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Effect of Music Therapy and Aromatherapy Massage on Autonomic Nervous System Response among Severe Traumatic Brain Injury Patients

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Abstract:
Background: *About15% to 33% of severe TBI patients develop sympathetic storming. Under treated sympathetic storming in severe TBI patients who admitted to ICUs has been linked to a number of adverse outcomes such as, increase duration of mechanical ventilation, increase risk of self-harm, increases the length of ICU stay, increase risk of delirium, and compromised immunity. Using music therapy and aromatherapy massage can counteract the activity of sympathetic storming and improve severe TBI patients' autonomic responses after TBI.* ***Aim****: To evaluate the effect of music therapy and aromatherapy massage on autonomic responses among severe traumatic brain injury patients.* ***Setting:*** *The study was conducted in four at Alexandria Main University Hospital (AMUH)-Egypt; unit I, unit II, unit III, and triage ICU. The total bed capacity of these intensive care units are 40 beds .****Tools:*** *Two tools were used for data collection. The first tool was demographic and clinical data. The second tool was Autonomic Responses Assessment Sheet.* ***Results:*** *Findings of the present study revealed that there was significant difference in all mean values of autonomic response parameters. It can be found that the mean values of pupils' size, respiratory rate, heart rate, body temperature, mean arterial pressure, and peripheral oxygen saturation between 1st and 4th day for the study group P= 0.006, P=0.038, P=0.030, P=0.009, P=0.024, and P=0.003 respectively.* ***Conclusion:*** *Implementation of music and aromatherapy massage had effects on promotion of severe TBI patients' autonomic responses.* ***Recommendations****: The intervention of music therapy and aromatherapy massage should be a nursing care focus in ICUs parallel with pharmacological management and conventional nursing care of severe TBI patients.*
Keywords: *Traumatic Brain Injury, Music Therapy, Aromatherapy massage, Lavender oil, Autonomic responses.*

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I. Introduction

Traumatic brain injury (TBI) is a serious neuro-disorder commonly caused by falls, motor vehicles accidents, violence, or sports related events. It is one of the leading causes of disability and death of young adults worldwide. Men are twice as likely to experience TBI compared to women and incidence curves show that TBI occurs primarily in people 15-24 years of age followed by another peak in persons more than 75 years old [(1, 2)].

Approximately 1.7 million people will sustain a TBI each year in the United States, resulting in 52,000 deaths and 235,000 of whom are serious enough to require ICU care. In Egypt, the burden of morbidity and mortality that severe TBI imposes on society, makes it a serious public health problem. According to global burden of diseases (GBD) study 2016, there were 262,264 new cases of TBI with age-standardized prevalence rates 601 per 100 000 population [(3, 4)].

Severe TBI patients in intensive care units (ICUs) are often sedated and intubated in an effort to suppress the workload of the brain. Agitation is common in these patients and can be associated with tachypnea, hypertension, tachycardia, fever, and increase pupil size. This exaggerated autonomic response, known as sympathetic storming. It occurs in 15% to 33% of patients with severe TBI with Glasgow coma scale (GCS) ≤ 8. Sympathetic storming can occur in the first 24 hours post TBI or up to weeks later [(5, 6)].

Under treated sympathetic storming in severe TBI patients who admitted to ICUs has been linked to a number of adverse outcomes such as, increase duration of mechanical ventilation, increase risk of self-harm, increases the length of ICU stay, increase risk of delirium, and compromised immunity. In the ICU after discontinuation of narcotics and sedatives administration sympathetic storming usually occurs. A number of researchers and studies nowadays have explored the role of music therapy and aromatherapy massage in the management of exaggerated autonomic response after TBI. They concluded that using of such complementary therapies can help in improving signs and symptoms of increase the sympathetic activity by stimulating the parasympathetic activity [7-9].

However, use of music therapy and aromatherapy massage in nursing or as nursing interventions are quite rare. The effect of these therapies on patients' well-being was first emphasized by Florence Nightingale in early 1800s. They were defined as nursing intervention which reduced stress pain and increased patient comfort. So, the critical care nurses (CCNs) must integrate these interventions the care provided to the TBI patients in the ICU [10-12].

