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PERSPECTIVE/ PERSPETIVA

Transcranial Magnetic Stimulation and its Role in Restructuring Mental-Health Services

Estimulação Magnética Transcraniana e o seu Papel na Reestruturação dos Serviços de Saúde Mental

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INTRODUCTION

Transcranial magnetic stimulation (TMS) is a non-invasive neurostimulation technique increasingly used to treat treatment resistant depression (TRD) and obsessive compulsive disorder (OCD). There are further clinical approvals awaiting ongoing trials.[1]

Applying a magnetic field of variable intensity, waveform and frequency to specific cortical targets, TMS alters local excitability and induces long term plasticity in functional networks downstream from the stimulated target, allowing different approaches with distinct neuromodulatory and clinical characteristics and outcomes.[2,3]

TMS is also used for neurophysiological research, providing a non-invasive and easily accessible method to study brain connectivity, neuromodulatory changes, and conductivity, among others.[4,5]

The use of TMS in clinical practice requires a multidisciplinary team of trained professionals performing a diverse number of tasks pertaining to patient evaluation, treatment and follow-up.

As an emerging, cost effective treatment option for depression and other disorders, TMS is increasingly recognized in international guidelines and by health providers of both the public and private sector, through the creation of TMS units and teams as integrated strategies available to Psychiatry Departments and their patients.[6]

We share our experience in assembling the first TMS unit in Portugal's National Health System, in Hospital Magalhães Lemos (HML), in Porto, focusing on its structure, functional organization, treatment procedures and overall characterization, to provide a template for implementation of other similar units.

STRUCTURE AND FUNCTIONAL ORGANIZATION

Our team is composed by three Senior Psychiatrists, a Clinical Neuropsychologist, a group of collaborating Psychiatry Trainees and a mental health nursing team. It functions in Hospital Magalhães Lemos, in strict articulation with both the TRD outpatient consultation and the ECT unit.

Clinical Psychiatrists supervise the unit's functioning, treatment procedures and patient referrals, coordinating daily activity. They are also responsible for neurophysiological measurements, like assessing the motor threshold by using the targeting coil and electrophysiological monitoring.

Psychometric evaluations are applied by the team's Neuropsychologist in different moments during treatment, as established in our evaluation protocol.

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The Nursing team welcomes the patients, applies daily safety and adverse-effect questionnaires, and supervises vital signs before and after each treatment. With proper training, they can also double in the preparation of the patient and machine for treatment.

We use a MagPro® R30 (MagVenture, Denmark) stimulator, approved for treatment of TRD and OCD and also for diagnostic purposes.[7] It allows stimulation frequencies up to 30Hz and waveform modulation, and is compatible with different stimulation coils. We use a MagVenture CB-60 "butterfly" coil for target determination, and a Cool-B65 stimulation coil for treatment.

This equipment enables the use of rTMS (repetitive) and iTBS (intermittent Theta-Burst) protocols, used to treat depression, and cTMS (continuous) proposed as a treatment alternative for OCD. By applying pulses of triphasic waves at higher stimulation frequencies, iTBS decreases the time needed for a treatment session for Depression from 37 minutes (rTMS) to 3 minutes.[4] The recently approved protocol for treatment of OCD with the dTMS (deep) protocol, requires a different coil, the Cool D-B80 (Table 1).

One of the main advantages of TMS is its versatility, since there are currently studies using protocols for drug addiction, chronic pain, and stroke rehabilitation, among others. Future protocols and indications can easily be adjusted into the medical practice if they are within the technological capacity of the TMS machine being used. More complex protocols also allow neurophysiological study of patients like, e.g. differential diagnoses of types of dementia or psychosis.

This heralds the emergence of the sub-specialization called Intervention Psychiatry, allowing a more physical interaction with the patient and a deeper and more effective psychiatric intervention, bringing it to a full diagnostic, therapeutic and recovery capability similar to other medical specialities.

Table 1. FDA-approved treatment options using MagPro® R30

	iTBS	**rTMS**	**dTMS**
Frequency	50Hz triplet bursts repeated at 5Hz	10 Hz	20 Hz
Target	Left DLPFC	Left DLPFC	mPFC, ACC (bilaterally)
Pulse duration	2 seconds	4 seconds	2 seconds
Pause	8 seconds	11 seconds	20 seconds
Total pulses	600	3000	2000
Duration	3.15 minutes	18.43 minutes	18.33 minutes
Stimulus intensity	120% RMT	120% RMT	100% RMT
Indication	TRD	TRD	OCD
References	Blumberger *et al*, 2018	O'Reardon *et al*, 2007	Carmi *et al*, 2019
MagVenture coil	Cool-B65	Cool-B65	Cool D-B80

mPFC: dorsal medial prefrontal cortex; ACC: *nucleus accumbens*

PROCEDURES AND CHARACTERIZATION

Our unit is mainly oriented for the treatment of patients with TRD.

