BlueCross BlueShield Federal Employee Program.

FEP Medical Policy Manual

FEP 2.01.50 Transcranial Magnetic Stimulation as a Treatment of Depression and Other Psychiatric/Neurologic Disorders

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Related Policies:

2.01.90- Navigated Transcranial Magnetic Stimulation

Transcranial Magnetic Stimulation as a Treatment of Depression and Other Psychiatric/Neurologic Disorders

Description

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Transcranial magnetic stimulation (TMS) is a noninvasive method of delivering electrical stimulation to the brain. The technique involves the placement of a small coil over the scalp and passing a rapidly alternating current through the coil wire. The electrical current produces a magnetic field that passes unimpeded through the scalp and bone and stimulates neuronal function. Repetitive TMS is being evaluated for the treatment of treatment-resistant depression (TRD) and other psychiatric and neurologic disorders. A variety of TMS modalities have been developed, which differ on parameters including stimulation intensity, frequency, pattern, and site of the brain stimulation. In conventional TMS, high frequency stimulation is delivered over the left dorsolateral prefrontal cortex (DLPFC) or low frequency stimulation over the right DLPFC. In bilateral TMS, both procedures are performed in the same session. Deep TMS employs an H-coil helmet designed to encompass a broader surface area and stimulate deeper brain structures than conventional TMS. Theta burst stimulation is administered at lower intensities and shorter intervals than conventional TMS.

Transcranial magnetic stimulation (TMS), introduced in 1985 as a new method of noninvasive stimulation of the brain, involves placement of a small coil over the scalp, passing a rapidly alternating current through the coil wire, which produces a magnetic field that passes unimpeded through the scalp and bone, resulting in electrical stimulation of the cortex. Transcranial magnetic stimulation was initially used to investigate nerve conduction (eg, TMS over the motor cortex will produce a contralateral muscular-evoked potential). The motor threshold, which is the minimum intensity of stimulation required to induce a motor response, is empirically determined for each person by localizing the site on the scalp for optimal stimulation of a hand muscle, then gradually increasing the intensity of stimulation. Interest in the use of TMS as a treatment for depression was augmented by the development of a device that could deliver rapid, repetitive stimulation. Imaging studies had shown a decrease in the activity of the left dorsolateral prefrontal cortex in depressed patients, and early studies suggested that high-frequency (eg, 5 to 10 Hz) TMS of the left dorsolateral prefrontal cortex had antidepressant effects. In contrast to electroconvulsive therapy (ECT), TMS does not require general anesthesia and does not generally induce a convulsion. Repetitive TMS (rTMS) is also being tested as a treatment for a variety of other psychiatric and neurologic disorders.

OBJECTIVE

The objective of this evidence review is to evaluate whether the use of repetitive transcranial magnetic stimulation of the brain improves the net health outcome for individuals with various psychiatric or neurologic conditions.

POLICY STATEMENT

Transcranial magnetic stimulation (TMS) of the brain using an FDA-cleared device and modality, which can include but is not limited to, conventional TMS, deep TMS, and theta burst stimulation (see Policy Guidelines) may be considered **medically necessary** as a treatment of major depressive disorder when all of the following conditions (1 to 3) have been met:

1. Confirmed diagnosis of severe major depressive disorder (single or recurrent) documented by standardized rating scales that reliably measure depressive symptoms; and
2. Any one of the following (a, b, c, or d):
    1. Individual has tried and had an inadequate response to 2 antidepressant agents from 2 different antidepressant classes (i.e., selective serotonin reuptake inhibitors, serotonin and norepinephrine reuptake inhibitors, tricyclic antidepressants, bupropion, or mirtazapine). An adequate trial of an antidepressant is defined by BOTH of the following:
        1. The trial length was at least 6 weeks at generally accepted doses or of sufficient duration as determined by the treating physician at the generally accepted doses; AND
        2. Individual was ≥80% adherent to the agent during the trial.
    2. Inability to tolerate a therapeutic dose of medications due to distinct side effects; or
    3. History of response to TMS in a previous depressive episode (at least 3 months since the prior episode); or
    4. Is a candidate for electroconvulsive therapy; further, electroconvulsive therapy would not be clinically superior to TMS (eg, in cases with psychosis, acute suicidal risk, catatonia or life-threatening inanition TMS should NOT be used);

and

3. Failure of a trial of a psychotherapy known to be effective in the treatment of major depressive disorder of an adequate frequency and duration, without significant improvement in depressive symptoms, as documented by standardized rating scales that reliably measure depressive symptoms.

TMS for major depressive disorder that does not meet the criteria listed above is considered **investigational**.

Continued treatment with TMS of the brain as maintenance therapy is considered **investigational**.

TMS of the brain is considered **investigational** as a treatment of all other psychiatric and neurologic disorders, including but not limited to bipolar disorder, schizophrenia, obsessive-compulsive disorder, or migraine headaches.

POLICY GUIDELINES

Transcranial magnetic stimulation (TMS) should be performed using a U.S. Food and Drug Administration cleared device in appropriately selected individuals over age 18 years, by health care professionals who are adequately trained and experienced in the specific techniques used.

