ENTERHEALTH
ADDICTION & MENTAL HEALTH TREATMENT

WAVE NEURO

Results from Enterhealth's Precision Neuromodulation Program: Inpatient Addiction Treatment and Recovery

Introduction

Enterhealth Ranch, located in Van Alstyne, Texas, has pioneered state-of-the art addiction recovery for the past 15 years. Addiction is an ever-growing problem. Results from a national survey in 2022 reported that 48.7 million people in the United States (17.3%) had a substance use disorder (SUD), compared to 46.8 million (16.7%) in 2021 (SAMHSA, 2023). Specifically, 29.5 million people had alcohol use disorder (AUD) and 6.1 million people had opioid use disorder (OUD) in 2022. Substance use disorders are characterized as being chronic disorders that are difficult to treat (Moradinazar, 2020). Moreover, patient retention during treatment is challenging in this population, with studies reporting dropout rates ranging from 30% (Lappan et al., 2020) to 57% (Brorson et al., 2013) for inpatient programs. The difficulty in treating SUD may be due to the long-term impact of the illness on brain health, reducing impulse control and cognitive function, making intervention and recovery more difficult with time (SAMHSA, 2016). These challenges may be related to dysregulated brain networks observed in individuals with substance use disorders, including the default mode network (Zhang & Volkow, 2019).

In an effort to address the brain and behavioral correlates of substance use disorder, Enterhealth employs a multidisciplinary approach to treating this disorder in their patients. Treatment options are guided by comprehensive assessments and include pharmacotherapies (non-addictive) and talk therapies customized to each patient's specific psychiatric issues, as well as wellness, nutrition and stress management strategies. Critically, Enterhealth offers a precision neuromodulation program in the form of Magnetic e-Resonance Therapy (MeRT, Wave Neuroscience). MeRT is a specialized form of repetitive transcranial magnetic stimulation (rTMS) that is personalized to each individual's resting-state EEG alpha frequency. Studies have demonstrated that targeted neuromodulation upregulates impaired cortical circuitry impacted in SUD (Zhang & Volkow, 2019). Enterhealth's cutting-edge neuromodulation treatment in combination with standard therapy has been designed to address these underlying disruptions in SUDs. Results from program participants from 2019-2023 were reviewed retrospectively and reported on in this paper.

Materials and Methods

Charts of patients who participated in the MeRT program between February 2019 to April 2023 were reviewed for study inclusion following approval by an independent ethical review board. Patient charts were eligible for study inclusion if they were generated as a consequence of the patient receiving inpatient treatment at Enterhealth Ranch during the above time period and had no contraindications for MeRT (pacemakers, defibrillators, metal in the head, history of seizures). Selected records were anonymized and information was extracted for analysis. Sample characteristics included age, sex, length of stay, substance use disorder diagnoses, and number of MeRT sessions.

Patients completed the Treatment Effectiveness Assessment ("TEA"; Ling et al., 2012) at intake ("baseline") and discharge ("final"). The TEA was developed to quickly gauge a patient's progress through addiction treatment by surveying four domains related to recovery (substance use, health, lifestyle, and community). Each domain is measured on a scale from 1 (worst) to 10 (best). Scores were summed across domains for an overall measurement of recovery, and also analyzed within-domain.

Neuromodulation Program

The MeRT procedure begins with recording a 10-minute resting-state eyes closed electroencephalography (EEG) scan (plus electrocardiogram) at baseline and every two weeks prior to discharge. EEGs are used to extract features of brain activity and personalize the rTMS treatment frequency for each participant. Each treatment frequency was measured as the dominant EEG alpha peak frequency (individual alpha frequency, "IAF") in the 8-13 Hz range in a posterior-occipital region of interest consisting of P3, P4, Pz, O1, and O2 electrodes. The magnetic pulse frequency was set to their IAF, and pulse amplitude set to 80% of motor threshold. MeRT was delivered in 5s trains, with 45s intertrain intervals, for a total of 36 trains, or approximately 30 min. For more details and studies using a similar approach, see Bailar-Heath et al., 2024; Frueh et al., 2025.

Patients received approximately 30 MeRT treatment sessions in the program. At each session, patients are asked to provide a self-report on their anxiety, depression, anger, and pain levels from 1 (lowest) to 5 (highest). Additionally, patients are assessed for any side effects arising from rTMS treatments.

