

# Does Functionality Cease after Acquired Brain Injury? Vignettes from a Neuropsychosocial Perspective

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## Abstract

**Background** The outcome of acquired brain injury (ABI) depends largely on the nature and severity of injury, appropriate treatment, and rehabilitation that plays a vital role in recovery.

**Materials and Methods** A total of 18 patients after ABI, aged 18 to 50 years, were assessed pre- and post-neuropsychological rehabilitation (NR) on various psychosocial functions. The patient-specific NR included an eclectic approach using cognitive retraining for memory, attention and concentration, executive functioning, perceptuomotor speed, motor dexterity, basic functional skill training, cognitive behavior therapy, rational emotive behavior therapy, relearning, relaxation therapy, assertiveness training, anger management, and vocational and individual counseling following a neuropsychosocial perspective.

**Results** The post-rehabilitation assessment revealed improvements of statistical and clinical significance in the score of on dysfunction analysis ( $t = 7.10$ ) that was significant at 0.001 level. Significant improvements were found in each of the areas: social, vocational, personal, family, and cognitive as compared with pre-rehabilitation as described by the patient.

**Discussion and Conclusion** Eclectic approach to NR was successful in decreasing the overall dysfunction of the patients despite the severity of injury or the time elapsed after injury. Several therapeutic approaches have been used to assist individuals after brain injury, but more outcome studies are still needed to dictate which therapy works best, or if using an eclectic therapy is the key. The challenge is to make the therapy as person centered and individualistic as possible, depending on the individual needs as there is no “gold standard” for treatment for various issues arising following brain injury.

## Keywords

- ▶ cognition
- ▶ brain injury
- ▶ rehabilitation
- ▶ India

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## Introduction

Acquired brain injury (ABI) is an injury to the brain, which happens after birth, which can be due to the physical trauma after traumatic brain injuries (TBIs); assaults; neuro-surgery; or also nontraumatic sources such as infections, hypoxia, ischemia, encephalopathy, etc.<sup>1</sup> These injuries are characterized by a sudden onset followed by a period of organic recovery before the improvements plateau and level off. Other progressive diseases such as dementia in which injuries are not sudden are not included in definitions of ABI.<sup>2</sup>

ABI can result in changes in neuropsychological as well as psychological functioning that can be temporary or permanent. These can be cognitive, emotional, or behavioral impairments. The consequences of ABI often require a major adjustment for the patient and also his/her caregivers/family members around the new circumstances, and making the adjustments that are critical in recovery and rehabilitation.<sup>3</sup> The complications that arise may include cognitive impairments such as short-term memory loss, and physical difficulties such as fatigue, paralysis, visual, or hearing impairment. Whatever the disability, ABI patients' lives change, and so do their family members' lives. Patients with ABI do not necessarily experience a decline in intellectual functioning, but rather they experience specific cognitive impairment in areas such as memory, attention, concentration, communication, and behavior.<sup>3</sup>

Though the outcome of the injury depends largely on the nature and severity of the injury, appropriate and timely treatment and rehabilitation play a vital role in determining the level of recovery.<sup>4</sup>

## Neuropsychiatric Sequelae after Acquired Brain Injury

Memory loss and memory disorders are one of the most common and prevalent cognitive impairments experienced by patients of ABI.<sup>5</sup> People often struggle with memory problems following stroke, and this can lead to difficulties in everyday life. The degree and kind of memory problems, mood changes, and performance vary with everyday activities.<sup>6</sup> In a recent Cochrane review on 13 studies with 514 participants, the authors found that seven trials were conducted with community participants, four with in-patients and two with mixed community and in-patient samples. Most of the studies included memory rehabilitation as the therapeutic activity for ABI patients.<sup>7</sup> However, some aspects of memory are directly linked to attention, and it is challenging to assess what components are caused by memory and what by attention problems.<sup>8</sup> There is often a partial organic recovery of memory functioning following the initial recovery phase; however, permanent impairments are often common.<sup>9</sup> ABI patients report significantly more memory problems when compared with people without ABI.<sup>5</sup>

