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The Effects of Auditory Stimuli on Stress Levels of Adult Patients in the Critical Care Setting

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Showcase of Text, Archives, Research & Scholarship

THE EFFECTS OF AUDITORY STIMULI ON STRESS LEVELS OF ADULT PATIENTS IN THE CRITICAL CARE SETTING.

by

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ABSTRACT

The purpose of this review of literature is to explore the effects of interventional and environmental auditory stimuli on the adult critical care population. Current research has yet to compare and contrast the effectiveness of various interventional auditory stimuli on stress relief, an oversight this thesis aims to remedy. Modern day critical care settings demand the identification of the most therapeutic interventional auditory stimulus and the most stress-inducing environmental stimuli, so that interventions can be made to optimize patient stress levels and improve outcomes. Suggestions will be made on how to simultaneously reduce harmful or stress inducing auditory stimuli in the critical care setting and implement the optimal stress-relieving interventional auditory stimuli.

DEDICATIONS

I dedicate this thesis to all of those who have supported me on this long and rewarding journey. My Lord and savior Yahweh, my family, and my friends. I am so blessed and thankful to be surrounded by such love and encouragement!

I want to thank my Mother and Father for being a constant source of encouragement, strength, and support. You always taught me to work hard and follow my dreams, and now I've finally fulfilled my dream of graduating with University honors. Even through the tough times when I wanted to give up, neither of you ever waivered in your faith in my ability to succeed academically.

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INTRODUCTION

Problem

The problem being explored via this review of literature, is what effect both interventional (stress relieving) and environmental (stress inducing) auditory stimuli have on critical care patients. There is significant research and many literature reviews on the effects of music on patients in critical care settings, however, there are few literature reviews that explore and compare the various types of interventional auditory stimuli and their effects on critical care patients. Additionally, no literature reviews explore in-depth both environmental auditory stimuli and interventional auditory stimuli. This is necessary in order to describe the best overall course of removing stressful environmental auditory stimuli and implementing a stress-relieving auditory stimulus.

This literature review aims to discover: 1) which environmental auditory stimulus is the most stressful to critical care patients, and 2) which interventional auditory stimulus could be the most beneficial for the greatest amount of critical care patients.

Purpose

The purpose of this work is to review the literature associated with the effects and purposeful use of auditory stimuli on the adult critical care patient. The aim of this work is to glean from the published literature recommendations for nursing care of the adult critical care patient regarding auditory stimuli to optimize stress levels. Findings from this study can guide nursing practice decisions based on previous research evidence, and should be used as a guide for future research and education.

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Methods

      A literature review exploring the effects of various auditory stimuli on the stress levels in the adult critical care patient, will be conducted. Information will be gleaned from databases such as: CINAHL plus, PubMED, EBSCOhost, MEDLINE, and Google scholar. Keywords, keyword roots and combinations thereof will include, but are not limited to: auditory stimuli, sound, noise, music, nature based sounds (NBS), white noise, environmental noise, critical care, critical care unit (CCU), intensive care unit (ICU), psychosis, anxiety, stress, and agitation. Article inclusion criteria will be: published in peer reviewed scholarly journals, available in full text, and available in the English language.

EXPLORATION OF AUDITORY STIMULI

This thesis will examine the effects that varying types of auditory stimuli have on critical care patients. Specifically this thesis will examine the following auditory stimuli: music, nature-based sound (NBS), noise cancelling headphones, white noise, noises generated by staff in the critical care setting, and general machinery noises.

Intentional Interventional Auditory Stimuli

According to Merriam-Webster (n.d.a), the medical definition for intervention is, "the act or fact or a method of interfering with the outcome or course especially of a condition or process (as to prevent harm or improve functioning)" (para. 1). This thesis will examine positive or possibly stress relieving interventional auditory stimuli that could be implemented into the routine care of critical or intensive care patients. Examples of these forms of intervention are: music, nature-based sound, noise cancelling headphones, and white noise.

Music

For the purpose of this thesis, music is defined as vocal and/or instrumental sounds that comprise a harmony, rhythm, or melody. Thus, interventional music thus for the purposes of this thesis is the therapeutic use of vocal and/or instrumental sounds, by the nurse in order to aid in the prevention of harm, or to facilitate the improvement of functioning. Types of interventional music in research studies range from classical, to instrumental, to choral, or to patient-selected music (Bhana & Botha, 2014).

Nature-based Sound

For the purpose of this thesis, NBS is defined as any sounds possessing the auditory input one would find in a natural setting devoid of human interaction. Examples of NBS used in studies are: waterfalls, rain, waves at a beach, river streams, bird's song, and walking through the forest (Aghaie et al., 2014; Saadatmand et al., 2013).

Noise Cancelling Headphones

For the purpose of this thesis, noise cancelling headphones is defined as any set of in-ear, around the ear, or over the ear devices, that significantly reduce or completely prevent the wearer from hearing external sounds (Molesworth, Burgess, & Kwon, 2013).

White Noise

Merriam-Webster (n.d.b) states, that the medical definition for interventional white noise is, "a heterogeneous mixture of sound waves extending over a wide frequency range that has been used to mask out unwanted noise interfering with sleep" (para. 3). For the purpose of this thesis, interventional or purposeful white noise is defined as any continuous sound that assists in reducing or completely eliminating a patient's stimulation from external auditory stimuli. Examples of purposeful white noise are typically a blended continuous track of 1-25 kilohertz (KHz) frequency sound played at a level of 62 decibels (Stanchina, Abu-Hijleh, Chaudhry, Carlisle, & Millman, 2004).

Unintentional Environmental Auditory Stimuli within the Critical Care Setting

Environmental noise for the purpose of this thesis, is defined as a sound that occurs as a natural side effect of an environment's activities and contents. This thesis will examine the sources of unintentional environmental auditory stimuli within the critical care setting that may cause an increase in patient stress. Auditory stimuli that will be examined are: unintentional white noise, noises generated by staff in the critical care setting; in addition to monitors, alarms, and other machinery noises.

White Noise

According to Merriam-Webster (n.d.c) white noise is defined as, "a constant background noise; especially: one that drowns out other sounds: meaningless or distracting commotion, hubbub, or chatter" (para. 2). For the purpose of this thesis, unintentional white noise is defined as any continuous noise heard by the patient, which is not conductive to or necessary for the treatment of the patient. Examples of unintentional white noise are: heart rate monitors, mechanical ventilators, and intravenous therapy drips.

Noise Generated by Staff in the Critical Care Environment

For the purpose of this thesis, noises generated by staff, are defined as any intentional or unintentional noises generated by either voice or action. Examples of noises generated by staff are staff chatter, housekeeping cleaning activities, routine care activities, door opening, and door closing.

Monitors, Alarms and, Machinery Noises

For the purpose of this thesis, alarms and machinery noises are defined as any sounds generated from an irregular source of sound. Examples of alarm noises are: bed alarms, heart rate/rhythm alarms, intravenous therapy alarms, mechanical ventilation alarms, dialysis alarms, and respiratory rate alarms. Examples of electronics generated sounds are telephones and tube systems: for the sending or receiving of samples or results.

