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Impact of Sensory Stimulation on Perception and Performance among the Comatose: A Pilot Study

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Adult brains in good health are capable of processing a variety of intricate sensory data. The faces of the object and the people are recognised, and the location, depth, and distance of the object and the people are identified. These basic and complex perceptual abilities may be impacted by a stroke or other acquired brain injury, such as a head injury. Being unaware of one's surroundings, as when sleeping, or being unresponsive to stimulation are both symptoms of being unconscious. In the area of neurorehabilitation, sensory stimulation programmes (SSP) have received the most research. A healthcare provider or a family member systematically stimulates the patient's five sensory modalities as part of sensory stimulation, a form of therapy that may improve the patient's responsiveness. In order to analyse the impact of sensory stimulation on perception and performance among comatose, double- blinded randomized clinical trial was conducted on 12 comatose patients with Glasgow Coma Scale score 3-8 and diagnosed with traumatic brain injury

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and cerebrovascular accidents. The patients were randomly assigned into two groups of experimental and control. The comatose patients were recruited via random sampling from various Intensive Care Units of AJ Institute of Medical Sciences, Mangalore. The experimental group was given sensory stimulation twice daily for seven consecutive days, with each session lasting 25 minutes. By contrast, the control group only received routine care from the hospital. Data was collected via demographic and clinical proforma and level of conscious was measured by Coma Recovery Scale-Revised (CRS-R). For statistical analysis, independent t test and ANOVA were computed. There was a significant increase in the post-test scores of CRS-R for experimental group which revealed that multimodal sensory stimulation effectively increased the CRS-R scores among unconscious patients in the experimental group. Nurses can use this intervention to improve sensory scores among unconscious patients in the Intensive Care Unit.

Keywords: Sensory stimulation; comatose patients; intensive care unit; brain injury: impact; perception.

1. INTRODUCTION

Around the world, being unconscious is a major factor in morbidity, mortality, disability, and intensive care unit (ICU) hospitalisation [1]. Being unaware of one's surroundings, as when sleeping, or being unresponsive to stimulation are both symptoms of being unconscious [2]. One of the most serious effects of trauma or cerebral haemorrhage is acute, severe brain injuries [1]. Traumatic brain injury (TBI) is the study of the disruption of normal brain function brought on by damage to the scalp, skull, and brain, which causes compromised neurological functioning and both focal and diffuse symptoms. The damage to the brain caused by a disruption in its blood supply is dealt with in cerebral vascular accidents, a medical emergency. The majority of those who survive are unable to lead normal lives because of cognitive impairment, and longer periods of these alterations (coma) are linked to worse outcomes [3,4]. In India, motor vehicle accidents, falls, assaults, injuries from firearms, and sports-related accidents are the main causes of traumatic brain injury. In the meantime, hypoxia-related lack of responses to sensory and motor stimuli, triggered by respiratory failure or shock, metabolic or chemical brain depressants [5].

The Centres for Disease Control and Prevention (CDC) estimate that 2.5 million people worldwide experience traumatic brain injury (TBI) every year. Traumatic brain injury's main causes are: Falls account for 40.5% of all accidents, followed by car crashes (14.3%), assaults (10.7%), and events that strike/against people (15.5%).23 Ischemic or haemorrhagic stroke (6 to 54%) was the most common cause of non-traumatic coma, followed by anoxia injury (3 to 42%), poisoning (1 to 39%), and metabolic (1 to 29%). The total non-structural causes (37 to 75%) tended to slightly outnumber the structural causes (28 to 64%) despite the fact that stroke was the most prevalent overall cause of non-traumatic coma [6].

The neurorehabilitation field's most extensively researched therapy is known as sensory stimulation programmes (SSP) [7,8]. The goal of sensory stimulation is to increase arousal and recovery by systematically revealing a comatose or partially conscious patient to various environmental stimuli (visual, auditory, tactile, olfactory, and kinaesthetic).It has been determined that the use of sensory and motor stimulation for patients who are unconscious through the coma arousal technique is a feasible, non-invasive, non-pharmacologic, and cost-effective intervention that improves medical care [9]. As a non-medical nursing intervention, family members can alter the unfamiliar, stressful environment of the ICU by giving sensory stimulations. They experienced an increase in O2 saturation and vital signs with each stimulation [10,11]. The physiology of each sense is influenced by a rise in arousal, awareness, and behavioural reactions. Aromatherapy's olfactory stimulation can assist in the release of G-protein, which raises antibodies and improves blood flow. Meanwhile, auditory techniques can stimulate brain nerve cells. Tactile stimulation therapy effectively compensates for blockages that could result in stroke by improving the blood flow system that returns blood to the cortical circulation system. Last but not least, stimulation of sight and taste can increase autonomic nervous system activity by simultaneously stimulating several senses that can stimulate the Ascending Reticular Activating System (ARAS) [12,13,14].

A quasi-experimental study was conducted in Iran showed that the patients who received auditory and tactile stimulation on the sixth and seventh days experienced significantly lower levels of agitation than the control group ($P < 0.01$) [15]. Another quasi-experimental study was conducted in Indonesia 2021 among 44 participants which highlighted on how multimodal sensory stimulation affected Glasgow Coma Scale (GCS) scores in stroke patients with decreased consciousness [16]. The results showed significant increase in post-test GCS scores for the intervention group (from 9.63 to 13.18, p=.001), but there was no significant increase for the control group (from 10.09 to 10.54, p=.085). This showed that multimodal sensory stimulation effectively raised GCS scores in stroke patients with low consciousness [17].

