

# Effects of a Sensory Stimulation by Nurses and Families on Level of Cognitive Function, and Basic Cognitive Sensory Recovery of Comatose Patients With Severe Traumatic Brain Injury: A Randomized Control Trial

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## Abstract

**Background:** Several lines of evidence suggest that early sensory stimulation and regular family visiting programs are potential nursing interventions to improve the outcomes of head injured comatose patients. However, little is known about the impacts of family involvement in providing sensory stimulation.

**Objectives:** To determine the effects of a sensory stimulation program conducted by nurses and families on the consciousness, level of cognitive function, and basic cognitive sensory recovery of head injury comatose patients.

**Patients and Methods:** This was a randomized clinical trial performed at the Shiraz level I trauma center including 60 head injured comatose patients with an initial Glasgow coma score (GCS) of less than 8. Patients were randomly assigned to receive sensory stimulation by a qualified nurse (nurse group; n = 20), by the family (family group; n = 20), or usual care (control group; n = 20). The sensory stimulation program involving the nurses and patients' families was conducted, twice daily, in the morning and evening for 7 days. The level of consciousness, level of cognitive function, and basic cognitive sensory recovery of the patients were evaluated and monitored using the GCS, Rancho Los Amigos (RLA), and Western Neuro-Sensory stimulation profile (WNSSP). Data were analyzed by chi square, Kruskal-Wallis, and repeated-measures tests using SPSS.

**Results:** All the patients were comparable regarding their baseline characteristics, level of consciousness, level of cognitive function, and basic cognitive sensory recovery determined by GCS, RLA, and WNSSP. Although the two intervention groups of the study improved, those who received the sensory stimulation program from their families had significantly higher GCS (P = 0.001), RLA (P = 0.001), and WNSSP (P = 0.001) scores after 7 days when compared to the two other groups.

**Conclusions:** The application of sensory stimulation by families led to significant increases in the consciousness, level of cognitive function, and basic cognitive sensory recovery of comatose patients with severe injuries.

**Keywords:** Coma, Sensory Stimulation, Traumatic Brain Injury, Consciousness Level, Cognitive Function

## 1. Background

Comas are mainly the result of trauma related to road traffic accidents (1-4). While patients frequently recover from comas, those with severe traumatic brain injury (TBI) will experience an alteration in their level of consciousness and cognitive function for a period of time. An increased length of these alterations (coma) is associated with worse outcomes; as such, most of those who survive are unable to live a normal life due to impaired cognitive function (5, 6). Prolonged hospitalization, social isolation, and complete bed rest in these patients will result in reduced sensory perception secondary to reduced sensory input (7).

It is hypothesized that applying a structured sensory stimulation program in those suffering from severe TBI will facilitate the recovery process and prevent sensory deprivation (7-10). Different types of sensory stimulation such as visual, auditory, tactile, olfactory, gustatory, and equilibrium stimulation can be used or applied in these patients (9). The research on the efficacy of musico kinetic therapy (MKT) as sensory stimulation for patients in a persistent vegetative state showed that the vegetative state score of patients with brain damage caused by trauma or subarachnoid hemorrhage can be more significantly improved than vegetative state patients with other underlying causes. In addition, the effects of MKT were clearly bet-

ter in patients in whom the MKT was initiated within 6 months after brain damage (11). In another study, a multimodal onset stimulation therapy (MEOS) was developed and applied during an early phase of rehabilitation to patients who had been in a coma for more than 48 hours following trauma. The authors identified significant changes in two of the patients' vegetative parameters (viz. heart and respiratory rates), even in cases of a deep coma (Glasgow coma score (GCS) 3 - 4). The most significant changes were caused by tactile and acoustic stimulation (12). Considering the importance of the early onset of sensory stimulation, in another study, the effects of a structured auditory sensory stimulation program were examined. The researchers initiated their program of sensory stimulation 3 days post injury and it continued for 7 days. The intervention group of the study showed a positive recovery of function, as evidenced by their higher GCS and RLA scores between baseline and upon discharge. Sensory stimulation did not affect hemodynamic or cerebral dynamic status (13). The results of another study suggest that sensory stimulation programs should be applied for more than 1 month to achieve a permanent effect on consciousness levels and that at least 2 weeks are required for any significant effect (7).

