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Telemedical Deep Brain Stimulation: Merits and Limitations

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Deep brain stimulation (DBS) is a well-established treatment for patients with certain chronic disabling neurologic or psychiatric disorders, such as Parkinson's disease (PD) and obsessive-compulsive disorder (OCD) [1]. The prerequisites of successful DBS therapy include accurate diagnosis, precise implantation of the DBS electrode, and optimal postsurgical DBS programming [2]. After surgery, several extensive programming sessions are needed to identify the optimal stimulation parameters for the individual patient. The success of the programming sessions is primarily dependent on the programmer's experience. Consequently, patients are often confronted with inefficient stimulation changes as well as with unnecessary visits. Furthermore, timely and efficient programming is especially challenging to achieve for patients from remote areas.

Telemedicine is widely used in public health care to increase patient access to specialty care and has been found effective in managing chronic diseases such as cardiovascular disease [3] and diabetes [4]. Patients with PD who are eligible for DBS typically experience mobility difficulties and require constant care. It would be desirable if patients could only travel to a specialized center for surgery while completing other visits and assessments in their respective communities [5].

Web-based remote wireless DBS programming systems, provided by two DBS manufacturers (PINS and SceneRay), are currently applied to patient care in many hospitals in China. These telemedical DBS systems have been described in previous reports [6, 7]. Briefly, parameter adjustments can be delivered via a Bluetooth-enabled dedicated device or mobile smartphone, to patients in their home environment or local hospital, while the control of the DBS programming is taking place at a distance using a computer at a potentially remote medical service center (Fig. 1). For the model of remote medical service centers and local hospitals, the local neurologist can assess changes in rigidity in response to DBS and adjust anti-PD drugs accordingly. Remote medical service officials serve as disease and DBS consultants and adjust the DBS parameters according to the video/audio of symptoms, such as dyskinesia and gait impairment. Another model consists of remote medical service centers and patients at home. In psychiatric patients, immediate changes in mood, anxiety, energy, and obsessive-compulsive behaviors following DBS adjustment are often unnoticeable, and weekly or biweekly programming continues for several months [8]. This model is especially beneficial for patients with certain types of severe OCD, such as checking or ordering, wherein patients experience extreme difficulties in leaving their homes.

The telemedical approach to DBS in practice primarily involves parameter adjustments (e.g., adjustment to contact selection, voltage, frequency, or pulse width), battery status check, and device troubleshooting (e.g., accidental shutdowns). To date, no remote-specific severe events have been reported. Electromagnetic interference or network instability may cause communication errors, yet previous DBS parameters are retained on these occasions. Careful attention should be devoted to the emergence of possible side effects, such as increased dyskinesia and speech difficulties. The presence of side effects, though reversible, should be addressed promptly to determine whether they could be resolved by DBS parameter adjustments. There are also theoretical network security risks, but this issue has not yet been reported.

Based on the evidence from real-world clinical practice, the merits of telemedical DBS can be summarized as follows: (1) improved patient access to DBS treatment, when patients are treated in their own home environment, precluding frequent visits to a remote hospital with DBS treatment facilities and expertise; (2) specialists can assess and monitor the patient in real-time; (3) clear practical advantages for patients and their families, including reduced travel time and costs; (4) this technology also has potential in delivering cognitive-behavioral therapy as addition for patients with OCD after DBS [9]. However, a current disadvantage of telemedical DBS is that the adjustments and fine tuning of the DBS programming parameters are more time-consuming and laborious than the corresponding programming session completed face to face.

Lastly, we describe a 36-year-old male patient who had suffered from intractable OCD for 20 years. The patient underwent ventral striatum/ventral capsule (VC/VS) DBS (Model 1242, SceneRay, Suzhou, China). This case study was approved by the local ethics committee, and the patient provided informed consent to participation and anonymous data publication. Following DBS surgery, clinical outcome assessments were performed after 3 months via telemedicine and after 6 months in person. The patient completed all post-surgery programming via the Internet, except a threshold check session conducted in a hospital. Programming followed an established algorithm, which has been developed and used by clinicians at the Academic Medical Centre of the University of Amsterdam: start with 3.5 V, 90 us, 130 Hz, case+, contacts 1–2– (+ anode, – cathode), contacts 5–6– and end up after 4-month adjustment at 5.5 V, 210 us, 130 Hz, case+, contacts 1–2–, contacts 5–6–. The patient was followed up using well-established clinical outcome measures, including the Yale-Brown Obsessive-Compulsive Scale (YBOCS)-II, Obsessive-Compulsive Inventory-Revised (OCIR), and the Hamilton Depres-

