

Perioperative Music and Its Effects on Anxiety, Hemodynamics, and Pain in Women Undergoing Mastectomy

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There is increasing interest in evaluating the use of nonpharmacologic interventions such as music to minimize potential adverse effects of anxiety-reducing medications. This study used a quasi-experimental design to evaluate the effects of a perioperative music intervention (provided continuously throughout the preoperative, intraoperative, and postoperative periods) on changes in mean arterial pressure (MAP), heart rate, anxiety, and pain in women with a diagnosis of breast cancer undergoing mastectomy. A total of 30 women were assigned randomly to a control group or to the music intervention group. Findings indicated

that women in the intervention group had a greater decrease in MAP and anxiety with less pain from the preoperative period to the time of discharge from the recovery room compared with women in the control group. Music is a noninvasive and low-cost intervention that can be easily implemented in the perioperative setting, and these findings suggest that perioperative music can reduce MAP, anxiety, and pain among women undergoing mastectomy for breast cancer.

Keywords: Anxiety, blood pressure, music, pain, perioperative.

The diagnosis of breast cancer in women engenders stress and anxiety related to future prognosis and potential mortality and uncertainty about changes in their body image and treatment options. The anxiety may include concerns about the surgical experience, coping with acute pain, treatment regimens, financial burdens of care, and disruptions of their personal and professional lives.^{1,2} Traditional methods of reducing anxiety in presurgical patients have been focused primarily on the use of pharmacologic interventions. However, such medications may result in delayed awakening and discharge from postoperative care and sometimes an untoward reaction to the medication itself.³

A nonpharmacologic intervention such as music may improve postoperative outcomes by reducing potential untoward effects of the pharmacologic agents. Music consists of “a complex web of expressively organized sounds” and includes the basic elements of tone, duration, loudness, and pitch.⁴ Although findings from some studies have indicated significant effects of music on selected outcomes, such as blood pressure, heart rate, anxiety, and pain,⁵⁻²⁰ others have reported no effects.²¹⁻²⁹ Because of the limitations of existing studies and inconsistency of findings across studies, there is a need for further research to evaluate the use of music during the perioperative period. The purpose of this study was to

examine the effects of a perioperative music intervention (provided continuously throughout the preoperative, intraoperative, and postoperative periods) on changes in mean arterial pressure (MAP), heart rate (HR), anxiety, and pain in women with a diagnosis of breast cancer undergoing mastectomy. The 4 study hypotheses were that women who received a perioperative music intervention would have a greater decrease from the preoperative to postoperative period in the following: (1) MAP, (2) HR, (3) anxiety, and (4) pain compared with women in a randomly assigned control group.

Methods

The study was approved by the institutional review boards of the University of Alabama at Birmingham and the Jackson-Madison County General Hospital, Jackson, Tennessee. A quasi-experimental design was used to test the study hypotheses. A convenience sample (n = 30) of women with a breast malignancy was assigned randomly to the control group or music intervention group.

The women in the sample were recruited from 2 general surgery practices after having received a diagnosis of breast cancer and deciding to undergo mastectomy. These women received their surgery in 1 urban hospital in a city in western Tennessee. Exclusion criteria included patients evaluated as ASA physical status 4 or 5. Additional exclusions were previous diagnosis

and treatment of breast cancer, diagnosis of chronic obstructive pulmonary disease, diagnosis of mental disorders (eg, bipolar disorder, schizophrenia, or cognitive impairment), use of antipsychotic and benzodiazepine medications, inability to receive midazolam, and use of hearing aids. Use of antidepressant medications (eg, escitalopram, bupropion, and fluoxetine) did not exclude a participant from the study. Cognitive impairment and other psychological disorders were assessed by a medical diagnosis included within the participant's history and physical examination report in the preoperative chart.