While the importance of sensory stimulation for patients in a coma has been considered in the literature, there is no strong evidence to determine whether sensory stimulation benefits people in comas (14). Furthermore, in most of these studies, sensory stimulation is provided by nurses rather than family members.

The involvement of families in patient care has been considered in other areas of care (15, 16); however, family involvement in intensive care units (ICUs) is limited to open visitation policies that provide a supportive and more familiar environment for patients and improve the relationship between nurses and families (17). It has been shown that family visits in ICUs are effective in offering programmed and structured approaches to providing nursing care to patients (18-22). Holding family meetings in ICUs within the first 3 days has led to success in reducing the length of stay in ICUs (20).

Although a great deal has been written about the needs and changes in practice regarding patients' families, little has been published on how to provide family-centered care (23). Previous lines of evidence suggest that involving families in nursing care should lead to better outcomes. However, this involvement in critical care units has always been a challenge for nurses; thus, many critical care units continue to struggle with implementing or maintaining family-centered critical care (23).

## 2. Objectives

We sought to assess the effect of an early sensory stimulation program provided either by a nurse or family member as a potential nursing intervention to improve the outcome of head injury comatose patients.

## 3. Patients and Methods

### 3.1. Study Population

This was a double blind clinical trial (Irct ID: IRCT201111262621N9) performed in ICUs of Shahid Rajaei hospital, a level I trauma center affiliated with Shiraz University of Medical Sciences during a 10-month period from January to October 2011. It was estimated that a sample size of at least 16 individuals per group was needed to detect an effect size of 1, as determined in another study (24) with an alpha risk of 0.05 and power of 0.80. We decided to include 20 subjects per group to compensate for non-evaluable patients. We included 60 adult (> 17 years) comatose patients suffering from severe TBI. Eligible patients were approached on their fourth day of admission if they were in a state of a coma during the first three days of admission, had a GCS score of 3 - 8, a Rancho Los Amigos (RLA) scale of I - II, and stable hemodynamics. Patients who were older than 65 years of age, opium and drug addicts, receiving sedatives, suffering from blindness, deafness and delusional disorders, and seizures were further excluded from the study.

### 3.2. Randomization and Intervention

The demographic information including age, sex, marital status, education, type of injury, injuries along with the head injury, cause of hospitalization, and vital signs upon admission consisting of temperature, heart rate, respiratory rate, and blood pressure were recorded in a data-gathering form. All the eligible patients were randomly assigned to one of three study groups. Those assigned to the family group received the sensory stimulation program from family members (n = 20), while those in the nurse group received the same program from a nurse (n = 20). Those assigned to the control group received usual care (n = 20). For the two intervention groups of the study, the second author assisted the family members to list all the stimulators familiar to the patient to be used in the program and the specific stimulus for each sense was chosen in accordance with the patient's priorities, his or her favorites, and acquainting the patient's family with the stimulus. The family members were also encouraged to bring perfumes, objects, and tapes at any time to vary the selection of stimuli. In the family group, a training session was

first held with patients' families and they were asked to introduce someone who was emotionally closest to the patients among their family and friends and was capable and willing to do the sensory stimulation program. The sensory stimulation program was conducted in both groups twice a day, in the morning and in the afternoon shift, each lasting for half an hour. The program was conducted for 7 days for each patient. The sensory stimulation protocol was developed based on previous studies (7) and was given to the head nurse of the ICU, an occupational therapist, and a neurosurgeon. The protocol was then revised based on their recommendations; the details of the program are provided in the following session.

### 3.3. Sensory Stimulation Program

The sensory stimulation program consisted of five parts as follows:

#### 3.3.1. (Part I) Awakening for 5 Minutes

First, a nurse or a close relative to the patient introduced himself/herself to the patient and spoke to the patient. During this process, a nurse or a close relative of the patient opened the patient's eyes or called him/her while moving his/her body at the same time or moistened the patient's face with a wet gauze.

#### 3.3.2. (Part II) Auditory Stimulation for 10 Minutes

At this stage, the patients' favorite music or taped recordings of the voice of the patient's family members and acquaintances who were speaking directly to patient or just talking to each other were played for the patient.

#### 3.3.3. (Part III) Visual Stimulation for 10 Minutes

A nurse or a close relative to the patient held one of the objects, a family photograph, a family film, a mirror, colored paper, or a 40-watt light bulb colored in red, blue, and green, before the patient's eyes. If the patient's eyes were closed, they were kept open with one hand.

