RESEARCH PAPER

Occupational therapy treatment with right half-field eye-patching for patients with subacute stroke and unilateral neglect: A randomised controlled trial

M. H. M. TSANG¹, K. H. SZE² & K. N. K. FONG³

¹Occupational Therapy Department, Kowloon Hospital, Kowloon, Hong Kong, ²Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong, and ³Department of Rehabilitation Sciences, the Hong Kong Polytechnic University, Hong Kong

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Abstract

Purpose. The right half-field eye-patching technique has been reported to be effective in reducing unilateral neglect (UN) and improving functional ability in stroke patients. This study investigated the efficacy of conventional treatment with right half-field eye patching in treating subacute stroke patients with UN, using a randomised controlled trial.

Method. Thirty-five inpatients with subacute stroke were recruited and randomised into intervention and control groups. The patients in the intervention group received 4 weeks of conventional occupational therapy with modified right half-field eye-patching. Those in the control group received 4 weeks of conventional treatment only. Assessors, who were blind to the treatments, assessed the groups using the Behavioural Inattention Test (BIT) and the Functional Independence Measure (FIM) on admission and at 4 weeks.

Results. Patients treated with right half-field eye-patching had significantly (p = 0.046) higher BIT gain (mean = 25.06, SD = 30.81) than those treated with the conventional treatment (mean = 8.29, SD = 10.35). There was no significant difference (p = 0.467) in FIM gain between patients in both groups.

Conclusions. Right half-field eye-patching improved stroke patients’ impairment level in terms of UN, but the potential benefits in impairment tests were not confirmed by improvements in function.

Keywords: Stroke, unilateral neglect, half-field eye-patching, occupational therapy

Introduction

Unilateral neglect (UN) is a common consequence of stroke. The reported incidence of neglect in right hemisphere stroke patients varies widely from 13 to 81%, in part due to cross-study differences in subject selection, lesion location, and assessment procedures [1,2]. The estimated frequency of UN among right and left hemisphere stroke patients is 33–85% and 0–25% respectively, and the frequency of recovery for right and left hemisphere stroke patients is 0–50% and 60%, respectively [3]. UN may spontaneously reduce. According to neuropsychological measurements, most patients with UN have recovered at 3 months poststroke [4]. However, comparing stroke patients with and without neglect, patients with UN needed a much longer hospital stay, had a higher level of residual disability, and needed much more assistance in activities of daily living (ADL), than those without UN [5]. Giaquinto et al. [6] revealed that only age, cognitive, and sphincter items of the Functional Independence Measure (FIM), neglect, and ideomotor apraxia at admission were significantly associated with the prognosis of outcome after stroke.

UN is a multifactorial, multifaceted syndrome that includes impairments such as dysfunction of the mechanism responsible for allocating attention to spatially coded targets, distortion of contralateral representational space, difficulty in executing motor plans aimed at the contralateral space, and difficulty in allocating an appropriate motivational valence to contralateral sensory stimuli [7,8]. Patients may perceive the contralateral side of the body as...
belonging to another person (i.e. within personal space), or that deficits to the area can be within reaching space (peripersonal neglect), or beyond (extrapersonal neglect). Patients with peripersonal neglect may exhibit personal neglect, or a deficit in grooming or dressing the contralateral sides of their bodies [7,9]. UN is a relatively common consequence of lesions to the right frontal lobe, and is also seen after damage to the right frontal lobe, the thalamus, and the basal ganglia.

The neurophysiological mechanisms underlying unilateral spatial neglect are not fully understood. Several models have been used to explain neglect phenomena, including the attention-arousal theory [10], the hemispheric specialisation theory [11], and the disengagement theory [12–14]; however, they are not mutually exclusive. These three theories have guided the development of a variety of neglect treatments. Over the last two decades, rehabilitative techniques developed for UN include alerting treatment, scanning treatments [15,16], limb activation [17,18], prism treatment [19,20], vestibular stimulation [21], motor imagery, neck vibration [22], and trunk rotation [23–25]. Previous systematic reviews reported that current training for UN could significantly improve performance on test batteries or specific measurements. However, there is no known therapy that can reliably meet the criteria of producing a long-lasting effect and an appropriate level of generalisation to everyday situations [26,27].