FINDINGS

Intentional Interventional Auditory Stimuli

Music

Bhana and Botha (2014) conducted a qualitative interview style study of the effects of music on cardiac patients in the ICU. Twenty minute shifts of music were played five times a day during routine care periods to nine study participants; and results were generated by questionnaires and open-ended interview style questions. In this study patients were then given the opportunity to select the music which they would prefer listening to during their postoperative period. Allowing patients an opportunity to select the music also gives them a sense of control or involvement in their care (Bhana & Botha, p. 3). However, it was also found that incorrectly selected or applied music can have adverse effects on the patient as shown in the client verbalization that, "I didn't quite make the right selection. I think I did, when I told you to choose something else for me. At some point when you feel well, certain music applies to you, when you not feel that well, then it's irritating" (Bhana & Botha, p. 5). It was found that participants in the study, "…have found music with slow, harmonious rhythm and low pitch to have a positive effect" (Bhana & Botha, p. 7). Bhana and Botha suggested that patients should be allowed to choose their own music to play, within the limits of it being slow, harmonious in rhythm, and low in pitch; additionally it was suggested that nurses maintain a collection of previously used music for future patients (p. 7). This study was conducted at a single hospital, thus the findings of this study may not be transferable to either other hospitals or other patient groups.

Sendelback, Halm, Doran, Miller, and Gaillard (2006) conducted a study examining if the use of therapeutic music on post-operative cardiac surgery days 1-3 decreases anxiety, pain levels, heart rate, blood pressure, and/or the amount of opioids administered. The study was a randomized controlled trial with 86 patients, 50 patients received the intervention of 20 minutes of music, whereas the remaining 36 received routine care (control). The variables were measured every 20 minutes: the findings revealed the intervention group when compared to the control group had a reduction in pain and a significant reduction in anxiety. There was no notable variation in the blood pressure or heart rate between the control and intervention groups. Yet, the researchers stated that this could have been due to the heart rate, rhythm, and pressure medications most patients are required to take after cardiac surgery (Sendelback et al., p. 199). Possible limitations or weaknesses of this study include: that it was a single-facility study, that those delivering the intervention also measured the variables, and that some patients refused to answer all questions on post-operative days two and three due to pain levels (Sendelback et al., p. 199).

Chlan et al. (2013) conducted a randomized controlled trial studying the effect of music therapy and noise cancelling headphones on the amount and frequency of sedatives, in addition to the levels of agitation and anxiety for mechanically ventilated patients. Patient directed music therapy intervention patients were allowed to play music when they so desired to do so. On average this group listened to about 80 minutes of music per day. The noise cancelling headphones intervention patients were allowed to put the headphones on whenever they pleased. On average they used the

headphones for 34 minutes a day. Gradually over the course of the study, the patient directed music therapy intervention groups' anxiety scores, sedation frequencies, and sedation intensities dropped. When comparing the patient directed music intervention group, to both the control group and noise-cancelling headphones group, it was found that patient-directed music therapy was the most beneficial. According to Chlan et al., "By the fifth study day, the PDM patients received 2 fewer sedative doses (reduction of 38%) and had a reduction of 36% in sedation intensity" (p. 2335). It was also found that noise cancelling headphones lowered sedation frequency and intensity, but not to the same degree as patient-directed music therapy. Only the patient-directed music therapy intervention was found to lower anxiety in mechanically ventilated patients (Chlan et al.).

Korhan, Khorshid, and Uyar (2011) conducted a randomized controlled trial examining the effects of classical music on physiological signs of anxiety in mechanically ventilated patients. In the study, classical music was played via headphones to the intervention group for 60 minutes. Data was collected 30 minutes before the intervention, and then on the 30th, 60th, and 90th minutes of the intervention. Blood pressure, heart rate, respiration rate, and pulse oximetry, were utilized as methods of measurement for physiological manifestations of anxiety. The intervention group had lower blood pressure and respiration rates than the control group, and it was found that the intervention had a cumulative dosage effect on the experimental group. There was no significant difference in heart rate or oxygen saturation between the intervention and control groups (there were high p-values for these measurements). There was a

difference in heart rate over time for both groups. The researchers interpreted the findings as music therapy has a relaxation effect on mechanically ventilated patients, which reduces anxiety. They further use citations from numerous other studies, which back the findings they found related to blood pressure and respiratory rates being lowered in response to music therapy. The researchers recommend that nurses utilize music therapy as a means to manage anxiety, because it is safe, inexpensive, easy to implement, and has many benefits. The researchers are specific about the tempo of selected music, "Nurses can implement music intervention using music with a tempo of 60–80 beats per minute to induce relaxation for short-term benefit" (Korhan, Khorshid, & Uyar, p. 1032).

Mangoulia and Ouzounidou (2013) conducted a review of literature to try and discern if listening to music in the ICU is conductive to promote relaxation. They found that multiple studies involving the use of therapeutic music revealed that music had physiological and psychological impacts across clinical situations. The impacted physiological parameters were: heart rate, blood pressure, and respiration rates. Impacted psychological parameters were agitation, anxiety, fear, and a sense of helplessness. Overall Mangoulia and Ouzounidou endorse the use of therapeutic music, they highlighted the fact that music is a personal experience, and the types of music one likes significantly impacts the results of therapeutic music on various stress measurement tools and parameters.

Nature-based Sound

      Saadatmand, et al. (2013) conducted a randomized, placebo-controlled, double-blinded study to evaluate the effect of NBS on agitation, anxiety, and stress in mechanically ventilated patients. The intervention was playing a recording of NBS that the patient selected via headphones, for a period of 90 minutes. Physiologic stress was measured by heart rate, blood pressure, and respiration rate. Agitation and anxiety were measured with quantified scale charts, where patients reported their own experience of their agitation and anxiety. All measures were done 30 minutes before intervention, at the 30th, 60th, and 90th intervention intervals, and 30 minutes after the intervention was finished. The significant findings by the researchers are as follows: the mean systolic and diastolic blood pressure(s) of the intervention group were significantly lower than the control group at all four data collection times. Independent t-test resulted in a p-value of $p<0.001$ for the systolic data, and a p-value of $p= 0.001$ for the diastolic data (p-value allows for us to determine how likely it was that the results were generated by chance alone). The mean heart rate and respiration rates of the two groups was not statistically significant ($p= 0.292$). However, the interaction between time and groups was statistically significant for both heart rate ($p<0.001$) and respiration rate ($p< 0.001$). A strong statistical significance lies in the overall anxiety and agitation scores, which is that the NBS group had lower overall scores ($p<0.001$ for both sets). Using a regression parameter for the variable group, generated a value of 1.496 for anxiety scores. This means that the chances of having elevated anxiety scores in the control group was 4.5 times more likely than in the intervention group. "The

estimated regression parameter for the variable group was 2.418. This means that the odds of having higher scores of agitation in the control group was exp (2.418) = 11.24 times of the same odds in the intervention group" (Saadatmand et al., p. 902). Based on the findings, the researchers recommend that nurses use NBS therapy as an alternative to sedatives (or as a means to lower the necessary amounts of sedatives for any given patient). They believe, and have citations backing the fact that NBS therapy is a cheap, easy, effective, and quality of life improving nursing practice.