TBI is also associated with postconcussive syndrome (PCS). These can have symptoms such as headaches, dizziness, noise intolerance, irritability, depression, anxiety, emotional lability, insomnia, etc. These can last for weeks or also till

months after the brain injury.<sup>10</sup> A study in which 53 symptomatic mild head injury patients were studied, they scored significantly poorer than uninjured controls on neuropsychological tests.<sup>11</sup> In another study, motivational deficits were observed in patients following brain injury. These patients also have lowered reward responsiveness and mood changes as compared with controls.<sup>12</sup>

Persons with ABI have shown emotional and psychological difficulties such as depression, issues with self-control, managing anger impulses, and challenges with problem solving. These challenges also seem to contribute to psychosocial concerns involving social issues such as social anxiety, increased loneliness, and lower levels of self-esteem. Some of the most common problems faced by ABI patients include anger management, reduced social contact, reduced frequency of leisure activities, increased unemployment, family problems including marital difficulties, returning to work, obtaining financial independence, driving, participating in social relationships, and self-acceptance.<sup>13-15</sup>

## Rehabilitation of Patients with Acute Brain Injury

*Neuropsychological rehabilitation* (NR) focuses on improving the patients with brain injury in different areas of functioning (cognitive, emotional, psychosocial, and behavioral) and helping in improving their deficits. Wilson in 2008 focused on NR as a goal planning approach that was established between the therapist, the patient, and his family members. Though there is a lot of literature that recognizes the importance of emotional, cognitive, and psychosocial functions, Wilson put all of these together and called it the *holistic approach*.<sup>16</sup>

Rehabilitation following an ABI has to be patient specific and cannot follow a set protocol as there are a variety of mechanisms involved and different structures are affected. Hence, rehabilitation should be individualized process that should involve a multidisciplinary approach.<sup>17</sup> It should also be guided by the patient's needs and personal goals.<sup>18</sup>

## Methods

### Aim

The aim was to study the psychosocial functioning as the primary outcome in patients with ABI after individualized neuropsychological intervention.

### Setting/Participants

Eighteen patients after ABI were from the Departments of Neurosurgery, Neurology (Neurosciences Center), and Psychiatry, for neuropsychological assessment and NR. They were referred between 6 months and 1 year after their date of injury/ictus. The diagnoses were made by the consulting neurosurgeon/neurologist/psychiatrist/clinical psychologist. These patients underwent a prospective outpatient group study (on an OPD/outpatient level) following an "ABA experimental design" where A was the baseline assessment, B was the NR, and A was the post-NR evaluation. Of these, eight patients were diagnosed as having severe TBI (diagnosed using the criteria of severity of TBI),<sup>19</sup> three of

moderate TBI, three of mild TBI, and four of hypoxia (due to strangulation-attempted suicide) (single causation).<sup>20</sup> These were patients after ABI (traumatic and hypoxic), aged between 18 and 50 years, both sexes, all education levels, and hailing from both urban and rural background. One of the prerequisites of NR was presence of a home-based therapist (immediate caregiver), who could supervise the patient at home and could personally communicate his/her progress. All individuals uncomfortable with the structure of the out-patient rehabilitative service (nonconsenting) were excluded. Exclusion of cases also included individuals with history of any previous penetrating head injury (PHI) other previous head injury, any major psychiatric illness, mental retardation, associated injuries/life-threatening injuries, or use of neuro-protective drugs.

Depending on the patients' chronological and mental age and reasons for referral including presenting problems, different tools were used. The assessment for effectiveness of rehabilitation outcome included the following:

1. *Assessment of psychosocial functioning of patients using dysfunction analysis questionnaire (DAQ)*<sup>21</sup> (which was the only outcome variable of the service) to see their

overall functioning at home, at the vocation/job, how they adjust or adapt socially, personally also their subjective cognitive functioning. This measure was used to describe the benefit of the NR in five areas: cognitive, personal, vocational, family, and social.

2. Other assessments included, as stated earlier, different neuropsychological tests depending on the reason for referral and presenting problems. The same could not be used as an outcome variable because these were different tests; hence, the information could not be clubbed/compared.

Depending on the specific level of impairments in different areas and subjective complaints, a *patient-specific NR was planned*. The NR mainly included basic skill training, functional skill training, neuropsychological training with home-based rehabilitation modules in increasing difficulty level with cognitive retraining for attention, memory, executive functioning, perceptuomotor speed, motor dexterity, and individualized counseling. This was followed by individualized counseling (including personal and family) (→ **Table 1**).