Hence, nurses are in a unique position to influence targeted sensory stimulation. They should feel empowered to calm the agitation of TBI patients hospitalised in ICUs because they are keen observers during the care process. The researcher also imparts nursing intervention skills to the patient's families on how to care for brain injury patients with diminished consciousness. In order to develop and improve targeted stimulation strategies and eventually make the lead goal a reality, this must continue to collaborate with other hospital professionals and family members [18]. The result of the study was to determine the impact of sensory stimulation on perception and performance among the comatose.

2. MATERIALS AND METHODS

A pilot study was conducted among 12 comatose patients, 6 of them each in experimental and control group diagnosed with traumatic brain injury and cerebrovascular accident cases with Glasgow Coma Scale Score between 3-8 in a selected hospital, Mangalore. The patients were selected by random sampling from various Intensive Care Units and were assigned to experimental and control group. Patients suffering from blindness and deafness before comatose state and those under septic shock were the exclusion criteria of the study.

2.1 Tool for Data Collection

It includes two tools which were designed by the researcher in an English language after reviewing the related literature. These tools were comprised of the following parts: -

Tool 1 – Demographic and Clinical Proforma

Part 1: Characteristics of unconscious such as patients age, gender, marital status.

Part 2: Clinical characteristics of unconscious patients such as current diagnosis, cause for unconsciousness, duration of unconsciousness, anatomical site of brain injury, surgical history and co-morbidities of patients suffering with traumatic brain injury and cerebrovascular accident.

Tool 2 – Coma Recovery Scale- Revised

The Coma Recovery Scale (CRS-R), also known as the JFK Coma Recovery Scale is used to assess patients with a disorder of consciousness, commonly coma. It was developed and revised by Giacino and Kalmar and White 2004 [19]. It may be used to differentiate between vegetative state (VS) and minimally conscious state (MCS). It can also be used to monitor emergence from minimally conscious state (EMCS or MCS+). The CRS-R consists of 23 items, grouped into 6 sub-scales: Auditory, Visual, Motor, Oro motor, Communication, Arousal. The lowest score on each sub-scale represents reflexive activity; the highest represents behaviours mediated by cognitive input. The total score ranges between 0 (worst) and 23 (best). This measure takes a minimum of 25 minutes to complete. The permission from author was obtained to use the tool [19].

2.2 Methods

This was a double blinded randomized clinical trial which was conducted on 12 comatose patients with Glasgow Coma Scale score 3-8 and diagnosed with traumatic brain injury and cerebrovascular accidents. The patients were randomly assigned into two groups of experimental and control. The comatose patients were recruited via random sampling from various Intensive Care Units of AJ Institute of Medical Sciences, Mangalore. The investigator explained the purpose of the study to the family members and obtained their consent prior to conducting the research. This study obtained an ethical approval from the institutional ethics committee of AJ Institute of Medical Sciences and Research Centre, Mangalore on July 1st 2022. Researchers gave information about the importance of family involvement in providing sensory stimulation and trained the qualified registered nurses regarding

the recording of Coma Recovery Scale- Revised Scores who was blinded to both the groups. For the experimental group, the investigator will provide sensory Stimulation for all five sensory modalities for duration of 5 minutes each. Total duration of the stimulation was for 25 to 30 minutes, which was carried out twice a day in the morning and afternoon for 7 consecutive days in the experimental group along with routine care. For the control group, routine care was given by the staff nurses. Post-test will be recorded in the morning and afternoon by the qualified nurse for 7 consecutive days [20]. The data were analysed with the help of independent t test and two- way factor of analysis of variance.

3. RESULTS

The collected data were organised, tabulated and statistically analysed using SPSS version 23.

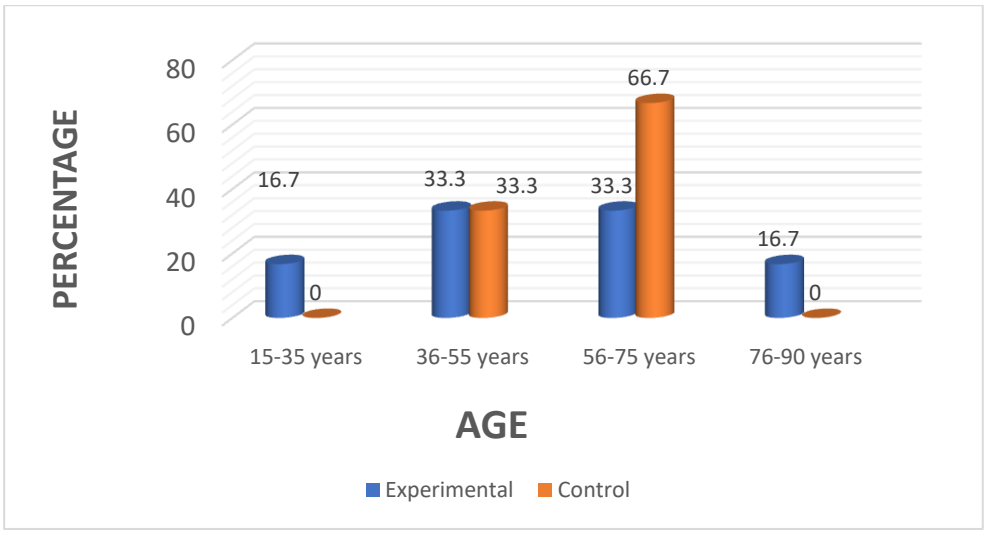
3.1 Demographic Characteristics

Highest percentage (33.3%) of the patients in the experimental group were in the age group of 36-55 and 56-75 years. Equal percentage (50%) of the patients were males and females and most (83.3%) of them were married. Whereas in the control group, highest percentage (66.7%) of the patients belonged to the age group of 56-75 years, majority 4(66%) were males and all 6(100%) were married (Table 1 and Figs. 1,2,3)