A variety of TMS modalities have been developed, which differ on parameters including stimulation intensity, frequency, pattern, and site of the brain stimulation.

In conventional TMS, high frequency stimulation is delivered over the left dorsolateral prefrontal cortex (DLPFC) or low frequency stimulation over the right DLPFC. In bilateral TMS, both procedures are performed in the same session.

Theta burst stimulation is administered at lower intensities and at shorter intervals than conventional TMS.

Deep TMS employs an H-coil helmet designed to encompass a broader surface area and stimulate deeper brain structures than conventional TMS.

A treatment course of conventional TMS usually does not exceed 5 days a week for 6 weeks (total of 30 sessions), however the treatment plan can be individualized depending on the type of device used, safety and side effect considerations and response to treatment.

Theta burst stimulation may be administered using an accelerated protocol. One example of an accelerated theta burst protocol is the Stanford Accelerated Intelligent Neuromodulation Therapy (SAINT) protocol, consisting of 10 daily sessions over 5 consecutive days.

Contraindications to repetitive TMS include:

1. Seizure disorder or any history of seizure with increased risk of future seizure; or
2. Presence of acute or chronic psychotic symptoms or disorders (eg, schizophrenia, schizophreniform or schizoaffective disorder) in the current depressive episode; or
3. Neurologic conditions that include epilepsy, cerebrovascular disease, dementia, increased intracranial pressure, having a history of repetitive or severe head trauma, or with primary or secondary tumors in the central nervous system; or
4. Presence of an implanted magnetic-sensitive medical device located 30 centimeters or less from the TMS magnetic coil or other implanted metal items, including but not limited to a cochlear implant, implanted cardioverter defibrillator, pacemaker, vagus nerve stimulator, or metal aneurysm clips or coils, staples, or stents.

The following should be present for the administration of repetitive TMS:

1. An attendant trained in basic cardiac life support and the management of complications such as seizures, as well as the use of the equipment must be present at all arial; and
2. Adequate resuscitation equipment including, eg, suction and oxygen; and
3. The facility must maintain awareness of response times of emergency services (either fire/ambulance or "code team”), which should be available within 5 minutes. These relationships are reviewed on at least a 1-year basis and include mock drills.

BENEFIT APPLICATION

Experimental or investigational procedures, treatments, drugs, or devices are not covered (See General Exclusion Section of brochure).

FDA REGULATORY STATUS

Devices for transcranial stimulation have been cleared for marketing by the U.S. Food and Drug Administration (FDA) for diagnostic uses (FDA Product Code: GWF). A number of devices subsequently received FDA clearance for the treatment of major depressive disorder in adults who have failed to achieve satisfactory improvement from prior antidepressant medication in the current episode. Some of these devices use deep TMS or theta burst protocols. For example, the Brainsway Deep TMS system was FDA cleared for treatment-resistant depression in 2013 based on substantial equivalence to the Neurostar TMS Therapy System, and the Horizon (Magstim) and MagVita (Tonica Elektronik) have FDA clearance for their theta burst protocols.

Indications were expanded to include treating pain associated with certain migraine headaches in 2013, and obsessive-compulsive disorder in 2018.

In 2014, eNeura Therapeutics received 510(k) marketing clearance for the SpringTMS for the treatment of migraine headaches. The device differs from the predicate Cerena™ TMS device with the addition of an LCD screen, a use authorization feature, a lithium battery pack, and a smaller size. The stimulation parameters are unchanged. The sTMS Mini (eNeura Therapeutics) received marketing clearance by the FDA in 2016. FDA product code: OKP.

In August 2018, the Deep TMS System (Brainsway) was granted a de novo 510(k) classification by the FDA as an adjunct for the treatment of adult patients with obsessive-compulsive disorder. The new classification applies to this device and substantially equivalent devices of this generic type.

The NeoPulse, now known as NeuroStar TMS, was granted a de novo 510(k) classification by the FDA in 2008. The de novo 510(k) review process allows novel products with moderate or low-risk profiles and without predicates, which would ordinarily require premarket approval as a class III device, to be down-classified in an expedited manner and brought to market with a special control as a class II device.

In 2014, the Cerena™ TMS device (eNeura Therapeutics) was granted a de novo 510(k) classification by the FDA for the acute treatment of pain associated with migraine headache with aura. Warnings, precautions, and contraindications include the following:

- The device is only intended for patients experiencing the onset of pain associated with a migraine headache with aura.
- The device should not be used:
    - on headaches due to underlying pathology or trauma.
    - for medication overuse headaches.
- The device has not been demonstrated as safe and/or effective:
    - when treating cluster headache or a chronic migraine headache.
    - when treating during the aura phase.
    - in relieving the associated symptoms of a migraine (photophobia, phonophobia, and nausea).
    - in pregnant women, children under the age of 18, and adults over the age of 65.

Table 1 lists some devices that are FDA cleared for major depressive disorder (Product Code: OBP), migraine headache pain (Product Code: OKP), and obsessive-compulsive disorder (Product Code: QCI).

