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The Effect of Music Entrainment on Respiration of Patients on Mechanical Ventilation in the Intensive Care Unit

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THE EFFECT OF MUSIC ENTRAINMENT ON RESPIRATION OF PATIENTS ON MECHANICAL VENTILATION IN THE INTENSIVE CARE UNIT

BY

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For my mother, through whose illness the idea for this thesis was born. I thank God every day that you are still here with me. You never cease to give me encouragement, hope, laughter, and most of all your unfailing love. You were right when you said God always works in mysterious ways, and even in bad times there can be good outcomes. Thank you for being the best mother in the world. I love you with all of my heart.

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ABSTRACT

The purpose of this study was to examine the effect of music entrainment on respiration of patients receiving mechanical ventilation in the Intensive Care Unit. Patients met criteria to participate in the study if they were admitted to the ICU, had a medical diagnosis or had undergone cardiac surgery, and were receiving mechanical ventilation for a period of 1-10 days. Subjects were divided into randomly assigned experimental (n = 20) and control (n = 20) groups. Each of the groups contained 10 patients with medical diagnoses and 10 who had undergone cardiac surgery. The experimental group received one session of live music during the spontaneous breathing trial, which was performed every morning during the process of weaning from the ventilator. Data were collected on the measures of rapid shallow breathing index, respiration rate, heart rate, and oxygen saturation rate. The researcher ascertained the patient's preferred music in a family interview (see Appendix F) and used that to fashion a music therapy intervention. Based on baseline readings, musical tempo was matched to the patient's beginning respiration rate. The patient then listened for 25 minutes to four songs which either gradually increased or decreased in tempo, with every 1st beat of the music accented in order to attempt entrainment of respiration. The control group received no music intervention. Each patient (if able) or a family representative gave consent to participate in the study. Results of a Two-Way ANOVA indicated a significant decrease in the RSBI readings of the medical group who received music therapy and only a slightly significant decrease in oxygen saturation rates of cardiac patients who received music therapy. There were no significant differences by group or from pre to post-test for other measures.

CHAPTER 1

INTRODUCTION

Admission to the Intensive Care Unit (ICU) is a reality for millions of people during some point of their lifetime and the possibility of being placed on mechanical ventilation (MV) while in the ICU is high. An estimated 33% of all ICU patients are placed on MV annually (Dasta, McLaughlin, Mody, & Piech, 2005), making MV the second most frequently performed therapeutic intervention after treatment of cardiac arrhythmias in the ICU. Mechanical ventilation is employed in the ICU to aid patients in the case of compromised respiration due to severe illness or trauma until the patient is able to breathe independently of the machine.

The ICU can be a stressful environment for patients who have to deal with illness, unfamiliar people, harsh lighting, noisy machines, and excessive talking by staff. Patients are exposed to sounds of ventilators, audible alarms, and unfamiliar voices even when the ICU is relatively calm (Finlaw, 1997). Patients on mechanical ventilation experience more anxiety because they are unable to speak, unable to breathe adequately, and are kept in restraints in addition to the above mentioned stressors.

Although mechanical ventilation is a life-saving intervention, its use comes with risks and expense to the patient. Patients are susceptible to ventilator associated pneumonia (VAP) and ventilator induced lung injury (VILI), and other serious complications due to their fragile condition and fluctuating hemodynamic state. Patients placed on MV incur costs at a rate almost double the norm for non-ventilated ICU patients. Current literature debates whether the process of removing a patient from the ventilator (weaning) is an art or a science. However, the literature consistently suggests that the patient must be weaned from MV as soon as it is safely possible to avoid possible life-threatening complications, exacerbated anxiety, and further expense.

ICU practitioners work toward the goal of successfully weaning patients on a daily basis with the aid of a spontaneous breathing trial if the patient is hemodynamically stable and any complications are resolved. If patients are able to exhibit a target respiration rate, target Rapid Shallow Breathing Index (RSBI), and stable vital signs, they are removed from the ventilator (extubated).

The literature is rich with studies that test the effectiveness of music on states of anxiety, pain perception, and vital signs of patients in the hospital setting. There is substantial evidence to suggest that music has a positive effect on these states and can be a therapeutic intervention, which expedites the healing process. However, there exist relatively few studies using directed music therapy in the ICU specifically. A literature review reveals an absence of studies regarding music entrainment of respiration in the ICU.

This study's purpose is to determine if music used to entrain respiration has a significant positive effect on patients' spontaneous breathing trials and aid in successful extubation from MV. The study includes both patients of: (1) varying medical diagnoses and (2) post-operative cardiac arterial bypass grafting (CABG) procedure. Patients selected for this study include only those on short term (1-10 days) invasive mechanical ventilation. Excluded from the study are patients on noninvasive mechanical ventilation and those with a tracheostomy.

CHAPTER 2

LITERATURE REVIEW

Mechanical ventilation facts and indications

A patient admitted to the Intensive Care Unit (ICU), may be placed on mechanical ventilation (MV) if the presenting illness or injury compromises respiratory function. Mechanical ventilation is used to deliver oxygen via invasive and noninvasive techniques to support respiration in patients who cannot breathe on their own (Woodruff, 2003). MV is a life-saving intervention which performs one of the most complex functions of the body: ventilation. Ventilation is the process by which the body takes in and disperses oxygen as well as gathers and expels carbon dioxide throughout the body through sac-like clusters in the lungs called alveoli (Kurtzweil, 1999). In healthy people, ventilation is an innate natural process; however, there are times the body can no longer perform this process adequately and breathing becomes quite difficult or even impossible, and MV becomes necessary (Hijazi & MacIntyre, 2000).

According to a recent study, MV is the second most frequently performed therapeutic intervention in the ICU after treatment for cardiac arrhythmias (Fenstermacher & Hong, 2004). An international study by Esteban, et. al (2002) suggested that of the 15, 757 patients admitted to ICU's, 5183 (33%) received MV for a mean (SD) of 5.9 (7.2) days. In this study, patients received MV for various illnesses including acute respiratory distress syndrome (ARDS), barotrauma, pneumonia, sepsis, renal failure, hepatic failure, and coagulopathy. A paper by Tobin (2001) studied 1638 patients in eight countries. Of those patients, the indications for MV were 66% acute respiratory failure (ARF) due to heart failure, sepsis, complications of surgery, and trauma, 15% for coma, 13% for exacerbation of chronic obstructive pulmonary disease (COPD), and 5% were indicated for neuromuscular disorders. According to Fenstermacher & Hong (2004), respiratory muscle fatigue is one of the most common indications for ventilatory support. A person is in respiratory distress when they exhibit respiratory rates greater than 40 breaths per minute (bpm) and oxygen consumption for the work of breathing (WOB) increases to levels up to 50% from the normal 3-5% range. When oxygen consumption reaches elevated levels, accessory muscles such as the sternocleidomastoids and abdominals are recruited for the WOB (Fenstermacher, & Hong, 2004).