Current theories favour the role of attentional mechanisms because underarousal is a prominent aspect of the neglect syndrome. Using this model, there is a new treatment technique, partial visual occlusion, that can be incorporated into conventional treatment approaches. Partial visual occlusion is achieved by either patching the nonneglected half-field of the study participants’ glasses with the ipsilesional (right) hemifield of both lenses blocked out by a light-deflecting lens or an opaque patch [28], or by providing the participants with hemispatial sunglasses [29]. This technique concentrates the patients’ attention on the contralesional space by blocking the ipsilesional visual field, and hence lessens the disinhibition of the orienting mechanism of the ipsilesional side resulting from interhemispheric imbalance [30]. Ipsilesional (right) eye patching reduces input to the left superior colliculus, which then releases its inhibition over the right superior colliculus [31]. This, in turn, improves visual functioning in the left hemifield. Previous studies of eye patching as an intervention for UN have reported varying results. Some studies found that right-eye-patching produced a transient reduction in the severity of neglect [30–33]. A recent study by Fong et al. [25] found, in a randomised controlled study, that ipsilateral eye patching might confound the advantages of using trunk rotation to the contralesional side to reduce neglect in left hemiparetic stroke patients. However, Arai et al. [29] showed that patching the right half-field improved performance in line bisection, line cancellation, and figure copying. Beis et al. [28] performed a randomised study that compared the functional outcomes of right half-field patching with right monocular patching. Increases in total FIM scores were found to be greater in the participants wearing right half-field patches. As well as this, the time spent looking at the left reference zone was longest in those participants who wore right half-field patching. Eye-patch techniques are of interest in this study because they are based on the use of anatomical, physiological, and psychological models; they are inexpensive and practical to use; and they can be used easily during daily activities. Once the glasses have been constructed, training is simple. The use of eye-patch techniques can also be incorporated into a home treatment program.

This study attempts to formulate a theoretically based treatment approach to improve UN and functional performance in stroke patients. Significant improvements in the Behavioural Inattention Test (BIT) [34] score will demonstrate the effectiveness of the eye-patching technique in improving UN. Improvement in the FIM [35] will demonstrate a functional improvement in the treatment approach. The study tests the hypothesis that there is a greater BIT gain for UN stroke patients treated with conventional occupational therapy treatment with right half-field eye-patching than for those treated with conventional treatment only, and that there is a greater FIM gain for UN stroke patients treated with right half-field eye-patching than for those treated with conventional treatment only.

Method

A total of 35 subacute inpatients with stroke were recruited by purposive sampling in a rehabilitation hospital in Hong Kong in a 6-month period. One patient dropped out during the trial, accounting for a 5.9% dropout rate. This patient withdrew because of deterioration in his medical condition. No adverse effect was reported during the study. Thirty-four subjects whose complete data had been obtained were included in the final data analysis (Table I). There were no significant differences between the control and intervention groups in terms of age \( (p = 0.605) \) and educational level \( (p = 0.595) \). The mean age of the subjects in the control group was 71.82 (SD = 5.259) and that of the subjects in the intervention group was 70.47 (SD = 9.295). The mean educational level of the subjects in the control group was 3.53 years (SD = 4.064) and that of the...
subjects in the intervention group was 2.88 years (SD = 2.87). There were 21 (61.8%) male subjects and 13 (38.2%) female subjects, and 29 (85.3%) of them were suffering from infarct, whereas five (14.7%) were suffering from hemorrhage. The average time between stroke onset and admission to the programme was 21.50 (SD = 21.67) days for the control group and 22.18 (SD = 15.87) days for the intervention group. The sex, stroke type, lesion site, time since onset and past history of stroke of the subjects were not significantly different between the two groups. All stroke patients with right brain damage undergoing active rehabilitation were initially screened for UN by BIT. Based on the total score in the standardised BIT conventional battery for neglect, patients were classified as having UN (BIT < 129) or not having neglect (BIT > 129). UN stroke patients who met the following inclusion criteria were eligible to participate in this study: (1) right cerebral vascular disease proven by computer tomography (CT) or magnetic resonance imaging (MRI); (2) neurological representation compatible with a unilateral (right hemisphere) involvement; (3) evidence on neurological testing of left visual field inattention; (4) right handed; (5) within 8 weeks after onset of stroke; and (6) Glasgow coma scale = 15. Patients with the following conditions were excluded from this study: (1) severe dysphasia that restricts communication; (2) transient ischemic attack or reversible neurological deficit; (3) significant impairment in visual acuity caused by cataracts, diabetic retinopathy, and glaucoma; and (4) history of other neurological disease, psychiatric disorder, or alcoholism.

