

CE Corner

What Works, What's New, and What's Next: Using Brain Stimulation to Treat Mental Illness

BY KIRSTEN WEIR

THE UNITED STATES Food and Drug Administration (FDA) cleared transcranial magnetic stimulation (TMS) for major depressive disorder in 2008, yet skepticism among clinicians lingered for years.

But evidence for its benefits has continued to grow as the treatment has evolved and expanded in new directions. Now, clinicians view neuromodulation—the process of delivering targeted electrical stimulation to the brain to normalize abnormal neural circuitry—as a valuable tool for understanding and treating a growing list of neuropsychiatric disorders.

Today's newer TMS technologies can reach more deeply into the brain, and updated protocols are shrinking treatment times from weeks to days. TMS has also been extended to other conditions beyond depression in adults. The therapy is now approved for obsessive-compulsive disorder (OCD), migraines, and smoking cessation, and in 2024 it was cleared as an adjunctive treatment for depression in adolescents starting at age 15. Meanwhile, researchers are exploring TMS as a tool in other mental health disorders, such as eating disorders and post-traumatic stress disorder (PTSD), and even in neurological conditions such as mild cognitive impairment, Alzheimer's disease, and autism.

Clinicians and patients are drawn to TMS for a variety of reasons. It is noninvasive, administered through an electromagnetic coil placed on the scalp. The devices deliver magnetic pulses that generate an electric current in the brain. While the practice can cause transient headaches and scalp discomfort, the risk of serious complications—such as seizures—is very low. And TMS can be effective when

other treatments, such as antidepressants or psychotherapy, have failed.

TMS requires a prescription and is therefore typically provided by medical professionals, although clinical psychologists with specialized training may be able to offer the procedure in states that grant them prescription privileges.

Yet psychologists come into contact with TMS in many other ways—referring patients for TMS, engaging in research to better understand and improve the treatment, and as a part of the multidisciplinary teams that deliver it.

“This is a treatment that really does well with interdisciplinary, integrated health care teams,” said Shawn McClintock, PhD, a clinical neuropsychologist, professor of psychiatry, and scientific director of the Perot Foundation Neuroscience Translational Research Center in the O'Donnell Brain Institute at University of Texas Southwestern Medical Center. “Psychology is a discipline that has a lot to offer for the continual evolution and use of TMS.”

Resetting circuits

Disorders of the brain were once framed as chemical imbalances or faulty brain regions. Increasingly, they are thought of as disorders of brain circuits. “Many disorders of the mind and brain can at least at some level be viewed as disorders of brain circuits,” said Michael Leuchter, MD, an assistant professor at the University of California, Los Angeles, Semel Institute for Neuroscience and Human Behavior. Depression, for instance, is often linked to disrupted connectivity between the left dorsolateral prefrontal cortex (DLPFC) and subgenual anterior cingulate

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Learning objectives

After reading this article, CE candidates will be able to:

- 1** Explain how transcranial magnetic stimulation (TMS) affects brain circuits to treat psychological symptoms.
- 2** Discuss which conditions have FDA clearance to be treated with TMS.
- 3** Describe emerging research to extend TMS to new indications and make the treatment more personalized and precise.

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KEY POINTS

1

TMS is approved to treat depression in adults and adolescents, as well as obsessive-compulsive disorder, smoking cessation, and migraines.

2

TMS uses magnetic pulses to generate an electric current that can repair disrupted brain circuits.

3

New protocols and approaches in development aim to make TMS more personalized to a patient's symptoms.

cortex (sgACC). “TMS interfaces with illness at the level of the brain circuit and more or less ‘rewires’ how it operates,” said Leuchter, who uses TMS as a treatment for his psychiatric patients and studies it as a treatment for Alzheimer’s disease. “The circuit-based approach is not inherently better or worse than therapy or medications; it just starts at an entirely different level.”

The new focus on circuits dovetails with a shift toward a more symptoms-based view of mental illness. Instead of targeting a particular disorder, clinicians increasingly target specific symptoms that, in many cases, extend across diagnoses. In depression, for example, dysphoric symptoms such as sadness and anhedonia might respond best to stimulation of one circuit, while anxiety and somatic symptoms might respond to stimulation of another (Siddiqi, S. H., et al., *The American Journal of Psychiatry*, Vol. 177, No. 5, 2020).

“This will clean up a lot of the messiness we have in clinical psychology, where people can’t agree on a diagnosis,” said Desmond Oathes, PhD, a clinical psychologist who directs

the Center for Brain Imaging and Stimulation at the University of Pennsylvania Perelman School of Medicine. “Maybe the diagnosis is not even that important. If we have a treatment that’s focused on a particular symptom, we can narrow that down and personalize the approach for better outcomes.”