Invasive ventilation involves the insertion (intubation) of an endotracheal tube (ET) into the thoracic cavity through the trachea. (Beers, et. al, Eds., 2003**)**. Noninvasive ventilation is administered through a mask that fits tightly over the nose and mouth (Beers, et. al, Eds., 2003). Research by Antonelli, et. al (1998) suggested that non-invasive ventilation was better tolerated, carried less risk of life-threatening complications, created shortened periods of ventilation, and shorter stays in the ICU than that of invasive MV. Although many types of ventilation exist, most patients receive assist-control ventilation, which delivers a set tidal volume (Vt) when triggered by the patient's inspiration or independently, if the patient does not initiate a breath (Tobin, 2001).

When MV is required, the presenting illness and hemodynamic state are assessed to detect the patient's level of respiratory distress (Karampela, Fuchs, Smith, Reily, & Hansen-Flaschen, 2001). Invasive MV, although a potentially lifesaving treatment, carries the possibility of life-threatening complications and high costs (Betbese, Perez, Bak, Rialp, & Mancebo, 1998). For this reason, clinicians may attempt to discontinue MV rather quickly, pending the patient's improved clinical status.

Complications of mechanical ventilation

The use of invasive MV may be associated with many complications. As previously mentioned, patients often experience physical discomfort due to endotracheal tube (ET) placement and they may experience oral, nasal, tracheal, and laryngeal trauma from this procedure (Fenstermacher & Hong, 2004). Woodruff (2003) discussed that atelectasis, or collapsed alveoli, may occur due to inadequate ventilator settings and may hinder the patient from taking a deep breath. Atelectasis can lead to hypoxemia and infection. Arm restraints are used with virtually all patients to prevent self-extubation, which may cause damage to the thoracic cavity and may warrant re-intubation. However, a study by Kapadia, Bajan, & Raje (2000) showed that self-extubation may be prevented through proper sedation dosing, secure anchoring of the ET, and adequate explanation and reassurance of the patient.

Ventilator- associated pneumonia (VAP) is one of the top causes of morbidity in the ICU. VAP may occur in 9-27% of all intubated patients (Craven, et. al, 2005). According to Chulay (2005), VAP prolongs a patient's ICU stay by an average of 4.3 days and costs approximately $20,000 - $30, 000 to treat. VAP is a nosocomial infection caused by the microaspiration of bacteria-containing oropharyngeal secretions into the patient's lower airways. This, coupled with the patient's weakened immune system, fosters VAP development (Jackson & Shorr, 2006). Also, frequent patient transport, inadequate subglottic suctioning, and low endotracheal tube cuff pressure may contribute to the infection. VAP prevention and treatment is the focus of much study because of its high morbidity risk. According to Chastre & Fagon (2002), mortality rates for VAP range from 20 to 50% and can go higher given specific settings or where initial antibiotic therapy is inappropriate. Kollef (1999) listed such preventative strategies as frequent hand washing, better oral care, suctioning of subglottic secretions, and further VAP education to caregivers in an effort lessen its occurrence in the ICU.

Ventilator Induced Lung Injury (VILI) is a complication of MV caused by mechanical stress to the lungs (Hotchkiss & Gunn, 2005). During MV, both normal and "pre-injured" lungs can suffer structural failure, produce inflammatory mediators, and sometimes even compromise the health of surrounding organs due to lung overdistention caused by ventilators with high Vt settings (Hotchkiss & Gunn, 2005). Trials conducted by Amato, et.al (1998) show a 22 % relative risk reduction in MV cases in which lower tidal volumes (Vt) are used. A study by Gajic, et. Al (2004) reveals that approximately 25 % of patients who did not have acute lung injury (ALI) and who were mechanically ventilated for at least 48 hours, developed VILI. Also, higher tidal volumes were revealed to be a significant risk factor, especially when gender and height were not taken into consideration when adjusting ventilator settings. According to Gajic et. Al (2004), height and gender are better predictors of actual lung size than actual body weight. In this study, females received larger tidal volumes, and thus developed VILI more often than males.

The literature is rich with studies concerning anxiety as a complication of MV. Anxiety is defined as a state of apprehension, agitation, increased motor tension, autonomic arousal, and fearful withdrawal (Webster's Unabridged Dictionary, 1997). A study by Chlan (2003) revealed that anxiety is one of the most distressful psychological experiences for the MV patient. Results of the study also showed that of a sample of 192 patients receiving MV, there is validation that MV increases anxiety regardless of gender, ethnicity, length of ventilatory support, or medical indication. In addition, patients who receive MV for 22 or more days have the highest anxiety levels and those receiving chronic support report the lowest levels. Rotondi, et. al (2002) found that of 100 patients in ICU units, 97 had recollection of the ICU experience and more than 20% of those remembered the ET experience. Results of this study also revealed the five experiences which bother patients the most, on a rating scale of moderately to extremely, were trouble speaking (65%), being thirsty (62%), feeling tense (42%), not being in control (46%), and difficulty swallowing (44%). Patients most likely not to remember events regarding MV were also the best protected from anxiety, panic attacks, and post traumatic stress disorder (PTSD) after discharge (Jones, Griffiths, Humphris, & Skirrow, 2001).

Sedation

The use of sedation has become common practice in ICU's for the mechanically ventilated patient. 85% of ICU patients receive intravenous (iv) sedation to relieve pain, anxiety, and agitation (Bair, et. al, 2000). Drugs such as propofol (Diprivan) and midazolam (Versed) are the most commonly utilized in the ICU (Egerod, 2002). Significant risks may accompany sedation use. Oversedation may reduce respiratory drive and increase drug toxicity, which could prolong MV and increase length of time in the ICU; inadequate sedation may result in increased agitation and increased risk of injury for the patient (Bateman & Grap, 2003). According to Egerod (2002), the tendency is to oversedate, which could prolong ventilator time. In a study by Brook, et. al (1999), median duration of length of MV was significantly shorter for patients in a protocol-directed sedation group (55.9 hours) than patients in a nonprotocol-directed sedation group (117.0 hours). Kollef and colleagues (1998) linked prolonged MV to continuous iv sedation, indicating that the duration of MV dropped from an average of 7.7 days to 2.3 days when patients were not given continuous sedative infusions. Normally, when the patient is hemodynamically stable enough to be removed from MV, clinicians may reduce the amount of sedation so that the patient is alert for the weaning process.

Mechanical Ventilation with Post-operative Cardiac Patients

Patients who undergo cardiac surgery are placed on mechanical ventilation during the procedure to sustain breath and are placed in the Surgical ICU to monitor the patient until they return to hemodynamic stability (Wake & Cheng, 2001). According to a study by Thung, Herzog, Christlieb, Thompson, & Dammann (1963), post-operative patients who received respiratory assistance (MV) following surgery had a smoother recovery from anesthesia and required less sedation. Their appearance was also better and they had more energy reserved than those who did not receive ventilatory support.