This is a single-blind, randomised control trial with a pretest-posttest control and intervention group design. All stroke patients with right brain damage undergoing active rehabilitation were initially screened for UN by the BIT conventional subtest. Based on their total score on the BIT for neglect, patients were classified as having neglect or not having neglect. Neglect patients were assigned randomly to two groups. Group 1 was the control group; group 2 was the intervention group (given right half-field eye patches). The patients in the intervention group received 4 weeks of conventional occupational therapy with right half-field eye-patching glasses, which were worn throughout the occupational therapy treatment session (Figure 1). Those in the control group received 4 weeks of conventional occupational therapy training without eye-patching. For inpatients, standardised conventional treatment included five physiotherapy sessions of 60 minutes each per week, five occupational therapy sessions of 60 min each per week, speech therapy and psychological counseling as indicated, skilled nursing care, and a daily medical round. Conventional occupational therapy consisted of 30 min of training in ADL and 30 min for upper extremity remedial tasks using the neurodevelopment approach. All patients in both the control and intervention groups underwent the same rehabilitation process. Each subject’s demographic data were collected, such as, age, sex, lesion site, educational level, other disabilities, and medical

| Table I. Baseline characteristics of stroke patients (N = 34). |
|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Baseline characteristics  | Control (N = 17) | Intervention (N = 17) | Control (N = 17) | Intervention (N = 17) | Control (N = 17) | Intervention (N = 17) |
| Age (years)               | 71.82 5.26  | 70.47 9.30  | 0.605         |                        |                        |                        |
| Sex                       | Male 9 52.9%  | Male 12 70.6%  | NS            |                        |                        |                        |
|                           | Female 8 47.1%  | Female 5 29.4%  | NS            |                        |                        |                        |
| Years of education        | 3.53 4.06  | 2.88 2.87  | 0.595         |                        |                        |                        |
| Stroke type               | Infarct 16 94.1%  | Infarct 13 76.5%  |                |                        |                        |                        |
|                           | Hemorrhage 1 5.9%  | Hemorrhage 4 23.5%  |                |                        |                        |                        |
| Lesion site               | Right MCA* 7 41.2%  | Right MCA* 6 35.1%  |                |                        |                        |                        |
|                           | Right parietal lobe 1 5.9%  | Right parietal lobe 3 17.7%  |                |                        |                        |                        |
|                           | Right temporal lobe 0 0%  | Right temporal lobe 1 5.9%  |                |                        |                        |                        |
|                           | Right occipital lobe 1 5.9%  | Right occipital lobe 1 5.9%  |                |                        |                        |                        |
|                           | Right frontal lobe 1 5.9%  | Right frontal lobe 0 0%  |                |                        |                        |                        |
|                           | Right cerebella 1 5.9%  | Right cerebella 0 0%  |                |                        |                        |                        |
|                           | Basal ganglia 2 11.8%  | Basal ganglia 0 0%  |                |                        |                        |                        |
|                           | Others 4 23.6%  | Others 6 35.4%  |                |                        |                        |                        |
| Past history of stroke    | 3 17.7%  | 5 29.4%  |                |                        |                        |                        |
| Time since onset (days)   | 21.50 21.67  | 22.18 15.87  | 0.680         |                        |                        |                        |

* MCA, middle cerebral artery; right MCA lesion might refer to the total lesion in the MCA area.

Figure 1. Occupational therapy treatment with right half-field eye-patching glasses.
complications. The BIT conventional subtest [34] and the FIM [35] were assessed on admission and on discharge by assessors who were blind to the purposes of the experiment. Briefing sessions were organised for all the occupational therapists. During the sessions, all therapists were required to practice the screening assessment for UN. This process was to ensure assessor consistency in using and making ratings on the measurements. Patients were randomly assigned, by a designated person, to either the control or the intervention group using consecutively numbered sealed envelopes for each group (according to random permuted blocks of four that were derived from the block of four randomisation table). Those patients assigned to the control group underwent a 4-week traditional occupational therapy programme, whereas those in the experimental group underwent a 4-week occupational therapy treatment with special glasses blocking the right half visual field. Written and informed consent was obtained from all subjects before the randomisation. If the subjects were not mentally competent to provide their own consent, health care staff or research investigators explained the study procedure in order to obtain the support and understanding from their next of kin or family relatives. Ethics approval was granted from the hospital and the academic institution involved.

