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Functional Assessment of Spatial Neglect: A Review of the Catherine Bergego Scale and an Introduction of the Kessler Foundation Neglect Assessment Process

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Abstract

Spatial neglect is a debilitating post-stroke neurocognitive disorder, associated with longer hospitalization and worse rehabilitation outcomes. Prior literature suggests a high prevalence of this disorder, but in reality clinicians have difficulty reliably identifying affected survivors. This discrepancy may result from suboptimal use of validated neglect assessment procedures. In this article, we suggest a validated assessment tool, sensitive to identify neglect and its functional consequences, the Catherine Bergego Scale (CBS). We provide detailed item-by-item CBS instructions for observation and scoring: the Kessler Foundation Neglect Assessment Process (KF-NAP). We describe a unique attribute of the CBS and the KF-NAP: rehabilitation researchers may be able to use them to measure both ecological outcomes, and specific, separable perceptual-attentional and motor-exploratory spatial behaviors.

The Practical Problem of Spatial Neglect

Spatial neglect is a debilitating neurocognitive disorder associated with longer hospitalization¹, worse rehabilitation outcomes in stroke survivors^{2–4}, higher fall risk⁵ and unsafe navigation while walking⁶ and using a wheelchair⁷. This disorder is characterized by a failure or slowness to respond, orient, or initiate action towards contra-lesional stimuli⁸ accompanied by functional disability⁹. Literature suggests that anywhere between 30 – 70 % of right-brain-damaged stroke survivors present with spatial neglect, and 20 – 60 % of left-brain damaged stroke survivors also have this disorder^{10–14}. This large variance in the

estimates of neglect's prevalence suggests a problem in the assessment and diagnosis of this disorder.

Difficulty with diagnosing spatial neglect derives from several sources: First, there is large variability in the assessments used in its diagnosis: Menon and Korner-Bitensky¹⁵ identified 28 standardized and 34 non-standardized neglect assessment tools, including behavioral tests and functional assessments. Second, neglect is a heterogeneous disorder¹⁶. Thus, some assessments may fail to detect specific aspects or subtypes of neglect. As a result, research suggests that assessment with more than one behavioral test is helpful to detect the disorder¹⁷, to investigate subtypes¹⁸, to differentiate various mechanisms of spatial neglect¹⁹, and to assess both clinical signs and real-world function, especially treatment outcomes^{20,21}. Lastly, in some contexts, neglect assessment may not be employed at all²², perhaps due to perceived barriers in the implementation of the assessment. In sum, clinical practice has not respected a consistent standard: some practitioners use behavioral tests (e.g., target cancellation, figure copying), some document clinical observations, and others make judgments about the presence and treatment of neglect based on a general evaluation rather than any specific cognitive testing^{22–24}. This inconsistent practice standard may contribute to the low detection rate of spatial neglect in medical and rehabilitation settings,²⁵ and it hampers efforts to optimize stroke management and rehabilitation through neglect-specific therapeutic interventions^{26,27}.

The Possible Solution: the CBS

To bridge the gap between the actual and best clinical practices, rehabilitation clinicians need successful strategies for knowledge translation²⁸ and practice reform²⁹. With the goal of increasing the clinical use of neglect assessments, we advocate for using a functional assessment for spatial neglect — the Catherine Bergego Scale (CBS)^{30,31}. Of the existing 28 standardized assessments¹⁵, the CBS is the only one assessing performance in personal (body parts or on the body surface), peri-personal (within arm's reach) and extra-personal spaces (beyond arm's reach), as well as in perceptual, representational, and motor domains. Thus, the CBS captures the heterogeneity of the neglect disorder. Additionally, the CBS assessment occurs via direct observation of spontaneous (i.e., self-initiated) behaviors in 10 everyday activities, such as brushing hair on both left and right sides and remembering to take care of the left limb that may be weaker and hanging outside the wheelchair. In contrast, a laboratory-based or paper-and-pencil behavioral examination usually requires patients to follow instructions to perform a task seldom encountered in daily life, which may be sensitive in detecting lateralized bias but not directly translatable to functional disabilities. Commonly used activity-of-daily-living (ADL) measures, such as the Barthel Index (BI)³² and the Functional Independent Measure (FIM)³³, do not directly assess the impact of spatial neglect versus other disabling impairments. Even though the presence of spatial neglect, detected by behavioral tests, is significantly correlated with BI^{34,35} or FIM^{3,4}, the CBS directly measures neglect-related limitation on activity and participation³⁶. Therefore, the CBS has the ability to assess ADLs that are directly related to spatial neglect, to provide clinicians with a more precise description of a patient's ability and disability, and to represent a useful and efficient tool in evaluating rehabilitation efficacy.

