Original Article

The Effect of White Noise Exposure on Anxiety and Hemodynamic Parameters of Operating Room Staff

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Abstract

Aim: Anxiety reduces performance at work. Anxiety is significantly prevalent among medical staff in general, and especially operating room staff. The present study was an attempt to investigate the effect of suction-induced white noise on anxiety and hemodynamic parameters of operating room staff during cesarean section. **Materials and Methods:** The present study was a crossover, single-blind clinical trial on 29 scrub staff during cesarean section. The subjects were assigned once to the control group and once to the intervention group with a 10-day washout period. In the intervention group, the suction machine was left on during surgery for 3 days in a row, but in the control group, the suction machine was switched off in idle times to make sure that noise exposure time would remain below 30 min. Hemodynamic parameters of subjects were measured on the last day immediately after surgery, and the Spielberger State-Trait Anxiety Inventory was used to measure the level of anxiety. SPSS 22 software and linear mixed model were used to analyze the collected data. **Results:** The control and intervention groups were not significantly different in terms of hemodynamic parameters, anxiety as well as the carryover-crossover effects ($P > 0.05$). A significant negative correlation was observed between anxiety score and age of the subjects ($P < 0.05$). **Conclusions:** Suction-induced white noise has no effect on anxiety and hemodynamic parameters of operating room staff. Adaptation to workplace noises can reduce the adverse effects of noise.

Keywords: Anxiety, operating room staff, suction, white noise

Introduction

Anxiety can be defined as a state of inner turmoil, tension, and fear when a person is exposed to a stressful situation.[1] Although anxiety is part of every job, it is more severe in jobs associated with human health care.[2] A considerable proportion of hospital staff suffer from anxiety, with operating room and surgery ward staff experiencing maximum levels of anxiety compared to others.[3] Unfavorable environmental conditions coupled with occupational exposure of nurses in general, and operating room nurses in particular, to high levels of psychological and physical stresses and considerable burdens of responsibility, can cause them to experience increasing levels of anxiety.[2] Increases in the level of anxiety among nurses are associated with declines in job quality and performance, increases in the level of burnout, absenteeism, family problems, and declines in patient satisfaction, turnover, and depression. It is, therefore, necessary to consider strategies that can help reduce anxiety among nurses.[4,5] Psychological, social, environmental, and physical factors trigger the highest levels of anxiety among operating room staff.[6] Of all the occupational pollutants, noise has the greatest impact on inner turmoil of people and can disrupt the occupational process.[7] Noise is recognized as a health hazard and a source of anxiety that undermines concentration and interpersonal interaction. In the meantime, the noise level of operating rooms is higher

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than other medical environments.[8] Previous studies show that increasing noise levels can intensify anxiety, whereas rhythmic sounds in general, and music in particular, can reduce the noise-induced anxiety in the operating room.[8,9] However, the surgeon's auditory processing functions became less accurate during the time music was being played than the time the operating room was quiet or the surgeons were just exposed to ambient noises.[10] A clearly audible sound such as music attracts attention, whereas inaudible and muffled sounds may not arouse any particular reaction. Many sounds with constant tune and rhythm have an incremental effect on the pace of work.[11] Some sounds, including the sound of rain, ocean, lightning, sea waves, air conditioners, air suction, and electric fan, which share the same characteristics as white noise, have been used as pleasant auditory stimuli to reduce anxiety.[12-14] White noise is a spectrum with a uniform frequency distribution. This phenomenon can be best defined as sound with a wide frequency range that is characterized by uniform intensity and a finite variance.[15] White noise can be recognized as a mixture of all sound frequencies that are used to treat tinnitus and insomnia.[16] White noise leads to masking or neutralization of other ambient sounds. This phenomenon is referred to as auditory masking which can affect the level of anxiety by itself.[17] As a background sound, white noise can also change the auditory threshold and thereby reduce brain stimulation and anxiety levels.[18] White noise reduces patient's anxiety and, depending on the duration of exposure, the functions of this noise may be variable.[12,13]

