Hypoxia: Can Neuropsychological Rehabilitation Attenuate Neuropsychological Dysfunction

Jamuna Rajan, Saumya Udupa¹, Srikala Bharat²

ABSTRACT
Anoxia and hypoxia may be caused by a number of events — heart attack, strangulation, anesthetic accidents, or poisoning. Cognitive dysfunction in hypoxia is well described. The purpose of the study was to examine the efficacy of neuropsychological rehabilitation in hypoxic brain damage. Single-case pre post intervention study design was adopted. The neuropsychological profile was compared pre- and post-neuropsychological rehabilitation. A 30-year-old woman with diagnosis of post- hypoxic encephalopathy underwent cognitive retraining every day for 1 hour. She had a total of 138 sessions over a period of 7 months. Results indicated improvement of cognitive functions post cognitive retraining in most of the cognitive domains. This improvement was also found to have a generalization effect in her every day functioning. Cognitive retraining was found to be useful in hypoxic brain damage. Cognitive retraining combined with other adjunct therapy was found to have significant impact on the patient and the family members. the significant others.

Key words: Cognitive retraining, neuropsychological assessment, neuropsychological rehabilitation

INTRODUCTION
Hypoxia is a condition in which there is a decrease of oxygen supply to the tissues in spite of adequate blood flow to the tissue. Anoxia and hypoxia, however, are often used interchangeably — without regard to their specific meanings — to describe a condition that occurs in an organ when there is a diminished supply of oxygen to the organ’s tissues. Anoxia and hypoxia may be caused by a number of events, such as heart attack, severe asthma, smoke or carbon monoxide inhalation, high-altitude exposure, strangulation, anesthetic accidents, or poisoning. In severe cases of anoxia and hypoxia, the patient is often stuporous or comatose for periods ranging from hours to days, weeks or months. Seizures, myoclonic jerks and neck stiffness may occur. If the patient’s respiratory and cardiovascular systems can be supported properly, recovery may occur; but that depends upon the severity/extent of injury. As recovery proceeds, a variety of psychological and neurological abnormalities may appear, persist for a time and may improve. Mental confusion, personality regression, parietal lobe syndromes, amnesia, hallucinations, memory loss and persistent myoclonus may also occur.

Cognitive dysfunction
Postoperative cognitive dysfunction (POCD) falls into 2 major categories: postoperative delirium and prolonged POCD, depending on the time after surgery and clinical features.

Postoperative delirium
Postoperative delirium is dominated by disorientation and increased psychomotor activity; it is usually acute in onset and lasts for days or few weeks. The intensity fluctuates typically during the day and tends to be...
greatest during the night. The incidence of delirium varies from 3% to 61% depending on the age, type of surgery, anesthetics used, preoperative cognitive status, as well as preoperative medical status.\textsuperscript{1,2} The mechanisms causing postoperative delirium are poorly understood, and it is usually the result of several causes rather than one specific factor.

**Prolonged postoperative cognitive dysfunction**

Prolonged POCD is found days or weeks after anesthesia and lasts for weeks, months or, in the worst cases, lasts permanently. In most cases, prolonged POCD resembles mild neurocognitive disorder. In a few cases, prolonged POCD may resemble postoperative dementia, a more severe impairment. Cognitive dysfunction after cardiac surgery is relatively well described. Several studies using neuropsychological testing have described prolonged POCD.\textsuperscript{3} The incidence of cognitive dysfunction is as high as 80% postoperatively.\textsuperscript{4,5} Neuropsychological deficits have been observed in 33% to 83% of coronary artery bypass graft surgery (CABG) patients postsurgery, persisting after 12 months in up to 35% of these patients.\textsuperscript{6} In a study, 42% of patients evidenced cognitive deficits 5 years after CABG.\textsuperscript{7} Studies have found postoperative declines in verbal and visual learning and memory, complex attention, information-processing speed and psychomotor speed in up to 70% of patients.\textsuperscript{8,9} The postoperative cognitive changes may result from non specific effects of surgery or anesthesia.

**Cognitive retraining**

Brain injury produces a complex constellation of medical consequences, including physical, emotional and cognitive deficits. Cognitive impairments in memory, reasoning, attention, judgment and self-awareness are prominent roadblocks on the path to functional independence and a productive lifestyle for the person with brain trauma. Cognitive rehabilitation is defined as a systematic, functionally oriented service of therapeutic cognitive activities, based on an assessment and understanding of the person’s brain-behavior deficits. Services are directed to achieve functional changes by reinforcing, strengthening or re-establishing previously learned patterns of behavior, or establishing new patterns of cognitive activity through compensatory mechanisms.\textsuperscript{10}