Aghaie et al. (2014) conducted a study evaluating the effects of NBS on coronary artery bypass graft patients' sleep quality, and ability to sleep, within the critical care environment, during the weaning of mechanical ventilation. The study was a randomized controlled trial with 120 patients, the intervention was playing NBS via headphones, while the control group received normal care. "Patients in both groups had vital signs recorded at the first trigger (of mechanical ventilation weaning), at 20 min intervals throughout the procedure, immediately after the procedure, 20 min after extubation, and 30 min after extubation" (Aghaie et al., p. 526). The data revealed the NBS intervention group's heart rate, respiratory rate, pulse oximetry readings, and mean arterial pressures improved. This group also displayed time related trend, which showed improvement in vital signs increased over time. Additionally, it was found that the control group had 2.669 times the odds as the intervention group to have high anxiety scores, and 2.927 times the odds as the intervention group to have high agitation scores (Aghaie et al., p.535). This study's limitations primarily stem from the fact that the study was conducted exclusively on coronary artery bypass graft patients,

who coincidentally were between the ages of 45 and 65. The researcher's noted that the study should be performed with other age and populations in various settings, to evaluate if the use of NBS as a therapeutic adjunct is generalizable.

Williamson (1992) conducted a qualitative study to explore if playing ocean sound to intensive care patients would increase the duration, quality, and patient perceived depth of sleep patients. The intervention group was played ocean sounds for three nights after being transferred to the ICU, while the control group was provided with routine care measures. Patients were then asked to participate in qualitative patient reported measurements on perceived quality, duration, and depth of sleep with and without the ocean sounds intervention. The findings were that patients in the interventional group rated their sleep as better quality, longer in duration, and greater in depth than the control group who received normal care (Williamson). Possible limitations or weaknesses for this study were the use of exclusively qualitative measures to examine the effects of ocean sounds on sleep, and that the ocean sounds were played over speakers instead of headphones. This could have revealed to the subjects, especially the control group, the goal of the study, whereas headphone based studies remove the possibility of subjects knowing exactly what variable was being examined.

Richards, Nagel, Markie, Elwell, and Barone (2003) found through their meta-analysis of the effects of NBS on sleep that the overall consensus is that, "the masking of noise (with nature-based sound) has been demonstrated to improve self-reported sleep quality and to reduce to overall number of nighttime awakenings" (p. 336).

Noise Cancelling Headphones

Chlan et al. (2013) conducted a study on the effects of music therapy on anxiety and sedative exposure on mechanical ventilation patients: the study also examined the use of noise-cancelling headphones on anxiety and sedative exposure. The study was a randomized controlled trial with 373 participants throughout 12 different intensive care units. Data revealed the noise cancelling headphones had no impact on anxiety, that they increased sedation intensity and frequency above the usual care baseline for care days 15 through 30.

Matvey et al. (2012) did a study on the effect of noise-cancelling headphones on pain perception and anxiety in men undergoing transrectal prostate biopsy. The study consisted of 88 patients and measured physiological (quantitative) and psychological (qualitative) parameters. Physiological parameters measured included heart rate, respiration rate, and blood pressure. Psychological patient reported parameters measured included a State-Trait Anxiety Inventory, verbal pain response scale, and visual pain response scale. The data revealed that noise-cancelling headphones had no apparent effects, on pain and anxiety perception in men undergoing transrectal prostate biopsy, though it did reveal that blood pressure remained close to baseline measurements in the noise cancelling headphones group. This study is not closely related to the ICU/CCU setting, thus should not be considered as generalizable.

White Noise

According to many studies, anomalous sleeping patterns are a preeminent cause of stress and anxiety in the critical care setting (Patel, Baldwin, Bunting, & Laha, 2014;

Kamdar, Needham, & Collop, 2012; Girard, Pandharipande, & Ely, 2008). Thus examining the effect that white noise has on levels of sleep, may in fact correlate with the levels of stress experienced by patients.

Stanchina, Muhanned, Chaudrhy, Carlisle, and Millman (2005) performed a study examining the effects of white noise on sleep for subjects exposed to ICU noise, with the hypothesis that using white noise, "…would reduce arousals by reducing the magnitude of changing noise levels" (p. 423). The study was performed on eight non-intensive care subjects, who had a series of three polysomnagrams (PSG) each. The first PSG gathered baseline sleep data, the second PSG gathered data on sleep when exposed to ICU noise via a home theater system, and the third PSG gathered data on sleep when the subjects had white noise played in the background, along with the stage two ICU noise track. The study found that playing white noise decreased the frequency of arousals, and also the amount of time it took for subjects to fall back asleep after arousals. Two investigators, independently reviewed all PSGs to assist in greater study reliability. However, the fact that the subject pool was so limited and had no underlying health problems that could affect stimulation thresholds, marks the study as being highly unreliable and not generalizable to ICU patient populations.

A study performed in 1999 by Broscious examined the effects of music and white noise on the levels of pain during chest tube removal. The study was a randomized controlled trial with 156 subjects. Heart rate, blood pressure, and pain were measured 10 minutes before chest tube removal. Pain scale was taken immediately after removal, and 15 minutes after removal. Blood pressure and heart rate were assessed every 5

minutes, from the time of removal to 15 minutes after removal. The study revealed that neither intervention significantly decreased the perception of pain, or vital sign measurements, as compared to the control group. However, Broscious did find that, "…most subjects enjoyed listening to the music or white noise" (p. 414). Broscious indicated that more studies in different settings focused on different procedures should be done, as his study had limited generalizability, as the group was from the same urban setting and hospital.

Unintentional Environmental Auditory Stimuli within the Critical Care Setting

White Noise

Qutub and El-Said (2009) conducted a study examining the ambient noise levels in an intensive care unit. This study monitored noise levels using a sound level meter in decibels, to see if there was a difference in noise levels depending on time of day or day of the week. The study found using independent t-tests, that there was no significant difference in sound levels between the day or night shifts, or the week-day or weekend shifts. "However, the assessed levels of exposures to noise were still higher than stipulated international standards" (Qutub & Khaled, p. 53). The researchers recommend, that alarms be lowered or changed to light alarms, and that all ICUs implement a noise level reduction protocol.