Table 1. Repetitive Transcranial Magnetic Stimulation Devices Cleared by the U.S. Food and Drug Administration for Major Depression, Migraine, or Obsessive-Compulsive Disorder

Device	Manufacturer	Indication	FDA Clearance No.	FDA Clearance Date
Horizon 3.0 TMS Therapy System	Magstim	Major depressive disorder and obsessive-compulsive disorder	K222171	01/13/2023
ALTMS Magnetic Stimulation Therapy System	REMED Co., Ltd	Major depressive disorder	K220625	04/06/2022
Neurostar	Neuronetics	Major Depressive Disorder	K083538	12/16/2008
		Obsessive-Compulsive Disorder	K212289	05/06/2022
Brainsway Deep TMS System	Brainsway	Major Depressive Disorder	K122288	01/07/2013
		Obsessive-Compulsive Disorder	K183303	03/08/2019
Springtms Total Migraine System	Eneura	Migraine headache with aura	K140094	05/21/2014
Rapid Therapy System	Magstim	Major Depressive Disorder	K143531	05/08/2015
Magvita	Tonica Elektronik	Major Depressive Disorder	K150641	07/31/2015
Mag Vita TMS Therapy System w/Theta Burst Stimulation	Tonica Elektronik	Major Depressive Disorder	K173620	8/14/2018
Neurosoft	TeleEMG	Major Depressive Disorder	K160309	12/22/2016
Horizon	Magstim	Major Depressive Disorder	K171051	09/13/2017
Horizon TMS Therapy System (Theta Burst Protocol)	Magstim	Major Depressive Disorder	K182853	03/15/2019
Nexstim	Nexstim	Major Depressive Disorder	K171902	11/10/2017
Apollo	Mag & More	Major Depressive Disorder	K180313	05/04/2018

RATIONALE

Summary of Evidence

For individuals who have treatment-resistant depression (TRD) who receive transcranial magnetic stimulation (TMS), the evidence includes a large number of sham-controlled randomized controlled trials (RCTs) and meta-analyses of these trials. Relevant outcomes are symptoms, functional outcomes, and quality of life. Meta-analyses found improved response rates and rates of remission for conventional TMS and theta burst stimulation compared with sham TMS. Additionally, a head-to-head trial showed noninferiority of theta burst stimulation to conventional TMS, with no difference in the incidence of adverse events. Meta-analyses have concluded that the effect of TMS on average depression scores is smaller than the effect of electroconvulsive therapy (ECT) on TRD and that the mean improvement in depression scores with TMS did not reach the minimal clinically important difference; however, clinically meaningful improvements were noted in a subgroup of studies using higher frequency pulses. One potential area of benefit for TMS is in accelerating or enhancing the response to antidepressant medications, and there is some evidence that TMS, when given in conjunction with the initiation of pharmacologic therapy, improves the response rate compared with pharmacologic therapy alone. The effect of TMS appears to be less robust when it is given in combination with a stable dose of antidepressant medication. Meta-analyses have also found that the efficacy of TMS decreases with longer follow-up, though some studies have reported a persistent response up to 6 months in some patients. There is limited evidence to compare the effects of these treatments on cognition, although the adverse events of TMS appear to be minimal. While meta-analyses have reported that the effect of TMS is smaller than the effect of ECT on TRD, because TMS does not require general anesthesia or induce seizures, some individuals may decline ECT so the balance of incremental benefits and harms associated with TMS may be reasonable compared with ECT. Based on the short-term benefit observed in RCTs and the lack of alternative treatments aside from ECT in patients with TRD, TMS may be considered a treatment option in patients with TRD who meet specific criteria. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have migraine headaches who receive TMS, the evidence includes a systematic review (n=8 trials) and a sham-controlled RCT of 201 patients conducted for submission to the Food and Drug Administration (FDA) for clearance in 2013. Relevant outcomes are symptoms, functional outcomes, and quality of life. The systematic review found that repetitive TMS (rTMS) reduced migraine pain intensity and frequency compared to sham; it was unclear whether patients were receiving background pharmacotherapy. The trial results were limited by the 46% dropout rate and the use of a post hoc analysis. No recent studies have been identified with these devices. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have obsessive compulsive disorder (OCD) who receive TMS, the evidence includes a number of small-to-moderate sized, sham-controlled, double-blind RCTs and meta-analyses of these studies. Relevant outcomes are symptoms, functional outcomes, and quality of life. A meta-analysis of 15 RCTs (N=483 patients, range 18 to 65 patients) conducted in 2016 found a benefit of TMS on patient-reported OCD symptom severity at time points ranging from 2 to 6 weeks, but there was substantial variability in the stimulation parameters, including the cortical region that was stimulated and the frequency of stimulation. A meta-analysis conducted in 2021 included 26 RCTs. The primary analysis found a significant effect of rTMS compared to sham on OCD symptoms, but the effect seemed to last only until 4 weeks after the last treatment. The RCT that was the basis of FDA clearance of deep TMS for treatment of OCD compared deep TMS to sham in 99 patients for 6 weeks, with an additional 4 weeks of follow-up as a secondary outcome. Using a modified intention-to-treat (ITT) analysis (n=94), there was a larger mean decrease from baseline (improvement) on the Yale-Brown Obsessive Compulsive Scale (YBOCS) score (the primary efficacy outcome) in the active treatment group (-6.0 points) than the sham group (-2.8 points), translating to a moderate effect size of 0.69. At 6 weeks, the response rate was 38.1% in the active treatment group compared to 11.1% in the sham group (p=.003), as measured by a 30% or greater increase in the YBOCS. The difference in the primary outcome measure between active and sham groups was not statistically significant in the ITT analysis. There was a benefit for TMS on clinician-reported measures of improvement, but no significant difference between groups on patient-reported disability and impairment. Additional trials with sufficient sample size and follow-up duration are needed to confirm these results. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have psychiatric or neurological disorders other than depression, migraine, or OCD (eg, bipolar disorder, generalized anxiety disorder, panic disorder, posttraumatic stress disorder, schizophrenia, substance use disorder and craving, amyotrophic lateral sclerosis, chronic pain, epilepsy, fibromyalgia, Parkinson disease, stroke recovery) who receive TMS, the evidence includes numerous small RCTs and meta-analyses of these randomized trials. Relevant outcomes are symptoms, functional outcomes, and quality of life. The trials included in the meta-analyses are typically small and of low methodologic quality. In addition, stimulation parameters have not been established, and trial results are heterogeneous. There are no large, high-quality trials for any of these conditions demonstrating efficacy or the durability of any treatment effects. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