Information flyers that were used for recruitment were posted in the waiting room of the surgeon's offices, and an office staff member identified potential participants who met sample selection criteria and informed them about the study. The staff member asked women who were interested in learning more about the study to sign permission forms allowing an investigator to contact them. One of us (P.G.B.-T.) called potential participants who signed the permission forms to explain the study in further detail, answer questions, determine eligibility, and inform potential participants that they would be asked to provide written consent on the day of their surgery. Each participant who was approached by an investigator (P.G.B.-T.) agreed to participate in the study, was enrolled, and completed the study. On the day of the scheduled surgery, one of us (P.G.B.-T.) met the participant preoperatively to review the study, answer questions, and obtain written informed consent.

Women in the intervention group listened to music throughout the perioperative period (during the preoperative, intraoperative, and postoperative periods), and women in the control group received standard care without the music intervention. Data on all study variables were collected preoperatively at time 1 (T1) in the presurgical area and postoperatively at time 2 (T2) when the participant was ready for discharge from the postanesthesia care unit (PACU). At the time of PACU discharge, each participant received a music CD as a thank you for being in the study.

The MAP was measured by using HP M3000A noninvasive blood pressure monitoring instrument. Accuracy is reported to be within ± 5 mm Hg maximum mean error (HP M3000-A Multi-Measurement Server, Hewlett-Packard Co, Palo Alto, California). Reliability of the automated noninvasive blood pressure monitoring was tested before data collection by measurement and calculation of a MAP with a manual sphygmomanometer in 3 volunteers. When compared with the automated noninvasive blood pressure monitoring MAP, both readings were within 5 points 100% of the time.

The HR was measured by using the HP M3000A electrocardiograph. Reliability of the electrocardiograph was tested before data collection by manual measurement of the carotid pulsation for 60 seconds to obtain beats per

minute in 3 volunteers. When compared with the automated HR readings, both readings were within 5 points of each other 89% of the time.

Interrater reliability of measures of MAP and HR was assessed between an investigator (P.G.B.-T.) and a PACU nurse on a random sample of 6 (20%) of the 30 participants at T1 and T2 using a percentage agreement method (counting as agreement if the readings were within 5 points of each other). The percentage of agreement across these 12 readings was 83% (10/12) for MAP and 92% (11/12) for HR.

Anxiety was measured by using the 20-item Spielberger State Anxiety Scale (SAI). Spielberger et al³⁰ reported an α reliability coefficient of .91 and evidence of construct validity for female college students by noting that SAI scores were lower after relaxation training and higher under stressful examination conditions. Internal consistency values in the present study for the SAI were 0.958 at T1 and 0.973 at T2.

Pain was measured by using a 100-mm visual analog scale (VAS) that had anchors of "no pain" (0 mm) and "the worst pain" (100 mm). Bijur et al³¹ reported test-retest reliability of 0.97 for a VAS for pain. The validity of the VAS has been supported through correlation studies with other self-reported measures of pain intensity such as the McGill Pain Questionnaire and the Visual Rating Scale, which is a Likert-type scale.³² Because of the many potential scoring values, the VAS is extremely sensitive to pain intensity.³³ Bijur et al³¹ reported a correlation of 0.94 between the VAS and a numerical rating scale for acute pain.

Additional data were collected preoperatively to ensure that there were no differences between intervention and control groups in the following variables that might influence the study results: age, race, ASA status, marital status, and medications taken before surgery. Additional data that were collected intraoperatively or postoperatively included surgical times, amount of fentanyl given intraoperatively, presence or absence of intraoperative complications, morphine equivalents administered postoperatively in the PACU, and time in the PACU to ensure that these variables were distributed equally between the intervention and control groups.

After the participants were checked into the preoperative area and signed the informed consent form, one of us (P.G.B.-T.) collected T1 baseline measurements and participants were then assigned randomly to the intervention or control group by drawing numbers from a reclosable plastic bag. An investigator (P.G.B.-T.) then provided the participant with an iPod (Apple Inc, Cupertino, California) with earphones that allowed ambient conversation to be heard. Each iPod was enclosed in a carrying case covering the display. Women in the control group also wore earphones attached to an iPod, but there was no music playing, to minimize bias that might result if

Variable	Intervention	Control	P ^b
Race			.326
White	13 (43)	11 (37)	
Black	2 (7)	4 (13)	
ASA status			.236 ^c
1	3 (10)	0 (0)	
2	9 (30)	10 (33)	
3	3 (10)	5 (17)	
Marital status			.355
Married	8 (27)	10 (33)	
Other ^d	7 (23)	5 (17)	

Table 1. Comparison of Demographic Characteristics for the Intervention and Control Groups^a

^aData are given as number (percentage).