Patients are referred from inpatient or outpatient departments by their Psychiatrists, filling a proposal form focusing on current diagnosis, treatment, psychiatric and non-psychiatric history, and possible contraindications. These referrals are evaluated in multidisciplinary team meetings.

There is no specific preparations before treatment. However, it should be avoided in people with metal implants above the upper torso. Caution should be given to pregnant women, or patients with elevated risk for seizure, but only as a precautionary measure.

The first assessment is conducted by the Neuropsychologist and/or Psychiatrist, conducting a brief clinical interview and applying psychometric scales (Montreal Cognitive Assessment, Montgmorey-Asberg Depression Rating Scale, World Health Organization Quality Of Life-Bref, Personal Health Questionnary-9 and Clinical Global Impression).

The dorsolateral pre-frontal cortex (DLPFC) location is determined in the first session using the "5-cm method", in which the motor cortex is stimulated with the targeting coil until movement in the contralateral hand muscles (i.e. *abductor pollicis brevis*) is detected, and then measuring 5 cm anteriorly from this position along a parasagittal line, or using a specific adapter on the targeting coil. The resting motor threshold (RMT) is measured as the lowest stimulation intensity able, when applied to the motor cortex, to produce a visible motor response on the contralateral hand muscles (or to produce an evoked motor potential of at least 50 μV).[8]

Treatment consists of daily sessions during 4 weeks, after which patients are evaluated to assess continuation versus suspension of treatment. Patients with a MADRS score between 9 and 20 continue treatment for another 2 weeks; partial responders (MADRS > 20) should be individually assessed by the team to decide between continuation and suspension of treatment.

FUTURE INVESTMENT

Mental health services are being restructured, and TMS units provide a new model of psychiatric treatment. The main investment consists of acquiring machines with multipurpose capacities, thus amenable to new stimulation protocols. Evolution of TMS techniques can thus easily upgrade existing units without requiring new or better equipment.

TMS units are not hospital-dependent and can be transformed into outpatient or communitary treatment providers, facilitating the access to patients. iTBS protocols reduce treatment duration, making it an ideal ambulatory option. Furthermore, the patient can schedule treatments according to his or her time availability, freeing personal time for other duties.

It is also a safe non-pharmacological option, with few side-effects, that can be used as a first treatment option. It can be used in special populations, including pregnant women, and offers an alternative for problems with fewer solutions, like OCD or drug and tobacco use (Table 2).

Table 2. Therapeutic indications for TMS

Major Depressive Disorder	**Approved protocols (HF-rTMS and iTBS) as second-line treatment.**
Bipolar disorder	Third line in the acute treatment of manic episodes or as an adjunct to depressive episodes.
Anxiety disorders, trauma and stress factors	No formal indication. Studies suggest efficacy in the treatment of GAD. Studies suggest efficacy in the treatment of PTSD.
Obsessive-compulsive disorder	rTMS and dTMS approved for adjuvant treatment if drug resistant.
Schizophrenia	No formal indication. Studies suggest efficacy in the treatment of verbal auditory hallucinations and negative symptoms.
Neurocognitive disorders	No formal indication. Studies suggest positive effects in improving cognition in AD. Case reports suggest potential in the treatment of behavioral symptoms.
Catatonia	No formal indication. Studies suggest efficacy in the acute treatment of mild cases in the maintenance treatment of catatonia due to schizophrenia
Drug-induced movement disorders	No formal approval. Cases refractory to initial measures in late syndromes.
Pediatric age	Without formal indication.

AD: Alzheimer's disease. dTBS: deep TMS. iTBS: intermittent theta burst stimulation. HFL-rTMS: High frequency rTMS. GAD: generalized anxiety disorder. rTMS: Repeated TMS. PTSD: post traumatic stress disorder

Adapted from: Mota J, Frias Gonçalves P, Sousa Martins P. Tratamentos Somáticos Em Psiquiatria. Lisboa: Viatris; 2022.[3]

CONCLUSION

TMS is a multimodal, multifaceted neurostimulation technique, capable of delivering treatment for diverse psychiatric disorders in an easy, safe, and convenient way. Future clinical applications will be reviewed in the coming years, namely protocols for nicotine and other addictions, ADHD, and new protocols for OCD.

Thus, at the present crossroad in mental health services reorganization, TMS presents a perfect opportunity for a better, effective, ambulatory, non-stigmatized, non-hospital, non-expensive and cost-effective option of treatment, that could easily be structured into both old and new health-service providers.

Declaração de Contribuição

PFG e JM: Concepção do manuscrito, colheita e análise de dados e referências, escrita do manuscrito
PSM: Colheita e análise de dados e referências, escrita do manuscrito
EP,SF e FC: Revisão e escrita do manuscrito

Contributorship Statement

PFG and JM: Manuscript conceptualization, data and reference collection and analysis, manuscript writing
PSM: data and reference collection and analysis, manuscript writing
EP,SF and FC: Manuscript writing and reviewing

Responsabilidades Éticas

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