CBS Validity

The strength of the CBS is not only in its direct observation of ADLs but also in its validity. Table 1 summarizes the eight studies^{30,37–43} verifying and confirming the validity of the CBS since the original English publication by Azouvi and colleagues in 1996³⁰. This summary is a result of our systematic review of literature covering the period from 1996 to August 2011 using electronic databases (PubMed, PubMed Central, MEDLINE, and ISI Web of Science) to search for English-written articles with the key word "Catherine

Bergego Scale” in “all fields” or “topic”. It is reported that the CBS is significantly correlated with behavioral paper-and-pencil tests for detecting spatial neglect, especially bell cancellation^{30,38}, but that the CBS may be even more sensitive to neglect symptoms than paper-and-pencil tests^{30,38,40}. Luukkainen-Markkula et al.³⁹ and Goedert et al.⁴¹ also found significant correlations between items of the CBS and the conventional subtest of the Behavioral Inattention Test (BIT)⁴⁴, which includes the widely used paper-and-pencil tasks: line crossing⁴⁵, letter cancellation, star cancellation, figure and shape copying, line bisection, and representational drawing. Among CBS items, internal consistency was verified such that all items were correlated with one another^{38,41}. Importantly, the CBS correlates with other functional assessments such as BI^{41,46}, FIM^{37,42}, the Postural Assessment for Stroke Scale³⁷, and wheelchair collisions⁴².

In addition to its apparent validity in the detection of spatial neglect and problems with ADLs, the CBS may also be used to assess for the presence of pathological unawareness of deficits, i.e., anosognosia. Azouvi et al. rephrased the CBS items into a questionnaire given to patients to self-evaluate their behavior³⁸. The difference between the self-assessed and therapist-assessed CBS scores served as a tool for detecting anosognosia. Anosognosia strongly correlated with therapist-assessed CBS score, supporting a strong relationship between neglect and anosognosia severity⁴⁰. Therefore, as an assessment highly sensitive to spatial neglect, carrying fine psychometric properties, and directly informative of functional disability, the CBS is a valuable tool for detecting and evaluating severity of spatial neglect in terms of its manifestation in functional activities³⁶.

CBS Implementation in Rehabilitation

In rehabilitation research, an improvement in functional outcome is the gold standard supporting efficacy of an experimental treatment. Bowen and Lincoln stated in a Cochrane review⁴⁷ that insufficient evidence is available supporting efficacy of neglect rehabilitation at reducing real-world disability. Although implementing more treatment studies with functional outcomes will be helpful to address this goal, improved identification and assessment of spatial neglect will optimize opportunities to manage symptoms in the hospital and at home. Rehabilitation studies have taken advantage of the CBS for quantifying the functional outcome. As summarized in Table 2 (resulting from the database search described earlier), all of the studies^{46,48–54} observed improvement in the CBS total score after the treatment, but two studies employing a no-treatment control group^{51,52} found equivalent changes in CBS total scores of both treatment and no-treatment groups, which could potentially reflect a failure of the treatment, or a lack of sensitivity of the CBS to those changes. Consistent with the studies reporting significant psychometric values in the CBS (Table 1), treatment outcomes measured with the CBS are correlated with those measured with the behavioral tests in the studies reviewed in Table 2^{48–53}. This indicates that functional abilities (measured with the CBS) improve with the improvement of perceptual-attentional or motor-intentional abilities (measured with behavioral tests such as the BIT). However, if the behavioral tests were used without the CBS for the outcome measure, it may have been difficult for clinicians to translate the treatment effect into functional outcome and thus underestimate the clinical significance of the studied treatment specifically for spatial neglect. In addition, using other conventional ADL outcome measures (e.g., FIM or BI), clinicians may not obtain direct information on neglect recovery either. Therefore, the CBS score may improve with other measures after a treatment (see the last column in Table 2), but the information provided by the CBS is unique such that improvement quantified in the CBS score over time may suggest functional neglect recovery directly.

