Effect of Nature-Based Sound Therapy on Stress and Physiological Parameters in Patients with Myocardial Infarction

Abstract

Background: Non-pharmacological interventions in clinical practice, such as Nature-Based Sounds (N-BS), can be an efficient way to reduce stress in patients with Myocardial Infarction (MI). This study was an attempt to investigate the effect of N-BS on stress and physiological parameters in patients with MI. **Materials and Methods:** This double-blind, randomized clinical trial was conducted on 80 patients with MI from two selected hospitals. Using headphones, the subjects in the intervention group listened to 30 minutes of N-BS twice a day for 3 days. The control group, on the other hand, wore headphones playing no sound. The data were collected using the Persian version of the Depression, Anxiety, and Stress Scale. The significance level was set at 0.05. **Results:** The repeated measure analysis showed that the within group effect is statistically significant for Systolic Blood Pressure (SBP) ($F = 113.32$, $p < 0.001$), Diastolic Blood Pressure (DBP) ($F = 67.22$, $p < 0.001$), Heart Rate (HR) ($F = 28.52$, $p < 0.001$), respiration rate ($F = 36.41$, $p < 0.001$), and stress ($F = 102.82$, $p < 0.001$). The reciprocal effect was statistically significant for SBP ($F = 11.76$, $p < 0.001$) and stress ($F = 5.31$, $p < 0.001$). **Conclusions:** N-BS can provide an effective, inexpensive, and non-invasive method of reducing stress in patients with MI. Nurses can incorporate N-BS intervention into the daily care of patients with MI in order to reduce their stress and lower their SBP and HR.

Keywords: *Music therapy, myocardial infarction, physiological, stress*

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Introduction

Patients with Myocardial Infarction (MI) experience a high level of stress and anxiety due to psycho-physical factors such as chest pain, shortness of breath, nausea, vomiting, fear of death and an unknown environment, loneliness, lack of sleep, and limited movements.[1,2] Prolonged stimulation of stress responses in patients with MI affects the recovery process and brings about disturbances in physiological indicators (increased rate of heartbeat, blood pressure, and respiration);[3] increased platelet count and platelet accumulation and adhesion; depression;[4] abdominal pain, severe fatigue, life-threatening arrhythmias, long-term hospitalization, and even death.[5,6] It is also known that stress often exacerbates chest pain and dyspnea. Therefore, physicians try to reduce the severity of the problems by prescribing sedatives or anti-anxiety drugs. However, drugs have several unexpected side effects that may prolong the recovery of the patient.[7] Common non-pharmacological treatments include prayer, massage therapy, exercise, cognitive therapy, muscle relaxation, music therapy, aromatherapy, Nature-Based Sound (N-BS), and guided imaging, which are used to relieve patient stress. Given its simplicity, low cost, and non-invasiveness, N-BS as a method that does not actually waste considerable time and energy seems to have a beneficial effect on reducing stress. Accordingly, non-pharmacological treatments such as a combination of sedative agents and N-BS intervention could be applied into the care of the patients.[8]

Kaplan and Ulrich emphasize the direct and indirect effects of N-BS not only on cognitive, emotional, and psychological processes but also on reducing stress and regaining attention and concentration.[9] This is in line with the theory of Kaplan and Kaplan (1995) in which directed attention capacity can be recovered through

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a natural environment and thereby mental fatigue can be reduced.[10]

Sounds of nature can positively affect everyone's emotions, and compared to other interventions, using these sounds has the most relaxing effect.[11-13] The results of studies on the following topics have all shown the positive effect of N-BS intervention: agitation and anxiety levels in patients with coronary artery bypass grafts in the process of weaning from mechanical ventilation,[12] agitation, anxiety, and stress in patients under mechanical ventilator support,[14] anxiety in patients undergoing percutaneous coronary intervention,[15] pain severity after cesarean section,[8] anxiety in women undergoing gynecological examination,[16] and anxiety and stress in critically ill patients.[17] However, Ghezeljeh *et al*. (2017) did not find support for the significant effect of nature sounds on physiological indicators of patients hospitalized in the Coronary Care Unit (CCU).[3]

The mixed results of previous non-pharmacological interventions could be explained by the little theoretical knowledge on sound and noise in health care units, restricted training in this field, and lack of professional frameworks to guide stakeholders, researchers, and clinicians. Therefore, routine care of patients has not fully benefited from such interventions due to these discrepancies and differences.[18] This study was conducted to identify the effect of an NB-S intervention on stress and physiological indicators in patients with MI.