Research indicates that music creates balance between mind, body and soul, has positive effects on relieving stress and pain and increasing quality of life for patients or healthy individuals. Music therapy is an important nursing intervention for severe TBI patients which can distract their attention. Music is considered as a non-pharmacological, non-invasive, simple, cheap, safe, and effective method for reliving patients' distress an improving autonomic response in severe TBI patients in ICUs [13-15].

Moreover, Reddy et al. (2017) [16] found that music therapy has a great role in decreasing the level of autonomic nervous system (ANS) arousal after TBI , namely, decreases of blood pressure, heart rate, and skin temperature. These changes of the ANS parameters represent the function of parasympathetic nervous system that counteracts the activity of sympathetic storming following severe TBI.

Massage therapy is a therapeutic technique, which because of improving hemodynamic and ANS functions has been gained popularity in a number of clinical trials. Massage is considered by many to be a therapy in its own right, offering the potential relieves tension, reduce fatigue and to enhance the body's ability to heal itself. Massage can also provide a medium for the use of aromatic oils such as lavender oil, which may be absorbed by the skin or inhaled by evaporation. This technique is known as aromatherapy massage [17, 18].

Parasympathetic activation following aromatherapy message, plays a pivotal role in controlling sympathetic storming following severe TBI. Meanwhile, massage therapy could decrease blood pressure, respiratory rate, heart rate, and temperature and increase oxygen saturation. In addition, message may help in managing agitation by inducing the sense of comfort and relaxation to TBI patients and then endorphins may be secreted which alleviates pain that is one of the triggers of sympathetic storming following TBI. Decrease workload of the brain is strongly associated with improving cognitive functions in TBI patients [19-21].

Rather than maintaining the tradition of providing general nursing and supportive care to patients with TBI, CCNs could play a more active and meaningful role. Integrating music therapy and aromatherapy massage by CCNs in TBI patients' plan of care can help in controlling the sympathetic storming after severe TBI. Therefore, this study was conducted to determine the effect of music therapy and aromatherapy massage on autonomic nervous system response among severe TBI patients

II. Aim of the study

The study aimed to evaluate the effect of music therapy and aromatherapy massage on autonomic nervous system response among severe traumatic brain injury patients.

III. Subjects and Method

3.1 Study design: A quasi experimental research design was utilized to accomplish this study.

3.2 Study hypothesis: Patients who are subjected to music therapy and aromatherapy message experienced improvement in autonomic responses in comparison with those who are not subjected

3.3 Study setting: This study was conducted in four adults ICUs at Alexandria Main University Hospital (AMUH) -Egypt namely; unit I, unit II, unit III, and triage ICU. The total bed capacity of these ICUs are 40 beds.

3.4 Subjects: A convenience sample of 60 severe TBI patients divided into two groups of patients; 30 patients were assigned the study group to receive music therapy and aromatherapy massage by the researcher and 30 patients who received the conventional nursing care for severe TBI provided by the CCNs. Patients were eligible if they were between 20-60 years old of both sexes, unconscious for more than 3 days with GCS$\leq$ 8 and hemodynamic stable. Exclusion criteria; patients diagnosed as brain steam dead, receiving sensory suppression medications, or have blindness, deafness, or seizures. The study sample size was calculated by power analysis

(Epi-info program); expected frequency = 50%, acceptable error = 5%, confidence coefficient = 95%, minimum sample size = 56.

3.5 Tools of the study: In order to collect the necessary data for the study two tools were used:

Tool (I): Demographic and clinical data: Structure schedule to collect information about severe TBI patients it included: demographic data such as sex, age, clinical data such as GCS score, date of admission, mechanism of injury, accompanying injuries, past medical history for sensory motor deficits.

Tool (II): Autonomic Responses Assessment Sheet:

This tool was developed by the researcher after reviewing the relevant literature (21-24). It is used to monitor changes in the physiological parameters that reflect stimulation of either sympathetic or parasympathetic activity in response to application of integrative nursing practices. It includes: pupillary assessment (size and reaction), vital signs (respiratory rate (RR), heart rate (HR), body temperature, and mean arterial pressure (MAP)), and peripheral oxygen saturation (SPO2). The physiological parameters were organized in a flow sheet to document patient's data from the beginning to the end of the study. Clinically relevant changes after application of integrative nursing practices of these parameters can be indicated by pupil size: <2 or >5 mm, pupil reaction: sluggish or non-reactive, RR: <12 or >25 c/m, HR: <60 or >100 b/min, body temperature: ≥ 37.5°C, MAP: < 90 or > 110 mmHg, and SPO2: <88%.