Table 1. Frequency and percentage of demographic variables

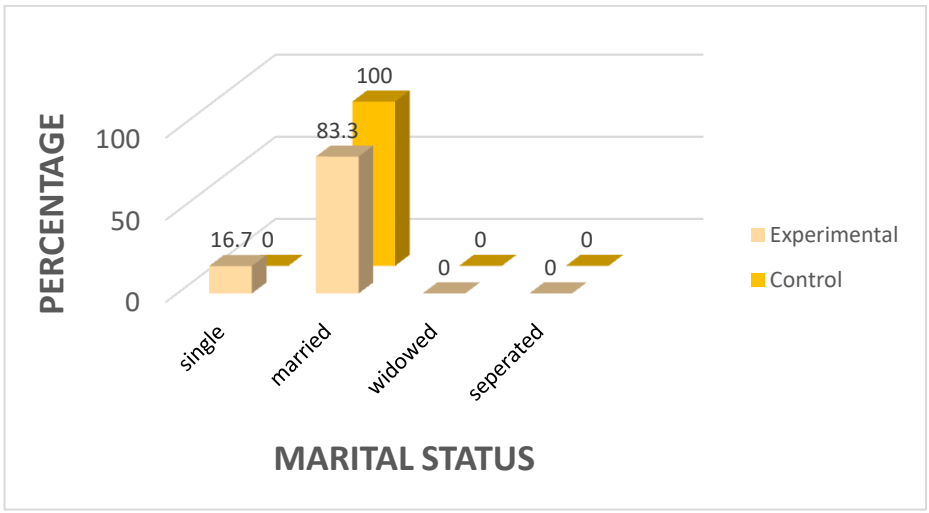
Variables		Experimental n=6		Control n=6	
		Frequency(f)	Percentage (%)	Frequency(f)	Percentage (%)
Age (in years)					
a.	15-35years	1	16.7	-	-
b.	36-55 years	2	33.3	2	33.3
c.	56-75 years	2	33.3	4	66.7
d.	76-90 years	1	16.7	-	-
Gender					
a.	Male	3	50	4	66.7
b.	Female	3	50	2	33.3
Marital Status					
a.	Single	1	16.7	-	-
b.	Married	5	83.3	6	100
c.	Widowed	-	-	-	-
d.	Separated	-	-	-	-

**frequency and percentage of demographic variables*



n=12

Fig. 1. Percentage distribution of the age of comatose patients in experimental and control group



n=12

Fig. 2. Percentage distribution of marital status of comatose patients in the experimental and control group

3.2 Clinical Characteristics

Both in experimental and control group, half (50%) of the patients were hospitalised due to cerebrovascular accident and suffered traumatic brain injury. Data also reveals that majority (66.7%) of the patients in the experimental group had duration of unconsciousness between 5-10 days and frontal lobe was most affected site. In control group, majority (66.7%) of the patients had duration of unconsciousness less than 5 days and half (50%) of them had parietal lobe as affected site of injury. Data depicts that half 3(50%) of the patients in the experimental group have undergone surgery and had a co-morbid history of cardiovascular disorder whereas in the control group, majority (66.7%) of the patients have not undergone any surgery and had a co- morbid history of cardiovascular disorder (Table 2 Figs. 4,5,6,7,8 and 9).

3.3 Description of CRS-R Scores (Mean ± Standard Deviation)

There was an improvement in mean CRS-R scores from day 1 (3.17±3.189) to day 7 (19.33±2.503) in the experimental group. Whereas in control group there was a slight improvement in mean CRS-R scores from day 1 (3.33±3.559) to day 7 (10.17±3.251). On day 7 the mean CRS-R scores of the experimental group (19.33±2.503) was more than the mean CRS-R scores of the control group (10.17±3.251) which reveals that sensory stimulation had an impact in improving the mean CRS-S scores of the patients in the experimental group (Table 3).

3.4 Paired t Test of CRS-R Scores in the Experimental Group

There was a significant difference between pretest (Day 1) and post-test (Day 7) CRS-R scores in the experimental group ($p<0.05$) which showed that sensory stimulation had an impact in improving level of consciousness among comatose patients in the experimental group (Table 4).