Suction machine is one of the indispensable devices in the operating room. Suction machine is a device that comes with a pump and creates negative pressure (vacuum) to collect secretions, fluids, and blood, thereby giving a better sight of the surgery site. Suction is actually an indispensable OR apparatus that comes in different types and is used in most surgeries.[19] The noise made by the suction device is below the level of occupational safety standard.[20] The steady suction-induced noise, which actually falls within the category of white noise, can also mask the ambient sounds to some extent, reduce their effect on individuals, and consequently affect the level of anxiety.[11] Nevertheless, there is still a lot of controversy over the effect of suction-induced noise on anxiety of operating room staff.[21,22] Considering the importance of anxiety control and its effect on performance of operating room staff on the one hand, and the exposure of these individuals to various sources of noise such as suction devices and the unknown effects of white noise on them, on the other hand, it is necessary to investigate suction-induced noise effects. Moreover, detection of the most critical environmental stressors arising from occupational exposure of operating room staff to unwanted factors can contribute to enhancement of job productivity.

Materials and Methods

Design and participants

This single-blind, crossover clinical trial study was conducted from 2019 to 2020 on 29 scrub staff (with 2–20 years of occupational experience) who participated in cesarean sections in the gynecology operating room of Mohammad Sadegh Afshar Hospital of Yazd, Saadi Hospital of Isfahan, and Shariati Hospital of Isfahan. Due to the limitations of the study population, all eligible individuals were included in the study. Subjects with a history of psychiatric, neurological, and auditory disorders as well as the individuals taking drugs with known effects on the central nervous system, cardiovascular system, and blood pressure were not included in the study.

White noise induced by suction device and anxiety of operating room staff were considered independent and dependent variables, respectively.

It should be mentioned, the characteristics of white noise have been determined through the MATLAB software FFT output by observation of the wave power uniformity in the emitted frequency spectrum.

Intervention and data collection instruments

In the present study, a simple randomization method at the individual level was used to generate a random sequence. Nineteen individuals were assigned to the intervention group and ten individuals were assigned to the control group accordingly. Once the informed consent of the participants was obtained, the intervention group members were exposed to suction-induced white noise for 30–60 min,[23] and the suction machine (C55 SAIRAN) was left on, as usual, from the beginning till the very end of surgery. In the control group, the researcher switched off suction machine using a foot pedal (at times when the surgeon did not need the device) to make sure that the duration of noise exposure would remain below 30 min. This trend was continued for 3 consecutive days during the first morning shift cesarean section. The right arm systolic and diastolic blood pressure of scrub subjects was measured by a research partner using a mercury sphygmomanometer (ALPK2 FT-801) on the 3rd intervention day immediately after the cesarean section. The radial pulse and respiratory rates of subjects were also measured in 1 min.[24]

The mean ambient noise level in the operating room during cesarean section was 76.37 dB, which is below the threshold of HSE (Health and Safety Executive) risk in Iran.[25]

The questionnaire was filled out by the scrub subjects up to 10 min after the cesarean section. The questionnaire consisted of two parts. The first part covered demographic information including age, sex, work experience, education level, and history of specific diseases. The second part consisted of the 40-item Spielberger State-Trait Anxiety Inventory (STAI). The first and second 20 items of the inventory were used to measure the state and trait anxiety, respectively. Both score scales ranged from 20 to 80. The first test determines baseline anxiety level, and the second test indicates anxiety level generated by environmental changes. STAI test is a reliable test whose reliability and validity have been confirmed.[26]

Each subject (in the control and intervention groups) was assigned to the opposite group after the 1-week washout period

to avoid the potential effects, and finally underwent all the abovementioned steps again. In order to control the ambient noises in the operating room, the ambient sound pressure level in network A was measured by a sound level meter (TES-1351). The performance of the device has been optimized by calibration.