SUPPLEMENTAL INFORMATION

Practice Guidelines and Position Statements

Guidelines or position statements will be considered for inclusion in 'Supplemental Information' if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

American Academy of Child and Adolescent Psychiatry

In 2013, the American Academy of Child and Adolescent Psychiatry published practice parameters on the assessment and treatment of children and adolescents with tic disorders.[58,] The Academy did not recommend rTMS, citing the limited evidence on the safety, ethics, and long-term impact on development.

American Psychiatric Association

The American Psychiatric Association (2018) published consensus recommendations on rTMS for the treatment of depression.[59,] The guidelines state, "Multiple randomized controlled trials and published literature have supported the safety and efficacy of rTMS antidepressant therapy." The recommendations include information on the following variables: clinical environment, operator requirements, documentation, coils, cortical targets, coil positioning methods, determination of motor threshold, number of treatment sessions for acute treatment, and allowable psychotropic medications during TMS treatment.

The American Psychiatric Association's (2007, reaffirmed in 2012) guidelines on the treatment of patients with obsessive-compulsive disorder have indicated that "findings of the 4 published trials of rTMS are inconsistent, perhaps because the studies differed in design, stimulation sites, duration, and stimulation parameters. The available results and the technique's non-invasiveness and good tolerability should encourage future research, but the need for daily treatment may limit the use of TMS in practice."

Veteran's Affairs/Department of Defense

The 2022 Veteran's Affairs/Department of Defense guideline for management of major depressive disorder recommends offering rTMS to patients who have experienced partial response or no response to an adequate trial of 2 or more pharmacologic treatments (strength of recommendation: weak).[60,] Recommended options for the second treatment attempt after the initial therapy tried include switching to another antidepressant or adding augmentation therapy with a second-generation antipsychotic. The recommendation for rTMS was graded as weak due to limitations of the available literature including small study effects, high rates of discontinuation, lack of allocation concealment, and the practical limitations of the need for daily treatment and lack of widespread access to facilities that offer this therapy. The guideline also concluded that there is limited evidence to recommend for or against theta-burst stimulation for treatment of depression.

National Institute for Health and Care Excellence

In 2015, the National Institute for Health and Care Excellence (NICE) provided revised guidance, stating that evidence on the short-term efficacy of rTMS for depression is adequate, although the clinical response is variable and some patients may not benefit.[61,]

In 2014, the NICE provided guidance on the use of rTMS for treating and preventing migraine.[62,] The guidance stated that evidence on the efficacy of TMS for the treatment of migraine was limited in quantity and for the prevention of migraine was limited in both quality and quantity. Evidence on its safety in the short- and medium-term was adequate, but there was uncertainty about the safety of long-term or frequent use of TMS.

In 2020, the NICE stated that rTMS has not demonstrated any major safety concerns for management of obsessive-compulsive disorder or auditory hallucinations, but evidence for both uses is lacking; therefore, NICE recommends that rTMS be used in patients with these conditions only in the context of research.[63,64,]

International Neuromodulation Society/North American Neuromodulation Society

In 2020, an expert consensus panel from the International Neuromodulation Society-North American Neuromodulation Society performed a literature review and published recommendations for transcranial magnetic stimulation in the treatment of pain and headache.[65,] For neuropathic pain, the panel recommended transcranial magnetic stimulation to the primary motor cortex (high level evidence) or the left dorsolateral prefrontal cortex (F3 location) (at least moderate level evidence). For postoperative pain, the panel recommended that transcranial magnetic stimulation to the F3 location be only selectively offered due to at least moderate certainty that the net benefit is small. For primary headache, the panel only based 2 recommendations on moderate certainty evidence: single transcranial magnetic stimulation for acute migraine and high-frequency rTMS to the primary motor cortex for migraine prevention. For posttraumatic brain injury, high level evidence supported a recommendation for high-frequency transcranial magnetic stimulation to the primary motor cortex or the F3 location.