3.5 Paired t test of Area Wise CRS-R Scores in the Experimental Group

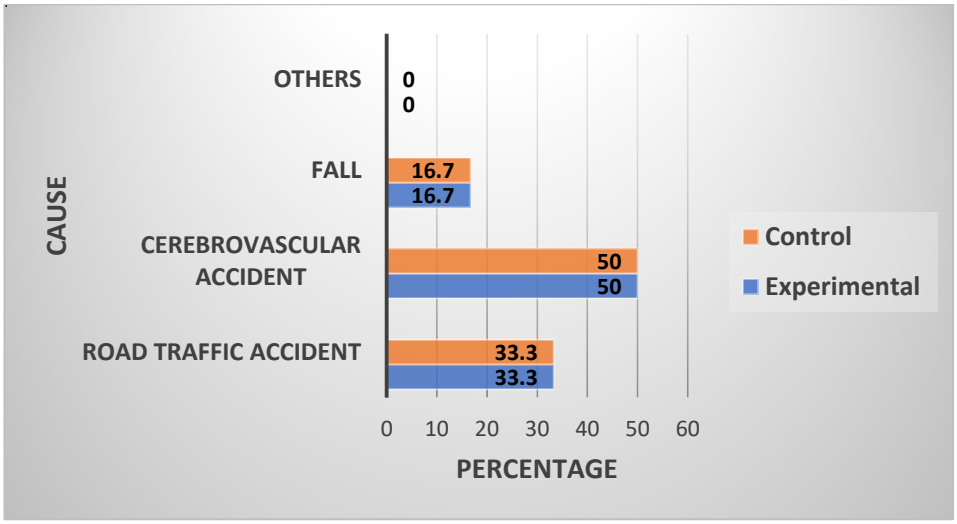
There was a significant difference between pretest (Day 1) and post-test (Day 7) area wise CRS-R scores in the experimental group ($p<0.001$) which indicates that that sensory stimulation had an effect in improving the level of consciousness among comatose patients in the experimental group (Table 5).

3.6 Unpaired t Test of CRS-R scores in the Experimental and Control Group

There was no significant difference in CRS-R scores on day 1 and 2. Whereas there was a high significant difference in CRS-R scores which was seen from day 3 to day 7($p=<0.001$) which revealed that sensory stimulation was effective in improving the level of conscious in the experimental group (Table 6).

Table 2. Frequency and percentage of clinical variables

Variables		Experimental N=6		Control N=6	
		Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
Current diagnosis					
a.	Road traffic accident	2	33.3	2	33.3
b.	Cerebrovascular accident	3	50	3	50
c.	Fall	1	16.7	1	16.7
Cause for unconsciousness					
a.	Traumatic injury	3	50	3	50
b.	Anoxic injury	-	-	-	-
c.	Hemorrhagic injury	1	16.7	1	16.7
d.	Metabolic injury	-	-	-	-
e.	Ischemic injury	2	33.3	2	33.3
Duration of unconsciousness					
a.	<5 days	1	16.7	4	66.7
b.	5-10 days	4	66.7	1	16.7
c.	11-15 days	1	16.7	1	16.7
d.	> 15 days	-	-	-	-
Anatomical site of brain injury as per ct/mri findings					
a.	Frontal lobe	4	66.7	1	16.7
b.	Temporal lobe	-	-	2	33.3
c.	Parietal lobe	-	-	3	50
d.	Occipital lobe	1	16.7	0	-
e.	Cerebellum	-	-	-	-
f.	Brainstem	1	16.7	-	-
Present surgical procedure					
a.	Yes	3	50	1	16.7
b.	No	3	50	4	66.7
Co-morbidities					
a.	No co- morbidities	2	33.3	1	16.7
b.	Cardiovascular disorders	3	50	4	66.7
c.	Diabetes mellitus	1	16.7	1	16.7



n=12

Fig. 3. Percentage distribution for the current diagnosis of comatose patient in experimental and control group

