

## Neurobehavioral Changes: An under looked aspect of Head Injury

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**Background:** Different types of behavioral changes are seen in head injury patients, and these changes are directly or indirectly related to daily activities. Major alterations of personality after head injury are generally seen in the patients with severe head injury. However, disturbing post-concussional symptoms like headache, dizziness and memory problems generally persists for few months even in the less severely injured ones.

**Materials and methods:** Objective: To analyze the neurobehavioral changes in adult head injured patients. Study design: Prospective analytical study. Sampling technique: Non - probability consecutive sampling. Site of study: National Institute of Neurological and Allied Sciences, Bansbari, Nepal. Inclusion Criteria: All head injured patients above the age of 16 years. Exclusion Criteria: Extended Glasgow Outcome Scale of less than 3 at 6 months follow up. Data Collection and Analysis: All patients above the age of 16 years with head injury who got admitted were enrolled in the study. Parameters like age, gender, mode of injury, GCS at presentation were recorded. Extended Glasgow Outcome Scale along with Neurobehavioral rating was evaluated at 6 months. Then neurobehavioral rating scale was obtained by direct interview. Data analysis was done using SPSS v.20.

**Results:** Total number patients were 76 among which 71% were below 40 years of age and majorities (87%) were males. Neurobehavioral categories like abnormal intentional behavior, lowered emotional state, heightened emotional state, arousal state and language had significant association with GCS at presentation and EGOS at 6 months. Similarly, age had significant association with language, where there was absent to mild language difficulty in patients below 40 years of age. Likewise, language difficulty, lower emotional state and abnormal intentional behavior were significantly associated with gender, as it was mild to severe in 30% of the female population who had sustained head injury.

**Conclusion:** Several neurobehavioral characters seem to be present in the various categories of the head injured patients in different ratios. Language problems seems to be less in the younger patients below the age of 40 years; although, few neurobehavioral parameters seems to affects the females more common compared to male counterparts. Also, family disruption and its extent of severity was significantly related to the severity of head injury

**Key words:** Extended Glasgow Outcome Scale, Head injury, Neurobehavioral Rating Scale, Traumatic brain injury.

Behavioral disturbance is frequently manifested by patients during the subacute stage of recovery from severe closed head injury.<sup>1-7</sup> Residual behavioral problems are particularly debilitating sequelae of severe closed head injury which contribute immensely to chronic disability,<sup>8</sup> impose a burden on the family<sup>9-11</sup> and provide a challenge to rehabilitation.<sup>10</sup>

Although major alterations of personality after head trauma are generally confined to severe injury,<sup>2,9,12</sup> post-concussional symptoms like headaches, dizziness, fatigability, difficulty in concentration and memory and associated emotional distress may frequently persist for at least 1 to 3 months following minor head injury.<sup>13-15</sup> These symptoms, however minor, could nonetheless have long term psychosocial implications.

Administration of structured interviews and rating scales to relatives has elucidated the diversity of behavioral sequelae exhibited by head injured patients in various situations and the psychiatric repercussions imposed on family members.<sup>9,16</sup> However, ratings by the clinician-investigator and self-reports by the patient can also be informative in assessing psychosocial outcome of closed head injury.

With the aim to analyze the neurobehavioral changes in adult head injured patients this study was performed.

**Methods and Materials:**

Analytical prospective study at National institute of Neurological and Allied Sciences Bansbari, Kathmandu, Nepal

Sampling technique: Consecutive non – probability sampling

Inclusion Criteria: All head injured patients above the age of 16 years. Exclusion Criteria: Extended Glasgow Outcome Scale of less than 3 at 6 months follow up.

