

# Domiciliary tDCS in Geriatric Psychiatric Disorders: Opportunities and Challenges

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The population of older adults in India was 8.6% of 1.2 billion, which translates to 103.8 million as per the 2011 census.<sup>1</sup> The steady decadal growth in the older-adult population poses several challenges for geriatric mental healthcare services. The National Mental Health Survey (NMHS, 2016)<sup>2</sup> reported that the lifetime prevalence of mental morbidity among older adults was 15.1%. The treatment gap for any mental health disorder in the general population is reported to be 83%.<sup>2</sup> This gap is likely to be higher in older adults. Even in those seeking treatment, there are many challenges in ensuring effective treatment for geriatric mental health problems.

The pharmacological management of mental health problems poses various challenges in older adults. Some of the critical factors contributing to these challenges are increased propensity for cognitive impairment, drug interactions, hyponatremia, falls, bradycardia, and treatment resistance and increased mortality risk.<sup>3</sup> The efficacy of

antidepressants for depression in dementia is still unclear.<sup>4-6</sup> However, the available evidence indicates that the studies are limited in number and heterogeneous to form a conclusion on the efficacy or the lack of it.<sup>7</sup>



Real-world implementation of non-pharmacological interventions for the behavioral and psychological symptoms of dementia is limited by the therapist's availability, willingness of the patient and family to participate, cognitive issues, sensory impairment, and financial issues.<sup>8</sup> COVID-19 pandemic has further complicated healthcare delivery for older adults.<sup>9</sup> Older adults suffering from chronic health conditions are probably the most affected as they seem to be stuck in a quagmire of risk of illness relapse plus the risk of contracting COVID-19 while accessing healthcare.<sup>10</sup> Older adults also represent an essential cohort in clinical research, given their multiple comorbidities. Hence, there is a need for safe and effective treatment options that are also cost-effective.

Transcranial direct current stimulation (tDCS) is emerging as a potential treatment option for depression, cognitive impairment, and auditory hallucinations in older adults. The possibility of promoting neuroplasticity through tDCS without any significant adverse

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effects has encouraged evaluation of the effectiveness of tDCS for many clinical indications in older adults with mental health problems. Ethical concerns related to administering tDCS (an intervention with low risk) in cognitively impaired older adults can be addressed by following the safeguards mandated for clinical trials assessing low-risk interventions.<sup>11</sup> However, the requirement for multiple sessions to ensure sustained effects is one of the crucial challenges for clinical research in this area. The possibility of domiciliary tDCS supported by technology for remote administration and telemonitoring provides the opportunity to continue research on tDCS for geriatric mental health conditions. This article attempts to evaluate the scope and challenges related to domiciliary tDCS to treat geriatric mental health conditions in the global and Indian contexts.

## Role of Transcranial Direct Current Stimulation (tDCS) in Geriatric Mental Health

Depression and neurocognitive disorders are the most common mental health problems in older adults.<sup>12</sup> Subsyndromal depression and cognitive impairment are common. They require intervention to prevent the adverse impact on quality of life and the negative effects on coexisting medical conditions. Over the last two decades, noninvasive brain stimulation (NIBS) has proven efficacious in managing the symptoms of mental illnesses that are not amenable to routine management strategies such as pharmacological and psychological interventions. The same has been evidenced in older adults to accelerate symptom remission as an independent intervention or an augmentation strategy.<sup>13-15</sup> NIBS includes repetitive transcranial magnetic stimulation (rTMS), and transcranial electrical stimulation (tES). Each of these differs in operability, efficacy, and safety.

Over recent years, tDCS (a type of tES) is evolving as a potential treatment modality for neurocognitive disorders and depression. It acts by creating a subthreshold modulation of neuronal membrane potentials, thereby altering cortical excitability and activity. In this regard, tDCS is different from TMS in that it does not induce a massive synchronized neuronal discharge;

instead, it changes the threshold and thus the likelihood of discharge. Apart from this, it also has other biological effects like changes in neurotransmitters, effects on glial cells and microvessels, and modulation of inflammatory processes.<sup>16</sup> The re-emergence of tDCS as a potential neuromodulatory treatment modality emerged following seminal studies by Priori et al., Nitsche, and Paulus.<sup>17,18</sup> In mild cognitive impairment (MCI) and Alzheimer's dementia, preliminary evidence suggests the efficacy of tDCS in cognitive symptoms, with uncertain efficacy over behavioral and psychological symptoms.<sup>15</sup> Concomitant cognitive interventions, like memory training and language training, have demonstrated an additional benefit.<sup>19,20</sup> Because tDCS works by altering the resting membrane potential rather than evoking an action potential, multiple sessions over a more extended period may be required. A recent study has indicated the effectiveness of tDCS in treatment-resistant vascular depression.<sup>21</sup> There are also reports of tDCS as a potential intervention for apathy, insomnia, alcohol dependence, etc.<sup>22-24</sup> Hence tDCS can be a potentially useful intervention for older adults with neuropsychiatric conditions.