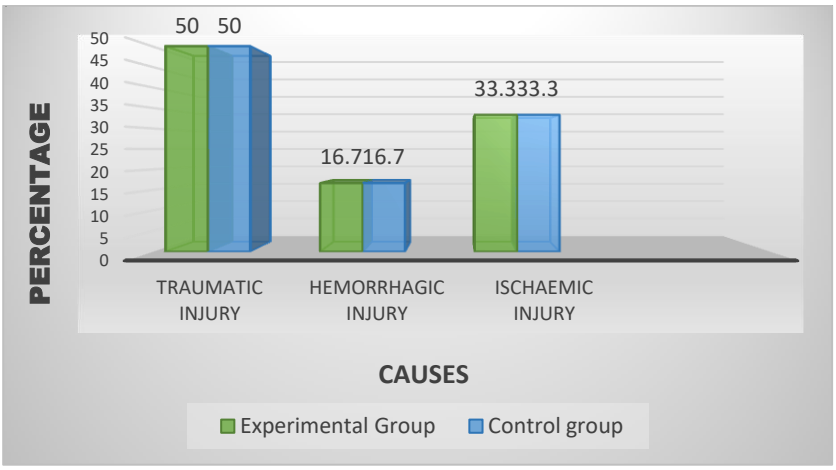


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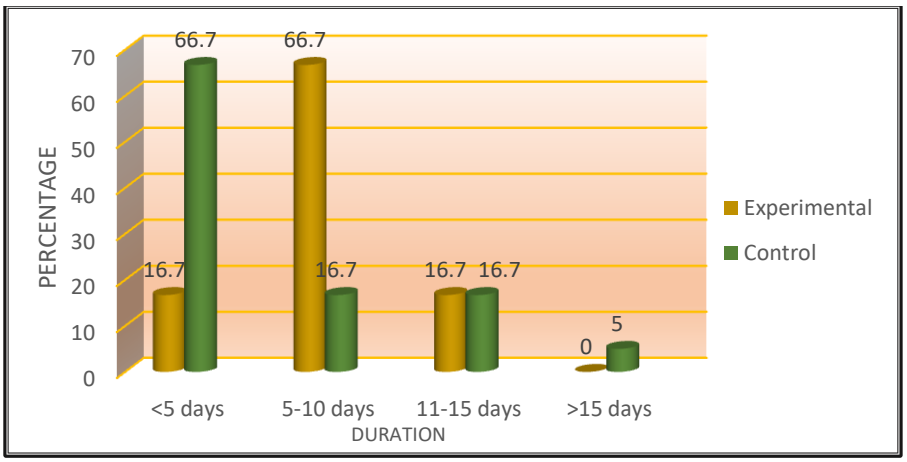
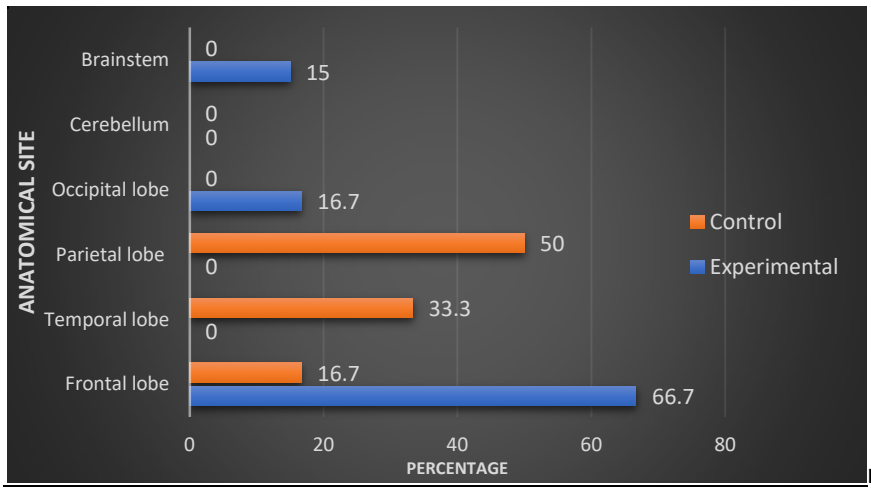
Fig. 4. Percentage distribution for the various causes of comatose patient in experimental and control group



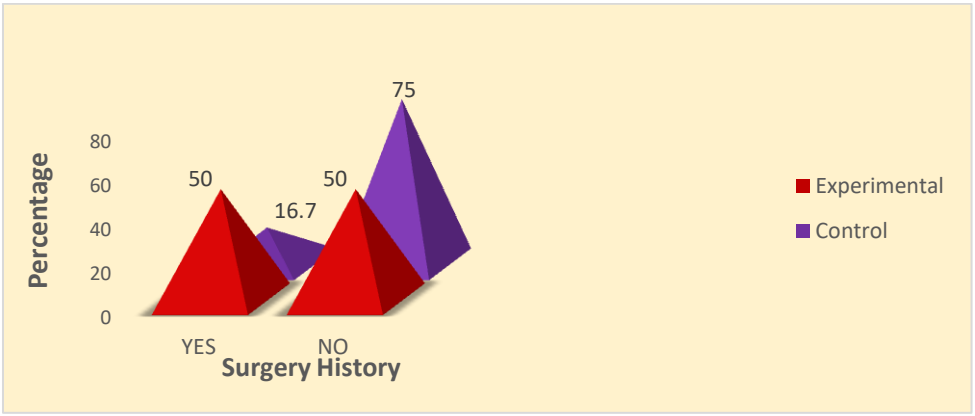
n=12

Fig. 5. Percentage distribution for the duration of comatose patient in experimental and control group



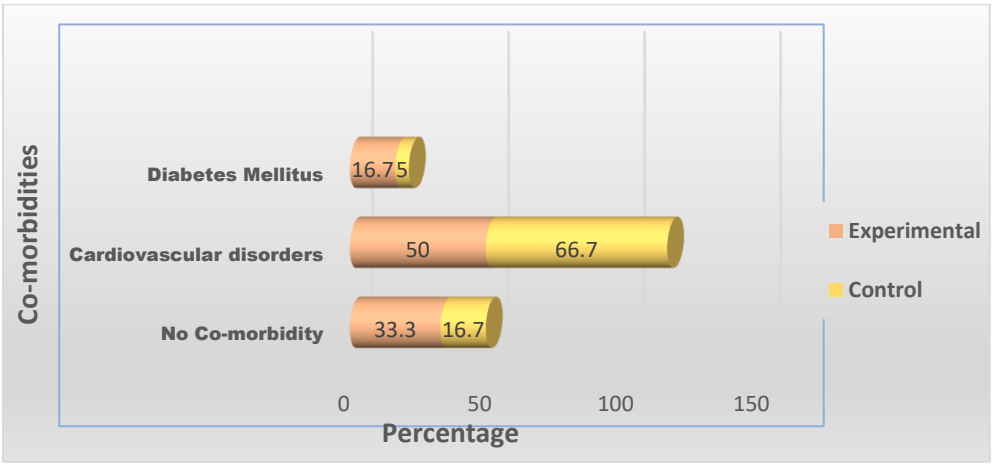
n=12

Fig. 6. Percentage distribution for the anatomical site of brain injury among comatose patient in experimental and control group



n=12

Fig. 7. Percentage distribution for the surgery history among comatose patient in experimental and control group



n=12

Fig. 8. Percentage distribution of co-morbidities among comatose patient in experimental and control group

Table 3. Mean, Standard Deviation of CRS-R scores of the Experimental and Control groups at fourteen measurement time points