Data analysis

Once the collected data were introduced to SPSS v. 22 (IBM, Armonk, NY, USA), the frequency distribution and descriptive statistics were recorded and then the data were analyzed using a linear mixed model. The results were checked in terms of carryover effect, crossover effect, and group effect. The tradeoff between the variables was also estimated using the coefficients of the mixed linear model.

Results

The participants (20.70% – male and 79.30% – female) were characterized by a mean age of 38.41 and a mean work experience of 11.93. Since it was a crossover study, all subjects were present in two groups and there was no significant difference between demographic variables within them. As for education level, 1 (3.40%) participant held a high school diploma, 8 (27.60%) of them held an associate degree, 19 (65.50%) of them held a bachelor's degree, and 1 (3.40%) of them held a master's degree.

The maximum mean systolic blood pressure (125.30 mmHg), diastolic blood pressure (80.70 mmHg), and respiration rate (30) were related to those who had been assigned to the intervention group in the second phase of the study.

The anxiety of most subjects assigned to the intervention group in the first and second phases of the study was in the moderate (36.80%) and mild (40.00%) range, respectively. The state anxiety of most subjects assigned to the control group (in the first and second phases of the study) was found to be mild (44.80%). The trait anxiety was mild for most subjects assigned to the intervention group (in the first or second phases of the study) and zero or minimal for the subjects assigned to the control group (in the first or second phases of the study).

Comparison of heart rate, respiration rate, blood pressure, as well as state and trait anxiety in the control and intervention groups showed no significant difference between the two groups. The group differences in terms of crossover/carryover effect and the stage of the intervention were not significant [Tables 1 and 2].

A linear mixed model was used to check the relationship between demographic indices and the state and trait anxiety. The results show that the state and trait anxiety scores significantly decline as the subject's age increases ($P = 0.00$) [Tables 3 and 4].

Discussion

According to the results of the present study, there is no significant correlation between suction-induced noise and the level of state and trait anxiety of operating room staff. Although familiar and meaningful sounds such as music may attract attention, meaningless sounds may not arouse any reaction.[11] Employees in general and operating room staff in particular can adapt themselves to and get used to the incessant noises of their workplace, and this can, in turn, reduce the adverse effects of environmental noises on them. Thus, concerns over the unknown effects of suction-induced noise on the anxiety of the operating room staff were mitigated. The results of a study on the effects of music, white noise, and ambient noise on sedation and anxiety of patients undergoing spinal anesthesia showed that postsurgery white noise reduces patient's anxiety but has no effect on anxiety before and during surgery.[12] The results of this study (white noise has no effect on anxiety prior to and during surgery) were found to be consistent with the results of the present study. This consistency can be seemingly attributed to similar exposure time (30–60 min). Nevertheless, the contradiction between the results in terms of postsurgery effects of white noise can be attributed to more than 60-min exposure to white noise (from the beginning of spinal anesthesia until the time of transference to recovery wards). On the other hand, preoperative anxiety that usually arise from patient's lack of familiarity with the environment and ignorance of the outcome and consequences of surgery is more severe than postoperative anxiety. Therefore, it can be argued that anxiety reduction is more probable in the postoperative stage.

The results of a relevant study with inconsistent results showed that chronic exposure to high-level white noise has no effect on learning and activity of individuals but can rather increase anxiety levels.[21] Accounting for this contradiction, it can be argued that anxious behaviors developed after exposure to white noise are attributable to noises with intensity of 100 dB, and the fact that high-level noises with constant tune and rhythm could be annoying.

The results of a study on the effect of white noise on anxiety of patients admitted to the cardiac intensive care unit (CICU) showed that white noise can lead to reduction of anxiety levels.[22] Accounting for the contradiction between the results, one can argue that the white noise used in this study was actually the sound of sea waves (50–60 dB) which does not fall within the category of ambient noises with constant tune and rhythm. In this study, elderly patients were sampled in relaxation state.