3.6 Method:

1. An official letter from the faculty of nursing were sent to the administrative authority in AMUH and written approval to conduct this study was obtained after providing explanation of the aim of the study.

2. Ethical consideration:

- Informed written consent has been obtained from each patient or patient's family, after complete explanation of the study purpose before the study.
- The anonymity, privacy, confidentiality, and right to refuse of their patients' participation in the study have been assured.
- The researcher attended an extensive therapeutic massage training program in Health Sciences Department, Faculty of Physical Education, Alexandria University before starting the study.

3. Tools were tested for their content validity by 7 experts in the critical care and emergency nursing Field and necessary modifications were done based on their comments. Test the reliability was conducted for the tool II, Cronbach's alpha test was 0.855.
4. A pilot study was carried out on 6 severe TBI patients (3 for each group) to test the feasibility and clarity of tool and accordingly necessary modifications were done.
5. At initial contact, the demographic and clinical data of the studied patients were collected from the patient's chart or from the patient's family and recorded using tool I.

6. For both groups

- ❖ Eligible patients were approached in the fourth day post injury to ensure hemodynamic stability. The researcher selected 2 hours between 3 pm and 9 pm.
- ❖ The baseline measurement of autonomic responses was obtained at the 1st day of the study using tool one.

7. For the control group:

- ❖ Patients were subjected to the conventional nursing care provided by CCNs in the study settings without the researcher interference.

8. For the study groups:

- ❖ Music therapy and aromatherapy massage were carried out for 90 minutes per day for four consecutive days, from the fourth day to the seventh day post injury.

9. **Music therapy:** The study group listened to 30 minutes of brain stimulating music using an mp3 player once daily for four consecutive days of the study period, and to prevent external noise interference, the ears of the patients will be plugged with a headphone. The patient was informed by the reason for having them listen to the music and time of therapy regardless their level of consciousness.

10.

11. **Aromatherapy massage technique:** Each patient in the study group was massaged by the researcher during a 40 minute session once daily for four consecutive days of the study period. Lavender oil will be used for effleurage and massage facilitation and also as a part of aromatherapy massage. A 5drops of lavender oil was poured into researchers hands and was warmed it by holding it for a few seconds before beginning the rub. Each massage session was consisted of : back massage for 10 minutes, feet and legs massage for 10 minutes, abdominal massage for 5 minutes, hands and arms massage for 10 minutes, and chest massage for 5minutes. Massage techniques included static massage, frantic massage, stretching massage, Vibratory massage, and

transverse friction massage. Areas with inflammation, petechiae, ecchymosis, subcutaneous hemorrhage, or wounds will not be massaged.

12. For both groups after music therapy and aromatherapy massage/ conventional nursing care:

❖ The autonomic responses were measured using tool two after each implementation of music therapy and aromatherapy massage for the study group and after 90 minutes of observation of conventional nursing care for the control group throughout the four days of the study period to be compared with the baseline data.

13. Data were collected over 9 months during the period from July 2018 to March 2019.

13-Statistical analysis:

- The raw data were coded and transformed into coding sheets. The results were checked. Data were analyzed using the statistical package for social science SPSS (version 20). Qualitative data were described using number and percent and quantitative data were described using mean, standard deviation. Level of significance for this study is equal to or less than 0.05%. The following statistical tests were used:

1. Chi-square test was used for categorical variables to compare between different groups.
2. Fisher's Exact or Monte Carlo correction Monte Carlo correction: correction for chi-square when more than 20% of the cells have expected count less than 5.
3. Student t-test: for normally distributed quantitative variables, to compare between two studied groups

IV. Results

Table (1) represents the distribution of the studied groups according to their demographic data. Concerning patients' gender, this table shows that 73.3% of the control group of patients were males compared to 86.6% of the study group of patients. In relation to the age, it can be noted that the age of the studied groups ranged from 21 to 60 years. This table depicts that half (50%) of the patients in the study and control group were between 21– 30 years. The differences between the studied groups in relation to all patients' sex and age were not statistically significant P=0.542, P=0.634 respectively.