Observations (Days)	Experimental n=6 Mean±SD		Control n=6 Mean±SD	
	Morning	Afternoon	Morning	Afternoon
DAY 1	3.17±3.189	3.33±3.266	3.33± 3.559	3.50±3.564
DAY 2	5.33± 4.320	5.83±4.708	3.50 ±3.728	4.67 ±3.777
DAY 3	6.50±4.764	8.33 ±3.204	8.33±3.204	5.33± 3.615
DAY 4	9.17±3.061	11.00±3.162	6.17±3.764	7.83±3.371
DAY 5	11.83±3.125	12.83±3.312	7.83±3.817	8.33±3.777
DAY 6	13.67 ±2.658	15.17 ±2.041	9.17±4.070	9.50±4.037
DAY 7	17.50 ±2.588	19.33±2.503	10.00±3.286	10.17±3.251

Table 4. Mean, standard deviation, t value of CRS-R scores among the comatose patients in the Experimental group

Group	Parameter	Day 1 (Mean ±SD)	Day 7 (Mean ±SD)	t value	p value
Experimental group n=6	CRS-R	3.17±3.189	19.33±2.503	15.77	0.025*

*p<0.05; df=5; *HS- Highly significant*

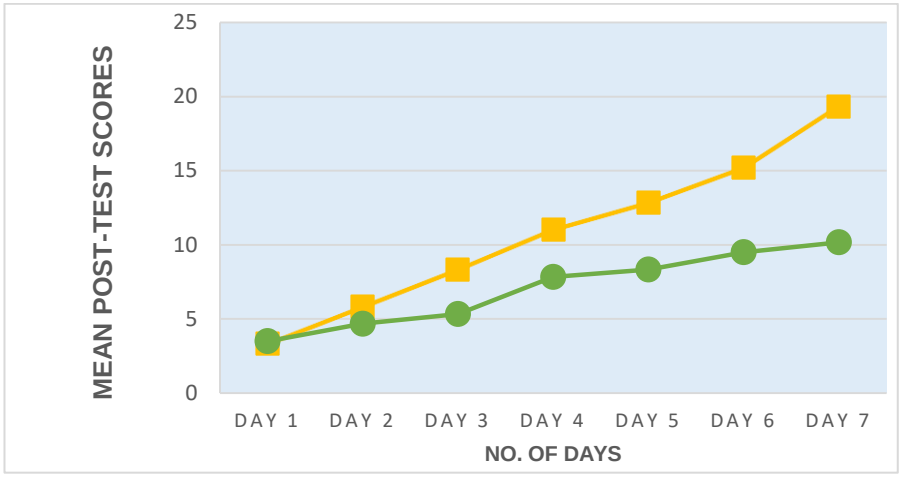


Fig. 9. Mean Post-Test CRS-R Scores of the Experimental and Control group in the afternoon at fourteen measurement points

Table 5. Mean, Standard Deviation, t value of Area wise CRS-R scores among comatose patients in the Experimental group

Group n=6	Day 1(Mean ±SD)	Day 7 (Mean ±SD)	t value	p value
Experimental				
Auditory	0.67± 0.81	3.67±0.57	12.01	<0.001*
Visual	0.67±1.21	4.34 ±0.81	13.553	<0.001*
Motor	1± 0.894	4.83±0.75	15.762	<0.001*
Communication	0.34 ±3.16	2.16±0.40	12.939	<0.001*
Verbal	0.16 ±0.40	1.83±0.40	9.702	<0.001*
Arousal	0.34± 0.51	2.5± 0.54	12.654	<0.001*

*p<0.05; df=5; *HS-Highly significant*

Table 6. Mean, Standard Deviation and t value of CRS-R scores among the Comatose patients between the Experimental and Control group

Parameters with their days of observations	Post-test scores (Mean±SD)		t value	p value
	Experimental group n=20	Control group n=20		
CRS-R				
Day 1	3.33±3.266	3.50±3.564	0.46	0.101
Day 2	5.83±4.708	4.67 ±3.777	2.06	0.337
Day 3	8.33 ±3.204	5.33±3.615	4.88	0.001*
Day 4	11.00±3.162	7.83±3.371	5.54	0.001*
Day 5	12.83± 3.312	8.33±3.777	7.62	0.001*
Day 6	15.17 ±2.041	9.50±4.037	9.33	0.001*
Day 7	19.33±2.503	10.17±3.251	10.93	0.001*

*p<0.05; df=10; *HS- Significant*
p>0.05; NS-Not significant

3.7 Unpaired t Test of Area Wise CRS-R Scores between the Experimental and Control Group

The mean CRS-R scores in the experimental group was more than mean CRS-R scores in the control group in all areas of CRS-R scale. There was a significant difference in all areas of CRS-R scale between experimental and control group on day 7 (p=<0.001). Data inferred that sensory stimulation had an impact in improving the level of conscious among comatose patients in the experimental group (Table 7).

Table 7. Mean, standard deviation, t value of Area wise CRS-R scores among comatose patients between the experimental and control group

Group n=12	Day 7 Post-test (Mean ±SD)		t value	p value
	Experimental	Control		
Auditory	3.67±0.57	2.3±0.51	4.687	<0.001*
Visual	4.34 ±0.81	2.67±1.54	8.238	<0.001*
Motor	4.83±0.75	2.16±0.75	9.647	<0.001*
Communication	2.16±0.40	0.83±0.40	5.603	<0.001*
Verbal	1.83±0.40	1.34±0.81	4.223	<0.001*
Arousal	2.5± 0.54	0.83±0.75	4.668	<0.001*

*p<0.05; df=10; *HS- Highly significant*

Table 8. Two-way factor ANOVA Comparing the Impact of Sensory Stimulation among Comatose patients between the Experimental and Control group

Parameters	Two-way factor ANOVA	f value	p value	Interpretation	Effect size
CRS-R	To compare the impact between the group	5.02	0.049*	HS	0.334

*p<0.05; df=1&10; *HS-Highly Significant*

3.8 Two-way factor ANOVA Comparing the Effectiveness of Sensory Stimulation between the Experimental and Control group

There was a high significant difference in the CRS-R scores among comatose patients between the experimental and control group which revealed that sensory stimulation had an impact in improving the level of conscious among comatose patients in the experimental group (Table 8).