However, changes in the CBS total score may conceal changes in individual items that receive benefits specifically from the treatment. As ADLs are not uni-dimensional, but involve many brain networks and systems, an ADL/functional assessment should be multi-

dimensional. Clinicians may wish to review patient's scores on individual CBS items to explore a patient's individual symptom profile⁵⁵. Goedert et al.⁴¹ suggested that specific CBS items may support two distinct underlying constructs, potentially corresponding to impairment in different brain-behavior spatial systems: perceptual-attentional versus motor-exploratory components (CBS-PA and CBS-ME respectively; see Table 1). In addition, Goedert et al. found that poor performance on motor-exploratory items predicted a proportion of disability not correlated with performance on other, conventional, impairment measures. These findings are consistent with independent manifestation of spatial dysfunction in perceptual-attentional versus motor-intentional systems, induced by damages to distinct brain networks^{8,56-60}, and also consistent with the idea that the CBS captures the heterogeneity of spatial neglect¹⁵. Further research is needed to focus on brain-behavior neurocognitive relations of individual CBS items, and to use the CBS as outcome measures to investigate effective treatments targeting at the perceptual-attentional or motor-intentional neglect (e.g., determine whether patients with motor-exploratory deficits may respond better to targeted deficits such as limb activation therapy).

The Kessler Foundation Neglect Assessment Process

Since 2008, our team at the Kessler Foundation Research Center has used the CBS in our rehabilitation research on spatial neglect. However, we found limitations in administering the CBS. The original English publication of the CBS by Azouvi et al.³⁰ does not specify the observational context of each item. Thus, administration of the assessment might vary significantly between and among clinicians. Specifically, their CBS instructions do not specify whether performance is assessed 1) at one time point, or over a multi-session observation period; 2) if at one time point, based on one or multiple instructions/tasks/observations; 3) if performance is assessed at one time point, based on one observation, then is it based on a scripted task set, or specified testing context. For example, when grooming is assessed, are toiletries provided, where are they placed, and how is the patient positioned?

To overcome the obstacles using the CBS, we worked very closely with a therapy clinician collaborator (author KH)⁶¹ and the Kessler Institute for Rehabilitation and developed the Kessler Foundation Neglect Assessment Process (KF-NAP), a process for administering the CBS. The KF-NAP entails the use of two forms: Form A contains the table of the scale and the instructions for calculating the final score and suggesting the severity of spatial neglect; Form B provides item by item instructions for how to make observations. To complete all the observations in one visit takes approximately 20 to 40 minutes depending on a given patient's condition. Most of the time may be spent in observing the patient eat (item 9), and thus we suggest that the assessment start 20 minutes prior to a pre-determined meal time so that one may observe eating and cleaning after meal at the end of the visit (items 9 and 10 respectively). The order of items, which is different from Azouvi et al.'s original publication, suggests the actual sequence of observations during a single session, although it is not necessary to perform observations in a particular order. Also, if the CBS is used for multiple follow-up assessments, it is preferable to observe the patient at the same time of the day to reduce the effect of wakefulness, mood, or motivation that may fluctuate throughout the day and influence the accuracy of the assessment³⁷.

On the scoring sheet (Form A), the examiner is reminded of how to assign a score to each item. This reminder is based on our working experience with clinicians, who on occasion had difficulty reliably distinguishing how to assign a score of 1 for mild neglect or 2 for moderate neglect. Therefore, the KF-NAP follows and clarifies Azouvi et al.'s guidelines³⁰ and includes additional instructions for calculating the final score. In addition, the description of each item is shortened (in comparison to Azouvi et al.'s description³⁰) for the

convenience of potentially computerizing the database, but the instruction of each observation item is much more detailed (Form B).