Table (2) illustrates the distribution of the studied groups according to their clinical data. This table clarified that in relation to the GCS, there was no significant difference between the studied groups (P=0.420) with mean of the GCS 5.73 ± 1.26 and 6.0 ± 1.29 for the control and the study groups respectively. As regards the mechanism of injury, this table represents that there was no significant difference between the two groups (P=1.000) with 73.3% of the control group of patients and two third (60%) of the study group of patients had a motor vehicle accident.

This table also shows that 66.7% and 80% of the control and the study groups of patients respectively had accompanying injuries along with TBI, with no significant difference between them (P=0.243). As regards the CT scan findings, it can be noted that the highest percent was for subdural hemorrhage in both groups of patients with no significant difference between them (P=1.000), it accounts for 46.7% of the control group and more than half of the study group(56.7%). This table presents also, that half of the control group of patients (50%) and most of the study group of patients (70%) were managed medically only with no significant difference between the two groups (P=0.114).

Table (3) illustrates the comparison between the control and study groups according to the mean differences of autonomic responses throughout the study period. Regarding pupils' size, it can be noted that the study group had lower mean pupils' size than the control group in the 1st day (3.22±0.94 vs 3.53±0.72), 2nd day (3.25± 1.02 vs 3.60±0.87), 3rd (3.18±0.79 vs 3.48±0.85), and 4th day (3.13± 1.02 vs 3.48±0.84) with a significant difference of P2=0.047, P2=0.045, P2=0.048, and P2=0.045 respectively throughout the study time. Moreover, it can be noted that there was a significant difference in mean of pupils' size between 1st and 4th day for the study group (P1= 0.006) while, there was no significant difference in the mean of pupils' size between 1st and 4th day for the control group (P1= 0.068).

Concerning respiratory rate (RR), the mean values of RR in the 1st day was 22.18±4.30 for patients in the study group and 23.67±2.83 for patients in the control group. These values declined to 21.10±3.37 for the patients in the study group and increased to 24.08±3.41 for patients in the control group in the 4th day of the study with a highly significant difference between the two groups (P2= <0.001). Furthermore, there was a significant difference in RR between 1st and 4th day for patients in the study group (P1= 0.038) while, there was no significant difference for patients in the control group (P1= 0.327).

In relation to heart rate (HR), it can be observed from this table that the mean HR for patients in the study group decreased from 83.37±15.45 in the 1st day to 79.28±5.65 in the 4th day of the study with a significant difference (P1= 0.030) between 1st and 4th day of the study period. While, the mean HR for patients in the control group did not change significantly (P1= 0.934) from 1st day (90.37±11.77) to the 4th day (90.28±11.06) of the study period. In addition, it can be detected from the same table that there was a highly significant difference between the studied groups in the 4th day of the study period (P2= <0.001).

As regards body temperature, although this table depicts that the mean values of temperature did not change dramatically among patients in the study and control groups throughout the study period. It can be observed that there was a significant difference in the mean of temperature between 1st and 4th day for the patients in the study group (P1= 0.009). On the other hand, there was no significant difference in the mean values of body temperature between 1st and 4th day for the patients in the control group (P1= 0.187).

The current table presents that the mean value of mean arterial pressure (MAP) for the study group increased significantly (P1= 0.024) from the 1st day (93.40± 10.51) to the 4th day (95.63± 9.08) of the study period. Despite the mean value of MAP for the control group increased from 89.55± 10.02 in the 1st day to 91.63± 4.44 in the 4th day of the study period, there was no significant difference between 1st and 4th day of the study time (P1= 0.122). The current table presents also that the mean values of the MAP for the study group were significantly higher than the mean values of the MAP for the control group throughout the four days of the study period P2=0.042, P2=0.025, P2=0.015, and P2=0.003 respectively.

Concerning peripheral oxygen saturation (SPO2), the same table shows that the mean values of SPO2 are fluctuated among patients in both groups throughout the study period. It was 99.27±1.02 for the study group compared to 98.83±1.04 for the control group in the 1st day of the study. In the 4th day the mean values of SPO2 changed to 99.72±0.56 in the study group compared to 98.75±0.86 in the control group. The differences between the two groups were statistically significant during the four days of the study period P2=0.023, P2=<0.001, P2=<0.001, and P2=<0.001 respectively. Furthermore, it can be noted that there was a significant difference in mean of SPO2 between 1st and 4th day for the study group (P1= 0.003) while, there was no significant difference in the mean of SPO2 between 1st and 4th day for the control group (P1= 0.546).