4. DISCUSSION

The results of current study revealed that both in experimental and control group highest percentage of the patients in experimental group 2(33.3%) and 4(66.7%) were in the age group of 36-55 and 56-75 years respectively. Half 3(50%) of the patients in the experimental group were males and females and most 5(83.3%) of them were married. Whereas in the control majority 4(66%) were males and all 6(100%) were married. The findings of this study are similar with the results of other studies in which majority of subjects were in the age group of 35-80 years who were males and were married [1,16,21,22].

The present study result also showed that both in experimental and control group half 3(50%) were hospitalised due to cerebrovascular accident. Majority 2(66%) of the patients in the control group and half 3(50%) of the patients in the experimental group suffered traumatic brain injury. Data also reveals that majority 4(66.7%) of the patients in the experimental group frontal lobe was most affected site of injury. In control group, half 3(50%) of them had parietal lobe as affected site of injury. Other studies demonstrated that highest percentage of the patients in the experimental and control group were hospitalised to cerebrovascular accident and suffered traumatic brain injury along with fronto-parietal lobe as most affected site of brain injury [21,23,24,18,25].

The results of the present study also shows that half 3(50%) of the patients in the experimental group have undergone surgery and had a co-morbid history of cardiovascular disorder whereas in the control group, majority 44(66.7%) of the patients have not undergone any surgery and had a co- morbid history of cardiovascular disorder where in other studies majority of the patients in the experimental and control group have not undergone any surgery and had a co-morbid history of cardiovascular disorder [21,26,20].

The current study findings show that in experimental group there was an improvement in mean total CRS-R scores from day 1 (3.17±3.189) to day 7 (19.33±2.503). On day 7 the mean total CRS-R scores of the experimental group (19.33±2.503) was more than the mean total CRS-R scores of the control group (10.17±3.251). Additional research using a randomized control trial corroborates the findings that on day 7 the mean total CRS-R scores of the experimental group was more than the mean

total CRS-R scores of the control group at seven measurement time point [1,22,26]. We are able to determine that the experimental group's subjects' CRS-R scores improved as a result of the application of sensory stimulation at various points during the measurement process [22,26].

The results of the present study showed that after seven days of sensory stimulation, the level of consciousness of the patients in the experimental group was significantly higher than the patients in the control group ($p<0.001$) Moreover the results of repeated measures of ANOVA for within and between the subject factor of time in experimental group were statistically significant. In contrary, some of the studies showed positive effects of sensory stimulation provided by the family members on level of consciousness while some failed to show the effects of sensory stimulation provided by unfamiliar persons on level of consciousness [27-30,14,8,11,17,31,19].

However, the results of the present study illustrated that sensory stimulation was effective in improving level of consciousness among comatose patients with traumatic and cerebrovascular brain injuries.

5. CONCLUSION

Based on the present study results, it can be concluded that application of sensory stimulation had an impact on improvement of level of consciousness. Nurses can incorporate sensory stimulation into existing interventions, especially for patients with decreased consciousness. Both, independently performed nursing interventions and collaborative efforts with patient families can make use of sensory stimulation. Additionally, it is advised that it should be incorporated in the nursing curriculum and regular care plans for comatose patients in ICUs.

ETHICAL APPROVAL AND CONSENT

This study was conducted after obtaining approval from the institutional ethical committee. Permission to conduct the study was obtained from the study administrative authorities and confidentiality was assured. Written consent was obtained from the patient's family members who accepted to take part in the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Urbenjaphol P, Jitpanya C, Kharopthum S. Effects of the sensory stimulation program on recovery in unconscious patients with traumatic brain injury. Journal of neuroscience nursing 2010:41(3):10-16
2. Popescu C1, Anghelescu A1, Daia C1 and Onose G1. Actual data on epidemiological evolution and prevention endeavours regarding traumatic brain injury Med Life J. 2015;8(3):272-7.
3. Kashluba S, Hanks RA, Casey JE, Millis SR. Neuropsychologic and functional outcome after complicated mild traumatic brain injury. Arch Phys Med Rehabil. 2008;89(5):904–11.
4. Sinha S, Gunawat P, Nehra A, Sharma BS. Cognitive, functional, and psychosocial outcome after severe traumatic brain injury: A cross-sectional study at a tertiary care trauma center. Neurol India. 2013; 61(5):501–6.
5. Edlow JA, Rabinstein A, Traub SJ, Wijdicks EF. Diagnosis of reversible causes of coma. Lancet. 2014;384(9959):2064-76.
6. Bell JM, Breiding MJ, DePadilla L. CDC's efforts to improve traumatic brain injury surveillance. Centers for Disease Control and Prevention. National Center for Health Statistics. J Safety Res. 2017;62:253-256.
7. Mandeep, Chitkara N, Goel S, Sood S. Traumatic head injury: Early intervention by coma arousal therapy. Indian Journal of Neurotrauma. 2013:10(01):13-18
8. Shekhar C, Gupta LN, Premsagar IC, Sinha M, Kishore J. An epidemiological study of traumatic brain injury cases in a trauma centre of New Delhi (India). J Emerg Trauma Shock. 2015;8(3):131-139.
9. Potter PA, Perry AG, Stockert PA, Hall AM. Fundamentals of Nursing. 8th ed. St. Louis, MO: Elsevier. 2016;643–644.
10. Yousefi H, Naderi M, Daryabeigi, R. The effect of sensory stimulation provided by family on arterial blood oxygen saturation in critical care patients. Iranian Journal of Nursing and Midwifery Research. 2015;20(1):63–68.
11. Sargolzaei, K., Shaghaee F M, Aghebati N, Esmaily H, Farzadfard M. Effect of a Structured Sensory Stimulation Program on the Sensory Function of Patients with Stroke-induced Disorder of Consciousness. Evidence Based Care Journal. 2017:7(2);7-16.

