61%) were females and 15 (48.38%) were males. Participants' mean baseline scores were in the highest "severe" range for depression (Kroenke et al., 2007). Baseline EQ-5D-5L crosswalk data values indicated participants had a low average holistic health index and EQ VAS score compared to the general population. Numbers currently prescribed antidepressants were 23 (74.19%). All were on antidepressant medication. (See **Table 1** and **Table 2**)

Table 1. Baseline characteristics (n = 31).

| Variable | Mean (SD) |
|---|---|
| PHQ-9 | 20.87 (5.55) |
| WSAS | 31.32 (6.02) |
| EQ Health Index | 0.27 (0.34) |
| EQ VAS | 42.16 (21.64) |

Table 2. Numbers for each type of antidepressant.

| Antidepressant | Number of participants (percentage) prescribed this antidepressant |
|---|---|
| Citalopram | 1 (3.23%) |
| Duloxetine | 4 (12.90%) |
| Fluoxetine | 1 (3.23%) |
| Lithium | 1 (3.23%) |
| Mirtazapine | 3 (9.68%) |
| Sertraline | 4 (12.90%) |
| Trazadone | 2 (6.45%) |
| Venlafaxine | 9 (29.03%) |
| Vortioxetine | 2 (6.45%) |

### 3.2. PHQ-9

PHQ-9 scores significantly improved, from 20.9 (SD 5.55) to 14.6 (SD 7.33) at 6 weeks, with large effect size (Cohen's d = 0.986). At follow-up 4 participants (12.90%) experienced remission (a PHQ-9 score of 5 or less at post-intervention follow-up) and 16 participants (51.61%) reliable improvement (a reduction of 6 points on the PHQ-9 from baseline).

### 3.3. WSAS

WSAS scores significantly improved from 31.3 (*SD* 6.02) to 22.5 (*SD* 11.43) (decrease in WSAS score of 8.77) at 6 weeks, with large effect size (Cohen's d = 0.819).

### 3.4. EQ-5D-5L

There was a non-significant increase in EQ-VAS score of 4.52 ($p$ = .369) from baseline to 6-week follow-up. Table 3 contains data for each of the five dimensions, the mean health index and VAS at baseline and after the six-week intervention. From baseline to week six, quality of life increased with an improvement of 0.23.

Data screening permitted the use of a paired-sample t-test to determine whether there was a statistically significant difference in participants' EQ dimensions, as well as their health index score at the 6-week data point. The improvement was statistically significant for three EQ dimensions ("usual activity", "mobility", and

"anxiety/depression"), and for the overall health index score, with medium to large effect sizes.

**Table 3.** Means and standard deviations within each dimension across time with corresponding mean variation, significance, and effect size.

| EQ-5D-5L Dimension | Baseline | Week 6 | *t* | *p* | *d* |
|---|---|---|---|---|---|
| | *M* (*SD*) | *M* (*SD*) | | | |
| Mobility | 2.13 (1.28) | 1.81 (1.14) | 2.061 | 0.048* | 0.370 |
| Self-care | 2.22 (1.14) | 2.13 (1.15) | 0.722 | 0.476 | 0.130 |
| Usual activity | 3.35 (1.11) | 2.71 (1.19) | 2.930 | 0.006* | 0.526 |
| Pain/discomfort | 2.52 (1.39) | 2.39 (1.26) | 0.626 | 0.536 | 1.147 |
| Anxiety/depression | 4.22 (0.72) | 3.03 (1.22) | 5.436 | <0.001* | 0.976 |
| Health index score | 0.27 (0.34) | 0.50 (0.35) | −4.213 | <0.001* | −0.757 |
| EQ-VAS score | 42.16 (21.64) | 46.68 (29.34) | −0.912 | 0.369 | −0.164 |

*Significant at $p < 0.05$ level.

Table 4 contains the data collected from the EQ-5D-5L tool and broken down by five scores. Score 1 consists of responses where no problems are reported, score 2 indicates responses reporting a mild level of issues on a given dimension, score 3 moderate, score 4 severe and score 5 extreme issues reported. Significant improvements on "mobility" and "usual activity", and "anxiety/depression".