Since the CBS is to measure neglect-related ADLs in an ecological environment, the observation needs to be based on the fact that the new normal in inpatients' daily life occurs in their ward. This fact had created difficulties in scoring certain CBS items. Form B, i.e., the instruction for administering the CBS, is the result of a constant refinement via frequent communication with inpatient occupational therapists over the past three years. Items with longer instructions reflect greater confusion when therapists used the CBS at the beginning of our researcher-clinician collaboration. For example, item 2 "personal belongings" is *not* a visual search task (e.g., looking for a particular book on a packed multi-layer shelf); rather, it is a visuospatial memory task for patients to demonstrate whether they are able to locate familiar objects that they use frequently in daily life with all the cues and contexts available (i.e., therapists are instructed not to hide objects from the patient). Because patients may not have many personal belongings brought to the hospital to allow at least three questions on each of the hemispaces, the solution is that therapists may ask for the same objects later in the session when the patient is facing the opposite direction. This example represents our efforts in developing the KF-NAP to ensure that the observation score assigned to each CBS item is based on situations similar across different patients and examiners.

The KF-NAP is not an alternative to the CBS; rather, it is a detailed description on how to administer the CBS. One may question whether using the KF-NAP is better than the original method for the CBS. However, the difficulty in comparing the KF-NAP and other administration methods lies in the fact that there is no detailed description (at least not publically available) on how the CBS was administered in other studies or the original study³⁰. Using the KF-NAP to administer the CBS may standardize the administration and strengthen the CBS as the most-recommended functional assessment for spatial neglect^{15,36}.

Conclusion

As rehabilitation researchers, we have significant responsibility to assist clinicians in addressing the current problem of assessing spatial neglect after stroke. Research confirms the validity and value of the CBS as an outcome measure, and it has the unique attribute of potentially separating function in different brain-behavior networks supporting different spatial processing stages. The KF-NAP may make the CBS more useful to detect spatial neglect and its functional consequences, enable clinicians and researchers more agreeable in assigned scores, and help clinicians to assign neglect treatments. Routine identification of post-stroke spatial neglect fulfills national post-stroke rehabilitation guidelines⁶² and may enhance the quality of care and improve rehabilitation outcomes for these patients²⁵.

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Table 1

Validation Studies on the Catherine Bergego Scale (CBS).

Authors and year published	Characteristics of stroke patients	CBS correlations with other neglect assessments (uncorrected significance level: $p < .05$)	CBS associations with ADL or clinical assessments (uncorrected significance level: $p < .05$)	CBS sensitivity in detecting spatial neglect
Azouvi et al., 1996	50 RBD stroke patients - Age: 20 to 79 (57.1±14.2) yr - TPS: 3 wk to 6 yr (18.9±44.3 wk)	CBS-total correlated with scores in daisy drawing, Ogden scene copying, line cancellation, bell cancellation, and reading.	- Self-assessed CBS significantly lower than OT-assessed CBS, suggesting presence of anosognosia. - CBS-total correlated with anosognosia score. - CBS-total correlated with Barthel Index. However, one patient with perfect score on Barthel Index had moderate neglect on CBS.	94% Top three sensitive items: - Limb awareness (66%) - Dressing (60%) - Collisions (50%)
Azouvi et al., 2002	69 of the 206 RBD stroke patients were administered with CBS. - TPS (n=206): 11.1±13.8 wk.	CBS-total correlated with scores in bell cancellation, figure copying, clock drawing, 20-cm line bisection, overlapping figures test, reading, and writing.	CBS-total correlated with anosognosia score.	76.8% Top three sensitive items: - Limb awareness (68.3%) - Collisions (59.3%) - Dressing (57.9%)
Azouvi et al., 2003	83 RBD stroke patients. - Age: 54.5±14.1 yr. - TPS: 3 to 64 (15.9±15.2) wk	- CBS items all correlated with each other. - CBS-total correlated with scores in bell cancellation, figure copying, and text reading.	CBS-total correlated with anosognosia score.	96.4% Top three sensitive items: - Dressing (79.5%) - Limb awareness (74.5%) - Collisions (69.1%)
Azouvi et al., 2006	78 LBD stroke patients - Age: 54.6±15.7 y - TPS: 10.8±12.4 wk	- Results on RBD stroke patients were repeated from their previous studies. - LBD stroke patients' CBS-total correlated with bell cancellation, but the correlation coefficients were of lower magnitude than those in RBD stroke patients.	LBD stroke patients' CBS-total correlated with FIM and PASS.	77.3% In comparison to the 36% moderate and severe neglect in RBD stroke patients, only 5.4% LBD stroke patients had a CBS score higher than 10.
Qiang et al., 2005	19 stroke patients with left hemiplegia.	(No information)	CBS-total correlated with number of wheelchair	(Not applicable)