In addition, cognitive behavior therapy (CBT), rational emotive behavior therapy (REBT), alleviating focal signs,

**Table 1** Eclectic neuropsychological rehabilitation given to all patients (part A)

	Neuropsychological rehabilitation	About tasks	Tasks	Function targeted	Remarks
1.	The basic skill training		Activity scheduling, daily planner	Methodize and time each activity of the day	Seemed to be helpful for planning neuropsychological rehabilitation.
2.	Functional skill training				
3.	Cognitive retraining:				
a.	Attention	Modules based on increasing level of difficulty of lists symbol and letter cancellation tasks were used to retrain focused; divided and sustained attention.	Letter and symbol cancellations	Focused, sustained and divided attention	Was helpful for patients who showed impaired attention deficits on evaluation.
b.	Memory	Modules based on increasing level of difficulty of lists of words. These were timed and followed an increasing level of difficulty. Omissions and commissions were noted. The patient was given different modules for each week, and when a flooring effect was achieved for each difficulty level, the next one with an increased difficulty was introduced.	Memory aids (reminder diary), word learning and recalling	Immediate memory, delayed recall, new learning	Memory retraining was observed to be helpful for patients who had impaired memory on the neuropsychological assessment.
c.	Executive functioning	Modules based on mazes in increasing level of difficulty for planning, and organization. These mazes were made with increasing complexity to accomplish results as soon as possible.	Mazes	Planning and organizing	Observed to be effective on ~13 patients.
d.	Perceptuomotor Speed	Techniques, e.g., timed grain sorting were used, where the patient had to sort different grains as soon as they could with an increasing level of difficulty.	Grain sorting	Visual acuity	Was observed to be helpful for patients eventually carrying daily household tasks involving perceptuomotor speed including housekeeping, and tasks for independent living, etc.
e.	Motor dexterity	Everyday tasks of buttoning and unbuttoning shirts were given. The timed task used increasing level of difficulty ranged from buttoning and unbuttoning large buttons.	Buttoning and unbuttoning shirts	Finger dexterity	Most effective on 3 patients with decreased motor dexterity, to increasing the difficulty to small buttons over a period of 4-5 wk.
f.	Individual counseling	Individual and family	Insight oriented psychotherapy	Improving insight into their thoughts, feelings and behaviors	Given to all the 18 patients and their family members.

**Table 2** Eclectic neuropsychological rehabilitation strategies given for individualized problems (part B)

Type of therapy	Task	Function targeted	No. of patients
Cognitive behavior therapy	Anxiety charting, automatic thoughts questioning, reattribution	Dysfunctional emotions, maladaptive behaviors, anxiety, depression, overgeneralizations	5
Rational emotive behavior therapy	Rationalization, comprehensive, active-directive approach	Irrational thoughts, self-defeating thinking, emoting and behaving	8
Relaxation therapy	1. Coloring techniques, shading with colors 2. Jacobson's progressive muscle relaxation technique	1. Aggression, irritability, response inhibition 2. Insomnia, hypertension and anxiety, somatic complaints, postconcussive syndrome	19
Relearning	Relearning via charts for getting dressed, bathing, brushing teeth, combing hair, toilet training	Skills reacquisition, self-independence	5
Assertiveness training	Broken record, fogging, negative inquiry, negative assertion	Docility, aggressiveness	2
Social skills training	Development of social skills, assertiveness, problem solving	Interpersonal skills, effective communication	3
Anger management	Jacobson's progressive muscle relaxation, cognitive restructuring, improving communication	Emotional, behavioral, and cognitive effects of anger	3
Vocational counseling and guidance	Active listening, career talks	Facilitating return to work	14

relearning, relaxation therapy, assertiveness training, anger management, and vocational and individual counseling that were patient specific.