Materials and Methods

This double-blind, randomized clinical trial (IRCT20200922048798N1) was conducted in 2019. Assuming a power of 0.80, a confidence level of 0.95, the largest standard deviation of the dimensions of the Depression, Anxiety and Stress Scale (DASS) questionnaire to be 1.8, an estimation error of 2.10 units, and a probable attrition rate of 10%, the sample size was calculated to be 80. After screening 118 potential participants, a convenience sample of 80 patients was enrolled in the study. Sampling started on February 1 and ended on September 30, 2019. The participants were allocated to intervention (n = 40) or control (n = 40) groups through permuted block randomization and a table of random permutations. The block size was 4 [Figure 1]. The setting of the present study included the only two referral cardiac care units located in two general teaching hospitals affiliated with Ahvaz Jundishapur University of Medical Sciences (AJUMS). Participants were eligible to participate if they: were willing to participate in the study; had an accurate diagnosis of acute MI verified based on at least two of the three standard criteria; elevated cardiac biomarkers, electrocardiogram presentation, and typical chest pain; were aged between 20 and 60 years; had normal hearing ability and full consciousness; were not intubated; had no respiratory, neurological, or psychiatric disorders, had no drug addiction (anti-anxiety or benzodiazepine); were not smokers; had received no inotropic support; and had not already participated in any N-BS or any other holistic intervention. Participants who died during the study or were unwilling to stay in the study were excluded.

Medical records of the patients were used to collect the baseline data to compare patients in the experimental and control groups in terms of their age, gender, educational level, marital status, and drug therapy in the past 24