A study by Akansel and Kaymakci (2007) examined the effects of general intensive care unit noise on 35 coronary artery bypass graft surgery patients. The study was cross-sectional and descriptive, examining data collected for three beds in an eleven bed ICU. The unit was rectangular in design. The researchers were trying to

discern if patient's locations in relation to the nurse's station impact the levels of

environmental noise, which the patients are exposed to. For data collection a noise

analyzer was placed at the head of each study patient's bed to measure decibel (dB)

levels, and patients were asked a 31 question questionnaire about how they perceived

noise disturbances. Data collection began at 9am following the patient's coronary artery

bypass graft procedure and were taken for a total of 24 hours. Findings revealed that

the first bed was exposed to an average of 62.85 dB, the third was exposed to an

average of 63.75 dB, and the fifth was exposed to an average of 64.77 dB (Akansel &

Kaymakci, p. 1584). This translates to the finding that patients closest to the nurses

station are often exposed to higher levels of noise, than patients who are at greater

distances from the nurses station. It was additionally found via patient demographics

and gathered data, which those who had been in an ICU before and those who worked

in high-noise jobs within the past five years reported no or minimal disturbances related

to noise (Akansel & Kaymakci, p. 1585). Overall the study also found that the most

often recorded and most reported noise related disturbances were: the telephone (68

dB), monitor alarms (68 dB), infusion pump alarms (61 dB), vacuum cleaners (74 dB),

footsteps (89 dB), and staff conversations (74 dB). Akansel & Kaymakci reported that

these findings are, "… showing that the sources of the noise in the ICU unit can be

possibly traced to the noise created by humans 47.35% of the time" (p. 1584).

Stafford, Haverland, and Bridges (2014) conducted a review of literature focusing

on noise in the ICU, and previously studied interventions that can be implemented into

practice. "In a study in 5 ICUs, all the units recorded an (average dB level) greater than

45 dB at all times, and between 52 and 59 dB more than 50% of the time" (Stafford et al., p. 58). "When evaluating the effects of sound and noise in the ICU, it's important to also consider the psychological effects. In a survey of ICU patients 40% recalled ICU noise- 85% of whom reported feeling disturbed by it" (Stafford et al., p. 58).

Choiniere (2010) conducted a review of literature focusing on the effects of noise exposure on ICU patients. It was found that the overstimulation by a noisy intensive care unit is further exacerbated by unpredictable and loud alarms, which induce stress reactions via the sympathetic nervous system (Choiniere). For patients the effects of noise in the ICU can be far reaching as noise has extreme physiological and psychological effects, because noise triggers the human stress response by the sympathetic nervous system (Choiniere). Loud noise also stimulates the release of adrenocorticotropic hormone and its derivative cortisol (otherwise known as the stress hormone) this places the patient at risk for, "… accumulation of body fat and formation of atherosclerotic plaque… (and) delayed wound healing" (Choiniere, p. 329). In addition loud noises in the ICU setting cause sleep disturbances which impedes wound healing and ICU delirium, "ICU delirium is… changes in behavior, delusions, paranoia, slurred speech, irritability, and disorientation" (Choiniere, p. 330).

Noises Generated by Staff in the Critical Care Setting

Though the following studies examine the effects of noises generated by staff on patients sleep, it should be noted that no studies were found that specifically examined the effects of staff noise on stress in critical care patients. Furthermore, many studies aside from those below, cite that anomalous sleeping patterns are a preeminent cause

of stress and anxiety in the critical care setting, thus the below studies should be considered as findings for the effects of staff noise, on both sleep and stress in critical care patients (Kamdar, Needham, & Collop, 2012; Girard, Pandharipande, & Ely, 2008).

Patel, Baldwin, Bunting, and Laha (2014) conducted a study on the effect of a multidisciplinary bundle of interventions on sleep and delirium in medical and surgical intensive care patients. Though their study was based around sleep and delirium, anomalous sleeping patterns are a preeminent cause of stress and anxiety in the critical care setting (Patel et al.; Kamdar et al.; Girard et al.). It is widely believed that the stress and anxiety caused by lack of sleep when added to the plethora of abnormal stimulants one finds on a critical care unit, places patients at a higher risk of developing delirium. Interventions enacted in this study were multidisciplinary and multimodal, requiring staff education on how to enact interventions correctly. Interventions which impacted the noises generated by staff or perceived by patients are as follows: staff and visitors were to speak quietly at all times, at 11pm all patient doors were to be closed, from 11pm to 7am nonclinical staff chatter around the patient's bedside was to cease, and any and all patient care or procedures were to be avoided from 11pm to 7am unless emergent. The compliance data for each intervention was 96%, 96%, 92%, and 92% respectively. The data collected indicated a significant decrease in cases of delirium and increase in the quality, quantity, and perceived depth of patient sleep. This study utilized strong exclusion criteria, which signifies a degree of strength for the study's results. However, there were some possible limitations and weaknesses found, for instance the study was not a randomized controlled trial, it was performed at a

single center, and staff obviously had to know about the presence of a study. Overall the strengths the study has to offer likely outweigh the possible weaknesses, but further studies will need to be conducted to verify the findings and assure generalizability.

Delaney (2014) conducted an evidence based implementation project on behavioral modification of healthcare professionals in an adult critical care unit to reduce nocturnal noise. The study was open to all interested nursing staff, and only 41.25% of the total ICU nursing staff participated in the study. The study consisted of the use of an audit tool to gather data on staff knowledge, followed by 3 knowledge promotional in-service teachings, and finalized by a follow up audit to examine the knowledge gained, and the implementation of interventions to reduce noise. Delaney's hypothesis was not proven, as the compliance to interventional noise reduction protocols only increased by 8-10% (Delaney, p. 506). Though the researcher (Delaney) is highly qualified with many certifications and degrees, there were numerous weaknesses identified in this study that likely affected the outcomes; including the weakness of only having one researcher which can lead to data collection and evaluation bias. Delaney stated that, "… it was apparent that there was incongruence between clinical staff and clinical leadership regarding accepted practices in an ICU" (p. 512). This statement is indicative of staff dissonance that could have impeded floor nurses' participation in the study, and their implementation of interventions indicated. There was no requirement by leadership for uniform acceptance and following of the interventions. Furthermore there was no data in the study indicating the percentage of

study participants who actually went to all three in-service teachings. Moreover, Delaney indicated that the small time frame of the study (3 months) prevented the implementation of noise reduction strategies and protocol, which was, "further compounded by a large efflux and influx of staff prior to the second audit" (p. 517). Overall this study is not to be a significant indication of the ability for ICU/CCU staff to implement changes to reduce noise in the critical and intensive care settings. Rather, this study should be used as a guide, to better future studies on the same subject matter.

A study by Li, Wang, Wu, Liang, and Tung (2011) examined the efficacy of controlling nocturnal noise and activities to improve patients' sleep quality in a surgical intensive care unit. The study was a 55 patient quasi-experimental study utilizing two three month phases of first usual care (control) and then interventional care measures. There was a decibel monitor placed at the head of each patients' bed, which measured sound levels from 11pm to 7am. The interventions in this study that were aimed at staff noise regulation include: closing patient doors at 11pm, decreasing the volume of staff conversation after 11pm, checking fluids and tube feed levels before 11pm to prevent alarms later in the evening, and to rearrange care and procedures to before 11pm or after 7am unless emergent. Data collected indicated that the compliance with implementing protocols was 98.6% (Li et al., p. 398). From the data collected it was found that the interventional group had significantly decreased: peak and average noise levels, patient reported perceived noise levels, patient reported sleep interruptions. It was also found that there was a significant increase in the intervention group's patient

reported sleep efficacy and quality, when compared to the control group. Overall, this study's weaknesses and limitations lie in that it is unknown if the study results are generalizable to smaller intensive care units, immediate post-surgical patients, or ventilator patients, due to the setting of the study, and exclusion criteria for subject selection.