**CASE REPORT**

A 30-year-old married woman, a homemaker, educated up to class XII, with upper socio economic background, was brought with complaints of forgetfulness, anger outbursts, irritability, stiffness and loss of sensation in left hand since 3 years. Onset was abrupt, and it was continuous in course. The precipitating factor was cardiac and respiratory arrest during the delivery of the third child. The patient was functioning normally till the delivery of the third child. Cardiac and respiratory arrest occurred during labor; she was on ventilators for 24 hours, was unconscious for 5 days and hospitalized for 15 days. After discharge from the hospital, she was able to recognize friends and relatives; however, she did not remember the reason for hospitalization. She had stiffness and partial loss of sensation in the left hand. She would forget day-to-day events, phone numbers, etc. This caused distress to family members. Biological functions were normal. Sexual functioning was deviod—it was a conscious decision made by the husband fearing that the patient might become pregnant. Her husband wanted to remarry due to her above-mentioned condition. She was brought to NIMHANS in February 2004. Diagnosis of hypoxic encephalopathy was made. She was referred from adult psychiatry unit to family psychiatry Unit and Neuropsychology Unit for family therapy and neuropsychological assessment and rehabilitation.

**Neuropsychological assessment and rehabilitation**

After obtaining written informed consent from the patient, neuropsychological assessment and retraining were carried out.

**Pre cognitive retraining**

Neuropsychological assessment showed deficits in attention, fluency, working memory, planning, verbal and visual learning and memory. The neuropsychological profile was indicative of dorso-lateral pre-frontal cortex and bilateral temporal lobe involvement.

Cognitive retraining was carried out for a period of 7 months over 138 sessions — everyday for 1 hour. Principles of saturation cueing were followed. The tasks were given in an order of increasing difficulty. The tasks were designed in such a way that the design had provisions for scoring error and time [Table 1].

**RESULTS**

Cognitive functioning of the patient was compared with normative data derived from a group of 540 normal healthy volunteers.\textsuperscript{11} Based on the number of test variables falling below the 15\textsuperscript{th} percentile, the severity of cognitive impairment was established. In the pre cognitive retraining neuropsychological assessment, deficits were seen in motor and mental speed, attention, fluency, working memory, planning, comprehension, verbal and visual learning and memory. In the postcognitive retraining neuropsychological assessment, significant improvement was seen on all the tests except divided attention and verbal and visual learning and memory [Figures 1 and 2, Table 2].
**DISCUSSION**

Following pre cognitive retraining neuropsychological assessment, deficits in the domains of attention, executive functions and verbal and visual learning and memory were seen. Cognitive retraining commenced with the target of improving the basic functions, viz., attention tasks were given to improve both focused and sustained attention, and response inhibition tasks were started from the first session onwards. Patient started showing improvement on these tasks and hence tasks for working memory were introduced from the 42nd session. In the 53rd session, verbal memory task was introduced. Patient showed significant improvement in all the tasks and in her day-to-day functioning, which was reported by the family members. However, her emotional regulation remained a matter of concern; hence tasks were devised to improve her emotional problems and were introduced in the 86th session. In all, the patient underwent cognitive retraining for 138 sessions in 7 months. Improvement was seen in the tasks as well as in her everyday functioning.

**Process issues during cognitive retraining**

Cognitive retraining began with the explanation of the tasks. The patient did not understand the implicit reasons for the tasks; hence she resisted by repeated questioning of ‘Why? Why Not? What For?’ Hence the importance of the tasks in relation to certain behavior of the patient was focused upon during explanation. Significance of the activity was indicated to her. Initially the therapist used paralinguistic modes, e.g., body language, changes in amplitude of the voice, alteration of movements, etc. Importance of motivation in the tasks was explained, and the patient was helped in orientation towards the search for meaning. It was ensured that the meaning had been registered and connections related to other events were highlighted; and she was helped to experience the success and to see its impact towards generalization on day-to-day functioning.

Since the patient had low self-esteem, feeling of competence was emphasized; and this was accompanied by helping the patient experience success or perceive the positive value of previously experienced encounters, offering enough assistance for success but limiting the same so that patient did not become dependent on the therapist. Patient also exhibited poor inhibitory control and hence this was achieved through regulation of control of behavior from inhibition to internal control, nonreflective to self-reflection, response inappropriateness to response appropriateness were emphasized. Due to poor inhibitory control, patient was confined at home, since the family members felt embarrassed in social situations; hence the need to go outside on her own and participating with others to make others participate with the patient in social situations was explained. The meaning of sharing the process and experience was explained and amplified.