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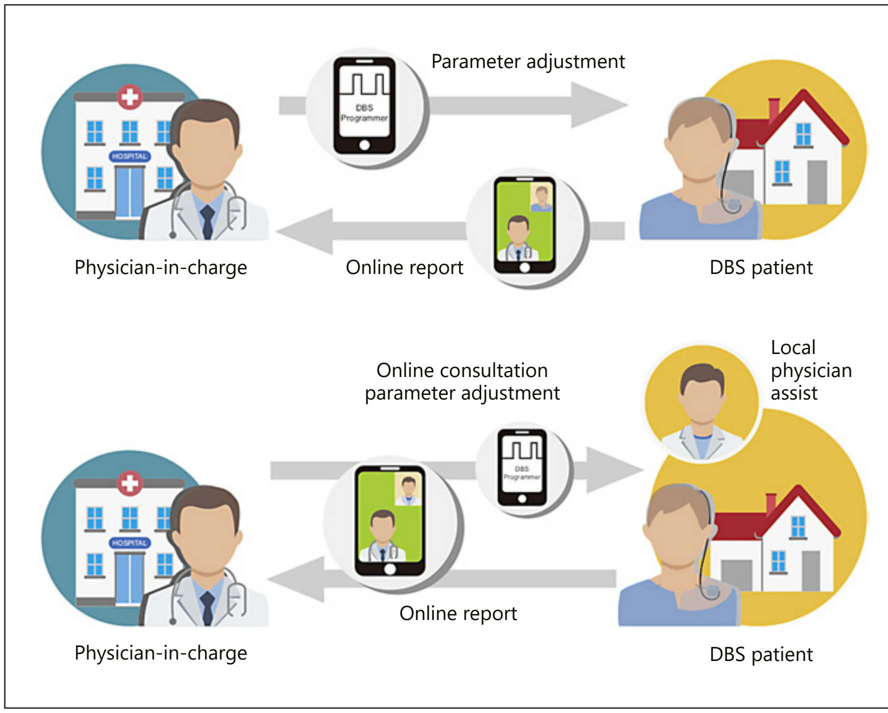

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Fig. 1. Telemedical DBS schema graph.

sion/Anxiety Rating Scale (HDRS/HARS). Other outcome measures included neurocognitive function, sleep quality, and quality of life.

At the 6-month follow-up, the patient showed a marked improvement in the severity of OCD symptoms, as reflected by a 43% reduction in the YBOCS-II score (42 at baseline vs. 24 at follow-up) and a 38% reduction in the OCIR score (21 at baseline vs. 13 at follow-up). Moreover, the patient displayed a 79% reduction in symptoms of depression (HDRS score of 14 at baseline vs. 3 at follow-up) and a 32% reduction in anxiety (HARS score of 22 at baseline vs. 15 at follow-up). Some aspects of neurocognitive function of the patient were also improved, such as psychomotor function, visual processing, and working memory. However, other aspects of neurocognitive function, such as attention and executive function, were not affected or slightly impaired. To our knowledge, this is the first case of OCD who has been successfully treated using telemedical DBS, without any telemedicine-related adverse events.

In conclusion, telemedical DBS is a new therapeutic approach that makes DBS treatment more accessible and convenient. In the future, it will be necessary to integrate objective qualitative monitoring of symptoms with telemedical DBS to supply the programmer with information and to record disease progress. Yet, telemedicine as currently practiced is still in its infancy, additional work is required to fulfill its promise.

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References

1 Okun MS. Deep-brain stimulation — entering the era of human neural-network modulation. N Engl J Med. 2014;363:1–3.
2 Ramirez-Zamora A, Ostrem JL. Globus pallidus interna or subthalamic nucleus deep brain stimulation for Parkinson disease: a review. JAMA Neurol. 2018 Mar;75(3):367–72.
3 Purcell R, McInnes S, Halcomb EJ. Telemonitoring can assist in managing cardiovascular disease in primary care: a systematic review of systematic reviews. BMC Fam Pract. 2014 Mar;15(1):43.
4 Pal K, Eastwood SV, Michie S, Farmer A, Barnard ML, Peacock R, et al. Computer-based interventions to improve self-management in adults with type 2 diabetes: a systematic review and meta-analysis. Diabetes Care. 2014 Jun;37(6):1759–66.
5 Achey M, Aldred JL, Aljehani N, Bloem BR, Biglan KM, Chan P, et al.; International Parkinson and Movement Disorder Society Telemedicine Task Force. The past, present, and future of telemedicine for Parkinson's disease. Mov Disord. 2014 Jun;29(7):871–83.
6 Chen Y, Hao H, Chen H, Li L. The study on a telemedicine interaction mode for Deep Brain Stimulation postoperative follow-up. Proc Annu Int Conf IEEE Eng Med Biol Soc EMBS 2015;2015–Novem:186–9. doi:
7 Zhang C, Li D, Zeljic K, Tan H, Ning Y, Sun B. A Remote and Wireless Deep Brain Stimulation Programming System. Neuromodulation. 2016 Jun;19(4):437–9.
8 Bais M, Figee M, Denys D. Neuromodulation in obsessive-compulsive disorder. Psychiatr Clin North Am. 2014 Sep;37(3):393–413.
9 Mantione M, Nieman DH, Figee M, Denys D. Cognitive-behavioural therapy augments the effects of deep brain stimulation in obsessive-compulsive disorder. Psychol Med. 2014 Dec;44(16):3515–22.