The eclectic NR (► **Tables 1, 2**) varied from 2 to 18 months for each patient. These ranged from 8 to 41 sessions between different categories of patients. Each session lasted for 1 hour (i.e., 45 minutes for NR session + 15 minutes for compiling the information). The rehabilitation followed the flooring and ceiling principles of rehabilitation.<sup>22,23</sup>

## Neuropsychological Rehabilitation following an Eclectic Approach included

### Aiding in Basic and Functional Skills Training

Patients after ABI start having problems in their everyday functioning, as their everyday schedules and time-bound tasks get disrupted. With the help of activity scheduling, all the patients were aided in basic functional skill training. The patients were also asked to maintain a daily and weekly chart with things-to-do on the basis of importance, which they were supposed to bring back every week for a weekly follow-up of NR. The same was followed by NR/cognitive retraining. This included NR of attention, memory, executive functioning, perceptuomotor—speed, motor dexterity, and individual counseling (► **Table 1**).

Besides this, individualized psychological rehabilitation was given depending on the reported problems (► **Table 2**). The same was individualized because of heterogeneity of reported problem. Moreover, the total duration of NR varied

between weeks, depending on the performance of each person. A brief description of the rehabilitation strategies given to the patients is given in ► **Table 2**.

### Cognitive Behavior Therapy

Five patients with dysfunctional emotions, maladaptive behaviors, and cognitive processes were given cognitive behavior therapy (CBT) through several goal-oriented, explicit systematic procedures. Most patients had symptoms of depression and anxiety, for which anxiety charting was done for patients where the automatic thoughts were questioned and alternative thoughts were given with reattribution of the situation. The patient's generalizing, overgeneralizing, or jumping to conclusions were directed to an alternative view to decrease the actual anxiety and depressive thoughts. The goal was that the patients should become fully independent with lesser anxiety and depressive tendencies.

### Rational Emotive Behavior Therapy (REBT)

Eight patients with irrational (self-defeating, socially defeating, and unhelpful) thoughts and tendencies were channeled toward more rational thoughts and tendencies by a comprehensive, active-directive approach for the patients with emotional difficulties such as self-blame; self-pity; clinical anger; hurt; guilt; shame; depression and anxiety; and behavior tendencies such as procrastination, overcompulsiveness, avoidance, addiction and withdrawal by the means of their irrational and self-defeating thinking, emoting, and behaving.<sup>24</sup>

### Relaxation Therapy

Relaxation training was used to reduce the patients' experience of anger and tension.<sup>25</sup> Jacobson's progressive muscle relaxation technique (JPMR) was given to six patients with insomnia or even hypertension with anxiety. This helped most of the patients relax and even their somatic complaints decreased. This technique was also beneficial to ease the PCS symptoms and the patients' somatic complaints.

Thirteen patients with aggressive tendencies and irritability were given coloring tasks. The patients were given a shape to be colored every day and he/she had to make sure to color it without getting any color out of the boundary of the design. This also helped in response inhibition retraining. Personality changes, one of the most common symptoms of head injury, result in various kinds of disinhibition.<sup>26</sup> Coloring helps in certain functions such as fine motor coordination and self-regulation. It also helps reduce stress.

### Relearning

Martelli et al in 2008 evaluated the importance of skills reacquisition after ABI, which is a holistic habit retraining model of neurorehabilitation.<sup>27</sup> Five of the eight patients with severe TBI who had "no memory" of everyday activities such as getting dressed, bathing, brushing teeth, combing hair, toilet training, etc., had to be taught again via relearning. Techniques were taught to the patients and their caregivers so that they could relearn how to manage themselves, ultimately aiding in self-independence.

### Assertiveness Training

This was used for two patients who were either docile or very aggressive. This helped the patients use assertiveness as a means of "reciprocal inhibition" of anxiety. The goals included increased awareness of personal rights, differentiation between nonassertiveness and assertiveness, differentiation between passive-aggressiveness and aggressiveness, and learning both verbal and nonverbal assertiveness skills.

### Social Skills Training

Social skills training programs are implemented with individuals who lack interpersonal skills and the ability to effectively communicate their desires in a problem situation or conflict.<sup>28</sup> This is geared toward patients with problems in social interactions and includes focus on the development of social skills, assertiveness, and problem-solving techniques. Three patients who had difficulty expressing, low social desirability, or had problems adjusting that resulted in frustration and maladaptive responses were given this training.