Weaning from mechanical ventilation

Due to the association of major complications to MV, weaning (discontinuation from) and removal of the ET should begin as soon as spontaneous ventilation is sustained. Much of the weaning literature discusses whether the process is an art or a science, nevertheless expedient weaning is the focus of study. Multidisciplinary team collaboration is the most successful method of weaning, and decreases MV period of stay by an average of 2.7 days (Lindgren & Ames, 2005). Eden (2004) studied a cohort group of MV patients (n = 324) by using a developed checklist containing metabolic, cardiorespiratory, and neurological criteria which suggested that patients begin the weaning process. Results show that the checklist is a strong predictor of subsequent ventilator independence when the criteria were met on day 1 (likelihood ratio 11.1) and day 2 (likelihood ratio 6.9) but weaker when met more than or equal to 4 days (likelihood ratio <3). The rapid shallow breathing index (RSBI) was developed by Yang and Tobin (1991) and is more accurate and powerful in predicting weaning outcome than the long employed methods of vital capacity, maximal inspiratory pressure, and minute ventilation (El-Khatib, et. al, 2001). A review of weaning studies conducted by Meade, et. Al (2001) showed that respiration rate (RR) and RSBI are the best predictors of weaning success, although they are poor due to the fact the many clinicians predict outcomes before choosing patients to trial, and those who are likely not to 'pass' may not be given a daily trial. This review of studies also revealed that a RR < 38 and a RSBI < 100 (RR/expired Vt) are required for successful weaning toward extubation.

During the weaning process, a spontaneous breathing trial (SBT) is conducted each morning to assess the patient's independent respiration and hemodynamic state. At this time such measurements as heart rate (HR), respiration rate (RR), RSBI, blood pressure (BP), and oxygenation (SPo2) are recorded to assess readiness for extubation (K. Pfeil, R.N., TMH, personal communication, February 21, 2006). An article by Dries (1997) states that prior to the SBT, staff may explain the procedure to the patient and provide environmental stimulation such as the use of television, music, or books to lessen patient fear. Dries (1997) also concluded that weaning conditions should be similar to that of indications for MV; the patient should be adequately oxygenated, be able to maintain normal breathing, able to meet increased work of breathing, and must be conscious and responsive. According to Dries (1997), patients' ventilator settings should be gradually decreased during the SBT by way of T-tube trials whereby the patient breathes through a T-shaped tube attached to the ET from 30 minutes to several hours, intermittent mandatory ventilation (IMV) which is a gradual reduction in the amount of support being provided by the ventilator and a progressive amount of increase in the amount of respiratory work done by the patient, and pressure support ventilation (PSV) which is also used to gradually decrease the level of ventilator support. The pace of ventilator weaning is generally based on clinical assessment of the patient and measurement of arterial blood gases (ABG's) (Lindgren & Ames, 2005). Once patients are able to sustain adequate respiratory function with RR and RSBI measurements within desired parameters, they are liberated from the ventilator (Meade, et. al, 2001).

Entrainment

Entrainment is defined as the 'locking into phase of two previously out-of-step oscillators'. An oscillator is 'anything that vibrates in a regular, periodic manner between two points of rest'. (Wigram & Saperston, Eds., 1995). Larsen & Galletly (2006) explained that while the exact nature of the central respiratory pattern generating system is still debated, it can be classified as a form of an oscillator which may be entrained by a wide number of inputs. In order for entrainment to occur, the two oscillators must pulse at nearly the same time (Wigram & Saperston, Eds, 1995).

Physiological rhythms are rarely periodic but rather fluctuate irregularly over time from the combined influences of the fluctuating environment and from different, possibly chaotic, mechanisms. Glass (2001) suggested that de-synchronicity of these rhythms are the cause of human disease and call for re-entrainment in order to regain homeostasis, or well-being.

Entrainment mechanisms have been studied and explained in several disciplines, including psychology, physiology, and music therapy. A study by Rider, Floyd, & Kirkpatrick (1985) used music and guided imagery (GI) to lower adrenal corticosteroids and re-entrain circadian rhythms of humans using the iso principle developed by Altshuler (1946) (see definition below). Results of the study showed that music did not have a significant effect on lowering adrenal corticosteroids, but did show an almost unanimous tendency for re-entrainment during treatment. It is speculated whether music could be employed to entrain respiration.

Music Therapy

Music Therapy is defined by the American Music Therapy Association as ‘the clinical and evidence-based use of music interventions to accomplish individual goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program (AMTA, 2005). There are many studies in current literature regarding the use of music therapy in a clinical setting such as neurology (Magee, 2002), preoperative anxiety (Robb, Nichols, Rutan, Bishop, & Parker, 1995), and cardiology (Hanser, 2005). However, only a few studies exist using music in the ICU, and even fewer which study music therapy with MV patients. Chlan (2000) reported that the entrainment of heartbeat and respiration to relaxing music with critical patients decreased sympathetic nervous system activity, and thereby lead to a decrease in physiological signs such as HR, RR, and BP. Music used with postoperative cardiac patients elicited a decrease in HR and BP, and a general sense of relaxation (Barnason, Zimmerman, & Nieveen, 1995). Lee, Chung, Chan, & Chan (2005) studied 64 subjects on MV and found that those who listened to a single 30-minute session of music showed greater relaxation as exhibited by a decrease in physiological signs. A similar study by Wong, Lopez-Nahas, & Molassiotis (2001) found similar results to that of Lee, et. al (2005), with the exception of a smaller sample size (n = 20). This supports the article by Glass (2001) and upholds the theory that physiological rhythms can be entrained by external input.

It should be stated that in all music studies that were reviewed, only recorded music was utilized. It is speculated that the use of 'live', or unrecorded, music was not used in these studies for the simple fact that researchers were not themselves musicians. The current study will examine the use of live music with mechanically ventilated patients using the iso principle. Matching musical tempo to the patient's RR will allow for manipulation of the RR by decreasing or increasing musical tempo to the desired threshold for successful weaning and possible extubation. It is postulated that music can be used to rhythmically entrain respiration in order to promote successful extubation from mechanical ventilation, as evidenced by a decrease in physiological signs of respiration and heart rates, RSBI, and observable anxiety.

H1: The hypothesis tested was:

There will be a significant difference in respiration of ICU patients who have music as an intervention and those who do not as evidenced by decreased respiration rate, pulse rate, RSBI, and observable behaviors indicative of anxiety.

Operational Definitions and Acronyms

Alveoli: Small, thin-walled compartments typically arranged in sac-like clusters inside the lungs where respiratory gases are exchanged with pulmonary capillaries.

Anxiety: A state of uneasiness, apprehension, or worry.

ARDS: Acute Respiratory Distress Syndrome.

Bpm: Breaths per minute with regard to music tempo.

Brpm: Breath rate per minute with regard to respiration.

CABG: Cardiac Arterial Bypass Grafting.

COPD: Chronic Obstructive Pulmonary Disease.

CPAP: Continuous positive airway pressure; respiration accomplished by the patient's muscular effort; prevents alveolar collapse.

Entrainment: Determination or modification of the phase or period of.

Extubation: The physical removal of mechanical ventilation.

Hemodynamic State: State involving the movement of blood and forces involved in systemic or regional blood circulation.