#### 3.3.4. (Part IV) Tactile Stimulation for 5 Minutes

For tactile stimulation, a nurse or a close relative to the patient touched his/her shoulder outside the patient's visual field with a soft brush and a comb, and a hair brush/comb or a soft brush was applied to various body parts. The patient's lips, around the top and bottom, were touched with the tip of a pen or spoon.

#### 3.3.5. (Part V) Olfactory Stimulation for 10 Seconds

This was done using aromatic stimuli with a fragrance to which the patient had been accustomed. These included the patient's favorite aromas, such as perfumes and spices, herbs, orange or lemon peels, and garlic and onion.

To monitor the possible adverse effects of the stimulation program, patients' pulse rate, mean arterial blood pressure, and respiratory rate were assessed before and after the sensory stimulation period to cease the intervention should a problem arise.

### 3.4. Outcome Measures

A qualified nurse, blinded to the groups, measured and recorded the consciousness, level of cognitive function, and basic cognitive sensory recovery in all three groups, using the GCS, RLA, and the western neurosensory stimulation profile (WNSSP) in the afternoon over the course of 7 days.

The GCS is a reliable, objective way of recording individuals' (25) consciousness level, derived from eye opening, verbal response, and motor response. The lowest possible GCS (the sum) is 3 for a deep coma or death, while the highest is 15 for a fully awake person. In the present study we gave the score of one for patients' verbal responses if they were intubated. The inter-rater reliability of GCS has been reported to be in acceptable range (26).

The RLA scale was used to evaluate the behavioral characteristics and cognitive deficits associated with brain injury (Rancho Los Amigos national rehabilitation center). I - No response; II - generalized; III - localized; IV - confused-agitated; V - confused, inappropriate, non-agitated; VI - confused-appropriate; VII - automatic-appropriate; VIII - purposeful-appropriate (the level of cognitive functioning scale (27, 28).

Response to sensory stimulation and basic cognitive sensory recovery was assessed by the WNSSP. The WNSSP had 32 items that assess patients' arousal/attention, expressive communication, and response to auditory, visual, tactile, and olfactory stimulation. All items were scored using multipoint systems that ranged from 0 - 1 to 0 - 5 and varied from item to item. The minimum score is 0 and the maximum score was 110 (8). Two evaluators measured 20 patients' level of consciousness, level of cognitive function, and basic cognitive sensory recovery using the GCS, RLA, and WNSSP scores simultaneously. Spearman's correlation coefficient was 0.94 for GCS, 0.92 for RLA, and 0.92 for WNSSP.

### 3.5. Statistical Analysis

The statistical package for social science, SPSS for Windows, version 16.0 (SPSS, Chicago, Illinois, USA) was used

for the data analysis. Overall differences among groups were determined using the Kruskal-Wallis test for quantitative variables and the chi-Square test for the level of consciousness, level of cognitive function, and basic cognitive sensory recovery. The Mann-Whitney U-test thereafter was used to compare each 2 groups in the study. Repeated measurements were used to determine significant differences regarding patients' consciousness, level of cognitive function, and basic cognitive sensory recovery between and within groups based on the GCS, RLA, and WNSSP scores. Data are reported as means  $\pm$  SD or proportions as appropriate. A 2-sided  $P < 0.05$  was considered statistically significant.

#### 4. Results

Overall, of the 228 patients who were assessed for eligibility during the study, 168 either did not meet the inclusion criteria or met the exclusion criteria. The remaining 60 were randomly assigned to one of the three study groups (each 20 patients). None of the patients in the 3 study groups were lost to follow-up and all the patients finished the study (Figure 1). The 3 study groups were comparable regarding their demographic and baseline characteristics, including age, sex, marital status, education, accompanying injuries, mechanism of injury, and type of brain injury (Table 1). As shown in Table 2, the baseline level of consciousness, level of cognitive function, and basic cognitive sensory recovery determined by the GCS ( $P = 0.292$ ), RLA ( $P = 0.355$ ), and WNSSP ( $P = 0.512$ ) were comparable between groups.