Sample size calculation

Assuming equal variance of the BIT and FIM scores in the two groups, 50 subjects were needed in each group ($p = 0.05$, power $= 0.8$, 1–side test). This was based on the moderate effect size of 0.5 (PASS 2000, NCSS Statistical Software). Taking into consideration a 15% dropout rate, at least 59 patients were needed in each group.

Instrumentation

The BIT conventional subtest was used for two purposes. First, it was used as a tool for measuring treatment outcome. Second, it was used to classify subjects into ‘with UN’ and ‘without UN’ groups. The diagnosis was based on the combined score in the six ‘conventional’ subtests (line crossing, maximal score = 36; letter cancellation, max = 40; star cancellation, max = 54; figure and shape coping, max = 4; line bisection, max = 9; and representational drawing, max = 3; cut-off for normality < 130; maximal score = 145). The scores represent the number of targets or drawings that were cancelled or drawn correctly. Lower scores are negative, indicating more inattention. The FIM was used to measure the degree of independence and assistance needed in ADL. The FIM consists of 18 items that assess a broad range of ADL: 13 motor items (e.g. bed transfer, toileting, and dressing) and five cognitive items (e.g. comprehension, expression, and social interaction).

The baseline characteristics, such as chronological age, sex, lesion site, educational level, comorbidity, and baseline scores of Mini-mental State Examination (MMSE) [36], BIT-conventional, and FIM, were compared between the control and intervention groups by $t$ test. The paired $t$ test was used for comparing BIT-conventional gain and FIM gain within the groups. The level of significance was set at 5% in all comparisons. The dependent variables were the BIT-conventional gain and FIM gain over 1 month. Statistical package for the social sciences for personal computer, Windows – Version (SPSS for Windows 11.0) was used in the data analysis.

Results

The $t$ test was used to compare the initial BIT-conventional and FIM scores between the two groups before the treatment (Table II). At the baseline, the patients in the control and intervention groups were comparable in all important prognostic characteristics. There were no significant differences in the initial scores of BIT-conventional ($p = 0.394$) and FIM ($p = 0.099$) between the two groups. Both the control and intervention groups showed significant within-group improvements in BIT-conventional (control mean = 8.29, $p = 0.004$; intervention mean = 25.06, $p = 0.004$) and FIM (control mean = 12.41, $p = 0.002$; intervention mean = 16, $p = 0.000$ after 1 month (Table III). The significant interception suggests that both the control and intervention groups showed an upward trend across BIT-conventional and FIM assessment.

Similarly, there were no group differences in the variable MMSE ($p = 0.6$; control mean = 15.94; intervention mean = 17.18).

The $t$ test revealed that there was a significant difference (Table IV) between the subjects in the control and intervention groups in the BIT gain ($p = 0.046$). Specifically, stroke patients treated with

| Table II. Independent sample $t$ test to compare the baseline of dependent variables between the control and intervention groups ($N = 34$). |
|---|---|---|---|---|
| Dependent variables | Control, $N = 17$ | Intervention, $N = 17$ | $p$-Value |
| Mean | SD | Mean | SD |
| Pre-BIT | 43.94 | 34.56 | 34.84 | 25.99 | 0.394 |
| Pre-FIM | 46.94 | 16.15 | 56.24 | 15.72 | 0.099 |
| MMSE | 15.94 | 8.07 | 17.18 | 5.19 | 0.600 |
right half-field eye-patching had a significantly higher BIT gain (mean = 25.06) than stroke patients treated with conventional method (mean = 8.29). This supported the first hypothesis that there was greater BIT gain for UN stroke patients treated with right half-field eye patching than for UN stroke patients who received conventional treatment.