## Critical Appraisal of Domiciliary tDCS in General and in the Context of Geriatric Mental Health

The evidence for the role of tDCS in various neuropsychiatric disorders is continuing to grow. However, the evidence from short-term studies of tDCS may not be enough to conclude about its effectiveness in chronic conditions like neurocognitive disorders. There is a need to evaluate the effectiveness of the longer course of tDCS possibly delivered as domiciliary treatment with or without supervision (remotely supervised or preprogrammed).<sup>25</sup> This becomes increasingly relevant for geriatric mental health conditions, particularly in the context of COVID-19, as there is a need for precautions to avoid high-risk exposure in hospital settings. There is increasing evidence for the cumulative neurobehavioral changes following daily tDCS.<sup>26</sup> Targeted functional neuromodulation through the use of weak intensity current, with or without a behavior-based treatment

approach, offers a unique opportunity to capitalize on the translational aspects of neuroscience research in aging, disease, and rehabilitation.<sup>27</sup>

## Advantages of Domiciliary tDCS

1. **Improving treatment adherence:** The critical challenge in treating several psychiatric disorders includes the lack of adherence.<sup>28,29</sup> tDCS can be delivered at home by a trained family caregiver and can be supervised remotely to promote adherence and positively impact health outcomes.
2. **Acceptability:** Treatment delivered at home for psychogeriatric illnesses leads to improved psychosocial well-being, a better quality of life, fewer symptoms, better patient engagement,<sup>30</sup> and reduced expenditure. The unique additional advantage of domiciliary tDCS includes overcoming the mobility barrier.
3. **Tolerability:** tDCS is better tolerated than ECT and rTMS. The established safety profile for tDCS<sup>31-33</sup> makes it a promising treatment option in the psychogeriatric population. There is almost no propensity of seizures with tDCS, and its safety has been proven in adult patients. There is emerging evidence to suggest a good tolerability profile in the geriatric population.<sup>34</sup>
4. **Portability:** The relatively compact nature of tDCS devices makes it easy to transport the tDCS device and use it at home. This is not the case with other established neuromodulatory techniques such as ECT and rTMS.
5. **Cost-effectiveness:** Health economics, including the cost of treatment in psychiatric disorders, is a crucial determining factor in continued patient engagement and favorable outcomes in treating mental illnesses.<sup>35</sup> tDCS has a definitive favorable cost-utility profile when compared to different neuromodulatory techniques.<sup>36-38</sup> However, the cost-effectiveness as compared to pharmacotherapy requires further systematic evaluation.<sup>39</sup>
6. **Long-term benefits:** When it comes to domiciliary tDCS, the phrase "the more—the better" may hold true. There is evidence to suggest improved efficacy with long-term tDCS.<sup>40,41</sup> This stems from research supporting the efficacy via putative mechanisms

related to long-term potentiation and neuroplasticity.<sup>42</sup> Continuous and repeated tDCS may, therefore, hold the key to the treatment of chronic neurodegenerative illnesses. Domiciliary tDCS offers a unique advantage in terms of its potential for continued long-term use and translation into long-term benefits.

## Limitations of Domiciliary tDCS and Possible Solutions

We discuss the potential limitations of domiciliary tDCS and propose a few strategies to overcome these challenges.

1. **Training and safety:** Although simple to administer, tDCS delivery by a caregiver requires training under personal supervision, followed by remote supervision, to ensure safe administration of tDCS. A standard protocol for training and safe administration of domiciliary tDCS needs to be developed and validated.<sup>43</sup>
2. **Fidelity monitoring and supervision:** Perhaps the most significant challenge to domiciliary tDCS stems from the fact that for tDCS to be effective, the correct technique during the administration of tDCS is essential. This technique includes choosing appropriate electrodes, the intensity of stimulation, montage placement, and the prevention of effortful motor or cognitive activity during stimulation. There should also be adequate contact of the electrode-holding pouches with the cortical surface. There are two ways to ensure fidelity of tDCS delivery—remote supervision and the use of preprogrammed devices. Remote supervision involves the healthcare provider supervising the delivery of tDCS via video conference at the time of stimulation. Preprogrammed devices offer the advantage of setting the stimulus duration and intensity beforehand. If there is also a headgear with prepositioned electrodes, it is likely to promote safety in caregiver administration of domiciliary tDCS. Also, regular supervision for adverse effects is essential so that the healthcare provider can be contacted if needed.
3. **Potential for misuse:** There has been a growing body of evidence cautioning against the use of “Do It Yourself (DIY)” tDCS and abuse of tDCS,

given its potential “misuse” for cognitive/performance enhancement. Although excess caution in this respect can lead to decreased utilization of domiciliary tDCS, the healthcare providers have to be careful about such a possibility. This can be overcome by either the device being unlocked by the healthcare providers for each administration session using preprogrammed codes or the devices being remotely controlled for stimulus delivery. Additionally, the device can be programmed to digitally upload a data file with details of its use (dates that the device was accessed, stimulus parameters changed, duration of stimulation, etc.), with the option of a GPS facility to track the geographic location of the device.