Monitors, Alarms, and Machinery Noises

DeVaux and Cooper (2015) conducted a study on alarm fatigue reduction in a medical intensive care unit, via implementation of a patient safety initiative. The number and decibel level volumes of telemetry alarms were examined and a two-step intervention plan was implemented. The first step was employing the use of clinical engineers to zone alarm speakers to assist in nurses' ability to locate an active alarm. This would help to decrease the amount of time it takes to respond to and shut off alarms. The second intervention was to remove false and nonactionable alarms, to prevent reoccurring alarms for rhythms such as PVCs, which may be normal for some patients. Post-interventions, it was found that decibel level averages were reduced from 80-90 to 70, and that the total number of alarms was reduced 61.4% (DeVaux & Cooper, p. 68).

A study was conducted by Silva and Carlos (2012) that examined the effects of alarms within the ICU on patient comfort. Overall, the study was observational and descriptive, using data strictly from electronic media, which revealed the number and character behind each alarm. The findings revealed that 85% of all alarms were false-alarms, and that in the hours of higher alarm frequency the patients reported higher

levels of anxiety and agitation (Silva & Carlos, p. 2805). The results were that, "the high levels of noise is one of the most common problems that affect the physiology, the sleep-wake cycle, and beyond to be a potential influence to the safety of patients" (Silva & Carlos, p. 2800). The general statement made by this study was most alarms are false alarms, and aren't useful, but harmful to patients and healthcare providers.

Patel, Baldwin, Bunting, and Laha (2014) conducted a study on the impact of a multidisciplinary bundle of interventions on sleep and delirium in medical and surgical intensive care patients. Though their study was based around sleep and delirium, anomalous sleeping patterns are a preeminent cause of stress and anxiety in the critical care setting (Patel et al.; Kamdar, Needham, & Collop, 2012; Girard, Pandharipande, & Ely, 2008). It is widely believed that the stress and anxiety caused by lack of sleep, when added to the plethora of abnormal stimulants one finds on a critical care unit, places patients at a higher risk of developing delirium. Interventions enacted in this study were multidisciplinary and multimodal, requiring staff education on how to enact interventions correctly. Interventions that impacted the noises generated by alarms and machinery are as follows: at 11pm all telephones are to have their volume reduced, and all monitoring equipment will be turned to night mode. The compliance data for each intervention was 96% and 96% respectively. The data collected indicated a significant decrease in cases of delirium and increase in the quality, quantity, and perceived depth of patient sleep. This study utilized strong exclusion criteria, which signifies a degree of strength for the study's results. However, there were some possible limitations and weaknesses found, for instance the study was not a randomized controlled trial. It was

performed at a single center, and staff obviously had to know about the presence of a study. Overall the strengths the study has to offer likely outweigh the possible weaknesses, but further studies will need to be conducted to verify the findings and assure generalizability.

A study by Li, Wang, Wu, Liang, and Tung (2011) examined the efficacy of controlling nocturnal noise and activities, to improve patients' sleep quality in a surgical intensive care unit. The study was a 55 patient quasi-experimental study utilizing two three month phases of first usual care (control) and then interventional care measures. There was a decibel monitor placed at the head of each patients' bed, which measured sound levels from 11pm to 7am. The interventions in this study that were aimed at alarm and other machinery noise regulation include: decreasing telephone volume to 40 decibels and decreasing bedside alarm volumes to 50 decibels after 11pm. Data collected indicated that the compliance with implementing protocols was 98.6% (Li et al., p. 398). From the data collected it was found that the interventional group had significantly decreased: peak and average noise levels, patient reported perceived noise levels, and patient reported sleep interruptions. It was also found that there was a significant increase in the intervention group's patient reported sleep efficacy and quality, when compared to the control group. Overall this study's weaknesses and limitations lie in that it is unknown if the study results are generalizable to smaller intensive care units, immediate post-surgical patients, or ventilator patients due to the setting of the study, and exclusion criteria for subject selection.

Unexpected/Unintended Findings

The Effect of Noise Levels on Staff in the Critical Care Setting

The overstimulation by a noisy intensive care unit is further exacerbated by unpredictable and loud alarms, which induce stress reactions via the sympathetic nervous system (Choiniere, 2010). For health care personnel the effects of noise in the ICU can be far reaching as noise has psychological effects such as, "miscommunication and increased annoyance… decrease in sustained attention, rapid detection, multiple single tasks, and incidental memory. Noise-induced stress also has a negative effect on sensitivity to other and is linked to extreme and premature judgements" (Choiniere, p. 327-328).

According to Huffling and Schnek (2014) the noise pollution in the intensive care unit setting not only increases the patients' stress, but also leads to an overall decrease in staff satisfaction and retention (p. 244).

DISCUSSIONS

Intentional Interventional Auditory Stimuli

Music

Bhana and Botha (2014) conducted a qualitative interview style study of the effects of music on cardiac patients in the ICU. The study allowed patients an opportunity to select the music they listened to in the postoperative time period, which provided them a sense of control or involvement in their care (Bhana & Botha, p. 3). However, it was also found that incorrectly selected or applied music can have adverse effects on the patient. It was found that participants in the study, "…have found music with slow, harmonious rhythm and low pitch to have a positive effect" (Bhana & Botha, p. 7). Bhana & Botha suggested that patients should be allowed to choose their own music to play, within the limits of it being slow, harmonious in rhythm, and low in pitch.

Sendelback, Halm, Doran, Miller, and Gaillard (2006) conducted a study examining if the use of therapeutic music on post-operative cardiac surgery days 1-3 decreases anxiety, pain levels, heart rate, blood pressure, and/or the amount of opioids administered. The study was a randomized control trial with 86 patients, where the variables were measured every 20 minutes. Study findings revealed the intervention group, when compared to the control group, had a reduction in pain and a significant reduction in anxiety.

Chlan et al. (2013) conducted a randomized controlled trial studying the effect of music therapy and noise cancelling headphones, on the amount and frequency of sedatives, in addition to the levels of agitation and anxiety for mechanically ventilated

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patients. Patient directed music therapy intervention patients on average listened to about 80 minutes of music per day, whereas the noise cancelling headphones patients on average used the headphones for 34 minutes a day. Gradually over the course of the study, the patient directed music therapy intervention groups' anxiety scores, sedation frequencies, and sedation intensities dropped. According to Chlan et al., "By the fifth study day, the PDM patients received 2 fewer sedative doses (reduction of 38%) and had a reduction of 36% in sedation intensity" (p. 2335).

Korhan, Khorshid, and Uyar (2011) conducted a randomized controlled trial examining the effects of classical music, on physiological signs of anxiety, in mechanically ventilated patients. The researchers were specific about the tempo of selected music, "Nurses can implement music intervention using music with a tempo of 60–80 beats per minute to induce relaxation for short-term benefit" (Korhan et al., p. 1032). The intervention group had lower blood pressure and respiration rates than the control group. It was found that the intervention had a cumulative dosage effect on the experimental group. The researchers interpreted the findings, as music therapy has a relaxation effect on mechanically ventilated patients, which reduces anxiety.