However, there was no significant difference ($p = 0.467$) in FIM gain between UN stroke patients treated with right half-field eye-patching (mean = 16) and UN stroke patients treated with conventional method (mean = 12.41). Comparing the items in FIM, only eating ($p = 0.027$), bathing ($p = 0.047$), and dressing the lower body ($p = 0.045$) were significantly different between the two groups (Table V). Hypothesis 2 was therefore rejected.

### Discussion

This was a randomised control trial aimed at testing the effectiveness of right half-field eye-patching in treating stroke patients with UN. There were two aspects in this study. First, conventional occupational therapy treatment combined with right half-field eye-patching was investigated for its efficacy in reducing left side neglect by comparing the BIT gain between the two groups. Second, the method’s effectiveness in improving the functional ability of UN stroke patients was investigated by comparing the FIM gain between the two groups.

With respect to the first aspect, the results revealed that conventional treatment with right half-field eye-patching was effective in reducing a patient’s left side neglect. Turning to the second issue, the present study failed to show an improvement in functional ability in patients treated with eye patches, when compared with the control subjects. Both the control and intervention groups showed significant FIM gain after being given treatment for 1 month. Only three items in FIM showed a significant difference between the control and intervention groups. They were eating (control mean = 4.59; intervention mean = 5.82; $p = 0.027$), bathing (control mean = 2.12; intervention mean = 3.00; $p = 0.047$), and dressing the lower body (control mean = 2.35; intervention mean = 3.47; $p = 0.045$). No significant difference was found in FIM gain between the two groups. There was no generalisation effect from impairment level to functional level. This result was inconsistent with the previous systematic reviews [26,27]. Beis et al. [28] performed a randomised study that compared functional outcomes of right half-field eye-patching with a control group. The test group wore glasses with eye patches for an average of 12 h a day. Evaluations were performed on admission to the study and again at 3 months after admission. The results showed that participants...
who wore the right half-field patches spent a longer time attending to the left reference zone. Increases in total FIM score were also found to be greater among the participants wearing right half-field patches. Unfortunately, the extent of generalisation found in present study was not as great as that of the previous studies. Factors such as age, educational years, and MMSE on admission, which would affect the outcomes over time, were taken into consideration in the statistical analysis. Therefore, we believe that the negative result could not be confounded by these factors. We will discuss further the factors that might have confounded this study and led to the negative result.

### Insensitiveness of outcome measures

A stroke is a complex dysfunction caused by a lesion in the brain. The dysfunction after stroke depends on which arteries supplying the brain are involved. In addition to common motor paralysis, stroke patients may have other dysfunctions. These include sensory disturbance, perceptual dysfunction, visual disturbance, personality and intellectual changes, and a complex range of speech and associated language disorders. Right hemispheric stroke is usually coincident with perceptual-motor problems and loss of visuospatial memory. Patients with a left hemiplegia may show poor insight and judgment, and impulsive behaviour.

A gross ADL task is composed of many functions, attention or scanning probably being one of them. So an improvement in attention or scanning tasks may not necessarily be transformed into an overall task improvement. For example, dressing the upper body involves different skills, including motor, sensory, perceptual, and cognitive components. Improvements in cognitive or perceptual aspects may not necessarily be transferred to the dressing task.

The tools chosen for outcome measures in the present study were BIT and FIM. BIT provides a useful indication of changes in the underlying impairment, but does not indicate much about the person’s ability to carry out complex everyday activities. The FIM instrument is a measure of disability, not impairment. The FIM instrument includes a seven-level scale that designates major gradations in behaviour, from dependence to independence. This scale allows classification of patients by their ability to carry out an activity independently, versus their need for assistance from another person or a device.

However, the currently available measures of disability (FIM) may be too insensitive to detect changes. For example, Ms. C was able to perform the task of dressing the lower body with standby assistance, and she scored 5 on FIM on admission. When she was discharged, her UN had improved. However, she still scored 5 on FIM due to her impulsiveness and poor safety awareness. The negative result may therefore be due to reasons other than UN. The insensitivity of disability measure in this study was consistent with the results of the Cochrane Review (2007) that rehabilitation for spatial neglect improves test performance but not disability [27].