Hypoxemia: Low oxygen levels in the blood.

ICU: Intensive Care Unit

Invasive: Mechanical ventilation inserted into the body.

Intubation: The physical installation of mechanical ventilation.

Iso-principle: Developed by A. Altshuler (1946). Matching of musical stimuli to a person's mood state, then changing the stimuli in the direction to which the mood is to be influenced.

MAAS-R Scale: Motor Agitation Anxiety Scale-Revised; used to assess patient anxiety.

Mechanical Ventilation: Machinery used to do the work of breathing; the act of artificial respiration.

Music Entrainment: The use and manipulation of musical tempo to modify respiration.

Music Therapy: The use of music intervention to achieve a non-musical goal.

Nosocomial Infection: Any infection which a patient contracts in a health-care institution.

Observable anxiety behaviors: Behaviors that indicate anxiety as measured by observation.

Respiration: The act or process of inhaling and exhaling.

RSBI: Rapid Shallow Breathing Index; a proportion which is used as a predictor in weaning outcome.

Tidal Volume (Vt): The volume of air inspired or expired during each normal, quiet respiratory cycle.

VAP: Ventilator Associated Pneumonia.

VILI: Ventilator Induced Lung Injury.

Vital Signs: Respiration rate, pulse rate, oxygen saturation rate and blood pressure of a patient.

CHAPTER 3

METHOD

Subjects

Research was conducted with a sample of patients (n = 39) admitted to either the Medical Surgical or Cardiovascular Surgical Intensive Care Units at Tallahassee Memorial Healthcare. Prior consent was granted by the Institutional Review Board of the hospital and a HIPPA waiver was signed for the release of medical records (Appendix B). Each subject or family representative gave consent (Appendix D/E) and was recruited upon admission to the ICU. Criteria for admission to the study included those subjects 18 years of age or older, having a medical or cardiac diagnosis, being admitted to the ICU, having a length of stay on MV from 1 to 10 days, and having no previous music therapy while in the ICU. Subjects with a tracheostomy, noninvasive ventilation, and those who had prior music therapy intervention were excluded from study. Subjects for the study ranged in age from 26 to 85, with a mean overall age of 57.5 years. The mean ages for each group are as follows: cardiac experimental = 65.8 years, medical experimental = 53.4 years, cardiac control = 61.1 years, and medical control = 49.2 years of age. Subjects had varying diagnoses, however, all cardiac ICU admissions were due to cardiac artery bypass grafting surgery. Table 1 lists all demographic information.

Table 1 Demographic Information

Group	Age	Gender	Diagnosis
EC	64	M	CABG
EC	58	F	CABG
EC	68	F	CABG
EC	65	F	Mitral Afibrilation
EC	72	F	CABG
EC	54	M	CABG
EC	59	M	CABG
EC	70	F	CABG
EC	64	M	CABG
EC	78	M	CABG
EM	57	M	Septecemia, NOS
EM	70	M	Pneumonia
EM	41	F	Thyrotoxicosis
EM	50	F	Chronic Airway Obstruction
EM	48	F	Severe Acidosis
EM	90	F	CVA/Stroke
EM	68	F	Respiratory Failure
EM	47	F	Sepsis
EM	44	M	Pneumonia
EM	26	M	Motor Vehicle Accident
CC	74	M	CABG
CC	63	M	CABG
CC	60	F	CABG
CC	61	F	CABG
CC	62	F	CABG
CC	63	F	CABG
CC	48	M	CABG
CC	76	M	CABG
CC	46	F	CABG
CC	59	F	CABG
CM	65	F	Diarhhea
CM	35	F	Motor Vehicle Accident
CM	39	F	Chest Pain
CM	71	M	Lung Cell Carcinoma
CM	33	M	Gunshot Wound
CM	53	F	Congestive Heart Failure
CM	57	F	Diaphragmatic Hernia
CM	29	F	Overdose
CM	61	M	Severe Gastritis

Design

This study, utilizing pre and post-test data collection, included both experimental and control groups of 20 patients each with both medical (n = 10) and cardiac diagnoses (n = 10). Due to insufficient data, one subject was eliminated from the medical control group, bringing the total of all subjects to 39. The independent variable was live music therapy intervention provided in the morning during the spontaneous breathing trial (SBT) and matched to the RR of the patient. The dependent variables were RSBI, RR, HR and SPo2. Cardiac and medical patients were treated differently throughout the study due to differences in need for MV. Cardiac patients were placed on MV for breath support during surgery until they returned to hemodynamic stability; they had no additional illness to warrant the prolonged use of MV. Medical patients were placed on MV due to respiratory insufficiency due to illness or injury.

Procedure

Subjects were randomly chosen for either the experimental or control group. The researcher conducted an interview with either the subject's family representative or the subject (if alert) upon arrival to the ICU in order to obtain consent and ascertain the subject's musical preferences**.** The researcher chose to use subject preferred music, if available, in hopes of attaining a greater response (Standley, 2000). Subjects in medical and cardiac experimental groups (n = 20) received one 25 minute live music therapy session from the researcher using guitar and voice, and using song selections and/or music genre preference information obtained from the interview. If neither a family representative nor the subject knew the subject's music preference, the researcher used pre-selected songs from rock-n-roll, country, gospel, R&B, oldies, and patriotic music genres. Each genre selection included four songs (see Appendix I).

For this study, music tempo was matched to respiration rate. Due to the differing nature of the use of MV for cardiac and medical patients, the procedure was different for each group. Because vital signs of medical patients were generally higher, music intervention was geared to decrease them to ranges suitable for extubation. Cardiac patients typically exhibited lower than desired vital signs, so music intervention was used to raise them to ranges suitable for extubation. The target rates for the vital signs measured were the same for each group: RSBI = < 80, RR= 20-22/min., HR = 72-85 bpm, and SPo2 = 92-100 %. Because there is no true "low" threshold for RSBI, any number less than 80 is desirable, even if the RSBI increases slightly over time (Mary Lescher, MBA, RRT; Tallahassee Memorial Healthcare, June 9, 2006). Therefore, the researcher conducted a pre-test to calculate RR in order to ascertain the tempo for selected songs. Then, the researcher matched the tempo to the subject's RR. For the sake of continuity, only music in 4/4 time was used. The researcher then multiplied the pre-tested RR by 4 to get the beginning tempo. For example, a beginning RR of 30 x 4 equaled 120 bpm starting tempo. Based on beginning respiration, the researcher set the music tempo and began to play and sing, accenting every 1st beat with the voice and guitar in an attempt to entrain a four beat inhale and four beat exhale respiratory pattern in the subject. The researcher used pre-recorded metronomic changes on a cassette tape based on RR. Voice-over was used to signal each tempo change, for ease in locating each beginning tempo. Side A of the cassette tape started at 160 bpm (40 RR/min.) and decreased 8 bpm every two minutes across 25 minutes. Side B started at 48 bpm (12 RR/min.) and increased 8 bpm every two minutes across 25 minutes. The side of the tape used was based on whether the RR was too high or too low. If the RR was too high (22-40 RR/min.) the tempo decreased during the intervention. If the RR was too low (12-20 RR/min.) the tempo increased during the intervention. The researcher, due to the differences in illness and need for MV, only used side A (decrease in tempo) with medical patients and side B (increase in tempo) with cardiac patients.