12. Megha M, Harpreet S, Nayeem Z. Effect of frequency of multimodal coma stimulation on the consciousness levels of traumatic brain injury comatose patients. Brain Inj. 2013;27(5):570-577.
13. Gorji A H, Araghiyansc F, Jafari H, Yazdani J. Effect of auditory stimulation on traumatic coma duration in intensive care unit of Medical Sciences University of Mazandarn, Iran. Saudi Journal of Anaesthesia. 2014:8(1);69–72.
14. Ansell BJ, Keenan JE. The western neuro sensory stimulation profile: A tool for assessing slow-to-recover head injured patients. Archives of Physical Medicine and Rehabilitation. 1989; 70:104–108
15. Karagozoglu S, Kahve E. Effects of back massage on chemotherapy related fatigue and anxiety: Supportive care and therapeutic touch in cancer nursing. Applied Nursing Research. 2013;26(4): 210–217.
16. Faozi E, Fadlilah S, Dwiyanto Y, Retnaningsih LN, Krisnanto PD. Effects of a Multimodal Sensory Stimulation Intervention on Glasgow Coma Scale Scores in Stroke Patients with Unconsciousness. Korean Journal of Adult Nursing. 2021:33(6):649-656.
17. Zuo J, Tao Y, Liu M, Feng L, Yang Y, Liao L. The effect of family-centered sensory and affective stimulation on comatose patients with traumatic brain injury: A systematic review and meta-analysis. Int J Nurs Stud. 2021;115:103846.
18. Sedghi T, Ghaljeh M, Faghihi H, Sarani H. The effect of auditory and tactile stimulation by a family member on the level of agitation in patients with traumatic brain injury and decreased consciousness: A quasi-experimental study. Medical - Surgical Nursing Journal. 2020; 9(2).
19. Giacino J T, Kalmar K and Whyte J. The JFK coma recovery scale-revised: Measurement characteristics and diagnostic utility. International Journal of Archives of Physical Medicine and Rehabilitation. 2020;85(12):2020-2029.
20. Adineh M, Elahi N, Molavynejad S, Jahani S, Savaie M et.al. Impact of a sensory stimulation program conducted by family members on the consciousness and pain levels of ICU patients: A mixed method study Frontiers of Medicine. 2022;9:931-304
21. Abbasi M, Mohammadi E, Sheaykh Rezayi A. Effect of a regular family visiting program as an affective, auditory, and tactile stimulation on the consciousness level of comatose patients with a head injury. Japan Journal of Nursing Science. 2009;6(1):21-26.
22. Lijuan C, Daniela C, Martin M, Monti F, Francesco R et.al. Consciousness Recovery Using Sensory Stimulation. Frontiers in Neurology article. 2018;82(9): 15-22.
23. Oh, H and Seo W. Sensory stimulation programme to improve recovery in comatose patients. Journal of Clinical Nursing. 2003;12;(3):394-4.
24. Mandeep, Chitkara N, Goel S, Sood S. Traumatic head injury: Early intervention by coma arousal therapy. Indian Journal of Neurotrauma. 2013;10(01):13-18
25. Moattari M, Alizadeh Shirazi F, Sharifi N, Zareh N. 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. Trauma Monthly. 2016:21(4);23-31.
26. Salmani F, Mohammadi E, Rezvani M, Kazemnezhad A. Effects of family-centered affective stimulation on brain injured comatose patient's level of consciousness:A randomized control trial. International Journal of Nursing Studies. 2017;74;44-52.
27. Lombardi F, Taricco M, De Tanti A, Telaro E, Liberati A. Sensory stimulation for brain injured individuals in coma or vegetative state. Cochrane Database Systematic Review. 2002;(2):CD001427
28. Tavangar H, Shahriary-Kalantary M, Salimi T, Jarahzadeh M, Sarebanhassanabadi M. Effect of family members' voice on level of consciousness of comatose patients admitted to the intensive care unit: A single-blind randomized controlled trial. Adv Biomed Res. 2015;4:106.
29. Davis, AE, White JJ. Innovative sensory input for the comatose brain-injured patient. Critical Care Nursing Clinics of North America.1995;7(2):351-361.
30. Mandeep, Chitkara N, Goel S, Sood S. Traumatic head injury: Early intervention by coma arousal therapy. Indian Journal of Neurotrauma. 2013:10(01):13-18
31. Padilla R, Domina A. Effectiveness of Sensory Stimulation to Improve Arousal

and Alertness of People in a Coma or Persistent Vegetative State After Traumatic Brain Injury: A Systematic Review. Am J Occup Ther. 2016;70(3):7003180030p1-7003180030p8
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