4. **Managing adverse effects:** tDCS is a relatively safe method of neuromodulation.<sup>32</sup> However, there are several adverse effects of tDCS, most notable being local skin irritation, unpleasant sensations, headache, and cutaneous lesions. Although these may fall under the rubric of benign or mild adverse effects, they can lead to decreased adherence and increased caregiver/patient anxiety unless managed effectively. This can be effectively managed by psychoeducation before the onset of the treatment, continued supervision, timely reassurance, periodic in-person follow-up visits, and prompt intervention in case of any dangerous adverse effects.
5. **Device procurement and legal challenges:** This brings us to the fundamental question regarding the nature of the device to be recommended and the logistics of its procurement and standardization. This is partly due to the lack of large-scale level I evidence for tDCS and potential misuse concerns. The unlicensed and untested devices available in the e-commerce sector and DIY tDCS are neither safe nor recommended for use.

A minimum standard may be specified that ensures impedance monitoring, user-friendly application, dosing assurance, and safety.<sup>44</sup> The next question that arises is regarding the cost feasibility of purchasing a standard tDCS device. This cost includes the cost of purchasing such a standardized device and shipping across international waters. There is a pressing need to develop and

cross-validate (with standard devices) indigenously developed tDCS devices that pass through the rigorous safety standards, similar to the indigenous adaptation done for other such devices. Such devices can then be manufactured, assembled, and maintained by agencies in liaison with regulatory authorities to reduce costs substantially.<sup>45</sup>

## tDCS in Geriatric Psychiatric Disorders—The Indian Experience

There is preliminary evidence for tDCS in geriatric mental health from a few case reports and an open-label study. There is a need for more systematic, controlled studies. Published and unpublished data on the clinical applications of tDCS to date shows encouraging findings. An open-label trial of tDCS in patients with MCI reported that in addition to better tolerability, there was a significant improvement in immediate and delayed recall on the picture memory impairment test after 5 days of tDCS and that most effects were sustained at 1-month follow-up.<sup>34</sup> A case report on tDCS targeting apathy in a patient with frontotemporal dementia demonstrated an initial improvement that sustained for 7 months.<sup>22</sup> Another case series in which two patients, one with Alzheimer’s dementia and another with dementia with Lewy bodies, both presenting with auditory hallucinations, who received ten sessions of high definition tDCS, cathodal stimulation over the left temporoparietal junction, reported improvement in the auditory hallucinations following the completion of the sessions.<sup>46</sup> Domiciliary tDCS over 3 months in a 66-year-old case of schizophrenia with refractory auditory hallucinations has been reported to result in a subjective reduction in hallucinations by up to 95%.<sup>47</sup> Another unpublished case report of a patient with a semantic variant of primary progressive aphasia (svPPA) where the patient underwent multiple, intermittent booster tDCS sessions over 2 years, with concomitant language training, demonstrated incremental benefits over subsequent sessions with regard to language, which were sustained for a year, followed by a plateauing of response. In a series of four cases where tDCS was administered with concomitant language training for svPPA, the Western Aphasia



Battery scores demonstrated improvement after completing the sessions.<sup>48</sup> The safety of tDCS has also been evidenced from the published data of over 2000 sessions in 171 patients who received tDCS for various indications. The population was inclusive of 12 older adults. Notably, this study found that tolerability was similar in those receiving five or ten sessions, and there was no significant difference in adverse effects between true and sham stimulation.<sup>32</sup>