Instrumentation

Each subject in the study was placed on the same type of mechanical ventilator, the Servo 300A multifunctional ventilator. The researcher used an acoustic guitar and vocal music. Tempos were played during each intervention via a General Electric hand-held cassette recorder with GE earphones so the metronome would not be heard by the subject. An egg timer was used to time the 25 minute music intervention.

CHAPTER 4

RESULTS

This study contained groups divided as cardiac experimental (n = 9), medical experimental (n = 10), cardiac control (n = 10), and medical control (n = 10). The total sample for the study was n = 39. An individual sample t test revealed a significant difference between groups for age, with the experimental group having a greater mean than the control group (M = 59.95 vs. 54.8) There was no significant difference for length of time on MV (Table 2).

Table 2. Demographic Independent Samples t-test

	T	Df	Sig.(2-tailed)
Age	1.12	37	0.27
Time	0.14	37	0.89

Results for all data were computed separately for cardiac and medical groups due to differing characteristics of MV treatment. A two-way ANOVA with repeated measures for pre post data between experimental and control conditions was conducted for each of the measures of RSBI, respiration rate, heart rate, and oxygen saturation rate. Results are as follows:

RSBI

Table 3. RSBI Means and Standard Deviations for Cardiac Patients

Group	Mean	SD	N
Pre-experimental	37.22	11.088	9
Pre-control	36.70	10.446	10
Post-experimental	40.44	8.890	9
Post-control	39.70	9.214	10

Table 4. RSBI Means and Standard Deviations for Medical Patients

Group	Mean	SD	N
Pre-experimental	68.60	26.133	10
Pre-control	41.40	19.156	10
Post-experimental	67.10	28.380	10
Post-control	48.40	16.661	10

RSBI means and standard deviations for cardiac patients are listed in Table 3 and RSBI means and standard deviations for medical patients are listed in Table 4. A Two-Way Analysis of Variance with Repeated measure for RSBI indicated a significant difference between experimental and control groups, F (1, 77) = 4.58, p = .04 and between type of patients, F = (1, 77) = 10.51, p = .003. Further analysis of interaction effects indicated no significant difference, F = (1, 77) = 4.10, p = .051. Post hoc analysis indicated that there was not a significant difference between experimental and control cardiac patients for RSBI, $p > .05$; however, a post hoc analysis indicated a significant difference between experimental and control medical patients F (1, 18) = 5.11, p = .04.