### Anger Management

Three patients had anger issues that were resolved through relaxation techniques, cognitive restructuring, and improving communication strategies. The patients were encouraged to increase their awareness of emotional, behavioral, and cognitive changes that occur when they become angry. The participants practiced self-talk methods and timeouts.

### Individual Counseling

All patients in all the NR sessions were given insight-oriented psychotherapy to gain more awareness and insight into their thoughts, feelings, and behaviors.<sup>29</sup> The counseling also included family counseling.

### Vocational Guidance and Counseling

After ABI, almost all patients who were working or were students left their respective jobs/academic pursuits and became unemployed.

Last evaluation included reassessment of psychosocial functioning of patients using DAQ<sup>26</sup> to see their overall improvement on psychosocial functioning after extensive and personalized NR, with the special focus on "neuropsychosocial perspective."

## Results

As it was a prospective study based on OPD-generated data for psychosocial functioning (with the special focus on "neuropsychosocial perspective," subjective feelings of functioning were assessed post-rehabilitation after attaining ceiling and flooring effect on all the domains. This assessment of improvement and effectiveness of the NR focused on five domains: social, vocational, personal, cognitive, and family. **Table 3** shows the improvement in the scores on DAQ post-NR. In all the cases, it can be seen that the level of functioning has improved.

As shown in **Table 3**, a significant difference in the DAQ post-NR showed significant difference in all the five areas of functioning: cognitive, personal, vocational, family, and social. As given in **Table 4**, the overall improvement in psychosocial functioning post eclectic NR in the five areas – cognitive, personal, vocational, family, and social can be studied.

## Discussion

NR is recognized as an important factor in aiding the process of picking up life, as much as possible, as it was before brain injury.<sup>30</sup> Prigatano in 2005 adds that it should "help patients to manage residual neuropsychological disturbances as they emerge into interpersonal situations."<sup>24</sup>

NR with patients post-ABI varies according to the nature and severity of the injury, patient's psychosocial context, clinical setting, and time since injury. Early rehabilitation optimizes outcome, but rehabilitation at a later stage in recovery can also improve functions significantly.<sup>2</sup> Two key principles underpin all types of rehabilitations: (1) engaging and maintaining the patient (and family) involvement with the rehabilitation services by the provision of an emotionally supportive environment and relationships within which empathetic expert help can be easily accessed and (2) increasing the patient's (and his/her families) understanding of ABI, their strengths and weaknesses, and the means by which impairments may best be managed.

In this study, 18 individuals after ABI were followed up and given a comprehensive NR intervention that was personalized per patient, to rehabilitate the patients' functioning in

**Table 3** Changes (reported improvement) in pre- and post-NR dysfunction scores

Patient	Pre-NR DAQ %	Post-NR DAQ %
Case 1	54.40	43.60
Case 2	99.20	86.00
Case 3	49.60	44.00
Case 4	96.00	91.90
Case 5	84.00	65.60
Case 6	52.00	43.20
Case 7	48.40	41.60
Case 8	80.00	58.40
Case 9	66.00	60.00
Case 10	92.00	69.00
Case 11	77.60	55.60
Case 12	68.40	52.00
Case 13	78.60	42.10
Case 14	86.80	57.20
Case 15	64.00	46.00
Case 16	88.40	48.40
Case 17	56.80	44.00
Case 18	80.00	62.40

Abbreviations: DAQ, dysfunction analysis questionnaire; NR, neuropsychological rehabilitation.

Note: Below 40% indicates no dysfunction.

cognitive, personal, vocational, family, and social areas. They were rehabilitated by an eclectic approach using cognitive retraining, functioning retraining, psychological therapies, relaxation training, relearning, anger management training, and counseling. There has been extensive literature from all over the world, which proves the effectiveness of cognitive rehabilitation of patient post-ABI in different cognitive domains such as attention, concentration, and memory.<sup>24,29,30</sup> Studies have shown that patients make larger gains in functional tasks used in their rehabilitation (i.e., activity schedul-

ing) and are more likely to continue practicing these tasks in everyday living; better results during follow-up are obtained.<sup>31</sup> Studies show that a combination of approaches can benefit individuals after TBI.<sup>32</sup> However, there is a need to study additionally better and effective measures of therapeutic interventions that have been adapted to be used with patients with TBI.<sup>25</sup> It needs to be seen whether the results are sustainable post-NR.<sup>7</sup>