^b χ^2 tests of homogeneity.

^cFisher exact *P* value.

^dSingle, divorced, or widowed.

anesthesia, surgical, and recovery staff were aware of the women's treatment group assignment. Women in both groups were asked not to mention the absence or presence of music.

Women in the intervention group chose 1 of 4 types of music after listening for 5 minutes to a selection of each genre (classical, easy listening, inspirational, and new age). The order in which the participant heard the genre selection was randomly presented each time to each participant. The participants' music selections contained 4 hours of continuous nonrepeating music to prevent potential satiation. The maximum volume setting on the iPod was locked so that the volume would not exceed a level of 70 dB, substantially lower than the permissible exposure limit of 90 dB for more than 8 hours to prevent permanent hearing damage established by the National Institute for Occupational Safety and Health.³⁴

The music intervention began after the participant received midazolam preoperatively. To minimize differences in anesthesia care that might influence the study outcomes, all anesthesia was provided by 3 Certified Registered Nurse Anesthetists (CRNAs) familiar with the study protocol. All CRNAs used the same anesthesia protocol, using a combination of intravenous drugs that was standardized. Unless contraindicated by patient allergies, each participant received 2 mg of intravenous midazolam preoperatively. The anesthetic began with preoxygenation of 100% oxygen for 3 minutes. The following drugs were given: fentanyl, 1.5 μ g/kg; lidocaine, 1.5 mg/kg; propofol, 2 mg/kg; and succinylcholine, 1.5 mg/kg. The airway was then secured by placement of an endotracheal tube, and ventilator support was provided to ensure normocarbia. Anesthesia was maintained with a 1:1 nitrous oxide–oxygen mixture and an end-tidal desflurane concentration of 5%. Fentanyl, 1 μ g/kg, was given whenever the patient's HR increased by more than

20% over the baseline value. Ondansetron, 4 mg, was given for prevention of nausea and vomiting 15 minutes before emergence. The CRNA administered intravenous fluids (lactated Ringer's) to appropriately replace each participant's fluid deficit due to fasting, blood loss, and insensible losses from the surgical field and to maintain the hourly maintenance fluid rate. No reversal medications were necessary or given.

In the PACU when the patient had an Aldrete score of 9 or more and was ready for discharge, data collection for T2 began. This Aldrete score indicated that respiratory effort was adequate, vital signs were within 20% to 50% of baseline measures, skin was warm with good color, and the patient was alert and oriented and had purposeful movement.

All statistical analyses were performed using SPSS, version 15.0 (SPSS Inc, Chicago, Illinois). Statistical tests performed for comparisons of groups at baseline included independent sample *t* tests for continuous variables and χ^2 analyses for categorical variables, as appropriate. Independent sample *t* tests were also used for comparison of change scores for the main study outcomes and for other intraoperative and postoperative variables. A *P* value of .05 was considered significant.

Results

The age of the participants ranged from 42 to 70 years, with a mean of 56.63 years. A total of 24 participants were white (80%) and 6 were black (20%). All but 2 participants completed high school, and 14 (47%) had between 1 and 6 years of college education. Results of χ^2 analyses indicated that there were no significant differences at baseline between the women in the intervention and control groups in age or for the variables of race, ASA status, or marital status (Table 1). The intervention and control groups were also similar in the number

Variable	Intervention group mean	Control group mean	<i>t</i> ^a	<i>P</i>
Intraoperative measures				
Length of procedure, min	77.7	71.7	0.642	.526
Amount of opioid (fentanyl, µg)	220	233	-0.807	.426
Postoperative measures				
Morphine equivalents in PACU, mg	17.7	22.1	-0.623	.538
Time in PACU, min	52.8	50.0	0.495	.624
Time of last opioid to T2 VAS, min	19.1	28.3	-1.31	.201

Table 2. Comparison of Potentially Extraneous Variables for the Intervention and Control Groups

Abbreviations: PACU indicates postanesthesia care unit; T2, time 2 (when the participant was ready for discharge from the PACU); and VAS, visual analog scale.

