Implementation of a Novel Bluetooth Technology for Remote Deep Brain Stimulation Programming: The Pre– and Post–COVID-19 Beijing Experience

In light of the COVID-19 pandemic, telemedicine has emerged as the ideal methodology for care provision. Crisis care includes those infected with COVID-19; however, the majority of the need lies with the "uninfected." The "unaffected" have in many cases been cut off from usual healthcare services as a result of social distancing, quarantines, and lockdowns.[1] In China, during the past 2 decades, deep brain stimulation (DBS) has emerged as an innovative treatment option for more than 20,000 patients with various movement disorders. These cases require complex device programming and management.[2,3] The China experience in overcoming the technological challenges of remote device adjustment prior to and during the current crisis will be important for moving the field forward.

Since 2014, Chinese engineers and clinicians have been developing and implementing a unique secure web-based remote wireless programming system for DBS (Fig. 1). This system was approved by the National Medical Products Administration (Chinese administration for drug and medical instruments) in 2017.[4] In addition, the virtual telehealth care center implemented a unique teleprogramming system in 2019. The complete system is regulated and supervised by the National Health Commission and is composed of 160 licensed providers.

Since December 2019, a total of 2126 telemedicine visits have been performed for 819 patients with movement disorders. These experiences have been drawn from 33 "lockdown" Chinese provinces. Among these, 1256 teleprograming visits have been performed on 589 cases (289 men and 300 women with a mean age of 58.3 ± 13.6 years). All cases were unique DBS implants in different patients. There were 426 Parkinson's disease cases, 159 dystonia cases, and 4 essential tremor cases from the lockdown area. In total, these cases had a mean travel distance to Beijing of 1141 km ± 825 km. Among these, 487 patients had a subthalamic nucleus DBS implant, 98 cases had a globus pallidus internus DBS implant, and 4 had a ventralis intermedius thalamic DBS implant. The battery status and electrical integrity of the system could be checked remotely utilizing this system (100% of the patients underwent this check). Specific DBS programming was also pursued in many cases. There were 402 patients who underwent voltage adjustments, 192 who had pulse width changes, 181 with frequency adjustments, and 129 who had the "activated" contacts on the DBS lead switched. The medications were optimized in 386 cases. Overall, teleprogramming adjustments resulted in transient mild dysarthria in 25 cases and in transient dizziness in 38 patients. These side effects were identified and managed through the Chinese remote programming system.

There were 13 Parkinson's disease patients with freezing of gait who were able to be programmed with a complex variable frequency stimulation (VFS) adjustment. VFS is a novel

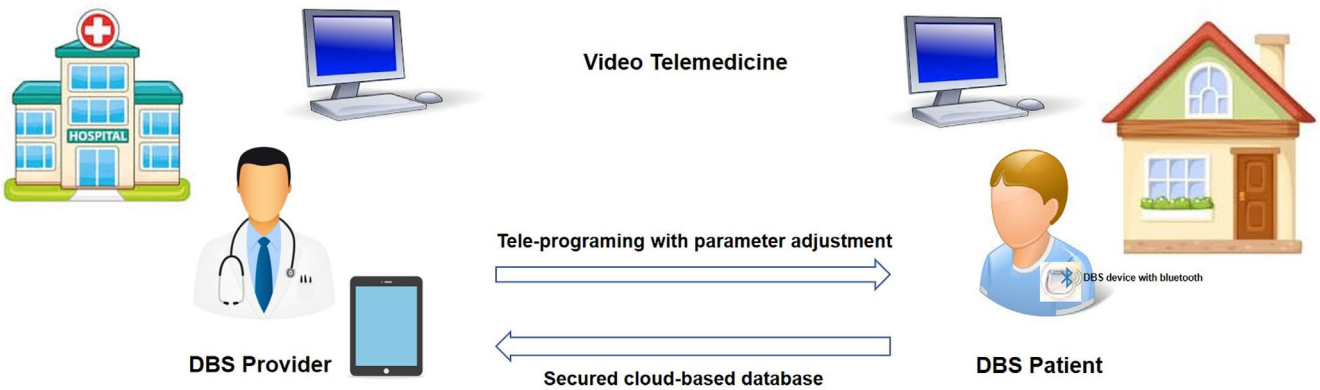

FIG. 1. Remote deep brain stimulation (DBS) teleprogramming schema graph. Video telemedicine is used to evaluate disease symptoms and medication adjustments. A teleprograming DBS system can remotely adjust the parameters via a novel bluetooth technology by a provider. The notes from every encounter can be uploaded to a secured cloud-based database and be accessed by any provider. [Color figure can be viewed at wileyonlinelibrary.com]

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DBS paradigm used to combine varying patterns of both high-DBS and low-DBS frequencies. VFS delivers stimulation to the same DBS contact and was recently shown by a Beijing-based study to potentially improve axial and appendicular motor symptoms.[5] Because many patients in China participated in this VFS study, it was important that teleprogramming could be utilized for their ongoing management. Overall, teleprogramming adjustments resulted in transient mild dysarthria in 25 cases and in transient dizziness in 38 cases. These side effects were identified and managed by clinicians through the remote programming system.

We conclude that timely and efficient programming can be safely achieved by a remote teleprogramming system. The novel Bluetooth-enabled technology is simple and can potentially be shared with other centers. Furthermore, this remote programming option represents a promising approach that may be applied to other implantable medical devices, including spinal cord stimulators, insulin pumps, and pacemakers. We speculate that this approach will reshape DBS management.

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