

## Effects of Organized Auditory Stimulation by Familiar Voice on Blood Pressure and Body Temperature in Comatose Patients

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Received: 2015January22; Accepted: 2015June17

### Abstract

**Introduction:** Brain injury induced coma is the main cause of hospitalization of patients in the intensive care unit (ICU) and their consequent stressful physiological complications, which can be prevented using sensory stimulation as a therapeutic method. Nevertheless, identifying and using the optimal sensory stimulation program is crucial.

**Objective:** The present study was conducted to determine the effects of organized auditory stimulation by familiar voice on blood pressure and body temperature in patients admitted to ICUs.

**Materials and Methods:** The present clinical trial was conducted on 60 comatose patients with traumatic brain injury (TBI) admitted to the ICU of Poursina Teaching Hospital, Rasht, Iran. The patients were randomly assigned to the intervention group (N=30) and the control group. In the intervention group, auditory stimulation was conducted using significant others' voices in three consecutive evening shifts, 10 minutes each time. Blood pressure and body temperature were evaluated using a checklist, and the findings obtained were analyzed using ANOVA, the t-test and the Chi-square test.

**Results:** The results obtained revealed significant differences in the mean blood pressure and body temperature before and after auditory stimulation in the intervention group ( $P < 0.001$ ), while these differences were insignificant in the controls. The two groups were also found to be insignificantly different in terms of the three-day variations in the mean blood pressure and the mean body temperature.

**Conclusion:** Given the significant effects of auditory stimulation on hemodynamic indicators, auditory stimulation by familiar voice is recommended in comatose patients admitted to ICUs through face-to-face visits with their family members or by playing their recorded voice.

**Keywords:** Acoustic Stimulation, Physiological Stress, Blood Pressure, Body Temperature, Coma

## Introduction

Brain and spinal injuries are among the accidents that constitute the most significant causes of hospitalization and patient deaths [1, 2]. Around 100 million cases of TBI are annually reported, over 800 thousand of which cause permanent disabilities [3]. Concussion presently makes for the second most prevalent cause of death in Iranians. According to the Iran's Ministry of Health, 25000 people died from traffic accidents in 2009 [4].

Although recently-advanced medical sciences and healthcare services have increased the survival rate of the victims, they have yet fail to guarantee the patients' return to their previous healthy status, which itself prolongs the patients' hospitalization in ICUs [5]. The threats posed by diseases, trauma and mental stress include physiological changes followed by frequent emergence of physiological responses such as hypermetabolism and the consequent hyperthermia, increased myocardial contractility and cardiac output and the resulting hypertension [4, 6]. Systolic blood pressures exceeding 140 mmHg caused by the stress accompanied by low pulse pressure is a symptom of extremely high peripheral vascular resistance with a potential risk of brain hemorrhage and stroke [7].

Life-threatening variations in the vital signs of patients with concussions can be prevented through the routine control of hemodynamic status by ICU nurses, which provide them with immediate and accessible information about the patients' cardiovascular function and enable rapid treatment and responses to potential and acute problems [8]. The accurate investigation and monitoring of hemodynamic status is therefore crucial in these patients.

Expensive medications including tranquilizers and analgesics which are currently used widely to control stress in ICU patients have many side-effects such as suppressing the respiratory system and

even death. Some studies suggest that prolonged use of sedatives postpones the removal of the mechanical ventilation from the patients and increase health care costs. Supplementary medications including sensory stimulation programs have been therefore proposed as psychological agents to calm the patients in stressful situations [4, 5, 9, 10]. Although sensory stimulation programs can prevent the complications of physiological stress, identifying and implementing the optimal one is crucial [11].

Although nurses can decide on using various sensory stimuli, auditory stimulation is crucial as hearing is the last sense lost in comatose patients [12, 13] and will surely remain functional even in case of losing all other senses. Moreover, auditory stimulation is the simplest method used through making verbal communications with the patient by nurses during routine health care activities [14]. Auditory stimulation can be performed using different voices [15, 16] with different effects, such as familiar voice that can be more quickly recalled by the patient [5].

Numerous studies conducted on various auditory stimulations indicate reduced anxiety and a sedation status, but no tangible effects on physiological indices such as blood pressure and body temperature. Han et al. suggested that music can reduce blood pressure, pulse rate and respiratory rate in mechanically ventilated patients [17], while Boukje et al. found music to lack significant effects on physiological indices such as Systolic Blood Pressure (SBP) and diastolic blood pressure (DBP), respiratory rate and heart rate in these patients, although they reported significant sedative effects [18].