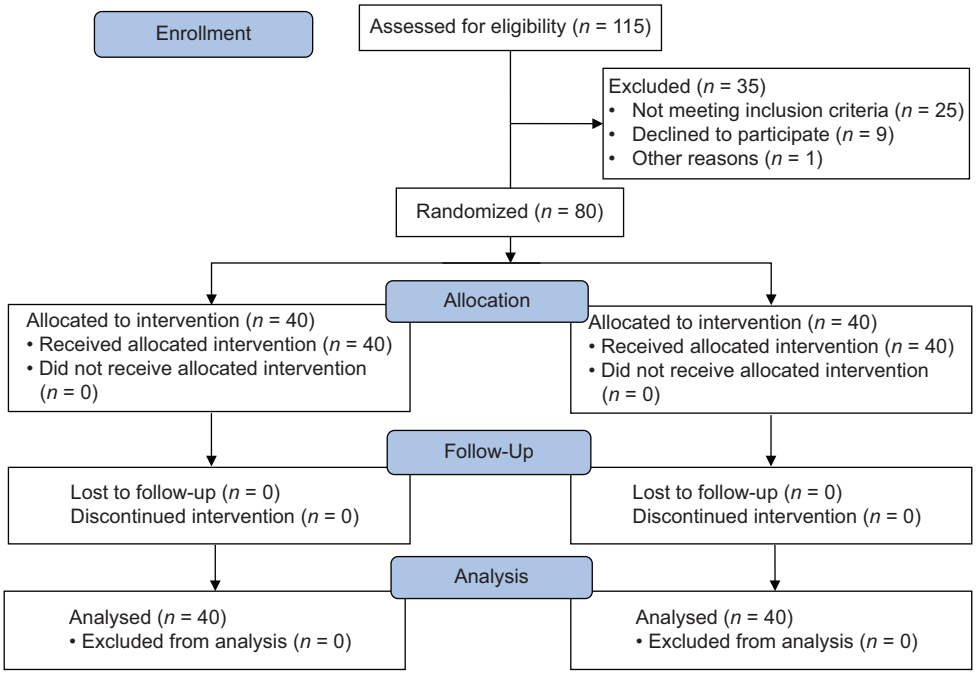

Figure 1: CONSORT Flow Diagram

hours. Physiological indicators for measuring stress and anxiety were Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Heart Rate (HR), and Respiration Rate (RR).. All indicators were measured using bedside monitors, which were carefully calibrated prior to data collection. The Persian version of DASS-21 entails 21 items in three self-assessment subscales (7 items each). DASS-21 measures the negative emotional states of depression, anxiety, and stress. The scale is completed according to the respondents' experiences during the week prior to completion of the scale. In this study, a four-point Likert scale was used for rating the items, with 0 meaning "did not apply to me at all" and 3 meaning "applied to me most of the time or very much." For each subscale, the total score ranged from 0 to 21. Larger scores represent higher levels of stress and anxiety and more severe depression. Cronbach's alpha coefficient was employed to calculate the internal consistency of items. Whereas the Cronbach alpha was 0.94 for the total score of the DASS-21, it was 0.85, 0.85, and 0.87 for the Depression, Anxiety, and Stress subscales, respectively.[19] In this study, only the subscale of stress (7 questions) was used. The final score was doubled.

After the study was approved by the Ethics Committee of AJUMS, the nurse manager in the cardiac care unit was briefed on the objectives of the study. Then, according to the inclusion criteria, eligible participants were selected from among the daily patient records. Afterward, the participants who met the inclusion criteria were briefed on the objectives, benefits, and potential risks of the study. Due to the fact that the time of day can affect the patient's anxiety during data collection, all interventions were carried out in the afternoon (from 2 pm to 3 pm) and at night (from 9 pm to 10 pm). The nurses were asked not to perform activities related to treatment and care of the patients during the hours when the patients were listening to music, and thus all care procedures were performed by nurses in hours other than the intervention hours. Additionally, in order to prevent patient family members' interference with the intervention, they were asked not to visit their patients while they were listening to music.[14]

The study was started 24 hours after hospitalization and remission of the acute phase of the disease. In this study, an MP3 media player with disposable foam-lined headphones that contained various sounds based on nature was provided to the patients in the intervention group, and they were asked to listen to their favorite natural sounds. The collection of natural sounds, such as singing birds, soothing rain, gentle wind, ocean waves, river streams, waterfall, and walking in the forest, were selected and played. The type of music was selected by a research team consisting of two nursing faculty members and a cardiologist. The patients were free to choose any sound they liked. The headphones' volume was set at a comfortable level, which was determined by asking the patients and checking their responses through facial expressions. During the intervention, the patients were asked to follow the flow of sounds while closing their eyes. Using headphones, the patients listened in their rooms to the sounds twice a day (afternoon and night) for 30 minutes continued for three days. In order to minimize unpleasant environmental stimuli or noises, the patients in the control group were asked to rest in silence and wear foam-lined headphones that played no sound, while the patients in the intervention group were listening to nature sounds. Also, this process was supervised by one of the nurses on duty in the shift. For both groups, the study environment was enhanced for improving the patients' rest and reducing the rate of unwanted disturbances. This involved closing the curtains, dimming the lights (except in contraindicated situations), partially closing the door, and installing the signs "Please Do Not Disturb" and "Patients Are Resting." The nurses and medical staff were instructed not to disturb the patients during their rest time. During the procedure, the physiological parameters of stress in patients of both groups were recorded by the lead researcher who was blind to group allocation in order to make bias in sedation scores and recording of parameters less likely. For each participant, the recorded parameters were monitored continuously based on CCU protocol. This made the process of data collection easier for the lead researcher and caused minimal patient disturbance. The physiological signs in both groups of patients were immediately recorded before and during the procedure at various intervals of 30, 60, and 90 minutes.[12,14]

The data were entered into SPSS (version 16, SPSS Inc., Chicago, IL, USA) to be analyzed statistically. The normality of quantitative variables was assessed using the Shapiro–Wilk test. A Chi-square test was used to detect any available significant difference between the groups' baseline data, such as gender, age, occupation, educational level, marital status, patients' interest in pleasant N-BSs, and insurance coverage. To compare the two groups in terms of quantitative variables, an independent *t*-test or its non-parametric equivalent (the Mann-Whitney U test) was used. Since none of the variables deviated from their normal distribution, repeated measures were used for each variable. Repeated measures were also employed to examine mean SBP, DBP, RR, and HR across the intervention period. The statistical significance level in the above tests was considered to be less than 0.05.

Ethical consideration

This study was approved by the Ethics Committee of AJUMS (IR.AJUMS.REC.1398.752). Patients' informed consent was obtained after they were informed about the purpose of the study and prior to assigning them into groups. The patients were assured of their anonymity and confidentiality and were then asked to choose their favorite nature sound for the intervention. The patients were also ensured that they could withdraw from the study any time they wanted, and that patients who did not prefer to

join the study would also benefit from essential hospital services and treatments. It should be noted that no risks associated with the use of N-BS interventions have been reported in previous studies. Moreover, due to the fact that the measurement of anxiety, physiological parameters, and agitation scores is part of the routine activities in the CCU, no extra financial burden was imposed on the patients.