Mangoulia and Ouzounidou (2013) conducted a review of literature to try to discern if listening to music in the ICU is conductive to promote relaxation. They found that multiple studies involving the use of therapeutic music revealed that music had physiological and psychological impacts across clinical situations. Such impacted physiological parameters were; heart rate, blood pressure, and respiration rates. Impacted psychological parameters were: agitation, anxiety, fear, and the sense of

helplessness. Overall Mangoulia and Ouzounidou endorse the use of therapeutic music, but they highlighted the fact that music is a personal experience, and the types of music one likes significantly impacts the results of therapeutic music on various stress measurement tools and parameters.

Nature-based Sound

Saadatmand, et al. (2013) conducted a randomized, placebo-controlled, double-blind study to evaluate the effect of NBS on agitation, anxiety, and stress in mechanically ventilated patients. Physiologic stress was measured by heart rate, blood pressure, and respiration rate. Agitation and anxiety were measured with quantified scale charts, where patients reported their own experience of their level of agitation and anxiety. The mean systolic and diastolic blood pressure(s) of the intervention group were significantly lower than the control groups. Additionally, the interaction between time and groups was statistically significant for both heart rate and respiration rate. The chances of having elevated anxiety scores in the control group was 4.5 times the odds of the intervention group. "… the odds of having higher scores of agitation in the control group was exp (2.418) = 11.24 times of the same odds in the intervention group" (Saadatmand et al., p. 902).

Aghaie et al. (2014) conducted a study to evaluate the effects of NBS on coronary artery bypass graft patients' sleep quality, and ability to sleep within the critical care environment during the weaning of mechanical ventilation. The study was a randomized controlled trial with 120 patients. The study's data revealed that the NBS intervention group's heart rate, respiratory rate, pulse oximetry readings, and mean arterial

pressures improved. They had a time related trend that showed improvement in vital signs increased over time. Additionally, it was found that the control group had 2.669 times the odds as the intervention group to have high anxiety scores, and 2.927 times the odds as the intervention group to have high agitation scores (Aghaie et al., p.535).

Williamson (1992) conducted a qualitative study to explore if playing ocean sounds to intensive care patients could increase the duration, quality, and patient perceived depth of sleep patients. The findings were that patients in the interventional group rated their sleep as better quality, longer in duration, and greater in depth than the control group who received normal care (Williamson).

Richards, Nagel, Markie, Elwell, and Barone (2003) found through their meta-analysis of the effects of nature-based sounds on sleep that the overall consensus is that, "the masking of noise (with nature-based sound) has been demonstrated to improve self-reported sleep quality and to reduce to overall number of nighttime awakenings" (p. 336).

Noise Cancelling Headphones

Chlan et al. (2013) did a study on the effects of music therapy on anxiety and sedative exposure, on mechanical ventilation patients, that also examined the use of noise-cancelling headphones. The study was a randomized controlled trial that found noise cancelling headphones decrease the frequency and intensity of required sedation in mechanically ventilated patients. Unfortunately, they seem to have no significant effect on anxiety levels.

Matvey et al. (2012) did a study on the effect of noise-cancelling headphones on pain perception and anxiety, in men undergoing transrectal prostate biopsy. The study found that noise-cancelling headphones had no apparent effects on pain and anxiety perception in men undergoing transrectal prostate biopsy.

White Noise

According to many studies, anomalous sleeping patterns are a preeminent cause of stress and anxiety in the critical care setting (Patel, Baldwin, Bunting, & Laha, 2014; Kamdar, Needham, & Collop, 2012; Girard, Pandharipande, & Ely, 2008). Thus examining the effect that white noise has on levels of sleep, may in fact correlate with the levels of stress experienced by patients.

Stanchina, Muhanned, Chaudrhy, Carlisle, and Millman (2005) performed a study examining the effects of white noise on sleep for subjects exposed to ICU noise, with the hypothesis that using white noise "…would reduce arousals by reducing the magnitude of changing noise levels" (p. 423). The study was performed on eight non-intensive care subjects, who had a series of three polysomnagrams (PSG) each. The study found that playing white noise, decreased the frequency of arousals, and also the amount of time it took for subjects to fall back asleep after arousals.

A study performed in 1999, by Broscious, examined the effects of music and white noise, on the levels of pain during chest tube removal. The study was a randomized control trial with 156 subjects. The study revealed that neither intervention significantly decreased the perception of pain or vital sign measurements, as compared

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to the control group. However, Broscious did find that, "...most subjects enjoyed listening to the music or white noise" (p. 414).

Unintentional Environmental Auditory Stimuli in the Intensive Care Setting

White Noise

Qutub and El-Said (2009) conducted a study examining the ambient noise levels in an intensive care unit. This study monitored noise levels using a sound level meter in decibels, to see if there was a difference in noise levels depending on time of day or day of the week. The study found using independent t-tests that there was no significant difference in sound levels between the day or night shifts, or the week-day or weekend shifts. "However, the assessed levels of exposures to noise were still higher than stipulated international standards" (Qutub & Khaled, p. 53).

A study by Akansel and Kaymakci (2007), examined the effects of general intensive care unit noise on 35 coronary artery bypass graft surgery patients. The researchers were trying to discern if location in relation to the nurses' station, would impact the levels of environmental noise that the patients are exposed to. Findings revealed that the first bed was exposed to an average of 62.85 dB, the third was exposed to an average of 63.75 dB, and the fifth was exposed to an average of 64.77 dB (Akansel & Kaymakci, p. 1584). This translates to the finding that patients closest to the nurses' station are often exposed to higher levels of noise, than patients who are at greater distances from the nurses' station. Akansel and Kaymakci, reported that their findings, "... show(ing) that the sources of the noise in the ICU unit can be possibly traced to the noise created by humans 47.35% of the time" (p. 1584).

Stafford, Haverland, and Bridges (2014), conducted a review of literature focusing on noise in the ICU. "In a study in 5 ICUs, all the units recorded an (average dB level) greater than 45 dB at all times, and between 52 and 59 dB more than 50% of the time" (Stafford et al., p. 58). "When evaluating the effects of sound and noise in the ICU, it's important to also consider the psychological effects. In a survey of ICU patients 40% recalled ICU noise- 85% of whom reported feeling disturbed by it" (Stafford et al., p. 58).

Overstimulation by a noisy intensive care unit is further exacerbated by unpredictable and loud alarms, which induce stress reactions via the sympathetic nervous system (Choiniere, 2010). For patients the effects of noise in the ICU can be far reaching as noise has extreme physiological and psychological effects, because noise triggers the human stress response by the sympathetic nervous system (Choiniere). Loud noise also stimulates the release of adrenocorticotropic hormone and its derivative cortisol (otherwise known as the stress hormone). Loud noises in the ICU setting cause sleep disturbances which impedes wound healing and can cause ICU delirium, "ICU delirium is… changes in behavior, delusions, paranoia, slurred speech, irritability, and disorientation" (Choiniere, p. 330).