Those who received the sensory stimulation program from their family members had a significantly higher GCS after 7 days than the two other groups ( $P = 0.001$ ) (Table 2). The trend of changes in the level of consciousness in the 3 groups is shown in Figure 2, which indicates that the consciousness level determined by GCS increased in the 3 groups from the first through the seventh day of admission. However, the trend was significantly higher in the family-based sensory stimulation group than the other groups ( $P < 0.001$ ). In the same way, those who received the sensory stimulation program from their family members had significantly higher RLA scores ( $P < 0.001$ ) and WNSSP ( $P < 0.001$ ) than the other groups (Table 2). The trend of change in the RLA and WNSSP scores during the 7 days of intervention is demonstrated in Figures 2 and 3, respectively. The family-based sensory stimulation program was associated with a higher trend in RLA ( $P < 0.001$ ) and WNSSP ( $P < 0.001$ ) changes. This means that there was an improvement in patients' consciousness, level of cognitive functioning, and basic cognitive sensory recovery as time went on with larger improvements noted in the RLA and WNSSP

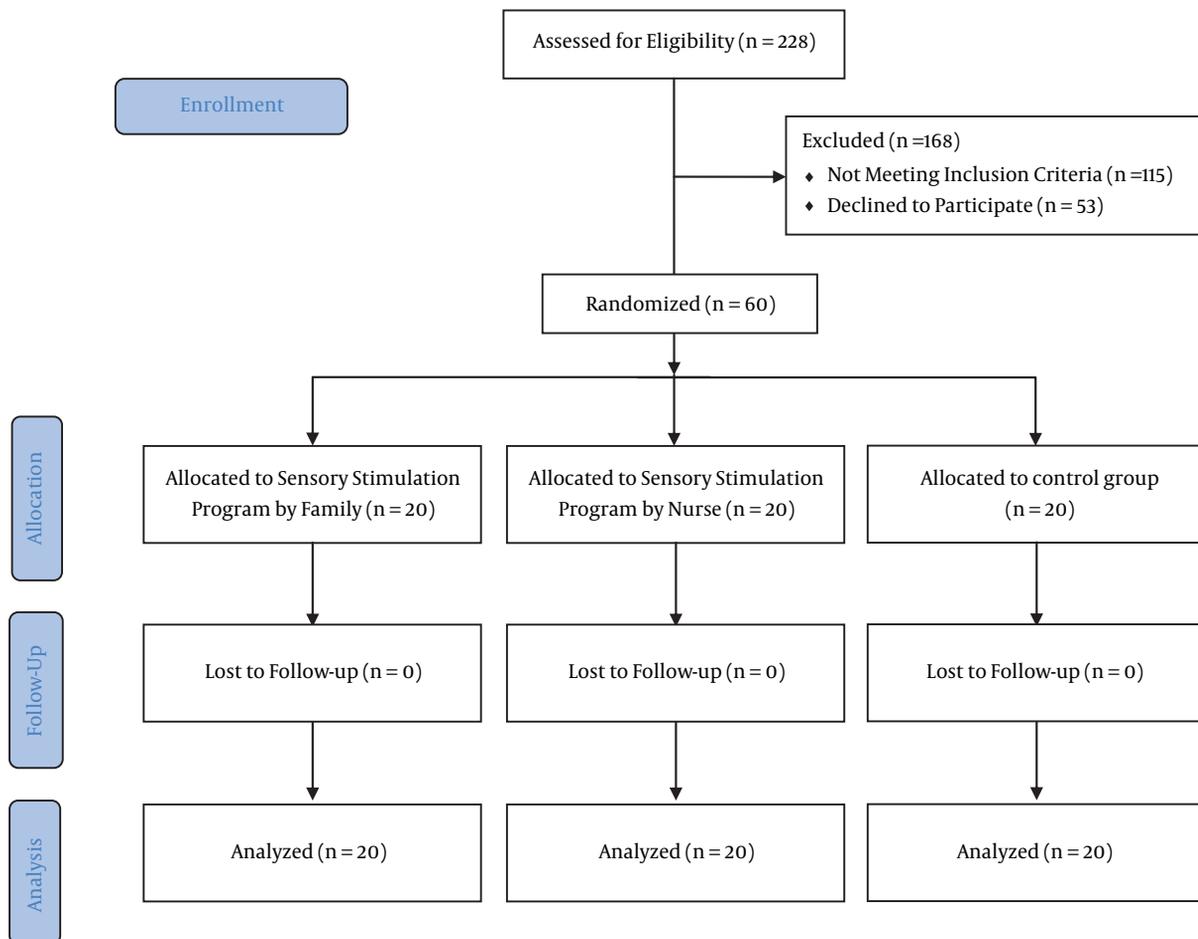
when the intervention was administered by patients' family members (compared to a nurse). Groups were compared to each other using the Mann-Whitney U-test considering a  $P$  value of 0.017 (Bonferroni correction). Results regarding the comparison between the control group and the nurse-based sensory stimulation group revealed no significant difference in their level of consciousness ( $P = 0.98$ ) and level of cognitive functioning ( $P = 0.38$ ); however, these 2 groups significantly differed in their basic cognitive sensory recovery ( $P = 0.002$ ). The comparison between the control group and the family-based sensory stimulation group revealed significant differences in their GCS ( $P = 0.001$ ), RLA ( $P = 0.007$ ), and WNSSP ( $P = 0.001$ ) scores.