In addition to the discrepancy of results cited, patients with different medical conditions selected in previously conducted studies and the failure to investigate hemodynamic balance and level of consciousness as the inclusion

criteria in samples have made it more difficult to draw definite conclusions from the findings. A review of available scientific literature suggests a lack of specifically conducted studies on the effect of organized auditory stimulation by familiar voice on blood pressure and body temperature, particularly in Iranian patients. The present study was therefore conducted to determine the effect of organized auditory stimulation by familiar voice on blood pressure and body temperature in comatose patients admitted to ICUs.

### Materials and Methods

The present controlled clinical trial was conducted on 60 patients with TBI admitted to the ICU of Poursina Teaching Hospital, Rasht, Iran. The sample size was calculated as 60 based on the mean Glasgow Coma Scale (GCS) score and the difference in the mean SBP between the intervention and control group found by Hosseinzadeh et al. using a confidence interval of 95% and a test power of 80% (19). Sampling in the present study was conducted over three months (14 July-19 October, 2014) using random blocks of four. Samples of both genders were assigned to the intervention and control groups based on the blocks arrangement. The inclusion criteria comprised being at least 16 years old,  $GCS \leq 8$  and a 24-hour stable hemodynamic status before being included (SBP: 90-160 mmHg, heart rate: 60-100 BPM and body temperature: 35.5-38 °C). The exclusion criteria consisted of having a history of head injury and any types of brain pathology, convulsions or partial deafness based on their family report or medical records, traumatic cerebrospinal fluid rhinorrhea and otorrhea, blood leaking from the nose or the ear, 4 min and longer cardiac arrest upon admission, having symptoms of brain stem infarction or injury, skull fractures, bleeding or surgery in the temporal region, hemodynamic variations during the intervention such as sudden changes of

over 20 mmHg in SBP and DBP compared to baseline blood pressure or over 20 BPM in heart rate compared to the baseline, over 25 breaths/min rise or over 8 breaths/min fall in respiratory rate compared to the baseline and the patient's death or discharge by the third day in both groups. After briefing the study procedure and objectives, 7 out of a total 83 eligible candidates withdrew from the study at the discretion of their guardians. Nine patients were also excluded owing to their unstable hemodynamic status within the first 24 hours of hospitalization. None of the study subjects presented hemodynamic variations during the intervention; however, 7 patients, two of whom were transferred to other hospitals and five who died during the intervention, were also excluded from the two groups and replaced by new samples in the same patient block. A total of 60 patients were ultimately included in the study.

The researcher-made data collection tools comprised demographics forms, clinical assessment forms and a checklist for recording physiological indices such as SBP, DBP, mean arterial pressure (MAP) and body temperature. After conducting a review of literature and developing the research-made questionnaire, ten faculty members including nursing experts and anesthesiologists of Guilan University of Medical Sciences were asked to comment on the tool, and the necessary modifications were accordingly implemented to confirm the content validity of the tool.

The validity and reliability of the monitoring device used to record hemodynamic indices were confirmed based on the brand authenticity and the device proper calibration. Noninvasive methods were used to measure right-arm blood pressure in all the patients with a 30-degree angle position. The monitoring device was used to record MAP and axillary mercury thermometers to record and assess body temperature in all the patients.

The present study received a written license from the authorities of Guilan University of Medical Sciences and was approved by the Ethics Committee of the university. It was also approved the authorities of a teaching hospital in Rasht, Iran. The eligible patients' guardians were then asked to sign informed consent forms. The patients were included in the study once their 24-hour stable hemodynamic status was confirmed through monitoring. Interviews were conducted in the intervention group with the patients' family to identify their significant others, who were then taught, verbally and in writing, how to record the message using a professional Lander LD-73 voice recorder. These people then recorded a 10-minute voice message for the patient with certain content in ICU visiting rooms before the start of visiting hours. The message started with notifying the patient of the person's presence, the time and the place, continued with a brief history of what happened to the patient and recalling their common sweet and promising memories and ended with optimistic and encouraging statements about the patient's future plans after being recovered and returned to their family. Auditory stimulation was conducted in the intervention group before the visiting time, once in every of three consecutive evening shifts to avoid the ICU congestion and numerous patient visits in morning shifts. Measures were taken to avoid any types of manipulation or touch of the patients during the intervention. Physiological indices, including SBP, DBP, MAP and body temperature, were simultaneously recorded in both groups 2 minutes before and 2 minutes after auditory stimulation. The data collected were processed and then analyzed in SPSS-20 using descriptive statistical indices, including frequency, relative frequency, mean and standard deviation, and inferential statistical tests such as the independent t-test, the Chi-

square test, Fisher's exact test and repeated measures ANOVA.  $P < 0.05$  was set as the level of statistical significance.