Fong et al. [37] found that the ability to perform a task in the neglect test was not highly correlated with one’s functional performance. The BIT is a paper-and-pencil task and should take place in a quiet room with the subject seated on a table. All materials should be presented in front of the subject’s midline. Although the FIM is less structured, it is more complicated and needs a longer time to complete. We usually performed the ADL assessment in a less-confined and less-structured environment. The different set up of each type of assessment might contribute to the negative finding in FIM testing. As we mentioned before, there was no significant difference in FIM gain between the two groups. Among the 18 ADL items, only eating, bathing, and dressing the lower body showed a significant difference in FIM gain between the two groups. These items were particularly relevant in UN because patients with severe neglect often manifest difficulties in such skills [38]. Eating especially showed a significant difference, with the highest p-value between the two groups. Eating involved sitting in a chair in front of a table and so was more structured in nature.

There are a number of limitations to the study. First, patient characteristics, and the baseline scores of BIT and FIM were compared. No difference was seen between the control and intervention groups. Obviously, this could not be attributed to a false-negative result. Second, we followed an RCT design as rigorously as we could. It was unlikely that the negative result was due to commitment of type I errors. Therefore, we believe that the negative result in FIM might be due to type II errors. In calculating the sample size, we aimed to recruit a total of 118 patients. However, due to time constraints, only 35 subjects were recruited. We therefore believe that the false-negative result might be due to a limited sample size.

Another possible explanation is that the training session might not have been long enough to allow the transfer of knowledge of useful compensatory strategies to functional tasks. Generalisation is the ability to transfer what is learned in the treatment situation to everyday situations. For this to happen, strategies and skills are practiced in multiple environments and tasks before they can be applied automatically, as a habit, with little conscious attention or disruption by external influences. In the present study, the
duration of intervention and each treatment session was much shorter than that in the previous studies. In this study, the intervention was five sessions per week and the duration of each session was 60 min. In each treatment session, about 50% of treatment relied on remedial activities, the remaining 50% being individual ADL or IADL training. Because the evaluation was performed 4 weeks after admission, the total duration for wearing the glasses with an eye patch was only 20 h. Therefore, the duration of treatment was too short to allow generalisation of skills.

Limited functional tasks in the treatment sessions also contributed to the negative finding. Toglia [39] stressed that transfer of learning does not occur automatically. She emphasised the importance of using different, meaningful treatment activities so that the patient can understand the relevance of the activities and is able to connect them with other experiences. Therefore, we had to offer the patient a chance to behave in different situations in order for a skill to be generalised and consolidated as a habit. Moreover, it was better to increase the length of time for which the eye patches are worn and focus more on the functional tasks in the training sessions.

Because of time constraints, the sample size in this study was small, and the pattern of patients’ neglect was poorly characterised. The period of treatment and the duration of each treatment session were short and this also probably reduced the level of improvement.

Lastly, a double-blind trial would be very difficult to conduct. In the present study, we tried to avoid assessor bias by using independent blind assessors for measurement of the outcomes. A follow-up measurement is also necessary to determine whether the effect is maintained over time.

The long-term benefits of right half-field eye-patching to remedy neglect impairments in stroke patients remain unproven. The implications for future research are that there is sufficient compelling evidence to encourage further randomised controlled trials. It might be useful if future studies of neglect treatment can be repeated with larger sample sizes, and the treatment effect over time can be measured at follow-ups. Advances in thinking about dissociable types of neglect and the use of neuroimaging methods such as fMRI and event-related potentials would be of interest to determine the basic arousal and its relationship to UN symptoms and treatment effects.

Conclusion

This study sought to investigate the efficacy of occupational therapy with right half-field eye-patching in treating stroke patients with UN. The results of this study indicated that right half-field eye-patching was able to improve patients’ UN impairment level. However, the potential benefits in impairment tests were not confirmed by improvements in ADL.

With increasingly shorter lengths of stay in hospitals and rehabilitation centres, emphasis on health care will enable patients to perform ADL as soon as possible. Shorter stays will necessitate teaching immediate compensatory methods to perform ADL. Using such methods at the onset of treatment may lead to some short-term task-specific gain. Repetition of skills in functional settings enhances generalisation. Future studies need to emphasise the transfer of skills in ADL tasks and the generalisation of skills. There is a clear need for the development of standard functional outcome measures for UN. The effectiveness of neuropsychological rehabilitation cannot be adequately assessed until standardised outcome measures, particularly for disability, are used and patients are reassessed after cessation of therapy.

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