According to the results of the present study, suction-induced white noise had no significant effect on hemodynamic parameters of participants. Similarly, the results of a relevant study showed that white noise has no effect on hemodynamic parameters including heart rate, blood pressure, and respiration rate of patients.[12] The consistency between the results of these two studies can be attributed to similar age range of the participants and duration of exposure to white noise.

The results of a relevant study showed that white noise exposure could decrease the heart rate of two groups of the elderly admitted to the CICU. This intervention, however,

Table 1: The effect of intervention on the level of hemodynamic parameters based on group type, stage, and interaction

Source	Numerator df	Denominator df	Heart rate		Respiration rate		Blood pressure (systolic)		Blood pressure (diastolic)	
			F	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Intercept	1	54	2.95	0	1.07	0.00	3.55	0.00	2.76	0.00
Group	1	54	2.39	0.12	0.43	0.51	0.06	0.80	0.17	0.68
Carry over	1	54	0.05	0.82	0.47	0.49	0.27	0.60	0.30	0.58
Crossover	1	54	0.40	0.52	0.03	0.85	0.10	0.74	0.05	0.81

Dependent variable: Hemodynamic parameters, $P<0.05$

Table 2: The effect of intervention on the level of anxiety based on group type, stage, and interaction

Source	Numerator df	Denominator df	State anxiety		Trait anxiety	
			F	*P*	*F*	*P*
Intercept	1	54	711.38	0.00	1.01	0.00
Group	1	54	2.54	0.11	0.53	0.46
Carry over	1	54	0.07	0.79	0.01	0.91
Crossover	1	54	2.34	0.13	2.11	0.15

Dependent variable: Anxiety, $P<0.05$

Table 3: Estimation of regression coefficients in examining the relationship between demographic variables and state anxiety

Parameter	Estimate	SE	Df	*t*	*P*
Sex	2.89	3.37	52	0.85	0.39
Age	−0.65	0.15	52	−4.14	0.00
Education level	2.05	3.09	52	0.66	0.51
Work experience	0.81	0.31	52	2.63	0.01

Dependent variable: State anxiety, $P<0.05$). SE: Standard error

Table 4: Estimation of regression coefficients in examining the relationship between demographic variables and trait anxiety

Parameter	Estimate	SE	Df	*t*	*P*
Sex	0.22	2.71	52	0.08	0.93
Age	−0.44	0.12	52	−3.45	0.00
Education level	3.91	2.49	52	1.56	0.12
Work experience	0.53	0.25	52	2.13	0.03

Dependent variable: Trait anxiety, $P<0.05$. SE: Standard deviation

had no significant effect on other vital signs such as blood pressure and respiration rate of subjects.[27] The inconsistency between the results of these two studies can partly be attributed to the high mean age of the participants as well as their cardiac conditions which could give rise to heart rhythm problems.

The results of the present study showed that the level of state and trait anxiety of operating room staff decreases as the age of participants increases. The results of a study on the level of irritability and its relationship with stress, anxiety, and depression of subjects showed that anxiety tends to decline as age increases.[28] The consistency between the results of these two studies can be attributed to the experience and knowledge people gain as they grow older, which could, in turn, improve their ability to control anxiety.

A limited number of participants (due to lack of expertise in this type of surgery) as well as confounding noises and unexpected events (befalling during this type of surgery) leading to exclusion of many samples were among the limitations of the present study.

Conclusions

The suction-induced white noise has no effect on the level of state and trait anxiety and hemodynamic parameters of the operating room staff. Adaptation to the workplace noises can reduce their adverse effects. The results of the present study increase the need to investigate the effects of other operating room environmental factors on anxiety of operating room staff. The results also showed that the level of anxiety among operating room staff is dependent on age.

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Ethical considerations

This study was approved by the Research Ethics Committee of Shahid Sadoughi University of Yazd (code: IR.SSU.SPH.REC.1398.048). All participants voluntarily participated in the study and provided written informed consent for participation. Confidentiality of the data was maintained.

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Conflicts of interest

There are no conflicts of interest.

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