Results

In the current study, 80 patients were randomly assigned to the control (n = 40) and intervention (n = 40) groups. Table 1 presents the baseline and clinical characteristics of patients in the control and intervention groups. Based on the results of the Chi-square test and Fisher's exact test presented in this table, it can be seen that there is no significant difference between these two groups in terms of age, gender, marital status, and level of education. To evaluate the concurrent effect of time, intervention (group variable), and interaction between time and group on different response variables, i.e., hemodynamic outcomes including SBP and DBP, HR, and RR, the repeated measures ANOVA model was used. In order to adjust the impact of the baseline values of these hemodynamic variables on response variables in these models, the baseline values of the hemodynamic variables were included as covariates. The results of the repeated measures test for SBP, DBP, HR, and RR revealed a significant time trend and interaction between time and group ($p < 0.001$) [Figures 2-5].

The results of marginal modeling for stress score revealed the significant effect of time and interaction between group and time ($p < 0.001$) [Figure 6]. Within-group effects in each group are used to simultaneously examine successive points. $\eta^2 = 59.20$ means that 59.20% of within-group changes of the response (SBP) are expressed as within-group changes, and that SBP is significantly different at different times ($p < 0.001$). $\eta^2 = 0.463$ means that 46.30% of within-group changes of the response (DBP) are expressed as within-group changes, and that DBP is significantly different at different times ($p < 0.001$). $\eta^2 = 0.27$ means that 26.80% of within-group changes of the response (pulse) are expressed as within-group changes, and that pulse is significantly different at different times ($p < 0.001$). $\eta^2 = 0.03$ means that 31.80% of within-group changes of the response (breathing) are expressed as within-group changes, and that breathing is significantly different at different times ($p < 0.001$). $\eta^2 = 0.569$ means that 56.90% of within-group changes of the response (stress) are expressed as within-group changes, and that stress is significantly different at different times ($p < 0.001$). The reciprocal effect is used to examine the trend of changes in the two groups (the difference between the slope of two lines at different times).

According to the results, 13.10% of SBP changes were related to the reciprocal effects of time and group. The trend of SBP changes in the two groups is statistically significant ($p < 0.001$). Also, 1.70% of DBP changes were related to the reciprocal effects of time and group. The trend of DBP changes in the two groups was not statistically significant ($p = 0.262$). Our results also showed that 2.70% of pulse changes were related to the reciprocal effects of time and group. The trend of pulse changes in

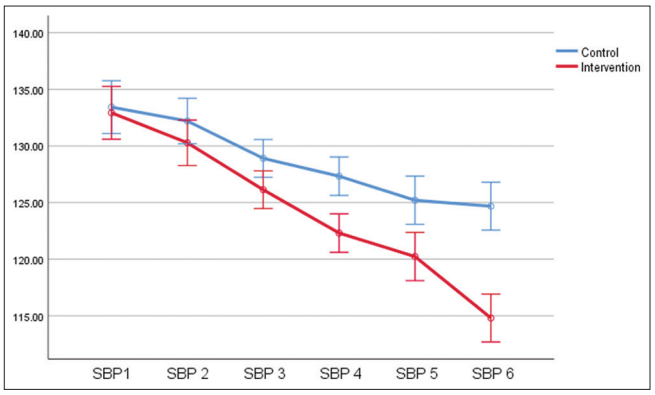

Figure 2: Time trend of mean systolic blood pressure in the intervention and control groups

Table 1: Socio-demographic data of the participants

Variables	Control *n* (%)	Intervention *n* (%)	Chi-square test	df	*p*
Gender			1.14	1	0.284
Male	29 (72.50)	33 (82.50)			
Female	11 (27.50)	7 (17.50)			
Age			0.21	1	0.644
<60	14 (35)	16 (40)			
>60	26 (65)	24 (60)			
Marital status			0.28	1	0.592
Married	30 (75)	32 (80)			
Unmarried	10 (25)	8 (20)			
Level of education			Fisher's exact test	1	0.253
Primary	15 (37.50)	8 (20)	3.98		
Diploma	11 (27.50)	18 (45)			
Bachelor's degree	10 (25)	9 (22.50)			
Master's degree, PhD	4 (10)	5 (12.50)			

the two groups was not statistically significant (p = 0.093). In addition, 2.70% of breathing changes were related to the reciprocal effects of time and group. The trend of breathing changes in the two groups was not statistically significant (p = 0.065). Finally, 6.40% of stress changes were related to the reciprocal effects of time and group. The trend of stress changes in the two groups was statistically significant (p < 0.001). [Table 2].