## Results

The results revealed no significant differences between the two groups in terms of age ( $P=0.807$ ), gender ( $P=0.619$ ), marital status ( $P=0.49$ ), education ( $P=0.141$ ), cause of injury ( $P=0.508$ ), type of damage to the cerebral tissue ( $P=0.145$ ), type of surgeries performed ( $P=0.605$ ), duration of injury ( $P=0.102$ ), duration of coma ( $P=0.102$ ) and level of consciousness upon admission ( $P=0.658$ ). The mean age of the subjects and their mean duration of coma were respectively found to be  $36.65 \pm 14.1$  years and  $31.16 \pm 5.92$  hours; 76.7% of the subjects were men; 61.6% were married; 38.3% had a university degree; 51.6% suffered car accidents; 26.7% had extradural hemorrhage and 53.3% had undergone a craniotomy. Moreover, the Chi-square test found the relationship of physiological indices, including SBP, DBP, MAP and body temperature, with the intervening variables including age, gender, marital status, education, type of injury, cerebral damage and brain surgery to be insignificant in the patients.

The pair wise daily comparison of the mean values of hemodynamic physiological indices in the intervention group indicated statistically significant differences in SBP, DBP, MAP ( $P < 0.001$  in all three days) and body temperature ( $P=0.003$ ,  $P=0.002$  and  $P=0.01$  in the first, second and third day respectively) 2 minutes after the organized auditory stimulation by familiar voice compared to 2 minutes before that. The same-time measurements conducted in the control group, however, indicated no significant statistical differences in these indices (Diagram 1).

[ DOI: 10.18869/acadpub.hnmj.27.1.95 ]

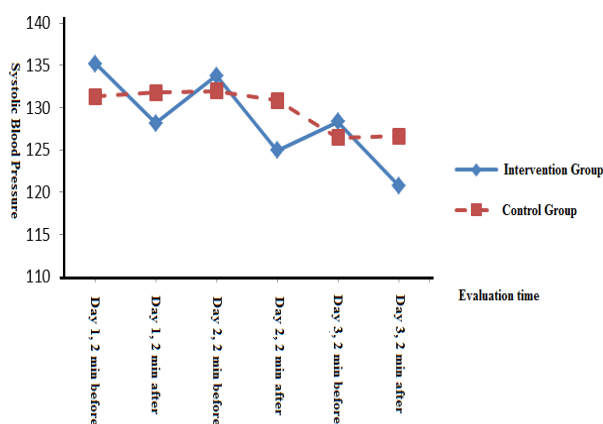
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**Table 1. The comparison of mean SBP, mean DBP, MAP and body temperature before And after the intervention**

Physiological index	SBP		DBP		MAP		Body Temperature	
	Intervention	Control	Intervention	Control	Intervention	Control	Intervention	Control
Day 1, 2 minutes before intervention	135.16±	131.30±	81±15.54	75.33±	98.53±	93.73±	37.33±	37.24±
	13.55	13.36		15.01	14.69	14.26	0.26	0.3
Day 1, 2 minutes after intervention	128.16±	131.8±	75.23±	75.53±	92.26±	94.83±14	37.28±	37.25±
	11.9	13.18	13.5	15.21	12.73		0.26	0.3
Test result*	P<0.001	P=0.556	P<0.001	P=0.696	P<0.001	P=0.337	P=0.003	P=0.103
Day 2, 2 minutes before intervention	133.76±	131.96±	77.93±	72.66±	96.96±	92.26±	37.31±	37.17±
	15.01	13.31	15.27	12.29	14.97	11.08	0.23	0.3
Day 2, 2 minutes after intervention	124.93±	130.83±	70.56±	72.06±	88.3±13	91.53±	37.26±	37.15±
	13.15	13.18	13.46	12.68		11.58	0.21	0.28
Test result*	P<0.001	P=0.065	P<0.001	P=0.08	P<0.001	P=0.079	P=0.002	P=0.38
Day 3, 2 minutes before intervention	128.13±	126.46±	72.6±13.4	70.33±	90.9±	88.93±	37.16±	37.17±
	12.53	12.93		12.25	12.66	11.89	0.27	0.25
Day 3, 2 minutes after intervention	120.76±	126.63±	67.6±	70.16±	85.6±	89.06±	37.13±	37.19±
	11.22	12.89	11.97	12.55	11.95	12.11	0.25	0.24
Test result*	P<0.001	P=0.731	P<0.001	P=0.587	P<0.001	P=0.728	P=0.01	P=0.375
Intragroup test result*	P<0.001	P=0.021	P<0.001	P=0.027	P<0.001	P=0.012	P=0.029	P=0.387
Intergroup test result**	P=0.636		P=0.628		P=0.897		P=0.329	

\*: Independent t-test      \*\*: Repeated measures ANOVA

Hemodynamic variations were also analyzed during the three-day study. The results of repeated measures ANOVA revealed significant differences between daily values of physiological indices including SBP, DBP and MAP ( $P < 0.001$ ) and body temperature ( $P = 0.029$ ) in the intervention group. Similarly, significant differences were observed in the control group ( $P = 0.021$ ,  $0.027$  and  $0.012$  in the first, second and third day respectively), but no significant differences were observed between the values of body temperature ( $P = 0.387$ ). No significant differences were however reported between the two groups in the trend of variations in SBP ( $P = 0.636$ ), DBP ( $P = 0.628$ ), MAP ( $P = 0.897$ ), body temperature ( $P = 0.329$ ) (Table 1). Organized auditory stimulation by familiar voice was therefore found to no significantly affect the three-day variations in SBP, DBP, MAP and body temperature.