The comparison between the family-based sensory stimulation group and the nurse-based sensory stimulation group is indicative of significant differences in the GCS ( $P = 0.001$ ), RLA ( $P = 0.011$ ), and WNSSP ( $P = 0.001$ ) scores.

#### 5. Discussion

The current study was conducted to compare the effect of an early sensory stimulation program provided by a nurse and the same program provided by a family member on the level of consciousness, level of cognitive function, and basic cognitive sensory recovery of head injury comatose patients. We found that the family-conducted sensory stimulation program is associated with higher levels of consciousness determined by the GCS, the level of cognitive function determined by the RLA, and basic cognitive sensory recovery measured by the WNSSP when compared to the nurse-conducted sensory stimulation program in comatose TBI patients. We also observed a gradual increase in the level of consciousness, level of cognitive function, and basic cognitive sensory recovery in the 3 groups during 7 days of intervention. These findings demonstrated that the significant changes in the GCS, RLA, and WNSSP scores are not representative of a single-day intervention, but are rather related to the effect of collective interventions over the course of 7 days.

Trends of the changes in the level of consciousness, level of cognitive function, and basic cognitive sensory recovery following a sensory stimulation program have not been explored in other studies. Oh and Seo carried out a study to examine the effects of multiple sensory stimulation, including auditory, visual, olfactory, gustatory, tactile, and physical programs on the level of consciousness and reported a significant improvement in the level of consciousness after 2 weeks. They indicated that at least 2 weeks of intervention is required to achieve the favorable results. They also indicated that the increase in the level of consciousness would be maintained if the sensory stimulation program were continued for 1 month (7). In the



**Figure 1.** Consort 2010 Flow Diagram for the Study

mentioned study, the researchers applied the program 6 months following a trauma, while in the present study the patients received the intervention in the early course of their ICU admission. We showed that the efficacy of an early sensory stimulation program is favorable, particularly when the program is being conducted by the family members. This is in concordance with Davis and Gimenez' viewpoints on the application of the sensory stimulation in the early stages of brain injury (13).

Karma and Rawat reported a significant improvement in the GCS two weeks after a sensory stimulation program was conducted in their intervention group. However, they found no change in the control group (9). Only one randomized controlled trial conducted by Abbasi et al. (2009) evaluated the effects of sensory stimulation (affective, auditory, and tactile) through structured family visits on consciousness. Patients receiving family visits had considerably higher GCS scores during each day of the intervention

and obtained a mean GCS that was 2 points higher than the control group. The improvements in the consciousness status of our family group who received sensory stimulation by their family members are in accordance with the results found in Abbasi et al.'s study (24). However, it should be noted that the degree of improvement in the GCS levels in the family group of the present study was still higher (3.5 points greater than the control group). It seems that the larger effect of the intervention in the family group in our study can be attributed to the type and duration of sensory stimulation, as Abbasi and colleagues only used touch and hearing stimulation. In addition, it was utilized for 6 days, while in the current study sensory stimulation included four senses and was conducted for 7 days. We did not examine the duration of hospitalization; however, there is some evidence that sensory stimulation reduces the duration of hospitalization (10). Mitchell and colleagues' study (1990) also showed that sensory stimulation can reduce the du-