Noise Generated by Staff in the Critical Care Setting

The following studies examine the effects of noises generated by staff on patients sleep. It should be noted that no studies were found that specifically examined the effects of staff noise, on stress in critical care patients. Furthermore, many studies aside from those below cited that anomalous sleeping patterns are a preeminent cause

of stress and anxiety, in the critical care setting. Thus the below studies should be

considered as findings for the effects of staff noise on both sleep and stress in critical

care patients (Kamdar, Needham, & Collop, 2012; Girard, Pandharipande, & Ely, 2008).

Patel, Baldwin, Bunting, and Laha (2014) did a study on the effect of a

multidisciplinary bundle of interventions, on sleep and delirium, in medical and surgical

intensive care patients. Interventions that impacted the noises generated by staff or

perceived by patients are as follows: staff and visitors were to speak quietly at all times,

at 11pm all patient doors were to be closed, from 11pm to 7am nonclinical staff chatter

around the patient's bedside was to cease, and any and all patient care or procedures

were to be avoided from 11pm to 7am unless emergent. The data collected indicated a

close adherence to the study's interventions caused the unit's significant decrease in

cases of delirium; and increase in the quality, quantity, and perceived depth of patient

sleep.

Delaney (2014), conducted an evidence based implementation project on

behavioral modification of healthcare professionals in an adult critical care unit to

reduce nocturnal noise (via staff education and implementation of protocols). The study

was open to all interested nursing staff, only 41.25% of the total ICU nursing staff

participated in the study. The compliance by staff to the interventional noise reduction

protocols only increased by 8-10% (Delaney, p. 506). However, there was no

requirement by leadership for uniform acceptance and following of the interventions, or

data in the study indicating the percentage of study participants who actually went to

all three in-service teachings. Moreover, Delaney indicated that the small time frame of

the study (3 months), prevented the implementation of noise reduction strategies and protocol, and there was a large staff turn-over during the study. This study should not to be a significant indication of the ability for ICU/CCU staff to implement changes, to reduce noise in the critical and intensive care settings, and should be used as a guide on how to better implement studies in the future.

A study by Li, Wang, Wu, Liang, and Tung (2011), examined the efficacy of controlling nocturnal noise and activities, to improve patients' sleep quality in a surgical intensive care unit. The level of noise was measured from 11pm to 7am. The interventions in this study aimed at staff noise regulation include: closing patient doors at 11pm, decreasing the volume of staff conversation after 11pm, checking fluids and tube feed levels before 11pm to prevent alarms later in the evening, and to rearrange care and procedures to before 11pm or after 7am unless emergent. Data collected indicated that the compliance with implementing protocols was 98.6% (Li et al., p. 398). The study found that the interventional group had significantly decreased: peak and average noise levels, patient reported perceived noise levels, and patient reported sleep interruptions. It was also found that there was a significant increase in the intervention group's patient reported sleep efficacy, and quality, when compared to the control group.

Monitors, Alarms, and Machinery Noises

DeVaux and Cooper (2015), conducted a study on alarm fatigue reduction in a medical intensive care unit, via implementation of a patient safety initiative. Clinical engineers first zoned alarm speakers to assist in nurses' ability to locate active alarms.

The second intervention was to remove false and nonactionable alarms. This study found that decibel level averages were reduced, from 80-90 dB to 70 dB, and that the total number of alarms was reduced 61.4% (DeVaux & Cooper, p. 68).

Silva and Carlos (2012), conducted a study that examined the effects of alarms within the ICU on patient comfort. The findings revealed that 85% of all alarms were false-alarms, and that in the hours of higher alarm frequency the patients reported higher levels of anxiety and agitation (Silva & Carlos, p. 2805). The results were that, "the high levels of noise is one of the most common problems that affect the physiology, the sleep-wake cycle, and beyond to be a potential influence to the safety of patients" (Silva & Carlos, p. 2800). The general statement made by this study was that, most alarms are false alarms and aren't useful, but instead are harmful to both patients and healthcare providers.

Patel, Baldwin, Bunting, and Laha (2014) did a study on the effect of a multidisciplinary bundle of interventions, on sleep and delirium in medical and surgical intensive care patients. Though their study was based around sleep and delirium, anomalous sleeping patterns are a preeminent cause of stress and anxiety in the critical care setting (Patel et al.; Kamdar, Needham, & Collop, 2012; Girard, Pandharipande, & Ely, 2008). Interventions that impacted the noises generated by alarms and machinery are as follows: at 11pm all telephones are to have their volume reduced and all monitoring equipment will be turned to night mode. The data collected indicated a significant decrease in cases of delirium; and increase in the quality, quantity, and perceived depth of patient sleep.

A study by Li, Wang, Wu, Liang, and Tung (2011), examined the efficacy of controlling nocturnal noise and activities, to improve patients' sleep quality, in a surgical intensive care unit. Sound levels were monitored from 11pm to 7am. The interventions in this study that were aimed at alarm and other machinery noise regulation include: decreasing telephone volume to 40 decibels and decreasing bedside alarm volumes to 50 decibels after 11pm. Data collected indicated that the compliance with implementing protocols was 98.6% (Li et al., p. 398). The study found the interventional group had significantly decreased: peak and average noise levels, patient reported perceived noise levels, and patient reported sleep interruptions. It was also found that there was a significant increase in the intervention group's patient reported sleep efficacy and quality, when compared to the control group.

Recommendations for Practice

Agitation, anxiety, and stress were the most corroborated points that have been reported as being positively affected by the interventional use of therapeutic sounds. The most explored interventional auditory stimulus in intensive and critical care settings is by far, the use of therapeutic music. Though the therapeutic use of music has been found in multiple studies to reduce stress levels, music as a stress intervention is not always practical. Research by Tracy and Chlan (2011) states that, "Because individuals have musical memories that can result in a profound emotional response to specific music, music should not be played without a patient's consent and participation in the selection of the music" (p. 24). Music is personal and profound, which can make it difficult to enable all patients to have the access to music they like. Even if nurses

allowed patients' families to bring in a playlist of favorite music, it would be impractical. The nurse would need to monitor the music chosen to verify is in fact relaxing and conductive to reducing stress levels. Additionally in the research article on the effects of music on cardiac ICU patients, Bhana and Botha (2014) found that patients can accidentally pick music they may like when well, but that is not conductive to healing, while they are ill and in the ICU/CCU environment.

There was an overwhelming disparity between the control and intervention group's agitation and anxiety values in the NBS article by Saadatmund et al. (2013). The strengths of data interpretation and study type implemented should call close attention to the findings from this study. Though the interventional use of NBS has an underwhelming amount of research, it has been shown to be very effective, in the management of stress, by both qualitative (agitation and anxiety) and qualitative (heart rate and blood pressure), means specifically in regards to mechanically ventilated patients.