U.S. Preventive Services Task Force Recommendations

Not applicable.

Medicare National Coverage

There is no national coverage determination. In the absence of a national coverage determination, coverage decisions are left to the discretion of local Medicare carriers.

REFERENCES

1. FDA Briefing Document Psychopharmacologic Drugs Advisory Committee (PDAC) and Drug Safety and Risk Management (DSaRM) Advisory Committee Meeting February 12, 2019. https://www.fda.gov/media/121376/download. Accessed September 26, 2022.
2. Zimmerman M, Chelminski I, Posternak M. A review of studies of the Montgomery-Asberg Depression Rating Scale in controls: implications for the definition of remission in treatment studies of depression. Int Clin Psychopharmacol. Jan 2004; 19(1): 1-7. PMID 15101563
3. Center for Drug Evaluation and Research Application Number: 211243Orig1s000 Summary Review https://www.accessdata.fda.gov/drugsatfda_docs/nda/2019/211243Orig1s000SumR.pdf. Accessed August 18, 2023.
4. Alphs L, Fu D-J, Williamson D, et al. Validation and mapping of the Suicidal Ideation and Behavior Assessment Tool (SIBAT). (abstract W88) Neuropsychopharmacology. 2018;43:S427S428.
5. Gross M, Nakamura L, Pascual-Leone A, et al. Has repetitive transcranial magnetic stimulation (rTMS) treatment for depression improved? A systematic review and meta-analysis comparing the recent vs. the earlier rTMS studies. Acta Psychiatr Scand. Sep 2007; 116(3): 165-73. PMID 17655557
6. Schutter DJ. Antidepressant efficacy of high-frequency transcranial magnetic stimulation over the left dorsolateral prefrontal cortex in double-blind sham-controlled designs: a meta-analysis. Psychol Med. Jan 2009; 39(1): 65-75. PMID 18447962
7. Sehatzadeh Sh, Tu HA, Palimaka S, et al. Repetitive Transcranial Magnetic Stimulation for Treatment-Resistant Depression: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Ont Health Technol Assess Ser. 2016; 16(5): 1-66. PMID 27099642
8. Brunoni AR, Chaimani A, Moffa AH, et al. Repetitive Transcranial Magnetic Stimulation for the Acute Treatment of Major Depressive Episodes: A Systematic Review With Network Meta-analysis. JAMA Psychiatry. Feb 01 2017; 74(2): 143-152. PMID 28030740
9. Voigt JD, Leuchter AF, Carpenter LL. Theta burst stimulation for the acute treatment of major depressive disorder: A systematic review and meta-analysis. Transl Psychiatry. May 28 2021; 11(1): 330. PMID 34050123
10. Blumberger DM, Vila-Rodriguez F, Thorpe KE, et al. Effectiveness of theta burst versus high-frequency repetitive transcranial magnetic stimulation in patients with depression (THREE-D): a randomised non-inferiority trial. Lancet. Apr 28 2018; 391(10131): 1683-1692. PMID 29726344
11. Food and Drug Administration. 510(k) Summary: Brainsway deep TMS System (K122288). 2013; https://www.accessdata.fda.gov/cdrh_docs/pdf12/k122288.pdf. Accessed August 18, 2023.
12. Kedzior KK, Reitz SK, Azorina V, et al. Durability of the antidepressant effect of the high-frequency repetitive transcranial magnetic stimulation (rTMS) In the absence of maintenance treatment in major depression: a systematic review and meta-analysis of 16 double-blind, randomized, sham-controlled trials. Depress Anxiety. Mar 2015; 32(3): 193-203. PMID 25683231
13. Dunner DL, Aaronson ST, Sackeim HA, et al. A multisite, naturalistic, observational study of transcranial magnetic stimulation for patients with pharmacoresistant major depressive disorder: durability of benefit over a 1-year follow-up period. J Clin Psychiatry. Dec 2014; 75(12): 1394-401. PMID 25271871
14. Richieri R, Guedj E, Michel P, et al. Maintenance transcranial magnetic stimulation reduces depression relapse: a propensity-adjusted analysis. J Affect Disord. Oct 2013; 151(1): 129-35. PMID 23790811
15. Connolly KR, Helmer A, Cristancho MA, et al. Effectiveness of transcranial magnetic stimulation in clinical practice post-FDA approval in the United States: results observed with the first 100 consecutive cases of depression at an academic medical center. J Clin Psychiatry. Apr 2012; 73(4): e567-73. PMID 22579164