Authors and year published	Characteristics of stroke patients	CBS correlations with other neglect assessments (uncorrected significance level: $p < .05$)	CBS associations with ADL or clinical assessments (uncorrected significance level: $p < .05$)	CBS sensitivity in detecting spatial neglect
	• Age: 65.2 ± 10.9 yr. • TPS: 23 to 115 (61.9 ± 25.8) d		collisions, FIM motor, FIM cognition, and FIM total scores.	
Wang et al., 2005	• 30 stroke patients with left hemiplegia. • Age: 64.1 ± 12.7 yr. • TPS: 23 to 115 (61.6 ± 22.8) d	• CBS-total correlated with rightward error in bisecting lines aligned with body center or lines placed on the left side. • Patients with severe neglect (CBS > 20) made more leftward error in bisecting lines placed on the right side.	(No information)	(Not applicable)
Luukkainen-Markkula et al., 2011	• 17 RBD stroke patients with left-sided neglect (BIT < 131 or CBS > 4). • Age: 40 to 74 (57 ± 8) yr • TPS: 0 to 131 (20 ± 32) mo.	• 17 pairs of CBS items correlated with each other. • CBS-eating correlated with BIT-line crossing, letter cancellation, and star cancellation. • BIT-line bisection correlated with CBS-grooming, gaze orientation, auditory attention, and navigation.	• Differences in CBS-total and navigation between those identified with and without VFD. • Number of months from stroke correlated with limb awareness, collisions, navigation, and personal belongings. • Number of lesion areas correlated with gaze orientation. • VFD correlated with auditory attention, navigation, and CBS-total.	(Not applicable)
Goedert et al., in press	• 51 RBD stroke patients with left-sided neglect (BIT < 129 or CBS > 11) • Age: 28 to 90 (66.9 ± 15.9) yr • TPS: 9 to 61 (22.3 ± 10.9) d	• Two groups of CBS items emerged from PCA, and then categorized as CBS-PA and CBS-ME items. – CBS-PA: personal belongings, eating, cleaning after meal, auditory attention, gaze orientation, and grooming. – CBS-ME: collisions, dressing, limb awareness, and navigation. • CBS-PA and CBS-ME correlated with each other. • CBS-PA correlated with BIT total score, DSS-visual, DSS-tactile, and "where" spatial bias. • CBS-ME correlated with BIT total score and DSS-tactile.	• Both CBS-PA and CBS-ME correlated with Barthel Index.	(Not applicable)

Abbreviations (alphabetical order): ADL, activity of daily living; BIT, Behavioral Inattention Test; CBS-total, CBS total score; CBS-ME, motor-exploratory CBS items; CBS-PA, perceptual-attentional CBS items; d, days; DSS, double simultaneous stimulation; FIM, Functional Independence Measure; LBD, left-brain-damaged; mo, months; OT, occupational therapist; PASS, Postural Assessment for Stroke Scale; PCA, principal components analysis; RBD, right-brain-damaged; TPS, time post stroke; VFD, visual field deficit; wk, weeks; yr, years

Table 2

Neglect Rehabilitation Studies Using the Catherine Bergego Scale (CBS) as an Outcome Measure.