Table (1): Distribution of the studied groups according to demographic data (n = 60)

Demographic data	Studied groups				Test of Sig.	p
	Control (n = 30)		Study (n = 30)			
	No.	%	No.	%		
Sex						
Male	22	73.3	24	80.0	χ^2=	0.542
Female	8	26.7	6	20.0	0.373	
Age (years)						
21– 30	15	50.0	15	50.0		
31 – 40	6	20.0	9	30.0	χ^2=	^{MC}p=
41 – 50	5	16.7	2	6.7	1.887	0.634
51 – 60	4	13.3	4	13.3		
Mean ± SD	33.97 ± 11.54		33.83 ± 13.88		t= 0.040	0.968

χ^2: Chi square test **t:** Student t-test **MC:** Monte Carlo

Table (2): Distribution of the studied groups according to clinical data (n = 60)

Clinical data	Control (n =30)		Study (n = 30)		Test of Sig.	p
	No.	%	No.	%		
GCS score						
Mean ± SD.	5.73 ± 1.26		6.0 ± 1.29			
Mechanism of injury						
Motor vehicle accident	22	73.3	18	60.0	χ^2=1.200	^{FE}p=0.273
Fall from height	8	26.6	9	30.0	χ^2=0.800	^{FE}p=0.371
Assault	2	6.7	3	10.0	χ^2=0.218	^{FE}p=1.000
Hard object hit the head	1	3.4	0	0.0	χ^2=3.158	^{FE}p=0.237
Presence of accompanying injuries:						
Yes	20	66.7	24	80.0	χ^2=	0.243
No	10	33.3	6	20.0	1.364	
CT scan findings:						
Subdural hemorrhage	14	46.7	17	56.7	χ^2=0.601	0.438
Epidural hemorrhage	2	6.7	2	6.7	χ^2=0.000	^{FE}p=1.000
ICH and brain contusion	7	23.3	4	13.3	χ^2= 1.002	0.317
Simultaneous SDH and EDH	7	23.3	2	6.7	χ^2= 3.268	0.145
Other	24	80.0	22	73.3	χ^2=0.373	0.542
Types of management :						
Medical	15	50.0	21	70.0	χ^2=	0.114
Both medical and surgical	15	50.0	9	30.0	2.500	

χ^2: Chi square test **t:** Student t-test **FE:** Fisher Exact
p: p value for Comparing between the two studied groups ***:** Statistically significant at p ≤ 0.05

Table (3): Comparison between the control and study groups according to the mean differences of autonomic responses throughout the study period (n = 60)

Autonomic responses	Time	Groups		t	P_2
		Control (n = 30)	Study (n = 30)		
Pupils size (mm)	1st day	3.53±0.72	3.22±0.94	2.009	0.047*
	2nd day	3.60±0.87	3.25± 1.02	2.026	0.045*
	3rd day	3.48±0.85	3.18±0.79	1.996	0.048*
	4th day	3.48±0.84	3.13± 1.02	2.029	0.045*
$t(p_1)$		1.860 (0.068)	2.853 (0.006*)		
Respiratory rate (breath/min)	1st day	23.67±2.83	22.18±4.30	2.234	0.028*
	2nd day	23.93±4.51	22.05±3.50	2.558	0.012*
	3rd day	23.90±4.47	22.05±3.81	2.439	0.016*
	4th day	24.08±3.41	21.10±3.37	4.820	<0.001*
$t(p_1)$		0.989 (0.327)	2.124 (0.038*)		
Heart rate (beat/min)	1st day	90.37±11.77	83.37±15.45	2.792	0.006*
	2nd day	88.83±11.24	83.37±8.09	3.056	0.003*
	3rd day	88.25±12.94	83.22±10.03	2.381	0.019*
	4th day	90.28±11.06	79.28±5.65	6.859	<0.001*
$t(p_1)$		0.083 (0.934)	2.222 (0.030*)		
Temperature (°C)	1st day	37.61 ± 0.6	37.60 ± 0.71	0.020	0.984
	2nd day	37.54 ± 0.65	37.66 ± 0.36	0.937	0.353
	3rd day	37.6 ± 0.59	37.42 ± 0.44	1.328	0.189
	4th day	37.54 ± 0.59	37.39 ± 0.38	1.150	0.255
$t(p_1)$		1.334 (0.187)	2.708 (0.009*)		
MAP (mmHg)	1st day	89.55± 10.02	93.40± 10.51	2.054	0.042*
	2nd day	91.43± 8.22	95.03± 9.10	2.274	0.025*
	3rd day	91.32± 5.92	95.13± 10.31	2.486	0.015*
	4th day	91.63± 4.44	95.63± 9.08	3.065	0.003*
$t(p_1)$		1.570 (0.122)	2.312 (0.024*)		
SPO_2 (%)	1st day	98.83±1.04	99.27±1.02	2.296	0.023*
	2nd day	98.93±0.66	99.42±0.72	3.832	<0.001*
	3rd day	98.07±0.95	99.45±1.94	4.949	<0.001*
	4th day	98.75±0.86	99.72±0.56	7.338	<0.001*
$t(p_1)$		0.608 (0.546)	3.095 (0.003*)		