16. Janicak PG, Nahas Z, Lisanby SH, et al. Durability of clinical benefit with transcranial magnetic stimulation (TMS) in the treatment of pharmacoresistant major depression: assessment of relapse during a 6-month, multisite, open-label study. Brain Stimul. Oct 2010; 3(4): 187-99. PMID 20965447
17. Saltychev M, Juhola J. Effectiveness of high-frequency repetitive transcranial magnetic stimulation (rTMS) in migraine - a systematic review and meta-analysis. Am J Phys Med Rehabil. Jan 14 2022. PMID 35034064
18. Food and Drug Administration. De Novo classification request for cerena transcranial magnetic stimulator (TMS) device. 2013; https://www.accessdata.fda.gov/cdrh_docs/reviews/K130556.pdf. Accessed August 18, 2023.
19. Goodman WK, Price LH, Rasmussen SA, et al. The Yale-Brown Obsessive Compulsive Scale. I. Development, use, and reliability. Arch Gen Psychiatry. Nov 1989; 46(11): 1006-11. PMID 2684084
20. Storch EA, De Nadai AS, Conceicao do Rosario M, et al. Defining clinical severity in adults with obsessive-compulsive disorder. Compr Psychiatry. Nov 2015; 63: 30-5. PMID 26555489
21. Farris SG, McLean CP, Van Meter PE, et al. Treatment response, symptom remission, and wellness in obsessive-compulsive disorder. J Clin Psychiatry. Jul 2013; 74(7): 685-90. PMID 23945445
22. Trevizol AP, Shiozawa P, Cook IA, et al. Transcranial Magnetic Stimulation for Obsessive-Compulsive Disorder: An Updated Systematic Review and Meta-analysis. J ECT. Dec 2016; 32(4): 262-266. PMID 27327557
23. Liang K, Li H, Bu X, et al. Efficacy and tolerability of repetitive transcranial magnetic stimulation for the treatment of obsessive-compulsive disorder in adults: a systematic review and network meta-analysis. Transl Psychiatry. May 28 2021; 11(1): 332. PMID 34050130
24. Carmi L, Tendler A, Bystritsky A, et al. Efficacy and Safety of Deep Transcranial Magnetic Stimulation for Obsessive-Compulsive Disorder: A Prospective Multicenter Randomized Double-Blind Placebo-Controlled Trial. Am J Psychiatry. Nov 01 2019; 176(11): 931-938. PMID 31109199
25. Perera MPN, Mallawaarachchi S, Miljevic A, et al. Repetitive Transcranial Magnetic Stimulation for Obsessive-Compulsive Disorder: A Meta-analysis of Randomized, Sham-Controlled Trials. Biol Psychiatry Cogn Neurosci Neuroimaging. Oct 2021; 6(10): 947-960. PMID 33775927
26. U.S. Food and Drug Administration. De novo classification request for Brainsway Deep Transcranial Magnetic Stimulation System. 2018; https://www.accessdata.fda.gov/cdrh_docs/reviews/DEN170078.pdf. Accessed August 18, 2023.
27. Konstantinou G, Hui J, Ortiz A, et al. Repetitive transcranial magnetic stimulation (rTMS) in bipolar disorder: A systematic review. Bipolar Disord. Feb 2022; 24(1): 10-26. PMID 33949063
28. Tee MMK, Au CH. A Systematic Review and Meta-Analysis of Randomized Sham-Controlled Trials of Repetitive Transcranial Magnetic Stimulation for Bipolar Disorder. Psychiatr Q. Dec 2020; 91(4): 1225-1247. PMID 32860557
29. Cui H, Jiang L, Wei Y, et al. Efficacy and safety of repetitive transcranial magnetic stimulation for generalised anxiety disorder: A meta-analysis. Gen Psychiatr. 2019; 32(5): e100051. PMID 31673675
30. Li H, Wang J, Li C, et al. Repetitive transcranial magnetic stimulation (rTMS) for panic disorder in adults. Cochrane Database Syst Rev. Sep 17 2014; (9): CD009083. PMID 25230088
31. Mantovani A, Aly M, Dagan Y, et al. Randomized sham controlled trial of repetitive transcranial magnetic stimulation to the dorsolateral prefrontal cortex for the treatment of panic disorder with comorbid major depression. J Affect Disord. Jan 10 2013; 144(1-2): 153-9. PMID 22858212
32. Trevizol AP, Barros MD, Silva PO, et al. Transcranial magnetic stimulation for posttraumatic stress disorder: an updated systematic review and meta-analysis. Trends Psychiatry Psychother. Jan-Mar 2016; 38(1): 50-5. PMID 27074341
33. He H, Lu J, Yang L, et al. Repetitive transcranial magnetic stimulation for treating the symptoms of schizophrenia: A PRISMA compliant meta-analysis. Clin Neurophysiol. May 2017; 128(5): 716-724. PMID 28315614
34. Dougall N, Maayan N, Soares-Weiser K, et al. Transcranial magnetic stimulation (TMS) for schizophrenia. Cochrane Database Syst Rev. Aug 20 2015; (8): CD006081. PMID 26289586
35. Guan HY, Zhao JM, Wang KQ, et al. High-frequency neuronavigated rTMS effect on clinical symptoms and cognitive dysfunction: a pilot double-blind, randomized controlled study in Veterans with schizophrenia. Transl Psychiatry. Feb 25 2020; 10(1): 79. PMID 32098946
36. Kumar N, Vishnubhatla S, Wadhawan AN, et al. A randomized, double blind, sham-controlled trial of repetitive transcranial magnetic stimulation (rTMS) in the treatment of negative symptoms in schizophrenia. Brain Stimul. May 2020; 13(3): 840-849. PMID 32289715
37. Zhuo K, Tang Y, Song Z, et al. Repetitive transcranial magnetic stimulation as an adjunctive treatment for negative symptoms and cognitive impairment in patients with schizophrenia: a randomized, double-blind, sham-controlled trial. Neuropsychiatr Dis Treat. 2019; 15: 1141-1150. PMID 31190822
38. Zhu L, Zhang W, Zhu Y, et al. Cerebellar theta burst stimulation for the treatment of negative symptoms of schizophrenia: A multicenter, double-blind, randomized controlled trial. Psychiatry Res. Nov 2021; 305: 114204. PMID 34587567
39. Jansen JM, Daams JG, Koeter MW, et al. Effects of non-invasive neurostimulation on craving: a meta-analysis. Neurosci Biobehav Rev. Dec 2013; 37(10 Pt 2): 2472-80. PMID 23916527
40. Chang CH, Liou MF, Liu CY, et al. Efficacy of Repetitive Transcranial Magnetic Stimulation in Patients With Methamphetamine Use Disorder: A Systematic Review and Meta-Analysis of Double-Blind Randomized Controlled Trials. Front Psychiatry. 2022; 13: 904252. PMID 35711590
41. Fang J, Zhou M, Yang M, et al. Repetitive transcranial magnetic stimulation for the treatment of amyotrophic lateral sclerosis or motor neuron disease. Cochrane Database Syst Rev. May 31 2013; (5): CD008554. PMID 23728676
42. O'Connell NE, Wand BM, Marston L, et al. Non-invasive brain stimulation techniques for chronic pain. Cochrane Database Syst Rev. Apr 11 2014; (4): CD008208. PMID 24729198
43. O'Connell NE, Marston L, Spencer S, et al. Non-invasive brain stimulation techniques for chronic pain. Cochrane Database Syst Rev. Apr 13 2018; 4: CD008208. PMID 29652088
44. Jiang X, Yan W, Wan R, et al. Effects of repetitive transcranial magnetic stimulation on neuropathic pain: A systematic review and meta-analysis. Neurosci Biobehav Rev. Jan 2022; 132: 130-141. PMID 34826512