Data Collection and Analysis: All patients who met the inclusion criteria were enrolled in the study. Their age, gender, mode of injury, GCS at presentation were collected. Extended Glasgow Outcome Scale and Neurobehavioral rating were evaluated at 6 months. Then neurobehavioral rating scale was obtained from all the remaining patients by direct interview using Levin’s Neurobehavioral Rating (NBR) Scale - Revised.<sup>17</sup> Data analysis was done using SPSS v.20. The frequencies were calculated for age, gender, mode of injury, severity of head injury, GOS-E and NBR changes.

Similarly, chi square test or fisher exact test where applicable were used to see the association of age, gender, severity of head injury, and GOS-E with the different NBR categories.

**Results:**

Total number of 76 patients were enrolled in the study with male (66, 87%) predominance compared to females (10, 13%). The mean age of the study population was 34.15 (SD 14.76). Majority of the injuries were due to road traffic accident (RTA) (46%), followed by injury due to fall (28%), physical assault (20%) and other mode of injuries (6%). In this study, 76% were mild head injury, followed by severe head injury (15%) and moderated head injury (9%)

GOS-E of eight was seen in 43% followed by GOS-E of seven in 37%. However, there were 20% of patients with GOS-E of ≤ 6.

Abnormal overall NBR in terms of abnormal intentional behavior, lowered emotional state, heightened emotional state, arousal state, and language were 10 (13.4%), 10(13.4%), 10(13.4%), 8(10.5%), and 11(14.5%) respectively (Table 1).

**Table 1: Overall Neurobehavioral changes**

Neurobehavioral Changes	Absent	Mild	Moderate	Severe	Total abnormal NBR
Abnormal intentional behavior	66(86.8%)	7(9.2%)	2(2.6%)	1(1.3%)	10 (13.4%)
Lowered emotional state	66(86.6%)	9(11.8%)	-	1(1.3%)	10(13.4%)
Heightened emotional state	66(86.6%)	7(9.2%)	2(2.6%)	1(1.3%)	10(13.4%)
Arousal state	68(89.5%)	6(7.9%)	2(2.6%)	-	8(10.5%)
Language	65(85.5%)	10(13.2%)	-	1(1.3%)	11(14.5%)

However, sub-categorical analysis of individual behavior showed 34/76 had headache as a somatic

concern, followed by 22/76 had depressive mood, 19/76 had irritability, 18/76 had agitation and so on (Table 2 and 3)

**Table 2: Overall frequency of different NBR category**

NBR individual	Absent	Mild	Moderate	Severe	Total of abnormal NBR Category
<b>Intentional Behavior</b>					
<b>Decreased initiative or motivation</b>	65	7	3	1	11
<b>Blunted affect</b>	62	11	2	1	14
<b>Difficulty in planning</b>	64	7	4	1	12
<b>Conceptual disorganization</b>	66	5	4	1	10
<b>Self-appraisal difficulties</b>	64	8	3	1	12
<b>Disorientation</b>	63	9	3	1	13
<b>Difficulty in mental flexibility</b>	66	8	1	1	10
<b>Memory difficulties</b>	62	10	3	1	14
<b>Emotional State (Lowered)</b>					
<b>Depressive mood</b>	54	20	1	1	22
<b>Anxiety</b>	60	15	0	1	16
<b>Emotional withdrawal</b>	66	7	2	1	10

**Table 3: Overall frequency of different NBR category contd...**

NBR individual	Absent	Mild	Moderate	Severe	Total of abnormal NBR Category
<b>Survival Orientation Behavior/ Emotional state (heightened) :</b>					