Results

A total of N=140 patients were identified between the date range of approval. Among those 140, there were n=119 (85%) who completed their MeRT treatment plan and only 21 who did not complete their program (15% attrition). Common reasons for non-completion of the program are often unexpected and may include requiring medical procedures for other conditions, pregnancy, or leaving to attend to loved ones.

Only patients who provided TEA data at both baseline and final assessments (n=83 of the 119; treatment completers) were included in the analyses. Participants received an average of 31 MeRT sessions (range 14-50). See Table 1 for sample characteristics.

Although the majority were diagnosed with AUD, most patients also had comorbid substance use disorders. Despite the heterogeneity of diagnoses, results did not vary by diagnosis (p>.05), indicating that all patients improved in a similar fashion regardless of condition.

Table 1: Sample Characteristics

Feature	Sample (N=83)
Age (*M*, *S.D.*)	41.7, 14.6
Sex (M, F)	54, 29
Length of Stay (days) (*M*, *SD*)	74, 42
Total MeRT Sessions (*M*, *SD*)	31, 7.3
Primary SUD Diagnosis (N)	
Alcohol	55
Opioids	8
Stimulants	6
Cannabis	6
Sedatives	5
Inhalants	2
Hallucinogens	1

TEA Scores

There was a significant increase in TEA sum scores from baseline (*M*=17.9, *S.D.*=8.7) to final assessment (*M*=34.7, *S.D.*=4.6) (*t*=13.0, *p*<.001), reflecting a 94% improvement in TEA scores over time (Figure 1). Additionally, all but three patients (n=80) scored *below* 40 at baseline, and subsequently one third of those reported the *highest* possible TEA score (score of 40) at discharge (n=26, 33%). Consistent with the summary score data, significant improvements were also found for all four TEA domains (Figure 2). Of note, the largest improvement was found for the 'substance abuse' domain (132% TEA score increase).

Figure 1: TEA Scores

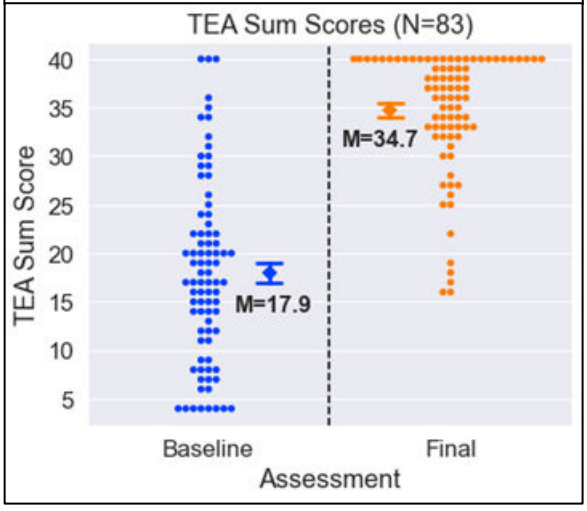
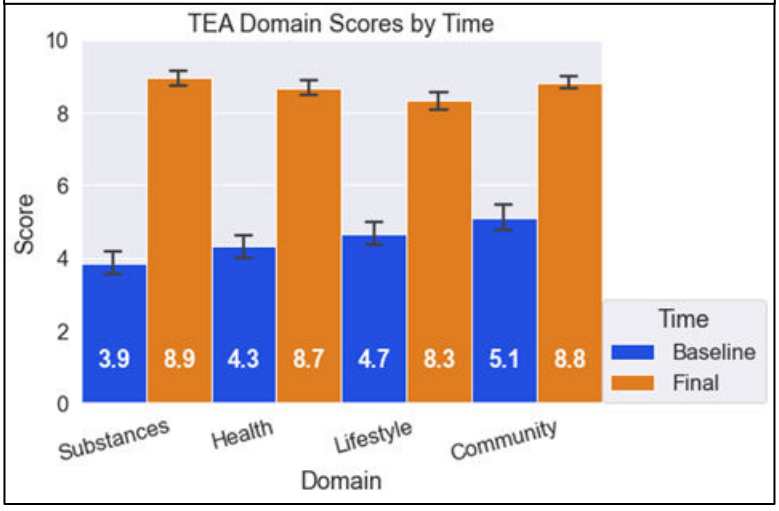