**Table 1.** Baseline Characteristics of 60 Comatose Patients with TBI in the 3 Study Groups<sup>a</sup>

	Family (n = 20)	Nurse (n = 20)	Control (n = 20)	P Value
<b>Age, y (mean ± SD)</b>	36.2 ± 10.5	37.9 ± 14.6	36.8 ± 12.0	0.983
<b>Gender</b>				0.432
Male	18 (90)	15 (75)	17 (85)	
Female	2 (10)	5 (25)	3 (15)	
<b>Marital status</b>				0.552
Single	4 (20)	7 (35)	5 (25)	
Married	16 (80)	13 (65)	15 (75)	
<b>Education</b>				0.542
> Diploma	2 (10)	8 (40)	3 (15)	
< Diploma	18 (90)	12 (60)	17 (85)	
<b>Surgery</b>				0.272
Yes	4 (20)	8 (40)	11 (55)	
No	16 (80)	12 (60)	9 (45)	
<b>Accompanying injuries</b>				0.887
No injuries	10 (50)	11 (55)	12 (60)	
Limb fracture	3 (15)	3 (15)	4 (20)	
Rib fracture	7 (35)	6 (30)	4 (20)	
<b>Mechanism of injury</b>				0.780
Motor accident	12 (60)	11 (55)	11 (55)	
Car accident	7 (35)	6 (30)	7 (35)	
Falling	1 (5)	3 (15)	10 (50)	
<b>Type of brain injury</b>				
SDH	3 (15)	7 (35)	4 (20)	
ICH	6 (30)	1 (5)	5 (25)	
BC	3 (15)	2 (10)	4 (20)	
DAI	2 (10)	3 (15)	4 (20)	
Mixed	6 (30)	7 (35)	3 (15)	

<sup>a</sup>Values are expressed as No. (%) unless otherwise indicated.

Abbreviation: BC, brain contusion; DAI, diffuse axonal injury; ICH, intracranial hemorrhage; SDH, subdural hematoma.

ration of comas in patients with TBI, but it had no effect on the level of consciousness, as measured by GCS scores (29). The ineffectiveness of sensory stimulation in improving the level of consciousness is not only limited to these studies. Davis (2003) also used an auditory sensory stimulation program and measured the degree of arousal and level of cognitive function in comatose patients. They reported an increase (from 1 to 4) in the level of cognitive function based on the RLA after 7 days, but the level of consciousness based on the GCS remained unchanged (13).

Wood et al. (1992) also found that organized sensory stimulation affected the level of cognitive function based

on the RLA (30). Kater (1989) applied a sensory stimulation program and showed a significant difference between the intervention and control groups' level of cognitive function based on the RLA (31). The present study showed that the stimulation program conducted by patients' families improved their level of cognitive function. Of note, although the RLA scale offers a description of general behavior, it does not provide particular qualitative or quantitative endpoints. Indeed, small but significant changes in the frequency or duration of arousal, like muscle tightening and eye twitches, cannot be detected by conventional clinical outcome tools, such as the RLA levels or GCS scores.

**Table 2.** Level of Consciousness and Cognitive Function Determined by the GCS, RLA, and WNSSP in the 3 Groups of Comatose Patients With TBI During the 7 Days of the Intervention