MAP: Mean Arterial Pressure **SPO2 :** Peripheral Oxygen Saturation

t: Student t-test

p1: p value for paired t–test for comparing between 1st day and 4th day for the same group

p2 : p value for comparing between the studied groups in each day throughout the study period

***:** Statistically significant at $p \leq 0.05$

V. Discussion

The present study shows that most of the studied patients were males; middle aged less than thirty years old. Moreover, the current results reveal that motor vehicle accidents are the main mechanism of injury among the studied patients. These findings may be attributed to the rapid lifestyle with lack of application of safety precautions among young adult males.

Measurements of autonomic responses (pupillary response, vital signs and SPO2) in relation to application of integrative nursing practices (music therapy, aromatherapy massage) are helpful in assessing TBI patients' brain activity. It can provide an insight into mental activity related to the perception and processing of environmental stimulation caused by using these practices, even in the absence of observable behavior [(25)].

Regarding the pupils' size, results of the current study depicted that the mean values of pupils' size decreased significantly among patients in the study group after application of music therapy and aromatherapy massage compared to patients in the control group. Findings of the current study may be attributed to the calming effects of implementing music therapy and aromatherapy massage using lavender oil that results in parasympathetic activation. This activation counteracts the sympathetic storming that usually occurs following severe TBI and causes pupils dilatation [(6, 17)].

Similar findings were documented by Elhady et al (2011)[(26)]. They reported that the pupils' size were significantly decreased in the study group after application of sensory stimulation compared to the control group. Findings of the current study are contradicted by Rigato et al (2016)[(27)] who found that multisensory stimulation were associated with pupils dilatation. Another study conducted by Reddy et al (2017) [(16)] examined

the effect of music therapy on autonomic responses among TBI patients. They concluded that pupils' size did not significantly changed in the study group compared to the control group.

Concerning HR, RR, and body temperature findings of the present study revealed that the mean values of HR and RR decreased significantly among patients in the study group after application of music therapy and aromatherapy massage compared to patients in the control group. While, no significant difference between the studied groups regarding the mean values of body temperature can be detected after application of music therapy and aromatherapy massage.

These findings may be related to the effect of application of music therapy and aromatherapy massage. It is documented that softening the harsh tech ICU environment by using such integrative therapies can attenuate physical and mental stress resulting from admission to the ICU. Furthermore, inhalation of lavender oil, listening to music and performing of massage significantly decrease the level of ANS stimulation leading to increase the activity of parasympathetic nervous system that counteracts the sympathetic storming following severe TBI [24, 28].

These findings are congruent with the findings of YekeFallah (2018) [29] and YekeFallah et al (2018)[30] they investigated the effect of tactile stimulation and massage on vital signs among severe TBI patients. They found that the mean values of HR and RR decreased significantly in the study group compared to the control group. Also, they stated that there was no significant change in the mean of temperature between the studied groups. Similarly, Han et al (2010) [31] studied the effects of music therapy on the physiological stress response among ICU patients who are mechanically ventilated. Results of this study reported a reduction in the mean values of HR and RR in music listening group than in the control group.