<b>Irritability</b>	57	12	5	2	19
<b>Hostility</b>	63	10	1	2	13
<b>Disinhibition</b>	63	10	2	1	13
<b>Hyperactivity / agitation</b>	58	10	7	1	18
<b>Unusual thought content</b>	65	7	3	1	11
<b>Excitement</b>	68	4	4	0	8
<b>Suspiciousness</b>	74	0	1	1	2
<b>Liability of mood</b>	62	10	3	1	14
<b>Arousal State :</b>					
<b>Reduced alertness</b>	66	9	1	0	10
<b>Mental fatigability</b>	68	6	2	0	8
<b>Attention</b>	66	9	1	0	10
<b>Motor slowing</b>	65	8	2	1	11
<b>Language :</b>					
<b>Difficulty in oral expression</b>	62	11	2	1	14
<b>Difficulties in oral comprehension</b>	65	7	3	1	11
<b>Difficulty in articulation</b>	66	8	2	0	10
<b>Not included in NRS –R item :</b>					
<b>Somatic concern ( headache)</b>	42	30	4	0	34
<b>Guilt</b>	70	6	0	0	6
<b>Hallucinations</b>	73	3	0	0	3

While calculating the overall NBR abnormalities with the various head injuries grades, all of them  
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were present in moderate and severe head injuries, which was 5(71.4%) and 8(72.7%) respectively (Table 4).

**Table 4: Overall NBR Abnormality in Various Head Injury Grades**

	No. of Patients	Overall NBR abnormality
Mild Head Injury	58	0 (0%)
Moderate Head injury	7	5 (71.4%)
Severe Head injury	11	8 (72.7%)
<b>Total</b>	<b>76</b>	<b>13 (17.1%)</b>

However, sub-group analysis of each of the behavioral changes showed 24 out of 58 mild head injured patients had headache as a somatic concern followed by few other changes like depressive mood, anxiety and irritability.

Overall association of gender with NBR was not statistically significant; however, sub-group analysis showed females to be significantly more affected with Intentional behavior, Lowered emotional state, Language. Similarly males were more affected with heightened emotional behavioral changes significantly (Table 5).

**Table 5: Sex Vs NBR in different category**

Intentional behavior					
Sex	Absent	Mild	Moderate	Severe	P Value
<b>Female</b>	7 (70%)	2 (20%)	0	1 (10%)	0.033*
<b>Male</b>	59 (89.39%)	5 (7.58%)	2 (3.03%)	0	
Lowered emotional state					
<b>Female</b>	7 (70%)	2 (20%)	0	1 (10%)	0.022*
<b>Male</b>	59 (89.39%)	7 (10.61%)	0	0	
Heightened emotional state					

<b>Female</b>	9 (90%)	0	0	1 (10%)	0.046*
<b>Male</b>	57 (86.36%)	7 (10.61%)	2 (3.03%)	0	
Arousal state					
<b>Female</b>	8 (80%)	1 (10%)	1 (10%)	0	0.279
<b>Male</b>	60 (90.91%)	5 (7.58%)	1 (1.52%)	0	
Language					
<b>Female</b>	7 (70%)	2 (20%)	0	1 (10%)	0.026 *
<b>Male</b>	58 (87.88%)	8 (12.12%)	0	0	

Overall association of age with NBR was not statistically significant; however, sub-group analysis showed age group of 60-69 year is more affected in language (Table 6 and 7).

**Table 6: Age Vs NBR category**

Intentional behavior					
Age	Absent	Mild	Moderate	Severe	P Value
<b>10-19</b>	13 (92.86%)	0	0	1 (7.14%)	0.399
<b>20-29</b>	15 (78.95%)	4 (21.05%)	0	0	
<b>30-39</b>	19 (90.48%)	1 (4.76%)	1(4.76%)	0	
<b>40-49</b>	7 (87.5%)	0	1(12.55)	0	
<b>50-59</b>	9 (90%)	1(10%)	0	0	
<b>60-69</b>	3 (75%)	1(25%)	0	0	
Lowered emotional state					
<b>10-19</b>	12 (85.71%)	1 (7.14%)	0	1 (7.14%)	0.284
<b>20-29</b>	16 (84.21%)	3 (15.79%)	0	0	
<b>30-39</b>	19 (90.48%)	2 (9.52%)	0	0	
<b>40-49</b>	7 (87.5%)	1(12.55)	0	0	