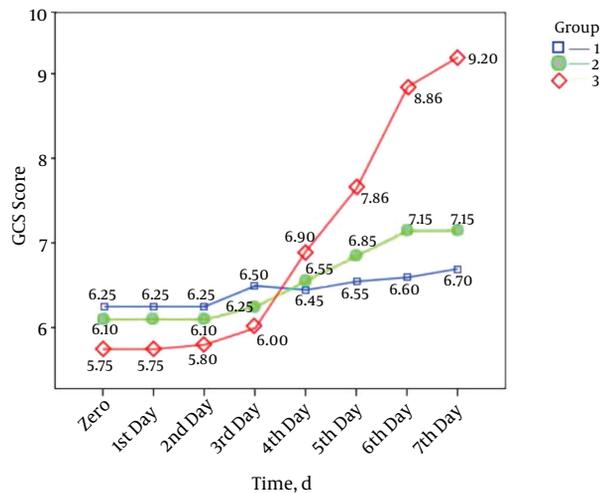
	Family (n = 20)	Nurse (n = 20)	Control (n = 20)	P Value
<b>GCS score</b>				
On admission	5.75 ± 1.02	6.10 ± 1.41	6.25 ± 1.44	0.292
First day	5.75 ± 1.02	6.10 ± 1.41	6.25 ± 1.44	0.292
Second day	5.80 ± 1.05	6.10 ± 1.41	6.25 ± 1.44	0.412
Third day	6.00 ± 1.29	6.25 ± 1.44	6.50 ± 1.50	0.400
Fourth day	6.90 ± 1.51	6.55 ± 1.57	6.45 ± 1.53	0.759
Fifth day	7.65 ± 1.92	6.85 ± 1.53	6.55 ± 1.79	0.313
Sixth day	8.85 ± 2.20	7.15 ± 1.63	6.60 ± 1.98	0.035
Seventh day	9.20 ± 2.16	7.15 ± 1.63	6.70 ± 1.97	0.001
<b>RLA scale</b>				
On admission	2.00 ± 0.000	1.90 ± 0.307	1.95 ± 0.223	0.355
First day	2.00 ± 0.000	1.90 ± 0.307	1.95 ± 0.223	0.355
Second day	2.00 ± 0.000	1.90 ± 0.307	1.95 ± 0.223	0.355
Third day	2.00 ± 0.000	1.90 ± 0.307	2.00 ± 0.324	0.368
Fourth day	2.05 ± 0.223	2.00 ± 0.561	2.00 ± 0.324	0.627
Fifth day	2.60 ± 0.680	2.15 ± 0.670	2.10 ± 0.552	0.006
Sixth day	2.95 ± 0.944	2.15 ± 0.670	2.15 ± 0.587	0.001
Seventh day	3.10 ± 1.200	2.15 ± 0.670	2.15 ± 0.587	0.001
<b>WNSSP</b>				
On admission	7.900 ± 2.468	7.90 ± 2.936	8.70 ± 2.848	0.512
First day	7.900 ± 2.468	7.90 ± 2.936	8.70 ± 2.848	0.512
Second day	9.250 ± 4.482	7.90 ± 2.936	8.70 ± 2.848	0.693
Third day	12.150 ± 6.729	9.10 ± 4.024	9.70 ± 4.354	0.433
Fourth day	17.550 ± 8.888	11.05 ± 5.316	11.15 ± 7.882	0.030
Fifth day	28.150 ± 17.856	15.450 ± 9.741	14.75 ± 16.833	0.003
Sixth day	44.750 ± 32.718	17.650 ± 13.861	14.45 ± 16.956	0.000
Seventh day	50.350 ± 35.712	18.400 ± 13.542	14.55 ± 17.015	0.001

As there is controversy regarding the use of different scales to measure consciousness, the level of cognitive function, or basic cognitive sensory recovery, other indices have been introduced. In this regard, Urbenjaphol et al. used The sensory modality assessment and rehabilitation technique (SMART) and the GCS to evaluate the effects of a sensory stimulation program on the recovery of unconscious patients with TBI. The results showed a significant increase in the SMART and GCS scores after applying multiple sensory stimulation, including tactile, gustatory, olfactory, auditory, and visual, in the intervention group (Urbenjaphol, Jitpanya, and Khaoropthum, 2009). Their intervention was conducted for 14 days, whereas in

the present study the increase in the recovery process of consciousness, the level of cognitive function, and basic cognitive sensory recovery was observed in less than 7 days.

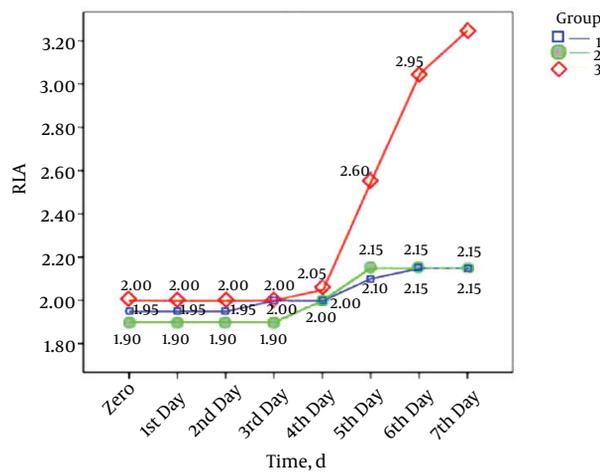
Davis and Gimenez (2003) used the sensory stimulation assessment measure (SSAM) and showed that SSAM scores at baseline and discharge were significantly different. Moreover, the sensory stimulation program did not have any adverse effect on patients' cerebral dynamic status (13). Other indices, such as the activity of Alpha. The autonomic nervous system (ANS) as reflected in the heart rate and skin conductance, have been shown to be associated with the recovery of consciousness (32). Salmond and co-workers suggested that the changes in the ANS

**Figure 2.** Mean Scores of Glasgow Coma Scale(GCS) in Three Groups of the Study



Receiving sensory stimulation by a nurse ●, receiving sensory stimulation by family members ◇ and receiving usual care (control group □) during the 7 days of the intervention. Repeated measured ANOVA; Wilk's Lambda; Value = 0.312, F = 19.15, P < 0.001.