On the contrary, Delavari et al (2016)[14] and Puggina et al (2011) [32] who evaluated the effect of music therapy on TBI patients' vital signs. They concluded that there were no significant reduction in the mean values of the HR and RR in the study group when compared to the control group. In another study conducted by Zolfaghari (2014)**[33]** to determine the effect of listening to music on physiological responses among unconscious patients in ICU. They reported a significant increase in the mean values of HR among patients in study group than patients in the control group. The findings of the current study were not also in the same line with Elhady et al (2011)[26] who found that the mean values of HR and RR in the study group did not change with application of sensory stimulation program.

In relation to the MAP, the present study found that the mean values of MAP in the study group were significantly higher than its values in the control group. This increase can be referred to aromatherapy massage applied to the study group. Aromatherapy massage has been linked to different physiological effects such as increasing of the blood flow and enhancement of venous return. These physiological effects can increase the cardiac stroke volume which in turn lead to increase of the MAP [34, 35].

Results of the current study are supported by Jamaati et al (2015) [36] and Vahedian-Azimi et al (2014)[21]. They approved that the mean values of diastolic blood pressure in the study group after applying full body massage were higher than the mean values of diastolic blood pressure in the control group. In this respect Reddy et al (2017) [16], reported that systolic blood pressure of severe TBI patients increased after listening to 30 minutes of music therapy.

Contrary to the current findings, Azami et al (2015) [37] examined the effect of short term foot massage on MAP of ICU neurosurgical patients. They stated that in the study group, MAP decreased significantly compared to the control group. Similarly, Elhady et al (2011) [26] found that the mean values of MAP in the study group did not change after application of sensory stimulation program. Furthermore, Delavari et al (2016)[14] found that there were no significant changes in the mean values of systolic and diastolic blood pressure in the study group when compared by the control group.

Regarding SPO2, the current study approved that the mean values of SPO2 in the study group were significantly higher than the mean values of SPO2 in the control group. This may be attributed to the calming and relaxation effects of implementing NMT and aromatherapy massage using lavender oil. Relaxation and calmness of severe TBI patients in the ICU are strongly linked to decreasing of HR, oxygen consumption, and oxygen demand and thus increasing the mean values of SPO2 [38].

The results of the current study were in agreement with Hatefi et al (2015) [39] and Jamaati et al (2015) [36]. They revealed that O2 saturation of trauma patients in the study group who received full body massage was significantly higher than the O2 saturation of trauma patients in the control group. Findings of Indriani et al (2018) [40] were in the same line of findings of the present study. They conducted a study to compare between the effectiveness of mobilization and music therapy on changes in non-invasive hemodynamic status of TBI patients. Where they reported that music therapy had a significant effect on TBI patients' SPO2 in the music therapy group compared to TBI patients in the mobilization group.

In addition, in Yousefi et al (2015) [41] study to determine the effect of sensory stimulation provided by family on SPO2 in critically ill patients. They reported that there was a significant difference between the study group and the control group as regards SPO2. Another study conducted by Bolhasani et al (2017) [42], noted that

SPO2 was significantly higher among agitated mechanically ventilated patients after implementing touch massage than the agitated mechanically ventilated patients in the control group.

On the other hand, Puggina et al (2011) [32] found that there were no significant changes in the mean values of SPO2 between the music group and the control group. Similarly, Elhady et al (2011) [26] concluded that the changes in the mean values of SPO2 between the study group after application of sensory stimulation program and the control group after conventional nursing care were not significant.

VI. Conclusion & Recommendations

Conclusion

Based upon the findings of the current study it could be concluded that implementation of music and aromatherapy massage had effects on promotion of severe TBI patients' autonomic responses. During the four day intervention period, the study group shows more improvement in pupils' size, heart rate, respiratory rate, mean arterial pressure, body temperature, and peripheral oxygen saturation than the control group. The intervention used in this study is non-invasive, costless, simple, safe, and effective strategy for improving autonomic response in severe TBI patients in ICUs.

Recommendations:

1- The intervention of music therapy and aromatherapy massage should be a nursing care focus in ICUs parallel with pharmacological management and conventional nursing care of severe TBI patients.

2- In-service educational programs and workshops should be conducted to raise CCNs' awareness regarding the safe use of music and aromatherapy massage for severe TBI patients.

3-Critical care nurses should attend training courses regarding massage therapy to gain knowledge about importance of massage and how to practice it effectively.

4- Replication of this study on large sample is needed for to allow generalization of the findings and confirm the effect of the intervention.

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