TMS is a flexible tool. Depending on the protocol, it can inhibit activity in overactive networks or enhance activity in sluggish circuits. A variety of devices and approaches have been granted clearance by the FDA (see “Expanding the Treatment Toolkit: FDA-Approved and Cleared Medical Devices,” APA Services, Inc., 2026). Standard protocols for treating depression delivered the electromagnetic pulses across 4 to 6 weeks. But newer approaches have shrunk that window, with some delivering multiple daily treatments for 5 or 6 consecutive days.

Given the variety of devices and protocols, firm estimates of response rates are hard to determine. Yet clinicians and researchers who administer the treatment say the improvements can be striking. “We see a lot of people who have been suffering for a long time get their lives back,” Leuchter said.

Research also indicates that the treatment is helpful in patients of all ages. In a study of adolescents and young adults who received TMS for major depressive disorder, nearly 70% reported meaningful improvement and 30% achieved remission (Croarkin, P. E., et al., *JAACAP Open*, Vol. 3, No. 4, 2025). Leuchter’s research, meanwhile, shows that TMS response rates are at least as high in older adults as in younger adults (*International Psychogeriatrics*, Vol. 36, No. 11, 2024). “There was a time in TMS research when it was thought we

really couldn’t treat older adults past the age of 65 or so, because of atrophy of the brain,” McClintock said. “As newer evidence has come about, we see that TMS can be used in adults across the life span.”

Still, researchers have more work to do to determine who is likely to respond well to TMS and which brain regions to target. A recent umbrella review concluded that much of the research on TMS was vulnerable to bias and small-study effects and that more work is needed to clarify the benefits of TMS in different patient populations (Brini, S., et al., *Clinical Psychology Review*, Vol. 100, 2023).

Yet the patchy findings do not necessarily suggest that there are people unlikely to respond to TMS, Oathes said. “In my opinion, it is more the case that we haven’t found the right target for that person, and we need to revise our personalization strategy depending on what we learn about the patient.”

Precision TMS

TMS involves placing the device against the scalp, where it sends short, intense electromagnetic pulses into the brain. But the traditional approach is not highly personalized. Instead of using neuroimaging to identify the brain region providers hope to target, they use a tape measure to identify the spot on the scalp that is likely to correspond with the brain target, or sweet spot, beneath. “It’s actually miraculous that it works,” said Andrada Neacsu, PhD, a clinical psychologist at Duke University who studies TMS.

Newer methods take a more tailored approach. In 2022, the FDA cleared the Stanford neuromodulation therapy protocol, a depression treatment that uses resting-state brain imaging data to identify a target in the brain. Using fMRI, providers



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measure correlations in brain activity between the left DLPFC and the sgACC to determine where to focus the magnetic pulses. In addition to the more individualized approach, the protocol is notable because it delivers the treatment in 10 sessions per day over a 5-day period instead of the traditional weeks-long protocol. In an early trial of the approach, 19 of 21 patients achieved remission criteria (Cole, E. J., et al., *The American Journal of Psychiatry*, Vol. 177, No. 8, 2020).

Psychological scientists are working to make TMS even more precise. “We think that taking actual brain

measurements in response to TMS pulses is a really promising avenue to make the treatment better,” Oathes said. In a study being prepared for publication, he compared standard scalp-based TMS to an fMRI-guided protocol he developed. The imaging-guided approach was more effective at relieving depression symptoms, he found (*MedRxiv*, 2024). At the end of the 10-session treatment, 68% of people in the fMRI-guided group showed clinical improvement, compared with 59% of the scalp-target group. “But if you track patients over time, those who have the nonindividualized approach tend to get worse,

whereas [fMRI-guided] patients tend to further improve. At 6 months, there is more than a 30% difference in symptom improvement between those two groups,” he added.

Neacsiu is undertaking similar work. While the Stanford protocol relies on scans of patients’ brains while they are at rest, she hopes that TMS outcomes could be improved by assessing brain function while people are actively engaged in relevant tasks. In one study, for instance, she asks participants to use techniques that help them downregulate distress while they are in the scanner. “We’re trying to see exactly what areas connect

when you're engaged in that task so we can pick a target based on those functional imaging results," she said.

TMS could also boost the impact of behavioral interventions. In an ongoing study, Neacsiu teaches cognitive restructuring—a skill from cognitive behavioral therapy—to people with emotion dysregulation, regardless of their diagnosis. Then, she applies TMS to the circuits involved to boost the efficacy of the intervention (*Psychotherapy and Psychosomatics*, Vol. 91, No. 2, 2022). A parallel project uses the same approach to help people with misophonia, an intense negative reaction to certain sounds, such as chewing or breathing. In preliminary research, Neacsiu found that the combination of TMS and cognitive restructuring was more effective at reducing the severity of misophonia than either intervention alone (*Journal of Affective Disorders*, Vol. 350, 2024).

"Our behavioral interventions are fantastic, but they are cumbersome, and patients need to do a lot of work to learn how to apply them," Neacsiu said. In a recent study, she lays out a blueprint for enhancing their efficacy with TMS (*Behavioural Brain Research*, Vol. 508, 2026). "The goal is to use neuromodulation to enhance the effects of that skills practice, to lead to better connectivity, so that learning can happen faster and the participant will be more likely to use the skill in the future," she said.