**Diagram 1.** Comparison of the variations in the mean SBP trends before and after the intervention

## Discussion

The pair wise comparison of the mean hemodynamic indices in the present study showed statistically significant differences in these indices after administering organized auditory stimulation compared to before this stimulation. No significant differences were also observed between the two groups in the mean hemodynamic variations during the three days. Organized

auditory stimulation by familiar voice was therefore found to reduce physiological indices two minutes after the stimulation compared to two minutes before it.

Auditory stimulation by music was found by Maleki et al. to exert significant effects on reducing the mean physiological indices including the mean body temperature, the mean SBP and the mean DBP [4] and by Han et al. to have significant effects on reducing blood pressure, pulse rate and respiratory rate in the experimental group [17]. Similarly, Lee et al. [9] and Puggina et al. [20] observed significant differences in patients' vital signs after conducting auditory stimulation by music in the experimental group.

Given the consistency of results obtained by the present study and the studies cited on the effects of auditory stimulation, organized auditory stimulation by familiar voice can account for the significant differences between the two groups before and after administering this type of therapy. These differences may be explained by the encouraging and comforting effects of the presence of patients' relatives and the consequent reductions in the sympathetic system activity. According to Han et al., comforting auditory stimulations can reduce the sympathetic nervous system activity, which is reflected in relaxation indices such as reduced pulse rate and respiratory rate, oxygen consumption, epinephrine levels and blood pressure [17]. No significant differences were observed in the trend of variations in the study indices between the intervention and control group over three days of the study. Organized auditory stimulation by familiar voice is therefore found not to significantly affect physiological indices such as SBP, DBP, MAP and body temperature, which is consistent with the insignificant effects of music found by Boukie et al. on the trend of variations in SBP and DBP and MAP [18]. Nilsson et al. [21] reported insignificant differences in blood pressure

between the intervention and control groups, as consistent with the present study.

The present study, however, is inconsistent with those conducted by Han et al. (17), Puggina et al. [20], Maleki et al. [4] in terms of SBP and DBP and MAP, which can be explained by the different intervention procedures used by these authors; Puggina et al. conducted auditory stimulation in patients for three days, three times a day [20]; the auditory stimulation duration was 30 minutes in the study of Han et al. [17] while Goudarzi et al. [5] performed 14 consecutive days of performing 15-minute auditory stimulation twice a day. Three-day auditory stimulation was also used for 15 minutes each time in the study conducted by Maleki et al. [4]. Moreover, the results obtained by Nilsson et al. [21], who administered two-day interventions, are consistent with the present study. The number of days and the frequency of auditory stimulation are therefore recommended to be increased so as to optimize hemodynamic status in patients. The different results obtained in the present study compared to those found by Han et al. [17] and Maleki et al. [4] can be attributed to the different methods they used. Han et al. conducted one-session auditory stimulations and ignored the trend of variations in consecutive periods, while the present study investigated the variations in three consecutive days. Furthermore, only a single group of 35 patients received the intervention in the study conducted by Maleki et al., although they investigated a three-day trend of variations in the same group.

The present study suggested that daily applications of organized auditory stimulation by familiar voice have short-terms favorable effects on reducing physiological indices such as SBP, DBP, MAP and body temperature. Given these temporary effects of the intervention, organized auditory stimulation by familiar

voice is recommended to be used in this type of patients.

Given the different and inconsistent results reported in literature compared to the results of the present study on the insignificant trend of physiological variations over three consecutive days of auditory stimulation, the number of intervention days is recommended to increase and the study groups to be matched in terms of the intervention procedure in future research.

The study limitation was that the patients were unable to specify their person of interest by themselves. Failing to control the person-specific sensory stimulation threshold in the study subjects was considered another limitation of the present study.

### Acknowledgement

The present article was adopted from a master's thesis on Critical Care Nursing which was approved by the Ethics Committee of Guilan University of Medical Sciences (REC.9161/2930162909). It was registered in the Iranian Registry of Clinical Trials (IRCT2014051517693N1). The authors would like to express their gratitude to the Deputy of Research at Guilan University of Medical Sciences and the authorities and staff of Poursina Teaching Hospital in Rasht, who played a key role in conducting this study, as well as to all the participating patients and their families for their friendly cooperation.

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