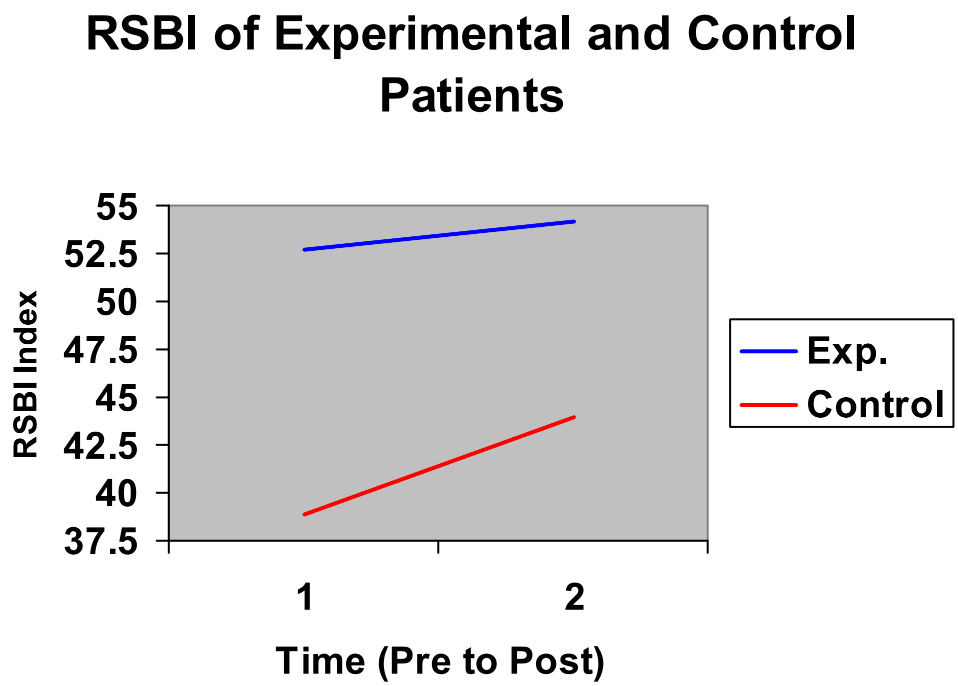

Figure 1. RSBI of Experimental and Control Patients

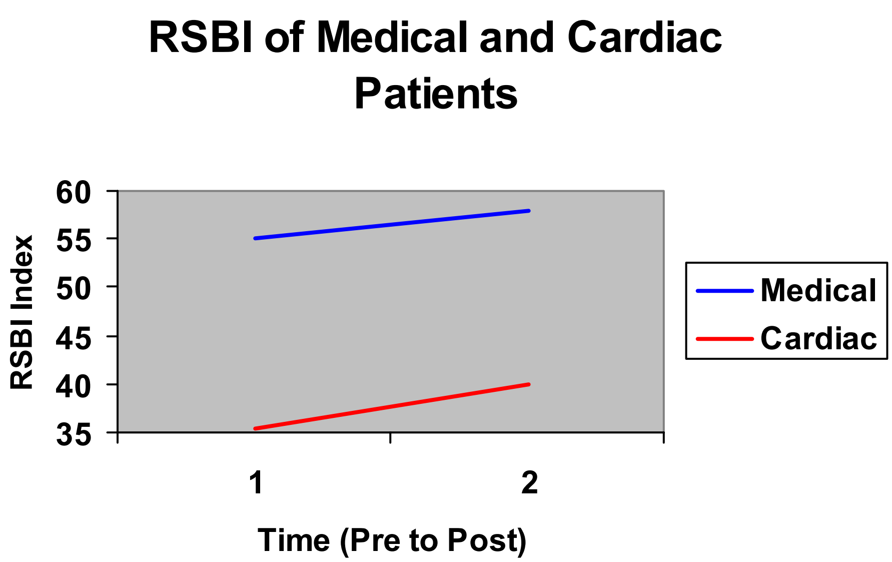

Figure 2. RSBI of Medical and Cardiac Patients

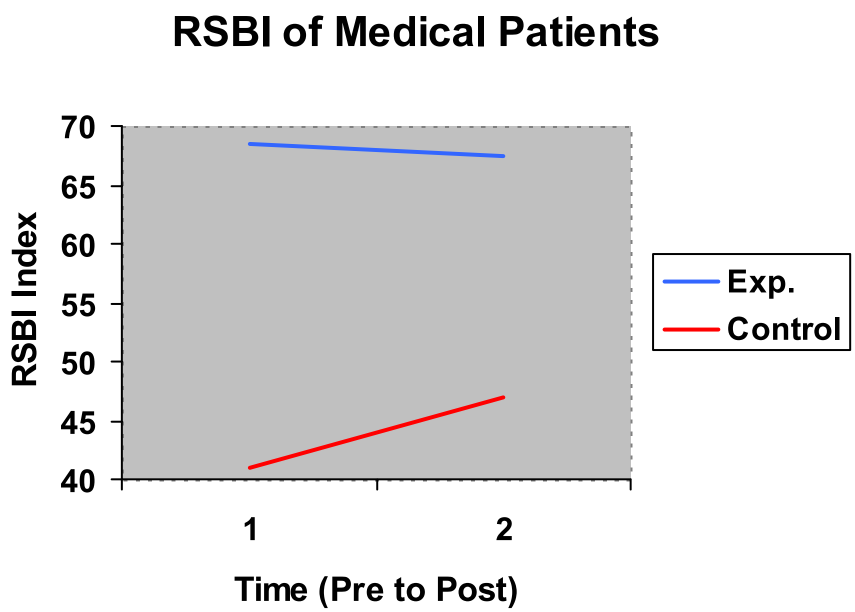

Figure 3. RSBI of Medical Patients

Respiration Rate

Table 5. RR Means and Standard Deviations for Cardiac Patients

Group	Mean	SD	N
Pre-experimental	16.89	3.408	9
Pre-control	16.40	4.061	10
Post-experimental	18.00	2.449	9
Post-control	18.30	2.214	10

Table 6. RR Means and Standard Deviations for Medical Patients

Group	Mean	SD	N
Pre-experimental	24.60	7.648	10
Pre-control	18.20	8.677	10
Post-experimental	24.40	7.560	10
Post-control	20.90	7.047	10

Respiration rate means and standard deviations of cardiac patients are listed in Table 5 and those of medical patients are listed in Table 6. A Two-Way Analysis of Variance with Repeated measure for RR indicated a significant difference between types of patients, F (1, 78) = 6.73, $p < .05$. Post hoc analysis indicated there was not a significant difference between experimental and control cardiac patients, F = (1, 77) = .08, p = < .05, nor was there a significant difference between experimental and control medical patients, F = (1, 77) = 2.26, p = < .05. It should be noted that respiration rates of both experimental and control cardiac patients tended toward the 20-22 bpm threshold, but this tendency was not significant.

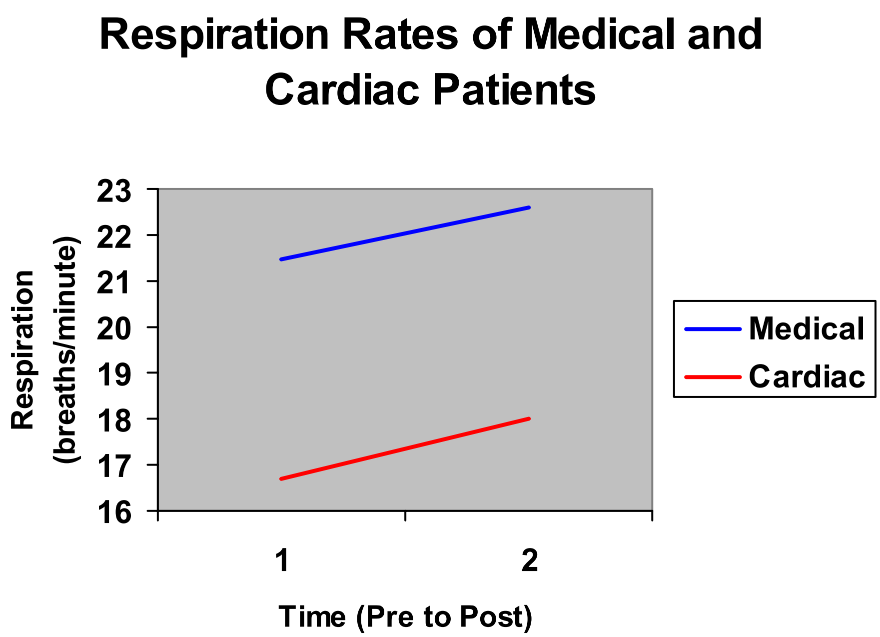

Figure 4. Respiration Rates of Medical and Cardiac Patients

Heart Rate

Table 7. HR Means and Standard Deviations for Cardiac Patients

Group	Mean	SD	N
Pre-experimental	80.89	11.548	9
Pre-control	90.50	12.085	10
Post-experimental	81.56	10.187	9
Post-control	92.20	13.348	10

Table 8. HR Means and Standard Deviations for Medical Patients

Group	Mean	SD	N
Pre-experimental	92.00	25.223	10
Pre-control	90.30	18.160	10
Post-experimental	92.20	24.142	10
Post-control	91.60	12.937	10

Table 7 shows means and standard deviations for cardiac patients' heart rates scores and Table 8 shows means and standard deviations of medical patients' heart rate scores. Two-Way Analysis of Variance with Repeated measure for HR indicated no significant differences between groups, F (1, 77) = .70, p = < .05, and type of patients, F (1, 77) = .96, p = < .05. It was noted that experimental patients only experienced a slight elevation in heart rate while control patients experienced a moderate elevation. Although not significant, these changes could indicate the relaxation response to music.

Oxygen Saturation Rate

Table 9. SPo2 Means and Standard Deviations for Cardiac Patients

Group	Mean	Sd	N
Pre-experimental	98.78	1.093	9
Pre-control	97.10	2.079	10
Post-experimental	98.67	1.581	9
Post-control	97.00	1.944	10

Table 10. SPo2 Means and Standard Deviations for Medical Patients

Group	Mean	SD	N
Pre-experimental	95.10	5.547	10
Pre-control	97.00	2.211	10
Post-experimental	94.80	5.371	10
Post-control	97.10	2.132	10

Table 9 shows all means and standard deviations for cardiac patients' oxygen saturation rates, while those of medical patients' oxygen saturation rates are listed in Table 10. A Two-Way Analysis of Variance with Repeated measure for Oxygen Saturation indicated no significant difference, $p = < .05$. In fact, both experimental and control groups showed a decrease in oxygen saturation which would indicate that the patient was not executing a full, deep breath. However, this decrease was not significant.

