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SPATIAL NEGLECT: AN OVERVIEW OF ASSESSMENT, REHABILITATION METHODS, AND CHALLENGES ENCOUNTERED IN CLINICAL PRACTICE

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ABSTRACT

Spatial neglect is a syndrome that stems from damage to brain regions that are critical for spatial attention and most commonly occurs post-stroke. Spatial neglect causes a lack of awareness of the contralesional space, affecting sensory perception, motor function, and daily life activities. Conventional paper-and-pencil tasks, the Behavioral Inattention Test, the Catherine Bergego Scale, and the Kessler Foundation Neglect Assessment Process, are the assessment methods used in clinical practice to detect spatial neglect and its impact on functional performance. Rehabilitation strategies, such as prismatic adaptation, non-invasive brain stimulation, and virtual reality, are considered to be promising methods. This review proposes that using a single assessment and a single treatment method still is not ultimately effective. Hence, combining different rehabilitation methods, as well as exploring the potential of artificial intelligence as an assessment and rehabilitation strategy may provide optimized outcomes. In order to overcome the current limitations and remove the ambiguity of long-term results, conducting future randomized controlled trials are critical.

Keywords: Functional status, perceptual disorders, rehabilitation, stroke

INTRODUCTION

Spatial neglect is a syndrome that stems from damage to brain regions critical for spatial attention (1-3). It manifests as a lack of awareness of the contralesional space, which cannot be explained by primary sensory or motor deficits (4, 5). Regardless of diagnostic methodology, time since post-stroke, or location of the lesion in the brain, the prevalence of spatial neglect after unilateral stroke is estimated to be 30% (6).

Common clinical features of patients with spatial neglect encompass failure to respond to stimuli from the contralesional side, reduced movements towards the contralesional side, and diminished use of their contralesional limbs. Patients may be unable to report stimuli on the contralesional side of space, and their body posture may also deviate towards the ipsilesional side (7-10). Some neglect behaviors may manifest during their daily life routine, such as not being aware of voices arising from the neglected side of the patient, leaving food uneaten on one side of the plate, shaving only one side of their face, and colliding with obstacles on one side (11). These impairments result in patients being more dependent on their daily life activities.

Spatial neglect is more common and more severe in patients with right brain damage than in patients with left brain damage. The severity may be attributed to the fact that neural networks of spatial attention predominantly reside in the right brain hemisphere (2, 6, 7, 12-14). However, spatial neglect after left brain damage is still quite common, with a prevalence of approximately 20% (6). The neglected space may be close to the patient or on their body (personal space), in their arm's reach (peripersonal space), or beyond their arm's reach (extrapersonal space) (8, 15, 16).

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Assessment of Neglect

Paper-and-pencil tasks: The line bisection and cancellation tasks are two of the most commonly used paper-and-pencil assessments for spatial neglect (17-19). In the line bisection test, the patient is asked to mark the midpoint of a horizontal line (18). In the cancellation task, the patient is required to search for spatially distributed targets (19). Several cancellation task variations exist, such as the letter cancellation task, the bells test, the Behavioral Inattention Test (BIT) letter cancellation, the star cancellation, and Ota's cancellation task (20-23). Despite their widespread use in clinical practice, these assessment tests do not adequately reflect functional performance in daily life activities and may underdiagnose the proprioceptive, auditory, or motor-intentional components of neglect (24).

The Catherine Bergego Scale (the CBS): The CBS is a functional assessment tool designed to identify spatial neglect-related impairments that may interrupt neglect patients' performance of everyday chores and compromise their safety (25). The scale aims to evaluate neglect-related disability in daily life by assessing the patient's asymmetric functional body movements (26). During the assessment, patients perform daily life tasks for approximately 15-20 minutes under professional examination (27).

The CBS inclusively assesses the functional performance of the suspected neglect patient in personal (body surface), peripersonal (within arm's reach), and extrapersonal spaces (beyond arm's reach). Hence, the CBS can capture the spectrum of variability in spatial neglect and is more responsive to the neglect detection than traditional paper-and-pencil tests (25, 26).