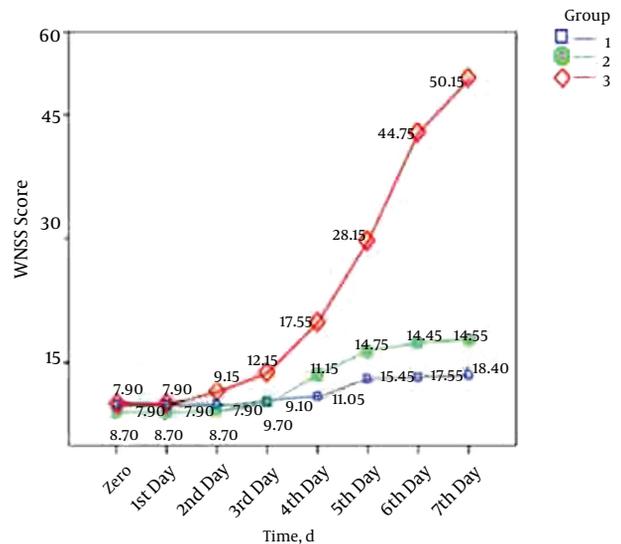
**Figure 3.** Mean Scores of Ranch Los Amigos Scale (RLA) in Three Groups of the Study



Receiving sensory stimulation by a nurse ●, receiving sensory stimulation by family members ◇ and receiving usual care (control group □) during the 7 days of the intervention. Repeated measured ANOVA; Wilk's Lambda; Value = 0.562, F = 8.249, P < 0.001.

while regaining consciousness could be due to the recovery of higher cortical structures controlling the ANS and the nuclei releasing the neurotransmitters involved in the ANS (33). In another study, Johnson et al. considered other indices, such as catecholamine, serotonin,

**Figure 4.** Mean Scores of WNSSP in Three Groups of the Study



Receiving sensory stimulation by a nurse ●, receiving sensory stimulation by family members ◇ and receiving usual care (control group □) during the 7 days of the intervention. Repeated measured ANOVA; Wilk's Lambda; Value = 0.443, F = 10.917, P = 0.000.

acetylcholine esterase, 3methoxy 4-hydroxyphenylglycol, skin conductance, and heart rate as evidence of the effects of sensory stimulation. They showed that 3methoxy 4-hydroxyphenylglycol levels were significantly higher in the sensory stimulation group (34). In the current study, we did not examine the autonomic nervous system neurotransmitters. Results of this study are consistent with previous studies (13, 24, 30, 35, 36). However the present study showed a greater increase in recovery and achieved more acceptable results in a shorter period of time compared with those of other reports (13, 24, 30, 35, 36). This could be due to the context of this study, different cultures or social and emotional factors, and the cooperation of family members. The influence of familial relationships on the lives of individuals in Iran's socio-cultural context has been highlighted by other researchers (37).

In conclusion, the results of the current study indicate that sensory stimulation programs, if provided either by nurses or families, can lead to improvements in the level of consciousness, level of cognitive function, and basic cognitive sensory recovery of comatose patients with severe TBI. Moreover, sensory stimulation, if provided by the family, can better increase the level of consciousness, level of cognitive function, and basic cognitive sensory recovery of these patients. Therefore, nurses can take advantage of families in patients' care to significantly reduce the duration of comas in comatose patients with TBI. They should

also integrate the sensory stimulation protocols by the family members in their usual care.

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## Footnotes

**Authors' Contribution:** Marzieh Moattari devised the concept for the study, developed the study design, supervised data collection and analysis, drafted the manuscript, and was involved in study coordination and manuscript critical analysis and revision; Fatemeh Alizadeh Shirazi collected data, ran the study intervention, was involved in the conception of the study, performed the analyses and drafted the manuscript. contributed to the study design and intervention; Nasrin Sharifi contributed to the design of the study and supervised the data collection; Najaf Zareh contributed in design of the study and supervised analysis of the data. All authors read and approved the final manuscript.

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