<b>50-59</b>	10 (100%)	0	0	0
<b>60-69</b>	2 (50%)	2(50%)	0	0

<b>40-49</b>	7 (87.5%)	1 (12.55)	0	0
<b>50-59</b>	9 (90%)	1 (10%)	0	0
<b>60-69</b>	2 (50%)	1 (25%)	0	1 (25%)

**Table 7: Age Vs NBR category contd...**

Heightened emotional state					
<b>10-19</b>	12 (85.71%)	1 (7.14%)	0	1 (7.14%)	0.183
<b>20-29</b>	17 (89.47%)	2 (10.53%)	0	0	
<b>30-39</b>	19 (90.48%)	0	2 (9.52%)	0	
<b>40-49</b>	7 (87.5%)	1 (12.55)	0	0	
<b>50-59</b>	9 (90%)	1 (10%)	0	0	
<b>60-69</b>	2 (50%)	2 (50%)	0	0	
Arousal state					
<b>10-19</b>	13 (92.86%)	0	1 (7.14%)	0	0.169
<b>20-29</b>	18 (94.74%)	1 (5.26%)	0	0	
<b>30-39</b>	19 (90.48%)	1 (4.76%)	1 (4.76%)	0	
<b>40-49</b>	7 (87.5%)	1 (12.55)	0	0	
<b>50-59</b>	9 (90%)	9 (90%)	0	0	
<b>60-69</b>	2 (50%)	2 (50%)	0	0	
Language					
<b>10-19</b>	13 (92.86%)	1 (7.14%)	0	0	0.022*
<b>20-29</b>	15 (78.95%)	4 (21.05%)	0	0	
<b>30-39</b>	19 (90.48%)	2 (9.52%)	0	0	

The association of admission GCS has got significant relation with the overall neurobehavioral changes (P Value <0.001\*). The more the grade of head injury the more is its association with the NBR changes (**Table 8**).

**Table 8: Grade of head injury Vs NBR category**

Intentional behavior					
GCS Category	Absent	Mild	Moderate	Severe	P Value
<b>13-15</b>	58 (100%)	0	0	0	0.000*
<b>9-12</b>	3 (42.86%)	2(28.57%)	1(14.29%)	1(14.29%)	
<b>3-8</b>	5 (45.45%)	5(45.45%)	1(9.09%)	0	
Lowered emotional state					
<b>13-15</b>	58 (100%)	0	0	0	0.000*
<b>9-12</b>	4 (57.14%)	2(28.57%)	0	1(14.29%)	
<b>3-8</b>	4 (36.36%)	7(63.64%)	0	0	
Heightened emotional state					
<b>13-15</b>	58(100%)	0	0	0	0.000*
<b>9-12</b>	2(28.57%)	4 (57.14%)	0	1(14.29%)	
<b>3-8</b>	6 (54.55%)	3(27.27%)	2(18.18%)	0	
Arousal state					
<b>13-15</b>	58 (100%)	0	0	0	0.000*
<b>9-12</b>	3 (42.86%)	3 (42.86%)	0	1 (14.29%)	
<b>3-8</b>	7 (63.64%)	3 (27.27%)	0	1(14.29%)	
Language					

<b>13-15</b>	58(100%)	0	0	0	0.000*
<b>9-12</b>	2(28.57%)	5 (71.43%)	0	0	
<b>3-8</b>	5(45.45%)	5(45.45%)	0	1(9.09%)	

The association of GOS-E has got significant relation with the overall neurobehavioral changes (P Value <0.001\*). The low the GOS-E score, higher is the frequency of the abnormal NBR noted and was significant in all the sub-group categories (Table 9 and 10).