Discussion

According to the results of the present study, using N-BS interventions dedicated to patients with MI could significantly reduce the self-reported scores on the scales of stress and regulate the heartbeat rate. The results of the present study are in line with those of other similar studies proposing that being connected to a pleasurable natural environment can decrease harmful physiological responses arising from agitation and anxiety among patients subjected to mechanical ventilation.[12,14] Moreover, exposure to pleasurable natural environments has been found to potentially decrease anxiety, acute procedural pain, and physiological parameters among patients undergoing port catheter placement.[20] In patients diagnosed with dementia, exposure to pleasurable natural environments was found to decrease the rate of agitation and anxiety.[21] Additionally, the same exposure decreased HR, pain, and postoperative anxiety in patients undergoing trans-esophageal echocardiography.[22] Based on studies carried out by Farzaneh *et al*. (2019), mothers undergoing elective cesarean experienced less pain after listening to 20 minutes of N-BS.[8]

The positive effect of the N-BS intervention in this study could be attributed to its potential in creating relaxing conditions for the patients. Interventions based on natural sounds seem to improve the recording of brain alpha waves, which are the waves of mental rest, and thus provide a relaxing condition[22,23] In fact, interventions based on natural sounds lead to a decrease in unpleasant emotions by activating several subclavian areas of the

Table 2: Within group effects and the reciprocal effect based on Repeated Measure Analysis

Variable	Within group effects			The reciprocal effect		
	F	*p*	η^2	*F*	*p*	η^2
SBP*	113.32	<0.001	59.20	11.77	<0.001	0.13
DBP**	67.23	<0.001	0.46	1.33	0.262	0.02
HR***	28.52	<0.001	0.27	2.15	0.093	0.03
RR****	36.41	<0.001	0.32	2.16	0.065	0.03
Stress	102.82	<0.001	0.57	5.31	<0.001	0.07

*Systolic Blood Pressure, **Diastolic Blood Pressure, ***Heart Rate, ****Respiration Rate

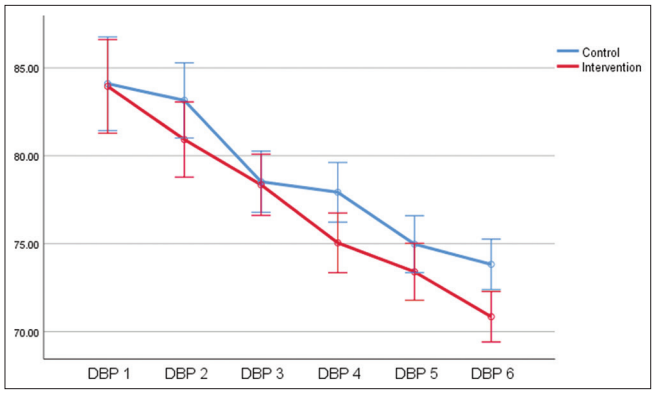

Figure 3: Time trend of mean diastolic blood pressure in the intervention and control groups