Authors and year published	Characteristics of RDB stroke patients with left-sided neglect	Intervention	Changes in CBS and other assessments
Samuel et al., 2000	2 patients aged 64 and 60 yr. - TPS: 7 and 4 mo.	- Visuospatial motor cuing: move the left arm while looking at the movement. - ABAB design (A: baseline; B: intervention; each period lasted for 14 days). - During intervention, three 45-min training sessions per day with ST, PT, and OT respectively.	Bell cancellation, line bisection, and CBS improved.
Keane et al., 2006	4 patients aged 71–78 yr. - TPS < 60 days	- Fresnel lenses with 15o rightward visual shift - Five sessions (one per day) of target pointing (30 trials per session) while wearing Fresnel lenses over 12 to 17 days.	Letter cancellation, line bisection, CBS, and FIM improved.
Erekin et al., 2009	- Supervised exercise group (n=10) aged 63.3±10.5 yr - Home exercise group (n=10) aged 61.8±9.0 yr - TPS: 3 mo and 24 mo.	- Supervised exercise group: PT-supervised exercise program for 12 weeks. - Home exercise group: unsupervised exercise program for 12 weeks with a written instruction. PT phoned the patients once a week.	BI, PASS, RMI, BBS, and CBS improved in both groups after the treatment and at one-year follow up.
Luukkainen-Markkula et al., 2009	- Arm-activation group (n=6) aged 59.5±8.4 yr; TPS 81.0±64.6 days. - Visual-scanning group (n=6) aged 57.8±11.8 yr; TPS 95.5±63.2 days.	- Arm-activation group: supervised left arm movement in the left space for 20–30 hours during hospitalization. - Visual-scanning group: visual scanning integrated with OT and PT sessions during hospitalization.	BIT, CBS and FIM improved in both groups.
Staubli et al., 2009	4 patients aged 39–60 yr. - TPS: 12 to 131 mo.	- A robotic device applied around the left arm for moving the arm passively and for supporting the arm to move actively. 8 weeks of training (3 to 4 sessions per week; one hour per session).	FMA, WMFT, MVT, and CBS improved after the treatment.
Fortis et al., 2010	10 patients aged 72.7±5.2 yr. - TPS: 1 to 10 mo.	- Wedge prism glasses with 10o rightward visual shift - Cross-over design: All the patients experienced both treatments. The order of the treatments alternated between patients. - Pointing treatment: 10 sessions (two per day) of target pointing (90 trials or 20 min). - Ecological activity treatment: 10 sessions (two per day) of performing visual-guided manual tasks with ADL validity (12 activities or 20 min).	Letter cancellation, bell cancellation, star cancellation, complex drawing, word and sentence reading, FIM, and CBS improved after the first treatment and continued improving after the second, independent of the order of treatments.

Authors and year published	Characteristics of RDB stroke patients with left-sided neglect	Intervention	Changes in CBS and other assessments
Turton et al., 2010	- Intervention group (n=16) aged 72±14 yr; TPS 45±23 days. - Control group (n=18) aged 71±14 yr; TPS 47±39 days.	- Wedge prism glasses with 60 rightward visual shift - Ten sessions (one session a day) of target pointing (30 trials per session) while wearing prism glasses (intervention group) or sham (control group) over two weeks.	BIT and CBS improved in both groups.
Mizuno et al., 2011	- Intervention group (n=20) aged 66±11.5 yr; TPS 67.1±18.4 days. - Control group (n=18) aged 66.6±7.7 yr; TPS 64.4±20.9 days.	- Fresnel lenses with 120 rightward visual shift 20 sessions (two sessions a day) of target pointing (90 trials per session) while wearing Fresnel lenses (intervention group) or sham (control group) over two weeks.	- BIT, CBS, and FIM improved in both groups after the treatment and at hospital discharge (97.5±45.3 days post stroke). - Patients with milder neglect had greater FIM change if they received the intervention.

Abbreviations (alphabetical order): BBS, Berg Balance Scale; BI, Barthel Index; BIT, Behavioral Inattention Test; FIM, Functional Independence Measure; FMA, Fugl-Meyer Score of the upper extremity Assessment; MVT, Maximal Voluntary Torques; OT, occupational therapist; PASS, Postural Assessment for Stroke Scale; PT, physical therapist; RBD, right-brain-damaged; RMI, Rivermead Mobility Index; ST, speech therapist; TPS, time post stroke; yr, years; WMFT, Wolf Motor Function Test.