Behavioral Inattention Test: Multiple assessment tests should be used in combination to diminish the likelihood of overlooking some of the neglect-related symptoms (28). The BIT is one of the most frequently used assessment tools (29-32). The BIT consists of nine behavioral tests and six conventional subtests, including the line cancellation test, letter cancellation test, star cancellation test, figure copying, line bisection test, and drawing test (11, 33). Compared to the line bisection and drawing tests, the score of the cancellation test holds considerable importance by facilitating the detection of recovery in the acute phase (11).

In the standard BIT test, the maximum total score is 146 points, and the threshold score is 129 points; if any of the test scores is below that minimum value, the behavioral test should be considered (11).

Kessler Foundation Neglect Assessment Process (KF-NAP): It was found that some additional instructions were required for a more reliable CBS administration (34). Therefore, the KF-NAP method was developed, which delivers comprehensive administration instructions and a scoring chart for the 10 original CBS categories of behavior (26, 35). Certain CBS category labels were transformed for a better demonstration of the aim of an observation, to encompass right-sided neglect symptoms, or to simplify the phrases. For instance, "knowledge of left limbs" on the CBS (36) is revised to "limb awareness" on the KF-NAP (34).

In addition, the KF-NAP incorporates and emphasizes the role of the environment in which the observation is conducted and evaluates the asymmetric performance between the right and left hemispaces. The ultimate goal is to make patients investigate the environment without premeditation and set them in motion, such as moving their gaze and posture. It is significant that both sides of space are assessed by the examiner because at the end of the examination, the scores of the patient should be compared between the right and the left sides (34).

Overall, conventional paper-and-pencil tests are efficient for rapid bedside monitoring owing to their simplicity and standardized scoring. However, functional assessment tools like the CBS and KF-NAP are superior at capturing deficits in daily life activities caused by spatial neglect.

Table 1 provides an overview of clinical assessment tools for spatial neglect in terms of their components and subtests, key features, and utility in clinical practice. Since the diagnostic focus of the assessment tools varies, in clinical practice the tools

Table 1: Summary of clinical assessment tools for spatial neglect.

Assessment tool	Components	Key features	Clinical value in practice
Paper-and-pencil tasks	Line bisection and cancellation tasks.	The line bisection test requires marking the midpoint of a horizontal line. The cancellation task requires to search for spatially distributed targets.	They are widely used. Nevertheless, functional performance in daily life activities is not adequately evaluated.
The CBS	Assessment of personal, peripersonal, and extrapersonal spaces.	Patients perform daily life tasks for approximately 15-20 minutes under professional examination.	Evaluates neglect-related disability in daily life by assessing the asymmetric functional body movements.
The BIT	Nine behavioral tests and six conventional subtests.	Multiple assessment tests are used in combination to decline the likelihood of overlooking some of the neglect-related symptoms.	The score of the cancellation test is particularly important for detecting recovery during the acute phase of the injury.
KF-NAP	Comprehensive administration instructions and a scoring chart for the ten original CBS categories of behavior.	Patients' capability of investigation of the environment is highlighted.	Evaluation and comparison of both the right and left hemispaces.

This table comprises the components, key features, and clinical value in diagnostic practice of the assessment tools for spatial neglect.
The CBS: The Catherine Bergego Scale, The BIT: The Behavioral Inattention Test, KF-NAP: Kessler Foundation Neglect Assessment Process.

should be chosen considering different clinical needs. The BIT has standardized threshold scores; and the cancellation task, in particular, holds considerable importance for detecting recovery during the acute phase (11). On the other hand, the CBS and KF-NAP, show better performance in capturing the neglect-related deficits in daily life activities (25-27, 34).

Rehabilitation of Neglect

Because of limitations such as anosognosia, in which patients are not aware of their deficit, and the varying nature of neglect, giving an ultimate verdict on the most effective way of treating spatial neglect patients is still a difficulty for clinicians to overcome (37-39).

Various approaches to spatial neglect rehabilitation have been developed. Some of these methods are mentioned below. However, the authors would like to highlight that given recent findings, prismatic adaptation, non-invasive brain stimulation (NIBS), and virtual reality (VR) are considered as the most promising approaches among them (17).

Prismatic Adaptation: The neglect patient is expected to point at the target while wearing prismatic goggles. Because of the visual shift caused by the prismatic goggles, the patient experiences a mismatch between the actual location of the target and the pointed location. After initial errors, with the help of visual feedback, adaptation occurs, and performance improves (17).