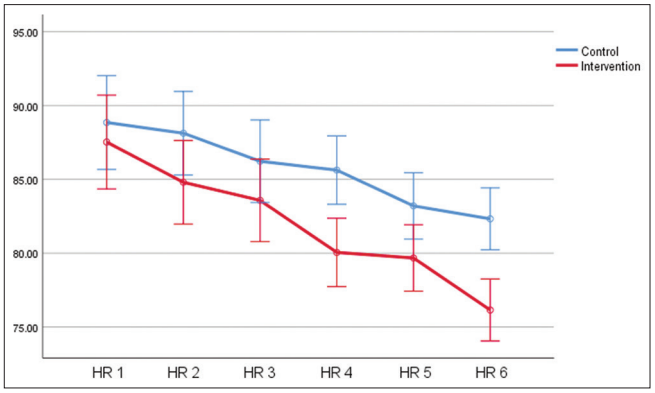

Figure 4: Time trend of mean heart rate in the intervention and control groups

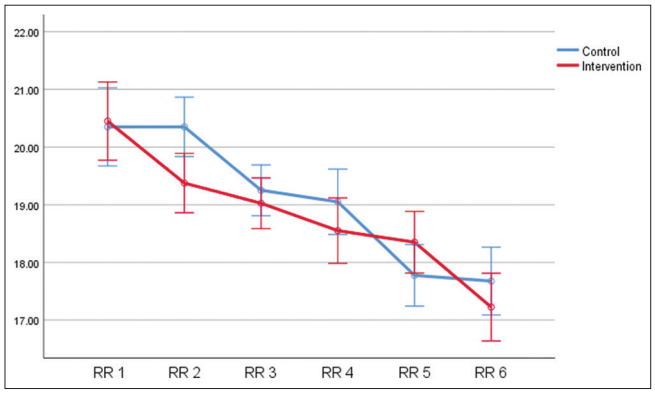

Figure 5: Time trend of mean respiration rate in the intervention and control groups

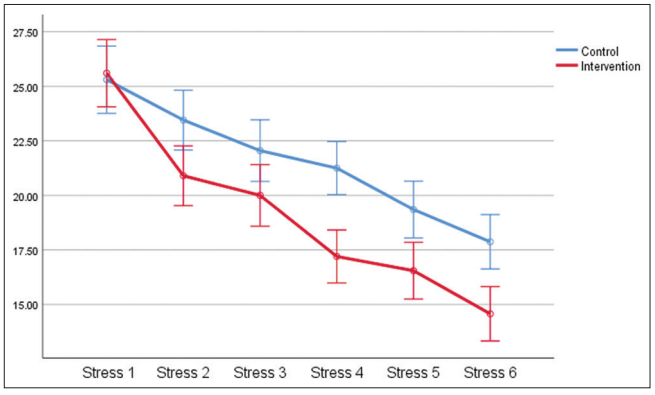

Figure 6: Time trend of mean stress in the intervention and control groups

brain, especially the dopaminergic system in the midbrain. In addition, by activating the frontal lobe in both hemispheres of the cerebral cortex, these interventions enhance brain consciousness and ultimately improve desirable cognitive-behavioral outcomes. In this way, music therapy plays a role in reducing patients' stress and anxiety. In addition, the effects of N-BS interventions on reducing stress and anxiety can be explained by the variety of reactions in the body, including muscle relaxation, HR regulation, and drowsiness.[24]

The study findings revealed that natural sounds could reduce the frequency of heartbeat rate in patients with MI and thus regulate their heartbeat rate. Reduced release of catecholamines and decreasing sympathetic activity may be a reason for the decrease in the number of pulses when listening to natural sounds.[15] Although factors such as age and socioeconomic status may affect the way people respond to music and pain, unappreciated or unwanted music styles would not improve and may even worsen the anxiety level.[22] Another study by Aktas *et al*. (2018) indicate that N-BS provide a pleasant and enjoyable stimulus for the patients during gynecological examination and cause relaxation while reducing anxiety level in the women.[16]

Despite its strengths, the present study had a number of limitations. Conducting the intervention in only two hospitals and having a small sample size are two of the main limitations of the study, which may impact the generalizability of our findings. Future studies are recommended to use a multi-center sampling design with a larger sample size. Moreover, interested researchers are advised to repeat this intervention, recruiting three groups of patients, with the third group not wearing headphones. In this condition, the calming effect of the N-BS intervention in association with the reduction of background noise could be taken into account. The patients' interest in pleasant N-BSs was not evaluated in this study. Therefore, it is suggested that the pleasant N-BSs and the satisfaction level be evaluated in further studies. Additionally, given the type and size of room as a potential confounding variable, the effect of background noise in single versus multiple-bedded rooms could be addressed.

Conclusion

The results of this study showed that interventions based on N-BS reduced stress and regulated the HR of the patients with MI. In high-tech cardiac care settings, the N-BS listening test is a non-pharmacological intervention in which nervous tensions could be stimulated by stressful and noisy aspects of the environment. To decrease patients' anxiety and stress, this kind of non-pharmacological intervention can be incorporated by nurses into the daily care of MI patients.

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Conflicts of interest

Nothing to declare.

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