**Table 1: Functions, tasks and number of sessions**

| Functions                  | No. of sessions |
|----------------------------|-----------------|
| Attention                  |                 |
| Sustained and focused      | 138             |
| Response inhibition        | 138             |
| Working memory             | 96 (42-138)     |
| Verbal memory              | 85 (53-138)     |
| Visual memory              | 46 (92-138)     |
| Emotional regulation       | 52 (86-138)     |

**Table 2: Visual analogue scale of symptoms**

| Symptoms            | Pre | Post |
|---------------------|-----|------|
| Forgetfulness       | 10  | 2    |
| Irritability        | 9   | 3    |
| Anger outbursts     | 9   | 2    |
| Lack of interest    | 9   | 1    |

Rating was on 10-point visual analogue scale by the patient’s father and husband (1-10) (score of 1 indicates adequate functioning; score of 10 indicates severe functioning).
Patient was helped to become independent in her activities and thinking; trust and acceptance was emphasized with the family members significant others. Emotional affective relationship was enhanced by a feeling of belonging to and a feeling of acceptance by others. The patient was also assisted in mediated goal-seeking, setting, planning and achieving desired behavior.

**Counseling and therapy**

Individual therapy as and when required was administered for 31 sessions. Issues regarding adjustment with her father; her personal requirements, which were at times unreasonable; etc., were dealt with. Supportive therapy was carried out with participation of her husband and father for 9 sessions. Since the patient was very demanding, they found it difficult to handle her; they were educated about the problems and were taught to handle her appropriately. Marital therapy including individual and joint sessions was carried out; predominantly emphasis was laid on their sexual functioning; this was carried out for 11 sessions. Other family issues as to how to handle the patient during her anger outbursts, adjustments with family members were addressed — 6 sessions with the patient’s brother and mother were carried out.

Cognitive retraining has been shown to be useful in hypoxic brain damage. Cognitive retraining combined with other adjunct therapy has been shown to have significant impact on the patient and the family members.

Cognitive retraining involves structured, systematic training to ameliorate cognitive dysfunction and to improve the quality of life in patients with brain injury. The training can be given hospital based or home based. Home-based cognitive retraining package[12] is administered by the family members of the patient. It is cost effective and has wide applicability.

**CONCLUSIONS**

- Cognitive retraining is useful in hypoxic brain damage.
- Cognitive retraining along with other adjunct therapy seeks to retrain and re-educate patients to compromise and cope with existing problems.
- Cognitive retraining integrates patients back into the society at the highest possible level of functioning.

**REFERENCES**

1. Newman MF, Croughwell ND, Blumenthal JA, Lowry E, White WD, Reves JG. Cardiopulmonary bypass and the central nervous system: Potential for cerebral protection. J Clin Anesth 1994;8:538-605.
2. Newman MF, Kramer D, Croughwell ND, Sanderson I, Blumenthal JA, White WD, et al. Differential age effects of mean arterial pressure and rewarming on cognitive dysfunction after cardiac surgery. Anesth Analg 1995;81:236-42.
3. Dodds C, Allison J. Postoperative cognitive deficit in the elderly surgical patient. Br J Anaesth 1999;81:449-62.
4. Blumenthal JA, Madden DJ, Burker EJ, Croughwell N, Schniebolk S, Smith R, et al. A preliminary study of the effects of cardiac procedures on cognitive performance. Int J Psychosom 1991;38:13-6.
5. Croughwell ND, Newman MF, Blumenthal JA, White WD, Lewis JB, Frasco PE, et al. Jugular bulb saturation and cognitive dysfunction after cardiopulmonary bypass. Ann Thorac Surg 1994;58:1702-8.
6. Barbut D, Caplan LR. Brain complications of cardiac surgery. Curr Probl Cardiol 1997;22:449-80.
7. Newman MF, Kirchner JL, Phillips-Bute B, Gaver V, Grocott H, Jones RH, et al. Longitudinal assessment of neurocognitive function after coronary artery bypass surgery. N Engl J Med 2001;344:395-402.
8. Newman MF, Croughwell ND, Blumenthal JA, Lowry E, White WD, Spillane W, et al. Predictors of cognitive decline after cardiac operation. Ann Thorac Surg 1995;59:1326-30.
9. O’Keefe ST, Chonchubhair AN. Postoperative delirium in the elderly. Br J Anaesth 1994;73:673-87.
10. Harley JP, Braciszewski AC, Cicerone TL, Dahlberg KD, Evans C, Foto S, et al. Guidelines for cognitive rehabilitation. Neuro Rehabil 1992;2:62-7.
11. Rao SL, Subbakrishna DK, Gopukumar K. NIMHANS Neuropsychology Battery—2004 manual. India: NIMHANS Publication; 2004.
12. Rao SL, Home based cognitive retraining. Presented at the CEN-2007 Neuropsychological assessment and rehabilitation workshop. NIMHANS; 2004.

**Source of Support:** Nil, **Conflict of Interest:** None.