^aIndependent sample *t* test; equal variances assumed; *df* = 28.

of subjects with diabetes (2 vs 3) and number taking a preoperative β-blocker (1 in each group). The groups were examined for differences in other intraoperative and postoperative variables that may have affected results. The intervention and control groups did not differ in the mean amount of fentanyl received or in average operating room time. They also did not differ in mean morphine dose equivalents received in the PACU or the time between the last opioid dose and measurement of pain via the VAS at T2 (Table 2).

One factor that could not be controlled was which surgeon provided the surgery for each patient. Surgeon 1 performed 18 of the procedures (60%), 10 in the intervention group and 8 in the control group. Surgeon 2 performed 8 of the procedures (27%), 2 in the intervention group and 6 in the control group. Four different surgeons performed the remaining 4 procedures, 1 in the control and 3 in the intervention group.

Results of independent sample *t* tests indicated that there were no differences between the women in the intervention and control groups in baseline measurements of the main study variables (MAP, HR, anxiety, and pain). The difference from T1 to T2 resulted in a change score from which an independent sample *t* test was calculated for each dependent variable, comparing the intervention and control group means. The *P* values for the Levene test for homogeneity of variance were more than .05 for all dependent variables. The observed power of all dependent variables except 1 was greater than 80%: MAP, 0.892; HR, 0.207; anxiety, 0.999; and pain, 0.810. Table 3 illustrates the means and SDs for T1 and T2 and the change scores (T1 – T2) for MAP, HR, anxiety, and VAS pain scores for women in the intervention and control groups and also indicates which T1-T2 change scores were significant at a probability level of .05.

The findings presented in Table 3 indicate there was a statistically significant difference (*P* = .003) in the MAP T1-T2 change scores when comparing the women in the

intervention and control groups, supporting the first study hypothesis. In addition to statistical significance, there was clinical significance supporting this hypothesis because the MAP for the control group increased postoperatively by a mean of 4.5 mm Hg, whereas the MAP for the intervention group decreased postoperatively by 15.1 mm Hg.

There was no significant difference between the women in the intervention and control groups in the T1-T2 change scores in HR (*P* = .248), and, thus, the second hypothesis was not supported. The women in the intervention group had a smaller increase in HR from T1 to T2 (2/min) than did women in the control group (6.8/min), but this difference was not statistically or clinically significant.

Women in the intervention group had a significantly greater decline in anxiety levels from T1 to T2 compared with women in the control group (*P* < .001), supporting the third study hypothesis. The postoperative anxiety score for the control group increased by a mean of 7.7, whereas the anxiety score for the music group decreased by 10.8. The ranges of these change scores for anxiety were from -24 to +1 for the intervention group and -8 to +33 for the control group.

Finally, women in the intervention group reported a significantly greater decrease in pain levels (as measured on the VAS) from T1 to T2 (*P* = .007) compared with the control group, supporting the fourth study hypothesis. It is interesting that results of independent sample *t* tests indicated that there were no differences in the amount of postoperative opioid morphine dose equivalents received by women in the intervention and control groups (*P* = .538), suggesting that the differences in perceived pain reported on the VAS were not due to differences in the amount of analgesics received postoperatively. In addition to statistical significance, there was clinical significance in this result because the VAS for the control group increased by a mean of 50.7, whereas the VAS