While NBS has not yet been proven to be generalizable or transferrable to the entire critical care population, studies outside of the critical care environment support such a supposition. The majority of studies have found that the overall effect of any given interventional sound has been a general reduction in stress, agitation, and anxiety across the intensive and critical care sub-groups. This fact combined with the significant qualitative (psychological) and quantitative (physiological) improvements via the use of therapeutic NBS warrants the initial use of NBS over any other type of interventional auditory stimuli. This is due to the further reaching potential benefits of NBS, when

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compared to the use of other interventional auditory stimuli. Another strength of using

NBS is the fact that NBS can be limited to a collection of perhaps 15 different playlists.

These are culturally neutral, allow for the patient to choose what to listen to, and are

able to still reduce stress, anxiety, and agitation levels (Saadatmand et al.). Music,

conversely has billions of songs/albums to pick from, each of which must be proofed by

the nurse to ensure that the music has therapeutic qualities conductive to reducing

stress.

This review of literature has caused me to come to the conclusion, that the

therapeutic use of NBS is likely the most conductive to reducing the overall stress of

intensive and critical care patients. The therapeutic use of NBS is non-invasive, has no

reported adverse side effects, and is economically feasible to implement, while also

being well within the capabilities of nurses.

The following are my recommendations for future multimodal critical care

unit protocol when in regards to auditory stimuli:

- **Implement a noise reduction protocol in critical care units.** Noise

  pollution has been found to increase adult intensive and critical care patients'

  stress levels. Reducing noise pollution by modifying nursing behavior and

  environment, is conductive to lowering stress levels, and promoting higher

  quality/quantity sleep for patients (Li, Wang, Wu, Luang, & Tung, 2011).

- **Teach nurses the impact of noise pollution on critical care patients'**

  stress levels and healthcare personnel performance. If a nurse does not

  know evidence-based practice suggests changes in the current methods of care,

or why these changes are suggested, they are less likely to change their current care methods.

- **Implementing nature-based sound therapy.** Though music therapy has been found to reduce stress levels, music therapy is not always a practical alternative therapy. Research by Tracy and Chlan (2011) states that, "Because individuals have musical memories, which can result in a profound emotional response to specific music, music should not be played without a patient's consent and participation in the selection of the music" (p. 24). Music is personal and profound, which can make it difficult to enable all patients to have the access to music they like. Even if nurses allowed patients' families to bring in a playlist of favorite music, it would be impractical. The nurse would need to monitor the music chosen to validate it is in fact relaxing and conductive to reducing stress levels. Nature-based sounds can be limited to a collection of perhaps 15 different playlists, which are culturally neutral. This allows for the patient to choose what to listen to, and are able to still reduce stress, anxiety, and agitation levels (Saadatmand et al., 2013). NBS should be the initial attempt at using interventional therapeutic auditory stimuli, with adjustments being made as needed, for the patient's communicated needs and desires.

- **Implement chosen auditory intervention with headphones.** Using headphones is imperative to this therapy, because noise pollution for other patients would occur should it be played on a portable speaker.

- **Allow for auditory intervention to be patient-controlled when able.**

  When a patient is bed ridden, unable to care for or even breath for themselves,

  allowing the patient to control even one aspect of their care is empowering

  (Baker, 1984; Chlan et. al., 2013). Johansson, Bergbom, & Lindahl (2012),

  studied what it meant for critically ill patients to be in a sound intensive ICU,

  where they found a key struggle of many patients is the complete lack of control,

  and an overwhelming feeling of helplessness. They found that a consistent

  theme expressed by many patients was, "I am an invisible audience in an

  imposed drama... I am struggling with unreal experiences interwoven with

  sounds" (Johansson et al., p. 111). I believe providing patients with a small

  amount of control, in choosing which audio track to play, when, and how much,

  will help to provide a sense of control. It is also a way to remove the patient

  from the, 'imposed drama' and 'sound', experiences in the ICU setting, that are

  not necessarily welcome. This stance is also backed by the study conducted by

  Bhana and Botha (2014) where it was found that patients be allowed to select

  the track they want to play. Patients prefer different lengths of listening

  experience, which should be patient-controlled when able to provide maximum

  therapeutic benefits (p. 6).

   Nurses should care about this intervention plan, because it is well within nurses'

capabilities and offers psychological and physiological benefits to patients. Hospitals

should care about this intervention plan, because it is economically feasible. It could

reduce the use of sedatives, which results in decreased medication costs, which in turn

can typically result in a decreased length of stay, especially in regards to mechanically ventilated patients in the ICU/CCU setting. Alternative sound therapies are, "a simple intervention that does not require focused concentration or active participation to be effective. This simplicity is ideal…" (Tracy & Chlan, 2011, p. 24). Nurses should allow patients to choose, when able, a preferred auditory stimulus as opposed to the imposed, and over stimulating auditory stimuli inherent to the critical care setting.

Further Implications

These findings should impact education, by encouraging all intensive and critical care units to educate staff on the effects of environmental noise on patients and staff.

These findings should impact the layout of intensive and critical care units, by highlighting the increased exposure to noise, when patients have roommates or are close to the nurses' station. Furthermore, this study should encourage the use of noise absorbing ceiling tiles, and wall mounts, to decrease the overall environmental noise in critical care settings.

These findings should impact noise control in the ICU, by providing a global view of sources of environmental noise that highlights what could be changed within the critical care setting to reduce noise exposure.

These findings should impact staff proficiency and/or error rates, by highlighting the fact that excess noise, specifically useless alarms, increase error rates and alarm fatigue. I am hopeful that hospitals will recognize the dangers to staff and patients in not zoning alarms, and setting parameters on monitors for what values should trigger alarms, within the critical care setting.

These findings should impact future research, by encouraging the exploration of the impacts of various auditory stimuli on various patient populations and care settings. Additionally, it should highlight the specific interventional stimuli, that should be further explored, and the weaknesses found in other studies that should be avoided. Szalma & Hancock (2011) did a meta-analytic synthesis of literature, reviewing the effects of noise on human performance. It was found that intermittent noise causes the most disruption in human performance, a fact which warrants future exploration of intermittent verses continuous noises effects on the levels of stress in critical care unit patients. Hancock (2009) did a study on the individualization of design, where it was suggested that the most purposeful and thoughtful change one can implement, is one which is individualized to each person. This study highlights a need to individualize care to the person, not population, research should be done to see if this is feasible within the critical care setting. Pozzi and Bagnara (2013) did a study on individuation and diversity, where it was stipulated that there is a distinct need for idiographic human-computer interaction that is designed for diversity or the individual. Pozzi and Bagnara state that human-computer interaction should, "… work on disciplined ways of overcoming the gap between individual users and design" (p. 12). In the case of interventional auditory stimuli being used as an intervention, this would equate to customizing each listening experience for the individual in order to have optimal outcomes for each patient. Szalma (2014) applied motivation theory to design principles for human-technology interaction, raising issues relevant to the issue of noise and its meaning to a person. According to Szalma, "Technology can be an effective tool for

improving well-being by facilitating the satisfaction of human needs for autonomy, competence, and relatedness" (p. 1468). In relation to using auditory interventions within the critical care setting, future research should be done to see if motivation theory and human-technology interaction could produce the same results of increased well-being, engagement, and sense of autonomy for patients within the critical care setting.

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