The effectiveness of CBT in individuals after TBI is dependent on his/her present level of cognitive functioning.<sup>33</sup> CBT adapted for ABI shows enduring benefits for mood and community integration.<sup>34</sup> Additionally, in REBT, self-defeating thoughts and feelings are challenged by the therapist. Therefore, it has been suggested that a more flexible protocol of REBT be implemented for these patients, which is less directive and more adjustable.<sup>33</sup> Manchester and Wood in 2001 supported the view that any form of psychotherapy given to patients after brain injury should be highly structured and repetitive, which increases the likelihood of procedural learning through which there are greater chances of the therapy being successful.<sup>25</sup>

Relaxation training is used to reduce one's experience of anger, frustration, and tension.<sup>25</sup> There is very little literature on the outcomes of the use of relaxation techniques after ABI, but it has been widely used for various psychological and psychiatric disorders<sup>35,36</sup> and neurologic diseases.<sup>37</sup> Denmark and Gemeinhardt advocated that training in social skills by role playing provides opportunities for repetition and rehearsal of skills, which helps ameliorate cognitive deficits such as planning and comprehension.<sup>25</sup>

The results show that the pre- and postdysfunction decreased significantly with the subjective complaints of the patients. Of the 18 patients, 8 of the 14 patients who had left their vocation due to the injury rejoined their jobs or academic pursuits at the end of the rehabilitation. Vocational rehabilitation is recommended as a means of facilitating return to work after TBI.<sup>38</sup> Cognitive retraining is given extensively the world over to patients after ABI. Eclectic mix of retraining approach at the OPD level was given to the present group of persons/patients. Various studies have evaluated the effectiveness of such cognitive rehabilitation in such patients in different cognitive domains such as attention, concentration, and memory.<sup>39-42</sup>

**Table 4** Overall improvement in psychosocial functioning posteclectic NR

Tests/domain	Pre-NR n = 18		Post-NR n = 18		t Value	p Value (level of significance)
	Mean	SD	Mean	SD		
DAQ—overall	73.45	16.49	56.16	14.74	7.10	0.001 <sup>b</sup>
Cognitive area	69.04	17.17	54.66	14.98	5.40	0.001 <sup>b</sup>
Personal area	73.33	19.65	55.00	15.21	5.51	0.001 <sup>b</sup>
Vocational area	80.11	15.96	60.77	17.82	6.13	0.001 <sup>b</sup>
Family area	66.77	20.29	52.44	13.62	4.70	0.002 <sup>a</sup>
Social area	76.94	17.05	57.88	17.32	6.17	0.001 <sup>b</sup>

Abbreviations: DAQ, dysfunction analysis questionnaire; NR, neuropsychological rehabilitation; SD, standard deviation.

<sup>a</sup>Significance at the 0.005 level.

<sup>b</sup>Significance at the 0.001 level.

With the results, it can be confidently said that the eclectic approach to NR is successful in decreasing the subjective complaints of the patients, improving the overall functioning in all five areas of patients: cognitive, personal, vocational, family, and social. Even the somatic complaints or the PCS symptoms of the patients such as headaches, dizziness, nausea, sleep disturbances, noise/light sensitivity, and restlessness were subjectively decreased after NR.

Studies evaluating the effectiveness of NR for patients with ABI are relatively sparse and frequently suffer from significant methodological constraints. There is some modest evidence that restorative techniques involving repeated practice of specific tasks in laboratory settings can be effective for improving some specific attention and language-based functions.<sup>2</sup> The current evidence also suggests that compensatory strategies are effective in reducing everyday memory failures, minimizing anxiety, and increasing self-concept and quality of interpersonal relationships. Behavioral approaches aimed at maximizing skill acquisition and monitoring, including performance feedback and reinforcements have also demonstrated their efficacy. These types of rehabilitations generalize best to everyday life situations.<sup>43,44</sup>

Cattelani and colleagues performed a systematic review on treatment efficacy and clinical effectiveness of a neurobehavioral rehabilitation program for patients with ABI. This was done to make evidence-based recommendations for trainings such patients. From 63 studies, they found that the most improvement was indicated when comprehensive-holistic rehabilitation program was used for improving psychological functioning. Other programs included CBT and applied behavior analysis.<sup>45</sup>