Outcome variable/group	T1 mean (SD)	T2 mean (SD)	T1-T2 change mean (SD)	<i>t</i> ^a	<i>P</i>
MAP				-3.31	.003 ^b
Intervention	98.7 (15.7)	83.6 (13.0)	15.1 (17.1)		
Control	92.1 (18.2)	96.6 (14.3)	-4.5 (15.3)		
HR				-1.18	.248
Intervention	77.9 (10.7)	79.9 (14.9)	-2.0 (11.4)		
Control	79.1 (12.4)	85.9 (12.7)	-6.8 (10.9)		
Anxiety				-5.16	< .001 ^b
Intervention	41.5 (15.8)	30.7 (12.3)	10.8 (7.7)		
Control	41.9 (14.5)	49.7 (18.9)	-7.8 (11.6)		
Pain				-2.94	.007 ^b
Intervention	11.8 (17.6)	41.5 (30.2)	-29.7 (19.8)		
Control	14.2 (14.3)	64.9 (20.9)	-50.7 (19.2)		

Table 3. Mean and SD for Time 1, Time 2, and Change Scores for MAP, HR, Anxiety, and Pain for Women in the Intervention (Music) and Control Groups

Abbreviations: MAP, mean arterial pressure; HR, heart rate.

^aIndependent sample *t* test; equal variances assumed; *df* = 28.

^bSignificant at *P* < .05.

for the intervention group increased by only 29.7. The women in the intervention group experienced a 41.4% smaller increase in pain compared with women in the control group.

Discussion

The study findings indicated that levels of MAP, anxiety, and pain were significantly lowered or improved postoperatively in the intervention group compared with the control group. Women in the intervention group had lower postoperative HR levels, but the difference was not statistically different from the change in HR for women in the control group.

A number of previously reported studies have evaluated the effects of music interventions during the perioperative period on 1 or more of the 4 dependent variables examined in this study (MAP, HR, anxiety, and pain). A total of 14 studies of music intervention were identified that included blood pressure as an outcome variable, and findings from 8 of these studies indicated that music had a significant effect on lowering blood pressure, consistent with the findings from the present study.^{5,6,8,10,11,19,20,27} In 7 of the 8 studies that reported significant effects of music on blood pressure, patients were allowed to choose the type of music,^{5,6,10,11,19,20,27} and in 4 of these studies with significant effects on blood pressure, the music intervention was initiated preoperatively.^{5,10,19,20} These findings suggest that music interventions may be most effective in reducing blood pressure if patients are allowed to choose the type of music and if the music intervention is initiated preoperatively.

A total of 15 studies were identified that examined the effects of a music intervention on anxiety levels. In

11 of these studies, authors reported reduced anxiety following a music intervention, consistent with the findings in the present study.^{5,7,11,14-16,18,20,22,25,29} The remaining 4 studies that included anxiety as a dependent variable reported no effect of music on anxiety.^{13,21,23,27} The State Trait Anxiety Inventory was used more often than the VAS in studies that reported significant effects of music on anxiety.^{6,11,15,16,18,20,22,25,29}

We found 11 studies evaluating perioperative music interventions in which pain was examined as an outcome variable. In 8 of these studies, pain was reduced following a music intervention, consistent with the results of the present study.^{8,9,12-14,16,17,24}

Of 13 previous studies that included HR as an outcome variable, 6 reported a significant effect of music on HR.^{5,6,8,10,11,19} In contrast, 7 of these studies did not find significant effects on HR, consistent with findings from the present study.^{14,20,22,23,25,26,29} The sample sizes in the 7 studies that did not report significant effects on HR ranged from 10 to 75, but only 2 of these studies had more than 15 participants per treatment group. The sample sizes in the 6 studies that reported significant effects on HR ranged from 10 to 100, and 5 of these studies included at least 20 participants per treatment group.