## Evidence for Domiciliary tDCS in Older Adults

A few studies have examined the efficacy and safety of domiciliary tDCS in older adults. The indications for which domiciliary tDCS was tried include cerebrovascular accident and ensuing motor or sensory weakness,<sup>27,40</sup> tinnitus,<sup>49</sup> coma,<sup>50</sup> amyotrophic lateral sclerosis,<sup>51</sup> osteoarthritis,<sup>49-51</sup> Mal de débarquement syndrome,<sup>52</sup> and depression.<sup>53</sup> Significant efficacy for active domiciliary tDCS (over sham tDCS wherever applicable) was noted in rocking perception, anxiety, arousability, pain, and depression. None of the studies reported any significant adverse effects, which is reassuring. Majority of the studies involved tDCS administration by self or the caregiver. A randomized, double-blind, sham-controlled tDCS study done over 6 months in mild Alzheimer's dementia found that tDCS administration over the long-term can be feasible, safe, and effective in improving global cognition, language, and executive function. Among 20 recruits, 2 had dropped out. However, considering the long duration of the intervention, the participant adherence is noteworthy.<sup>52</sup> Another factor that could have aided adherence is the at-home administration of tDCS following the initial in-hospital sessions. This option of at-home/domiciliary administration substantiates the advantage of tDCS over other NIBS modalities in terms of operability. Especially in the case of frail older adults, whose primary caregivers most of the time are their spouses, this can help to overcome the barriers in accessing health-care services.

## Take-Home Message from Available Studies

It is prudent to note that domiciliary tDCS may be used safely in the geriatric popula-

tion, provided at least open-label studies report efficacy for the clinical indication. The safety features used and steps taken by some of the previous researchers to promote ease of administration suggest the following key take-home points.

1. One or more in-person training sessions to be conducted for the patient or the caregiver to explain the correct administrative procedure (with or without an assessment procedure to evaluate the efficacy of the training).
2. Identification of an appropriately customized headgear with prefixed or marked positions for the electrodes, which are color-coded.
3. Stimulation parameters preprogrammed into the tDCS device, which could be additionally programmed to unlock only with codes available with the administrator
4. A manual (and a video demonstration) to be handed over to the patient and the relatives with details of the device. This manual should include safety features like information about adverse effects, emergency contact, and troubleshooting.
5. Remote supervision by the clinical or research team to ensure correct administration and evaluation for adverse effects.

## Challenges and Opportunities for Domiciliary tDCS in India

The telepsychiatry operational guidelines published recently has received a good response from the service providers across India.<sup>53</sup> Guidelines for telepsychotherapy have also been formulated. This has opened new avenues for equitable mental health care. There is emerging evidence for the utility of geriatric telepsychiatry.<sup>54,55</sup> As discussed above, telepsychiatry has a prominent role in remotely supervised tDCS.

There are challenges, nonetheless. In addition to the challenges specific to tDCS discussed above, certain factors are unique to India, impeding the progress of research and practice of domiciliary tDCS. The foremost of them is probably digital literacy. This has implications on multiple fronts ranging from a simple task of making calls on the mobile phone to using the tDCS device unsupervised or remotely supervised. A few nongovernmental organizations have published surveys on older

adults' digital literacy in India and conducted digital literacy programs.<sup>56</sup> The next important factor is the time to diagnosis. As much as "the more, the better" holds true for tDCS, it may also be "the sooner, the better." However, the heterogeneity of presentation confounds the diagnosis and treatment, thereby causing a delay in administering an appropriate intervention.<sup>1</sup> That said, there is also an advantage owing to the ethos of "family values," which is prominent in India. This can be used to its advantage.

The available data on the economic benefits of telepsychiatry can be extrapolated to domiciliary tDCS also.<sup>57</sup> Issues of accessibility, availability, and affordability of geriatric mental health services remain a significant challenge in the Indian scenario, particularly for those living in rural areas. Effective implementation and integration of geriatric mental health care in the District Mental Health Programme and the National Programme for the Health Care of the Elderly is essential to improve access to treatment and reduce the treatment gap in the future. If sufficient evidence is available for the clinical effectiveness of tDCS, a similar approach can be adapted to promote access to domiciliary tDCS for older adults in rural India.<sup>58-60</sup> The COVID-19 pandemic has created additional challenges. Domiciliary tDCS can offer an expedient solution in bridging this gap to some extent.<sup>61</sup> An indigenous tDCS device is being developed at the National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru. Such a device, fulfilling all the safety regulations and certification of the same, would reduce the import cost and enhance the feasibility of domiciliary tDCS. Clinical Research Centre for Neuromodulation in Psychiatry has been recently initiated with the support of the Department of Biotechnology, Wellcome Trust India Alliance.<sup>62</sup> This multi-institutional research program (NIMHANS, Central Institute of Psychiatry (Ranchi) and Kasturba Medical College (Manipal)) would further strengthen the research on domiciliary applications for psychiatric conditions and would disseminate these skills to clinical researchers and practitioners across the country.

## Conclusion

tDCS is one of the evolving somatic treatments for older adults. There is

emerging research from other countries on the feasibility and safety of domiciliary tDCS in older adults. In India, there is a role for domiciliary tDCS, which can be delivered using telepsychiatry with appropriate training and family caregivers' supervision. The available evidence demonstrates a favorable safety profile. There is preliminary evidence to support the efficacy, too. Further clinical trials are required to determine the effectiveness and feasibility of domiciliary tDCS.

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