CHAPTER 5

DISCUSSION

Although most results for this study were not significant, trends in the data show that music therapy is an effective and useful implementation in the ICU with mechanically ventilated patients. During music therapy intervention, the RSBI of experimental medical patients decreased, indicating that music tended to cause deeper and more productive breathing, and thus can bring RSBI into ranges acceptable for extubation. As stated previously, while there is no true “low” threshold for RSBI, a slight increase is acceptable if other hemodynamic factors are stable (Mary Lescher, MBA, RRT, personal communication, June 9, 2006). This was the case in RSBI readings of cardiac experimental patients. The rise in RSBI could be attributed to the waking period from anesthesia and an overall increase in all physiological signs. Trends in the data for respiration rates of experimental cardiac and medical patients show respiration in cardiac patients increased toward threshold (20-22 brpm) and respiration in medical patients decreased toward threshold after the music therapy intervention. Heart rates of both cardiac and medical control groups at baseline were in the 90-90.5 bpm range. Although heart rates for the cardiac experimental group were lower at baseline (81 bpm) than the control group, they increased slightly during music therapy intervention to 81.9-82 bpm. The medical experimental group began with higher heart rates at 92 bpm and increased only slightly to 92.5-93 bpm during intervention. The higher baseline heart rates of medical patients could be attributed to their current hemodynamic state (if in respiratory distress) and the lower baseline heart rates of cardiac patients could be due to the fact that they were still under the influence of anesthesia. Finally, trends in the data for oxygen saturation rates were distressing in the fact that rates decreased in both cardiac and experimental groups during the course of music therapy. For optimal oxygenation, a number of 95-100% is required. The decrease in patient rates could be attributed to the excitability of the music therapy intervention, which could have caused them to breathe faster and shallower breaths, thus decreasing the amount of oxygen to the blood.

As the study progressed, it became a continuing question to the researcher whether post-operative cardiac patients were oriented enough to attend to the music intervention. However, two patients from the experimental group gave recollection of the music therapy experience to the researcher upon follow-up and stated how they enjoyed the music. Also, both could recall familiar songs which were played for them. Most cardiac patients began to wake from the anesthesia approximately 4-6 hours after surgery and virtually all weaned and extubated soon after they were able to follow commands of staff. With the patient's system depressed due to anesthesia, it seemed clear to the researcher that all vital signs would increase with the wearing off of anesthesia. For this reason, it was postulated that cardiac patients, since they all extubated soon after surgery because they had no other existing illness, would be suitable candidates for different types of music therapy study.

The researcher kept data on whether patients successfully extubated in both control and experimental groups. 100% of cardiac control and experimental patients extubated successfully within 1 day of being placed on ventilation. One cardiac patient had to be re-intubated two days following surgery due to contracting a staph infection. 4 out of 10 (40%) of medical control patients did not extubate due to the severity of their illness despite successfully meeting extubation criteria. 3 out of 10 (30%) of the medical experimental group did not extubate due to the severity of their illness even after music therapy intervention. 2 of the 3 required tracheostomy; one patient being in end stage lung cell carcinoma and the other in respiratory distress from cardiac issues. The third patient was extubated the night following the music therapy session, due to respiratory distress from an undiagnosed illness.

It was also discovered that measuring entrainment of respiration toward extubation is very difficult without the use of appropriate equipment due to myriad complexities of the human body and the subjectivity of each person's hemodynamic state. The current research method seemed to be able to approximate respiration entrainment to music, but perhaps a more scientific approach would be helpful in gathering more exact data. The human body and etiology of disease is very different for each person; it would seem very difficult to follow a strict weaning/extubation protocol. According to many respiratory therapists/nursing staff, although they follow weaning protocols, they have a "feeling" of whether or not the patient is appropriate for extubation from the ventilator.

An additional question to the success of the study's design was the small sample size. With a beginning sample size of 40 subjects and one disqualification (n = 39), it is apparent that a larger subject pool would yield more significant results. It is clear that the larger the sample size, the more likely to have significant findings in the data because of the margin of error in parametric tests.

The researcher was given positive feedback regarding the study by most of the medical staff and virtually all subjects and family members. When approached, the subjects' family members were most cooperative and interested to know about music therapy in general. There were few declinations to participate in the study, and each family and/or patient was fascinated by the thought that music could help them with the existing illness. Many family members and/or patients remarked how they felt about the healing power of music, but all denied having ever received music therapy services. Also, there were 3 subjects who had previous music skills, and following extubation each remarked how the therapy session had been enjoyable to them.

Future research with mechanically ventilated patients is needed because of the expediency with which clinicians desire to extubate patients from mechanical ventilation. It is likely that a study using a larger sample size and greater diversity of subjects would yield more significant and helpful results. Also, using more scientific means of data collection could measure a more exact figure of respiration/tempo synchronicity. Differing types of study on the effects of music intervention with postoperative cardiac patients would be helpful in examining the speediness of recovery and return of normal cardiac functioning.

APPENDIX A

HUMAN SUBJECTS APPROVAL

Florida State
UNIVERSITY

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2763
(850) 644-8633 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 9/30/2005

To:
Sondra Phillips
2078 E Park Ave
Tallahassee, FL 32301

Dept.: **MUSIC THERAPY**

From: **Thomas L. Jacobson, Chair**

Re: **Use of Human Subjects in Research**
The effects of Music Entrainment on Respiration of ICU Patients on Mechanical Ventilation

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Human Subjects Committee at its meeting on **9/14/2005**. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals which may be required.

If the project has not been completed by **9/13/2006** you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. The principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

cc: Jayne Standley
HSC No. 2005.668

APPENDIX B

TALLAHASSEE MEMORIAL HEALTHCARE

HIPPA WAIVER

IRB Protocol # 49 (if assigned)

TALLAHASSEE MEMORIAL HEALTHCARE, INC.

IRB RECORD OF APPROVAL OF REQUESTED WAIVER

APPROVAL RECORD
FOR IRB USE ONLY

IRB Protocol No:______________

Reviewed by:
☐ Convened IRB
☑ IRB Chair or Vice Chair pursuant to expedited procedures

1. The use or disclosure of protected health information involves:
   ☑ MINIMAL RISK to individual privacy.
   ☐ MORE THAN MINIMAL RISK to individual privacy.

2. There ☑ IS
   ☐ IS NOT
   an adequate plan to protect identifiers from improper use/disclosure.

3. There ☑ IS
   ☐ IS NOT
   an adequate plan to destroy identifiers at the earliest opportunity.

4. There ☑ ARE
   ☐ ARE NOT
   adequate written assurances that information will not be reused/redisclosed.

5. The research ☑ COULD NOT
   ☐ COULD
   practicably be conducted without the waiver or alteration.

6. The research ☑ COULD NOT
   ☐ COULD
   practicably be conducted without the protected health information.

The request for waiver or alteration of authorization is:

☐ Not Approved
☑ Approved as a Waiver (the first box must be checked for all the elements above)
☐ Approved as an Alteration (*description of nature of alteration required*):

____

____

____

Signature of IRB Chair or Vice Chair __________ Date __________

25 Aug 05

Print Name

L C Deeb

Created 4/8/05
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Page 5 of 5

APPENDIX C

THE FLORIDA STATE UNIVERSITY

HUMAN SUBJECTS APPROVAL

Institutional Review Board 1300 Miccosukee Road
Tallahassee, Florida 32308
850 431-5122
850 431-6489 Fax

Tallahassee Memorial
HealthCare

August 31, 2005

Sondra Phillips
2078 E. Park Avenue
Tallahassee, FL 32301

Dear Ms. Phillips:

Your study "The Effect of Music Entrainment On Respiration of ICU Patients On Mechanical Ventilation" has been reviewed by Larry C. Deeb, M.D., Chair / IRB. Your study meets the criteria for an **Expedited Review** and upon receipt of this letter you may proceed with your study.