**Table 4.** Frequencies and percentages reporting scores 1 to 5 on EQ-5D-5L by dimension and time.

| EQ-5D-5L Dimension | Level | Baseline | Week 6 |
|---|---|---|---|
| Mobility | 1 | 15 (48.4) | 19 (61.3) |
| | 2 | 4 (12.9) | 3 (9.7) |
| | 3 | 6 (19.4) | 5 (16.1) |
| | 4 | 5 (16.1) | 4 (12.9) |
| | 5 | 1 (3.2) | 0 |
| Self-care | 1 | 13 (41.9) | 12 (38.7) |
| | 2 | 4 (12.9) | 8 (25.8) |
| | 3 | 9 (29.0) | 7 (22.6) |
| | 4 | 4 (12.9) | 3 (9.7) |
| | 5 | 1 (3.2) | 1 (3.2) |
| Usual activity | 1 | 2 (6.5) | 6 (19.4) |
| | 2 | 5 (16.1) | 6 (19.4) |
| | 3 | 8 (25.8) | 13 (41.9) |
| | 4 | 12 (38.7) | 3 (9.7) |
| | 5 | 4 (12.9) | 3 (9.7) |

**Continued**

| | | | |
|---|---|---|---|
| Pain/discomfort | 1 | 10 (32.3) | 11 (35.5) |
| | 2 | 6 (19.4) | 5 (16.1) |
| | 3 | 8 (25.8) | 8 (25.8) |
| | 4 | 3 (9.7) | 6 (19.4) |
| | 5 | 4 (12.9) | 1 (3.2) |
| Anxiety/depression | 1 | 0 | 2 (6.5) |
| | 2 | 0 | 11 (35.5) |
| | 3 | 5 (16.1) | 7 (22.6) |
| | 4 | 14 (45.2) | 6 (19.4) |
| | 5 | 12 (38.7) | 5 (16.1) |

## 4. Discussion

This study found that Flow delivered tDCS can be provided to patients by a CMHT service, and when offered patients will choose to use Flow. Flow was found to reduce impaired functioning and depression symptoms and increase health related quality of life in SMI patients with symptoms of depression. The outcomes add evidence to support the effectiveness of tDCS in reducing depression symptoms (D'Urso et al., 2023; Hsu et al., 2024; Lisoni et al., 2024; Mutz et al., 2018; 2019; Moffa et al., 2020; Razza et al., 2020; Tseng et al., 2022; Woodham et al., 2024). The outcomes support evidence of tDCS impact at six weeks course of treatment (Nikolin et al. 2023). This study's results link to interview evidence of positive CMHT patient reported experience of Flow (Griffiths et al., 2024c).

This study's results showed statistically significant improvements on "mobility" and "usual activity" dimensions measured by the EQ-5D-5L, and impaired functioning measured by the WSAS. These findings indicate the positive impact of Flow on self-management, mental health recovery, and real-world functioning, which are factors highly valued by people in their everyday lives. Being able to engage in everyday activities and activities that are important and meaningful to an individual can contribute to their mental health recovery (Griffiths, 2009).

This present study's sample had high average PHQ-9 baseline scores (depression in the highest "severe" range). This demonstrates the potential value of Flow for those with severe depression. It supports the design in this study of offering Flow to those with SMI and symptoms of depression many of whom will have been experiencing depression and been receiving treatment for depression for many years. Many of the participants in this study would meet the definition of TRD, therefore the results add evidence to value of tDCS in treating TRD (Li et al., 2024). This study shows that tDCS can be combined with antidepressant medication, and previous research has shown this can possibly enhance overall outcomes (Razza et al., 2020).