**Table 9: Relation of GOS-E with NBR category at 6 months**

Intentional behavior					
GOS-E at 6month	Absent	Mild	Moderate	Severe	P Value
<b>4</b>	1(33.33%)	1(33.33%)	0	1(33.33%)	0.000*
<b>5</b>	3(27.27%)	6(54.54%)	2(18.18%)	0	
<b>6</b>	1(100%)	0	0	0	
<b>7</b>	28(100%)	0	0	0	
<b>8</b>	33(100%)	0	0	0	

  

Lowered emotional state					
GOS-E at 6month					
<b>4</b>	0	2(66.67%)	0	1(33.33%)	0.000*
<b>5</b>	4(36.36%)	7(63.64%)	0	0	
<b>6</b>	1(100%)	0	0	0	
<b>7</b>	28(100%)	0	0	0	
<b>8</b>	33(100%)	0	0	0	

  

Heightened emotional state					
GOS-E at 6month					

<b>4</b>	1(33.33%)	1(33.33%)	0	1(33.33%)	0.000*
<b>5</b>	4(36.36%)	5(45.45%)	2(18.18%)	0	
<b>6</b>	1(100%)	0	0	0	
<b>7</b>	28(100%)	0	0	0	
<b>8</b>	32(96.96%)	1(3.04%)	0	0	

**Table 10: Relation of GOS-E with NBR category at 6 months contd...**

Arousal state					
GOS-E at 6month					
<b>4</b>	1(33.33%)	1(33.33%)	0	1(33.33%)	0.000*
<b>5</b>	6(54.54%)	4(36.36%)	0	1(9.09%)	
<b>6</b>	1(100%)	0	0	0	
<b>7</b>	28(100%)	0	0	0	
<b>8</b>	32(96.96%)	1(3.04%)	0	0	

  

Language					
GOS-E at 6month					
<b>4</b>	1(33.33%)	1(33.33%)	0	1(33.33%)	0.000*
<b>5</b>	3(27.27%)	8(72.72%)	0	0	
<b>6</b>	1(100%)	0	0	0	
<b>7</b>	28(100%)	0	0	0	

## Discussion:

In this study, abnormal overall NBR in terms of abnormal intentional behavior, lowered emotional state, heightened emotional state, arousal state, and language were 10 (13.4%), 10(13.4%), 10(13.4%), 8(10.5%), and 11(14.5%) respectively. However, sub-categorical analysis of individual behavior showed 34/76 had headache as a somatic concern, followed by 22/76 depressive mood, 19/76 irritability, 18/76 agitation and so on. Similarly, in the study of Mazaux JM et al<sup>18</sup> where they noted depressive mood being the most common (52%) findings in the head injured patients, followed by mental fatigability (47%), memory difficulty (46%), anxiety (28%), lack of initiative and motivation (28%) and so on. These findings are somewhat similar to this present study.

In the literatures, neurobehavioral abnormalities were more severe in patients with moderate and severe head injuries compared to the mild head injury.<sup>17</sup> In our study, 71.4% of the moderate and 72.7% of the severe head injured patients had such abnormality. The somatic concern like headache were present in 24 out of 58 mild head injured patients followed by few other changes like depressive mood, anxiety and irritability in the same head injury category. The grade of head injuries were also highly significant in all the categories of NBR, where poor the initial GCS had the worst neurobehavioral abnormalities.

Also as expected, better the outcome of the patients at six months, there was less severe the NBR and these values were also highly significant in all the subgroup analysis of the NBR.

Gender is not often tested against the occurrence of neurobehavioral changes. However, in our study, sub-group analysis showed females to be significantly more affected with Intentional behavior, Lowered emotional state and Language. Males were however; more affected with Heightened emotional behavioral changes significantly.

Age could be another confounding variable in the neurobehavioral changes, which in our study showed occurrence of language problem in the elderly population (>60 years).

## Conclusion:

On the basis of this modest study if we may, we like to suggest that neurobehavioral changes seems to be found in all grades of severity with the severe ones having the highest. Females seem to be more affected with abnormality in intentional behavior, lowered emotional state and language whereas males are more affected with heightened emotional state. Also, these neurobehavioral changes seem to be strongly associated with admission GCS and GOS-E.

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