The expiration date of this approval is **August 25, 2006**, one year from the approval date. If your study will not be completed by that date, you will need to submit to the TMH IRB an application for continuing review/ approval two (2) months in advance of the expiration date. You will also need to request approval throughout this study to make any amendments to either the study protocol or the informed consent.

For your records, the approved IRB Waiver of HIPAA Privacy Authorization is enclosed. Please provide a copy of your completed results to the Medical Staff Office at Tallahassee Memorial HealthCare so that the results can be archived and presented to the Institutional Review Board.

Sincerely,

Richard I. MacArthur, M.D., MS
Administrative Liaison/IRB

IRB#49
H:\IRB\Expdtd review ltrs\Phillips S 49.doc

APPENDIX D

INFORMED CONSENT LETTER

Informed Consent Letter

The effect of music entrainment on respiration of ICU patients on mechanical ventilation

2006

I am a graduate student under the supervision of Jayne Standley, PhD in the Department of Music Therapy at Florida State University. I am conducting a research study to examine the effect of music entrainment on respiration of ICU patients on mechanical ventilation.

Your family member's participation will include listening to live music for 25 minutes during their daily breathing trial while on mechanical ventilation. Your participation, as well as that of your family member, is completely voluntary. If you or your family member chooses not to participate or to withdraw from the study at any time, it will not affect your family member's care. The results of this study may be published, but your family member's name will not be used. The data for this study will be kept in a locked file drawer in the researcher's home. Only the researcher, supervisor, and respiratory therapist will view the data. The data will be destroyed by December, 2010. Your family member's chart will be viewed by the researcher for information concerning demographic information, diagnosis, length of time on mechanical ventilation, sedative medications, and respiration readings.

Although there may be no benefit to your family member, the possible benefit of your family member's participation may be respiration rates that are acceptable to pass their breathing trial and move toward extubation.

If you have any questions concerning your family member's participation in the study, please call me (850) 510-9075 or Dr. Standley at (850)644-4565.

Sincerely,

Sondra Phillips

****

I give consent for my family member ________________________________ to participate in the above study.

Family member/guardian's name: _____________________________________

Family member/guardian's signature: ___________________________________

Date: ___________

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at (850)644-8633.

APPENDIX E

INFORMED VERBAL ASSENT FORM

Informed Verbal Assent

The effect of music entrainment on respiration of ICU patients on mechanical ventilation

2006

I am Sondra Phillips, a graduate student in the Department of Music at Florida State University. Under the direction of Dr. Jayne Standley, I am conducting a research study on the effect of music on respiration of ICU patients. Should you choose to participate, you will listen to music for 25 minutes during your daily breathing trial. Your participation in the study is completely voluntary. You can withdraw from the study at any time and your care will not be affected. If you would like to participate, please indicate this by either nodding your head or lifting an index finger. If you are able, you may also give your signature.

Finger lift: ____

Head nod: ____

Signature(if possible): ________________________________

Date: _______

Time: _______

Subject # ____
Chart # ____

APPENDIX F

SUBJECT DEMOGRAPHIC AND PREFERENCE QUESTIONNAIRE FOR FAMILY REPRESENTATIVE

Demographic and Preference Questionnaire- The effect of music on respiration……2006

Today's Date: __________________

Gender: ____________

Age: _______________

Date of admission to ICU: ________________

Illness: ____

Does your family/friend enjoy music? ____

Does he/she prefer: Rock n Roll ____ Country ____ Jazz ____ Gospel ____

R & B ____ Oldies ____ Patriotic ____

Name some of his/her favorite musical artists: _______________________________________

____

Name some of his/her favorite songs: ____

____

Does he/she have musical skills? If so, what are they: _________________________________

____

Has the patient ever received music therapy services? If so, when: ________________________

____

Has the patient received music since admission to the ICU? _____________________________

____

Researcher use only:

Subject # ____
Chart # ______

APPENDIX G

SUBJECT DEMOGRAPHIC AND PREFERENCE QUESTIONNAIRE

Demographic and Preference Questionnaire- The effect of music on respiration……2006

Patient Directed – To be completed by researcher with patient in the absence of family interview.

Today's Date: ___________________

Gender: _____________

Age: ________________

Date of admission to ICU: ________________

Illness: ____

Do you enjoy music? Y ____ (raise 1 finger) N ____ (raise 2 fingers)

Do you prefer: 1. Rock n Roll ____ 2. Country ____ 3. Gospel ____

4. R & B ____ 5. Oldies ____ 6. Patriotic ____

(raise fingers to correspond with musical preference)

- Researcher selected songs will accompany each patient-preferred music genre in the absence of family interview.

  Rock – Ramblin' Man, I Can See Clearly Now, Peaceful Easy Feeling, Jailhouse Rock, You've Got a Friend
  Country – On the Road Again, Country Roads, Hey Good Lookin',
  Gospel –What a Friend We Have in Jesus, Leaning on the Everlasting Arms, Amazing Grace
  R & B –
  Oldies – Don't Sit Under the Apple Tree, Rock Around the Clock, Darktown Strutter's Ball,
  Patriotic – You're A Grand Ole Flag, My Country Tis' of Thee, America the Beautiful

Researcher use only:

Subject # ____
Chart # ______

APPENDIX H

DATA COLLECTION FORM

Data Sheet- The effect of music on respiration….2006

Date: ___________________ Time: ________________ C E

Patient age: ______________ Consent granted: Y N by whom : ________________

Patient gender: ___________

Diagnosis: ____

Sedative meds/dosages: ____

LOT on MV: ____

Previous weaning trials/outcomes: ____

____

Current weaning trial/outcome: ____

____

Music genre/songs used: ____

RSBI-baseline	20min. -intervention	45min-postintervention	60min.

MAAS-R- baseline	20min-intervention	45min-postintervention	60min.

RR-baseline	20min-intervention	45min-postintervention	60min

HR –baseline	20min-intervention	45min-postintervention	60min

Oxygen Sat.-baseline	20min. – intervention	45 min. – postintervention	60min.

Range of BPM/RSBI: ________________max to _____________________min.
Subject # _____
Chart # _____

APPENDIX I

SONG LISTS

Note: Preferred music was used if possible. If not, songs were taken from this list.

Rock – *Ramblin' Man, I Can See Clearly Now, Peaceful Easy Feeling, You've Got a Friend*

Country – *On the Road Again, Country Roads, Hey Good Lookin', Crazy*

Gospel –*What a Friend We Have in Jesus, Leaning on the Everlasting Arms, Amazing Grace, The Garden*

Oldies – *Don't Sit Under the Apple Tree, Rock Around the Clock, Daisy, Always*

Patriotic – *You're A Grand Ole Flag, My Country Tis' of Thee, America the Beautiful, God Bless the U.S.A.*

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