This present study shows that the use of Flow may lead to relatively quick (six-week) improvement in depression symptoms. Another study showed Flow produced

good rates of remission at three weeks (Griffiths et al., 2024b). The time course of response of serotonin and norepinephrine reuptake inhibitors (SNRIs) and selective serotonin re-uptake inhibitors (SSRIs) antidepressants is around 2 to 4 weeks to achieve significant benefits; but it may take longer to achieve most of the improvement (Jakubovski et al., 2019). Therefore, Flow might be considered as a treatment where a relatively quick relief of depression symptoms is required, of particular value in CMHT patients to address or prevent a mental crisis which may lead to suicide attempt, self-harm, or acute mental health ward admission. The mortality risk for suicide among patients with major depression has been calculated to be 20 times that where major depression is not present (Harris & Barraclough, 1997).

A systematic review and meta-analysis showed that tDCS plus SSRI antidepressant medication provided significant improvement in depression and achieved a significantly higher response rate than sham intervention, and that this was more effective than tDCS treatment alone (Wang et al., 2021). This finding is important for clinical practice, as it indicates that patients should continue their existing prescribed SSRI antidepressant use during tDCS treatment, and that patients can start using both tDCS and SSRIs at the same time (Wang et al., 2021). All of patients in this current study were prescribed antidepressants. CMHT services are well-placed to deliver Flow tDCS treatment as they provide patients with a named key-worker, access to a psychiatrist, and seek to understand a patient's individual circumstances and provide individualised support and treatment.

There was an exclusion criteria in this study of "a history of hypomanic/manic episodes"—a core feature of bipolar disorder; some people under the care of a CMHT would have history of hypomanic/manic episodes and diagnosis of bipolar disorder. Evidence indicates the efficacy of tDCS and lack of risk of developing mania or hypomania for people with a bipolar diagnosis (Ghazi-Noori et al., 2024; Hsu et al., 2024). There is a need for depression treatment options in bipolar disorder as there are only six drugs recommended for depression treatment in those living with bipolar disorder, and there are issues of interaction with drugs given for bipolar disorder treatment (Hsu et al., 2024). tDCS could be considered as a treatment option for depression in bipolar disorder.

Some participants did not experience remission or reliable change following the use of Flow, and it is not effective for everyone. Due to CMHT's active engagement with their patients, it is well-positioned to prepare them for this potential outcome, ensure they receive ongoing support, and suggest other treatments if tDCS does not provide relief from depression symptoms. Patients are told they may need to try a number of treatment options and combination of treatments.

## 5. Limitations

There were several limitations of the study. There was no control group, small sample size, and the treatment with Flow tDCS was open-label and adjunct to any existing depression or other treatments or therapies. Additional diagnosis was not

reported. This study collected outcome measures after six weeks of treatment, with no later follow-up data collection; it is recommended that future studies employ additional follow-up data collection points: 12, 24 and 36 weeks. The participants were from a single UK county reducing generalisability. Separate analysis of those with clinical factors such as "mild", "moderate", or "severe" depression severity was not undertaken.

## 6. Conclusion

This study demonstrated that Flow tDCS could be fully and effectively integrated into CMHT depression treatment. A CMHT was able to offer, and their patients choose to use Flow, providing evidence of the acceptability of and demand for Flow FL-100 delivered tDCS and software app behaviour change wellbeing training. This study's findings provide evidence that Flow tDCS can be effective against depression symptoms when offered through a CMHT for patients with depression symptoms. Treating depression symptoms, improving functioning and quality of life using tDCS in a CMHT service may allow discharge from a CMHT to care of a GP, prevent mental health in-patient admission, reduce A&E attendance, and prevent the need for more costly transcranial magnetic stimulation (TMS) or electroconvulsive therapy (ECT) depression treatment; and, therefore, may reduce healthcare costs.

It is important to be able to offer patients a wide choice of effective depression treatment options. This study's results support the use of Flow tDCS as a treatment option for people with SMI and symptoms of depression. Evidence indicates extending treatment from six to ten weeks might provide further improvements (Nikolin et al., 2023; Woodham et al., 2024). In many countries, people can buy and use Flow themselves, but most people with SMI have low levels of income, and the cost is prohibitive for most (around £400 GBP). Availability through free-to-access universal healthcare systems such as the UK's NHS would address inequality of access issues. More evidence is required on the long-term effectiveness of tDCS for people with SMI experiencing depression and the potential need for ongoing maintenance sessions to sustain benefits.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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