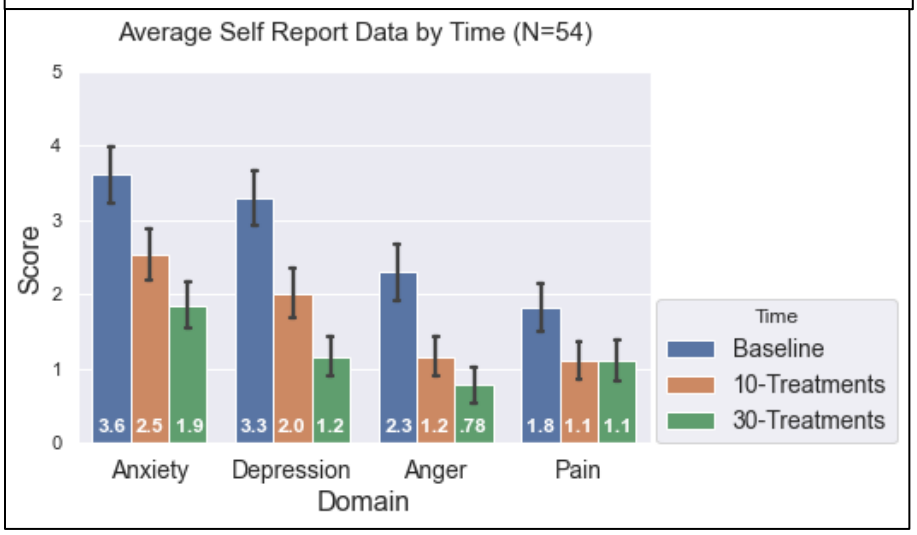
Figure 2: Four TEA Domains



Self-Report Assessments

Among the N=83 with TEA scores, there were n=54 who also completed self-report assessments at baseline, 10-treatments, and 30-treatments. In this sample, there were strong reductions in all self-reported domains. Self-reported anxiety decreased by 49%, self-reported depression decreased by 65%, self-reported anger decreased by 66%, and self-reported pain decreased by 39%, all from baseline to 30-treatments. Paired-samples *t*-tests with a correction for multiple comparisons suggested that all four scales exhibited a statistically significant reduction from baseline to 30-treatments ($p<.05$ for all scales). See Figure 3 for graphs depicting average self-report scores for each domain by time.

Figure 3: Self-Report Data



Side Effects

MeRT treatment was well-tolerated, and side effects were consistent with the level of those reported in the literature in similar applications of rTMS (Slotema et al., 2010). Side effects were generally transiently experienced and resolved by the end of the treatment program. Specifically, by the end of the program, an incidence of 5% (4 of 83) of participants reported headache, and 1% (1 of 83) reported fatigue. Importantly, no seizures or other serious adverse events were reported in charts, and no participants discontinued treatment due to side effects.

Discussion

Through the use of Enterhealth's cutting-edge substance abuse neuromodulation recovery program, Enterhealth Ranch is pioneering a state-of-the-art addiction treatment program to augment patients' recovery from addiction. Importantly, only 15% of patients receiving MeRT discontinued treatment (dropped out), which is much lower than the high dropout rates (31%-57%) observed in other inpatient settings using conventional treatments (Lappan et al., 2020; Brorson et al., 2013). Hence, the majority of those who started their program with MeRT continued through to completion.

Chart reviews of patients in the program reported an average of 31 MeRT sessions while in Enterhealth's residential treatment program. In addition to the low dropout rate, patients exhibited strong improvements in four domains related to addiction recovery. Significant improvement in TEA scores were found from intake to discharge. More specifically, TEA scores increased by an average of 16 points, which is nearly twice the effect found in a previous trial using medication assisted therapy in OUD patients (Ling et al., 2019). Self-report data collected over the course of the neuromodulation program related to patients' anxiety, depression, anger, and pain levels also showed robust improvements at the 10th and 30th session relative to baseline. Overall, MeRT was well-tolerated with side effect rates consistent with other studies utilizing rTMS, which highlights the safety profile of this treatment approach.

In conclusion, these results demonstrate that patients who received treatment through Enterhealth's addiction recovery program utilizing MeRT exhibit an addiction recovery profile that spans psychosocial, behavioral, and affective domains. Future studies will explore the durability of the treatment affect by examining follow up data on patients after program completion. The observed beneficial outcomes, coupled with the low attrition rate, showcases the importance of Enterhealth's rigorous approach to addiction treatment.

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