45. Chen R, Spencer DC, Weston J, et al. Transcranial magnetic stimulation for the treatment of epilepsy. Cochrane Database Syst Rev. Aug 11 2016; (8): CD011025. PMID 27513825
46. Mishra A, Maiti R, Mishra BR, et al. Effect of Repetitive Transcranial Magnetic Stimulation on Seizure Frequency and Epileptiform Discharges in Drug-Resistant Epilepsy: A Meta-Analysis. J Clin Neurol. Jan 2020; 16(1): 9-18. PMID 31942753
47. Su YC, Guo YH, Hsieh PC, et al. Efficacy of Repetitive Transcranial Magnetic Stimulation in Fibromyalgia: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. J Clin Med. Oct 12 2021; 10(20). PMID 34682790
48. Saltychev M, Laimi K. Effectiveness of repetitive transcranial magnetic stimulation in patients with fibromyalgia: a meta-analysis. Int J Rehabil Res. Mar 2017; 40(1): 11-18. PMID 27977465
49. Chou YH, Hickey PT, Sundman M, et al. Effects of repetitive transcranial magnetic stimulation on motor symptoms in Parkinson disease: a systematic review and meta-analysis. JAMA Neurol. Apr 2015; 72(4): 432-40. PMID 25686212
50. Shirota Y, Ohtsu H, Hamada M, et al. Supplementary motor area stimulation for Parkinson disease: a randomized controlled study. Neurology. Apr 09 2013; 80(15): 1400-5. PMID 23516319
51. Li R, He Y, Qin W, et al. Effects of Repetitive Transcranial Magnetic Stimulation on Motor Symptoms in Parkinson's Disease: A Meta-Analysis. Neurorehabil Neural Repair. Jul 2022; 36(7): 395-404. PMID 35616427
52. Hao Z, Wang D, Zeng Y, et al. Repetitive transcranial magnetic stimulation for improving function after stroke. Cochrane Database Syst Rev. May 31 2013; (5): CD008862. PMID 23728683
53. Le Q, Qu Y, Tao Y, et al. Effects of repetitive transcranial magnetic stimulation on hand function recovery and excitability of the motor cortex after stroke: a meta-analysis. Am J Phys Med Rehabil. May 2014; 93(5): 422-30. PMID 24429509
54. Li Y, Qu Y, Yuan M, et al. Low-frequency repetitive transcranial magnetic stimulation for patients with aphasia after stoke: A meta-analysis. J Rehabil Med. Sep 2015; 47(8): 675-81. PMID 26181486
55. Qiao J, Ye QP, Wu ZM, et al. The Effect and Optimal Parameters of Repetitive Transcranial Magnetic Stimulation on Poststroke Dysphagia: A Meta-Analysis of Randomized Controlled Trials. Front Neurosci. 2022; 16: 845737. PMID 35573312
56. Zhang L, Xing G, Fan Y, et al. Short- and Long-term Effects of Repetitive Transcranial Magnetic Stimulation on Upper Limb Motor Function after Stroke: a Systematic Review and Meta-Analysis. Clin Rehabil. Sep 2017; 31(9): 1137-1153. PMID 28786336
57. Graef P, Dadalt MLR, Rodrigues DAMDS, et al. Transcranial magnetic stimulation combined with upper-limb training for improving function after stroke: A systematic review and meta-analysis. J Neurol Sci. Oct 15 2016; 369: 149-158. PMID 27653882
58. Murphy TK, Lewin AB, Storch EA, et al. Practice parameter for the assessment and treatment of children and adolescents with tic disorders. J Am Acad Child Adolesc Psychiatry. Dec 2013; 52(12): 1341-59. PMID 24290467
59. McClintock SM, Reti IM, Carpenter LL, et al. Consensus Recommendations for the Clinical Application of Repetitive Transcranial Magnetic Stimulation (rTMS) in the Treatment of Depression. J Clin Psychiatry. Jan/Feb 2018; 79(1). PMID 28541649
60. VA/DoD Clinical Practice Guideline. (2022). The Management of Major Depressive Disorder. Washington, DC: U.S. Government Printing Office. https://www.healthquality.va.gov/guidelines/MH/mdd/VADoDMDDCPGFinal508.pdf. Accessed August 18, 2023.
61. National Institute for Health and Care Excellence (NICE). Repetitive transcranial magnetic stimulation for depression [IPG542]. 2015; https://www.nice.org.uk/guidance/ipg542. Accessed August 18, 2023.
62. National Institute for Health and Care Excellence (NICE). Transcranial magnetic stimulation for treating and preventing migraine [IPG477]. 2014; https://www.nice.org.uk/guidance/ipg477. Accessed August 15, 2023.
63. National Institute for Health and Care Excellence (NICE). Transcranial magnetic stimulation for obsessive-compulsive disorder [IPG676]. 2020; https://www.nice.org.uk/guidance/ipg676. Accessed August 16, 2023.
64. National Institute for Health and Care Excellence (NICE). Transcranial magnetic stimulation for auditory hallucinations [IPG680]. 2020; https://www.nice.org.uk/guidance/ipg680/chapter/1-Recommendations. Accessed August 17, 2023.
65. Leung A, Shirvalkar P, Chen R, et al. Transcranial Magnetic Stimulation for Pain, Headache, and Comorbid Depression: INS-NANS Expert Consensus Panel Review and Recommendation. Neuromodulation. Apr 2020; 23(3): 267-290. PMID 32212288