Assessed by paper-and-pencil tasks, some studies suggest that prismatic adaptation helps to show improvement in neglect behavior (40-42).

Non-Invasive Brain Stimulation: The symptoms shown by neglect patients are not only due to the decreased activity of the damaged brain area but also the increased activity of the homologous area of the other brain hemisphere. Therefore, making the lesioned area more active while reducing the overstimulated activity of the other hemisphere is the expected outcome of this type of rehabilitation (17, 43, 44). The lack of consensus about the NIBS parameters, as well as the significant heterogeneity, likely resulting from variations in NIBS protocols and the small sample sizes, represent limitations that should be considered regarding this rehabilitation method (45).

Virtual Reality: In a randomized controlled trial, VR was used for the rehabilitation of neglect (46). The results of the experimental group, which used VR for the tasks, were compared with a control group that was rehabilitated by the standard methods. Both groups improved their performance as a result of the treatment phase, while the experimental group showed better performance in both the star cancellation test and the CBS (46).

Nevertheless, several limitations such as lack of information regarding the underlying neuroplastic changes responsible for the observed improvements, inherent heterogeneity of neglect patient populations, variations in VR intervention protocols, and generally small sample sizes should be acknowledged (47). Even so, it is suggested that VR may have a powerful potential as a spatial neglect rehabilitation method (47). Further studies are needed to be done focusing on the efficiency of the VR technique in the rehabilitation of neglect patients.

Table 2 provides an overview of rehabilitation methods for spatial neglect in terms of their mechanism of method and clinical outcomes. VR is considered as a rehabilitation method that still requires further research and demonstrates superior efficacy in both the conventional task (the star cancellation test) and the CBS (46). On the other hand, the prismatic adaptation method optimizes sensorimotor deficits in paper-and-pencil tasks, while NIBS method stands out by effectively addressing inter-hemispheric imbalance (17, 40-44).

CONCLUSION

All these tools and methods discussed in this review, have unique aspects and are significant for overall neglect assessment and rehabilitation processes. Nevertheless, the remaining challenges should not be ignored. Although noteworthy improvements have been made in acknowledging and treating spatial neglect, inability to fully capture the extent of neglect in daily scenarios and lack of a treatment that works for every patient are remaining challenges.

In light of the findings discussed, this review proposes these three key clinical considerations in terms of assessment and rehabilitation methods of the spatial neglect.

First of all, conventional paper-and-pencil tests should be complemented by the functional tests such as the CBS and KF-NAP in order to better capture the deficits in neglect patients'

Table 2: Summary of rehabilitation methods for spatial neglect.

Rehabilitation method	Mechanism of method	Clinical outcomes
Prismatic adaptation	Usage of prismatic goggles to cause a mismatch between the actual location of the target and the pointed location, leading performance to get better with the help of visual feedback.	Associated with improvement in neglect behavior, assessed by paper-and-pencil tasks.
NIBS	Restoring the decreased activity of the damaged brain area and the increased activity of the contralateral brain hemisphere.	Regulation of the interhemispheric balance.
VR	Usage of VR during the tasks.	Experimental VR group showed better performance in both the star cancellation test and the CBS.

This table encompasses the underlying mechanisms and clinical outcomes of the rehabilitation methods for spatial neglect.
NIBS: Non-invasive brain stimulation, VR: Virtual reality, The CBS: The Catherine Bergego Scale.

daily activities. Another point is that, since using a single treatment method still is not ultimately effective, combining different rehabilitation methods, and exploring the potential of artificial intelligence as an assessment and rehabilitation method may improve clinical outcomes. Finally, in order to overcome the current limitations and remove the ambiguity of long-term results, especially in NIBS and VR, conducting future randomized controlled trials are critical.

Future studies are likely to become milestones by overcoming these current challenges encountered in assessment and rehabilitation processes of the spatial neglect.

Ethics

Ethics Committee Approval: *The authors declare that this manuscript is a review of previously published literature. Since the study does not involve primary data collection from human participants or animals, and no identifiable private information was used, and therefore, ethical approval was not required.*

Informed Consent: *Not required.*

Footnotes

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