The review of the existing literature indicates considerable variability in findings related to the effects of music during the perioperative period on blood pressure, HR, anxiety, and pain. Studies evaluating the effects of music interventions in surgical patients have examined music provided at different times (preoperatively, intraoperatively, and/or postoperatively), with different patient populations, and using different types of musical selections. Because of these differences, it is difficult to compare

findings across studies. Many of the existing studies have limitations that preclude generalizing their findings, such as uncontrolled confounders,^{6,8,10,13,16,17,23,25,27,28} small samples,^{14,18,19,20,22,23,25,26,29} nonrandom assignment to groups,^{5,11,19} and the use of music selected by the researcher rather than by the patient.^{8,12-17,21,22,24,25} The design of the present study addressed many of these limitations, including control of potentially confounding variables, random assignment to intervention and control groups, and the use of music selected by the patient rather than the researcher.

There were many strengths in the design of this study. The power for the *t* tests for all dependent variables was greater than 0.80 with the exception of HR. One reason for the failure to identify an effect of music on HR in the current study may have been an inadequate sample size, resulting in inadequate power, to detect the effect of music.

A homogenous sample that included only women with the same diagnosis and undergoing the same surgical procedure provided control of selected extraneous variables. The use of random assignment further controlled for potentially confounding variables in participant characteristics. Including women with breast cancer as the study population helped avoid a floor effect in anxiety and pain because numerous studies have suggested that women with breast cancer have high levels of anxiety and pain. An additional strength of the study was the use of the Spielberger SAI rather than a VAS to measure state anxiety as recommended by several researchers.^{6,11,15,16,18,20,22,25,29} Another strength was the finding that there were no differences between the intervention and control groups in numerous potential extraneous variables, including race, ASA status, and marital status (Table 1) and length of procedure, amount of intraoperative opioids received, amount of morphine dose equivalents in the PACU, average time in the PACU, and the time between the last opioid dose and measurement of pain via the VAS at T2 (Table 2). It must be acknowledged, however, that there were no measures of other potential extraneous or confounding variables such as socioeconomic status, baseline medications, or differences in outcomes based on the surgeon.

All enrolled participants completed the study procedures. The observers were blinded to the participant's group assignment, although the participants could not be blinded because of the nature of the music intervention. Participants in this study were allowed to choose from 4 categories of music and began listening preoperatively, as recommended on the basis of previous studies.^{5-7,9-11,18-20,27,29} The music intervention was noninvasive, with no apparent deleterious effects on MAP, HR, anxiety, and pain for the participants listening to music.

There were several limitations in this study that must be acknowledged. Because participants knew that their levels of pain and anxiety were being studied, a

Hawthorne effect may have been present because of the nature of the self-reported instruments used and may have introduced an element of response bias. The Hawthorne effect reflects the possibility that women may have responded differently from the way they normally would because of awareness that they were participating in a study. Although this study was carefully designed to control for confounders, we were unable to control the hospital perioperative environment (eg, noise and temperature). However, because random assignment resulted in groups that were similar, the intervention and the control groups were exposed to these same conditions. The study used a convenience sample, and the sample was relatively small; thus, the results should be generalized with caution to women undergoing mastectomy for breast cancer. Because only women were included as participants, the ability to generalize the results of this study to men is limited.

Conclusion

Future research is needed to determine whether perioperative music interventions might be helpful for other populations, including children, men, and patients undergoing other types of surgical procedures and other types of anesthesia. Expanding the timeline for data collection into the first several days to several weeks during the postmastectomy timeframe would provide additional information regarding the effects of music beyond the immediate perioperative period. Additional research is also needed to more specifically examine the mechanisms by which music produces beneficial effects to further test the conceptual framework proposed for this study.

The findings from this study provide new evidence about the effects of perioperative music on MAP, anxiety, and pain. Most previous studies have examined music that was provided only during the preoperative, intraoperative, or postoperative period and, rarely, throughout the perioperative period. The findings of this research are not only statistically significant, but they also demonstrate clinical significance. Music is a noninvasive and low-cost intervention that can be easily implemented in the perioperative setting and can reduce MAP, anxiety, and pain among women undergoing mastectomy for breast cancer. Several participants receiving music volunteered comments postoperatively about how much they enjoyed hearing the music and that it provided comfort to them. As healthcare providers search for ways to provide services to their clients that produce greater satisfaction, perioperative music may be an efficacious and cost-effective intervention.

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