POLICY HISTORY - THIS POLICY WAS APPROVED BY THE FEP® PHARMACY AND MEDICAL POLICY COMMITTEE ACCORDING TO THE HISTORY BELOW:

Date	Action	Description
September 2012	New policy	
March 2013	Replace policy	Policy reviewed and rationale updated for non-FDA approved indications. No change in policy statement. New FDA approved device added.
March 2015	Replace policy	Policy updated with literature review through October 30, 2014; references 15, 17, 25, 27, 36, 41, 48, 52, 53, and 55 added and some references removed; policy statements are unchanged.
June 2016	Replace policy	Policy updated with literature review through November 9, 2015; references 17, 36, 43, 46, and 48 added. Policy statements unchanged.
December 2018	Replace policy	Policy updated with literature review through August 23, 2018; references 9, 10, 19, 21, 24, 29, 31, 35 and 37 added. Policy statements unchanged except "not medically necessary, revised to "investigational, to align with FDA 510(k) status.
December 2019	Replace policy	Policy updated with literature review through August 26, 2019; references added. Policy statements unchanged.
October 2020	Replace policy	Policy updated with literature review through September 12, 2020; references added. Policy statements unchanged.
December 2021	Replace policy	Policy updated with literature review through September 3, 2021; references added. Medically necessary policy statement on transcranial magnetic stimulation (TMS) for treatment resistant depression revised to specify "using an FDA-cleared device and modality, which can include but is not limited to, conventional TMS, deep TMS, and theta burst stimulation." Information on different modalities including theta burst stimulation added to the Policy Guidelines. Policy statements otherwise unchanged.
December 2022	Replace policy	Policy updated with literature review through August 19, 2022; references added. Minor editorial refinements to policy statements; intent unchanged.
December 2023	Replace policy	Policy updated with literature review through August 18, 2023; no references added. Policy statements unchanged.