Better brain states

That research highlights another important trend in TMS: bringing more psychological science to bear on neuromodulation. To date there has been little attention paid to the psychological state a person is in while undergoing TMS treatment for depression. But early findings indicate that state

could matter a lot. Oathes's research on depression suggests that participants who watch relaxing nature videos in combination with TMS experience better outcomes than do participants who engage in cognitive exercises.

More work is needed to understand such state differences, but they make sense to Neacsiu. "TMS is a blunt tool—it doesn't know what it's doing in the brain. It's critical what state the brain is in before administering the treatment," she said. She cringes to hear about some patients scrolling their phones during TMS treatments. "If they start thinking about bad things in the news, that could set their brain up in the context of enhancing rumination," she added. "Every neuromodulation practice should bring in a clinical psychologist who can understand how the person might respond to the context that they're in, and to make sure that patients are also receiving [complementary] evidence-based behavioral treatments."

There is a precedent for combining TMS with behavioral interventions, she added. In OCD, for example, the standard TMS protocol prepares patients for treatment using structured tools from exposure and response prevention, an established, evidence-based behavioral intervention for the disorder. And in smoking cessation, clinicians induce cravings through cue induction before applying TMS. "The idea is to get the brain into a state where it's more receptive to neuromodulation, by targeting the circuitry affected by the disorder," Neacsiu said.

As researchers continue to optimize TMS for depression, scientists are also investigating the therapy for a variety of other conditions, including anxiety disorders, PTSD, and substance use disorders. It also shows promise for neurological disease. Evidence suggests that TMS leads to cognitive improvements in patients with mild cognitive impairment and

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Alzheimer's disease, in both short- and long-term assessments (Yan, Y., et al., *Frontiers in Neurology*, Vol. 14, 2023).

Leuchter is among those scientists exploring TMS as a treatment for Alzheimer's. The tool seems to help brain regions that have been disconnected by the disease begin communicating again, he said. "The idea is that we can target brain networks to reregulate some of the rhythms that have been thrown off by the disease—like putting a conductor back in front of an orchestra."

He is also studying TMS in autistic people with treatment-resistant depression. Behavioral interventions can be more complicated in autistic patients who have difficulties with interpersonal interactions, he noted, and they can respond less predictably to psychiatric medications than neurotypical people. "The things we typically rely on in psychology and psychiatry are less reliable in autism, so it's very exciting to have a tool that has the potential to intervene in a very specific, mechanistically guided way for depression in autism," he said.

behavioral interventions, and more. "Psychologists have amazing training in assessment and experimental methods, and we can definitely be part of the team treating patients and advancing the science of TMS," Oathes said. ■

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Assistant professor at the University of California, Los Angeles

Others are investigating the use of TMS with autistic people. James McPartland, PhD, a clinical psychologist and professor of child psychiatry and psychology at the Yale Child Study Center, is using TMS to target the superior temporal sulcus. This brain region is involved in social cognition and social perception, functions that many autistic people find challenging. In preliminary work using eye-tracking technology, he has found that after stimulating this region with TMS, autistic people are more likely to look to the eyes when viewing images of faces. "We're not interested in this as a way to homogenize autistic people to make sure they make eye contact the way nonautistic people do," he emphasized. "But for many people on the spectrum, this is something that gives them trouble by their own accounts, and it might be useful for them."

Time will tell whether TMS will prove valuable in treating patients with autism or Alzheimer's disease. But in the present, clinical psychologists have a role to play by referring patients who might benefit from TMS to reputable providers. Unfortunately, some private clinics have sprung up that offer TMS for diagnoses such as attention-deficit/hyperactivity disorder or insomnia that are not supported by the evidence, McClintock said. "TMS is not a panacea," he said. "I encourage clinicians to do their homework so they can separate fact from fiction about TMS and, if they're going to refer a patient for TMS, make sure they're comfortable with that person's level of expertise and experience."

Psychologists also have much to offer neuromodulation treatment teams—assessing patient symptoms, measuring clinical outcomes, providing complementary

FURTHER RESOURCES

Consensus review and considerations on TMS to treat depression: A comprehensive update endorsed by the National Network of Depression Centers, the Clinical TMS Society, and the International Federation of Clinical Neurophysiology
Trapp, N. T., et al.
Clinical Neurophysiology, 2025

Non-invasively targeting, probing and modulating a deep brain circuit for depression alleviation
Oathes, D. J., et al.
Nature Mental Health, 2023

The promise of brain stimulation treatments for depression, with Sarah Lisanby, MD, and Diana Daniele
Speaking of Psychology, APA, 2023

Expanding the treatment toolkit: FDA-approved and cleared medical devices
APA Services, Inc., 2026

FDA clears transcranial magnetic stimulation (TMS) for youth, and a shorter version for adults
APA Services, Inc., 2025