Evans et al in 2003 reported that to cope more effectively with memory issues after ABI, patients use compensatory strategies such as memory aids, such as diaries, notebooks, electronic organizers, etc. Moreover, such patients also use environmental adaptations and aids such as labeling kitchen cupboards.<sup>9</sup> Using a diary has been proven to be more effective if it is paired with self-instructional training, and it was also related to more frequent use of the diary over time, which proved to be more successful as a memory aid.<sup>7</sup> As a large percentage of the population of the country is low literate, it is necessary to develop memory aids, which are cultural and education free, which can be used in India.

Other strategies used for rehabilitating memory for patients after ABI are repetitive tasks with an attempt to increase the recall ability of the patient.<sup>18</sup> Research also shows that ABI patients use an more number of memory aids after their injury than they did prior to it, and also these aids vary in their degree of effectiveness.<sup>45</sup> While memory training increases the performance at hand, there is little evidence that the skills translated to improved performance on memory challenges outside the therapeutic zone.<sup>45</sup> Another strategy used for improving memory is the use of elaboration to improve encoding.

The principles<sup>16</sup> followed for an eclectic approach to NR in these cases included: They were begun as early after the injury as was feasible; services were provided in a holistic and interdisciplinary manner; and the design and

implementation of the various therapeutic regimens emanated from a comprehensive, systematic, and interdisciplinary evaluation process.

The eclectic approach to NR also included inclusion of immediate family members/caregivers in the therapy; empowerment of the client to become active participants in their own therapy (person-centered care approach)<sup>46</sup> communication between the therapists, patient, family members, caregivers, spouses, etc.; short- and long-term goal setting; psychoeducation; and supportive therapy.

The results show that the rehabilitation program was successful for all the patients despite the differences in the severity of injury (mild, moderate, or severe TBI, or hypoxia), the patient-specific complaints/symptoms, individual differences in impairments, and also differences in the delay after the date of injury the rehabilitation was started. Supporting our results, a randomized controlled trial of holistic NR was conducted in a study in 67 adults after TBI. The rehabilitation included intensive cognitive rehabilitation that emphasized on the integration of cognitive, interpersonal, and functioning outcomes of these patients. The results showed that a holistic NR program is effective in self-regulation and cognitive and emotional processes, and also helps improve the community functioning and quality of life after TBI.<sup>47</sup>

As can be seen from the results, the overall dysfunctional analysis of the patients pre- and post-rehabilitation has a significant difference that is significant at the 0.001 level ( $t = 7.10$ ). A significant improvement is seen in all the five areas of functioning: cognitive, personal, vocational, family, and social. All the patients reported a subjective improvement in their overall everyday functioning as well.

### Limitations and Future Directions

The scores on different neuropsychological tools could not be compared (pre- and post-rehabilitation), as not all the tools were used on all the patients. Also, the severity of the injury could not be correlated to the rehabilitation, whether the rehabilitation was more effective in any one type of TBI or hypoxia over the other. Further analysis of the role of age could also have given a clearer understanding of whether rehabilitation proves more effective in younger population or older.

As there were so many techniques used in the NR program, the efficacy of each could not be quantified. Therefore, the exact effectiveness of each type separately could not be observed. All the limitations of this study could be incorporated in a future cohort, where more substantial claims and generalizations can be made. In a future larger cohort, the importance of spontaneous recovery could be taken into consideration, where patients in the spontaneous recovery period be compared with those who have surpassed this phase.

### Conclusion

Eclectic approach to NR was successful in decreasing the overall dysfunction of the patients in all the areas of

functioning (cognitive, personal, vocational, family, and social) in all the patients despite the severity of injury or the time elapsed after date of injury. Several therapeutic approaches have been used to assist individuals after brain injury, but more outcome studies are still needed to dictate which therapy works best, or if using an eclectic therapy is the key. The challenge is to make the therapy as person centered and individualistic as possible depending on the individual needs as there is no "gold standard" for treatment for various issues arising following brain injury.

## Future Directions

Plan individualized NR packages as randomized controlled clinical trials, for different ABI conditions.

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