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NOISE: ITS IMPACT IN THE OPERATING ROOM

by

Brennon Wesley Sloan

A Capstone Project
Submitted to the Graduate School
and the Department of Advanced Practice
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Nursing Practice

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ABSTRACT

NOISE: ITS IMPACT IN THE OPERATING ROOM

by Brennon Wesley Sloan

December 2016

Orthopedic and neurologic cases routinely reach noise levels exceeding 120 decibels (Katz, 2014). Modern equipment and monitors used by anesthesia personnel only reach 85 decibels (Katz, 2014). These monitors can go undetected during peak noise levels creating a serious safety concern for patients that could lead to patient injury or death (Gawande, Zinner, Studdert, & Brennan, 2003). A clinical question was developed to determine if the education of noise levels in the operating room affects change in practice. For operating room managers and staff, does education of noise levels in the operating room compared to no education initiate a change in practice?

A review of the literature was conducted with 21 published articles meeting the inclusion criteria. A website was created in order to disseminate information to a larger population. The website can be visited at brennonsloan.wixsite.com/noise. Information gathered from the review of literature was placed on the website. A practice change proposal was presented to a local Level II operating room nurse manager. An evaluation tool was utilized after the practice change proposal. It was determined that the operating room nurse manager would be willing to implement practice change.

The evidence from published literature supports the need for practice change in modern operating rooms. Further research needs to continue along with education of patients and staff. Further research and education can improve safety and decrease miscommunication among staff, ultimately providing a higher level of care to patients.

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DEDICATION

I would like to thank my parents for all of the support and encouragement throughout my educational journey. Ashley, Blake, Lindsey, and Addison, thank you for the unconditional love and support during this process. Without you I would not be where I am today.

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LIST OF ABBREVIATIONS

<i>AORN</i>	Association of periOperative Registered Nurses
<i>DNP</i>	Doctor of Nursing Practice
<i>EPA</i>	Environmental Protection Agency
<i>IRB</i>	Institutional Review Board
<i>NIOSHA</i>	National Institute for Occupational Safety and Health Administration
<i>OSHA</i>	Occupational Safety and Health Administration
<i>WHO</i>	World Health Organization

CHAPTER I – INTRODUCTION

Background

Successful anesthesia care during surgery can be difficult, stressful, and requires strict attention to detail. Hazardous noise levels during surgery may lead to noise-induced hearing loss in anesthesia providers and other staff members in the operating room (Katz, 2014; Willett, 1991). Most noises created during surgery are from communication among staff and does not exceed recommended noise levels. However, music during surgery routinely contributes to exceeding national safety standard noise levels (Katz, 2014). Exceeding national safety noise levels in the operating room is associated with miscommunication, permanent patient disability, and patient death (Gawande et al., 2003). According to Gawande et al. (2003), miscommunication was cited as the contributing factor in 43% of errors resulting in permanent disability or patient death.

The Occupational Safety and Health Administration (OSHA) mandates hearing protection at 85 decibels for an 8-hour day ("Occupational Safety," 2008). A decibel is a logarithmic unit that measures the intensity of sound ("AORN position statement," 2014). OSHA has published a list of common decibel levels (Table 1).

Table 1

Common Decibel Levels

Decibel Level	Common Scenario
60 decibels	Normal conversation
74 decibels	Vacuum cleaner
94 decibels	Lawnmower
112 decibels	Ambulance siren
120 decibels	Rock concert
140 decibels	Threshold of pain
170 decibels	Shotgun blast

Many orthopedic and neurologic surgeries require repeated hammering and drilling which produce high noise levels. High surgical noise level combined with background music in the operating room has the ability to produce noise-induced hearing loss, patient morbidity and mortality, and increased health care costs (Chen, Brueck, & Niemeier, 2012; Gawande et al., 2003; Renshaw, 2013; Shambo, Umadhay, & Pedoto, 2015). Repeated exposure to noise levels above national recommended standards results in noise-induced hearing loss (Shambo et al., 2015). High surgical noise levels may lead to patient morbidity and mortality by unrecognized oxygen saturation alarms leading to low patient oxygenation (Gawande et al., 2003). Increased noise levels also contribute to increased health care costs by miscommunication leading to retained surgical instruments that may require repeated x-rays and prolonged hospital stay (Renshaw, 2013).

Significance and Implications

This Doctor of Nursing Practice (DNP) project determined if noise levels are a safety concern in the operating room. This project also examined noise levels in the operating room and its effects on patients and operating room staff. Also, ways to decrease overall noise levels in the operating room were studied.

The operating room nurse manager was eager to listen to the practice change proposal. The manager stated that certain portions of the practice change proposal would be implemented. The changes stated by the operating room manager have the ability to increase patient safety by decreasing miscommunication errors that may lead to morbidity and mortality. Also, decreasing noise levels in the operating room may prevent noise-induced hearing loss among staff and patients.

Clinical Question

Repeated exposure to noise levels at 131 decibels can produce noise-induced hearing loss (Shambo et al., 2015). Currently, operating rooms are not required to measure noise levels during surgery. A clinical question was developed to determine if the education of noise levels in the operating room affect change in practice. For operating room managers and staff, does education of noise levels in the operating room compared to no education initiate a change in practice?

Problem Statement

Orthopedic and neurologic cases routinely reach noise levels exceeding 120 decibels (Katz, 2014). Modern equipment and monitors used by anesthesia personnel only reach 85 decibels (Katz, 2014). Therefore, oxygen saturation alarms can go undetected during peak noise levels, leading to decreased oxygenation status, creating a serious safety concern for patients that could lead to patient injury or death (Gawande et al., 2003). High noise levels can not only lead to hazardous situations but also hearing loss and miscommunication among staff during surgery (Katz, 2014).

Miscommunication has been linked to discrepancies between surgeons and pathologists reporting benign and malignant tumors intraoperatively leading to an increase in health care costs (Renshaw, 2013). Miscommunication in the operating room was also linked to a surgical miscount of instruments or sponges (Greenberg et al. 2007). Surgical counts must be completed before patient closure in each operation. A miscount of instruments or sponges results in unnecessary health care costs and prolonged hospital stay due to x-rays that must be taken to determine if a retained item is located inside the

patient (Gawande et al., 2003). Direct patient care is inhibited by miscommunication due to the inability to hear a patients request intraoperatively (Gawande et al., 2003).

Purpose of Project

Noise levels in the operating room have been increasing over the past 40 years (Katz, 2014). Throughout this time period, many advances have been made in surgical tools to help decrease noise levels (Katz, 2014). Staff members in the modern operating room are subject to pneumatic or power drills, saws, cutting tools, monitor alarms, dropped instruments, and metal on metal contact (Chen et al., 2012). Due to confining operating rooms ambient noise levels can reach 120 decibels (Way et al., 2013). Education of noise levels and miscommunication occurring in operating rooms is needed to protect staff and patients from noise-induced hearing loss, increased patient health care costs, and patient morbidity and mortality.

The purpose of this project was to educate operating room nurse managers and operating room staff about the potential for noise-induced hearing loss, patient health care costs, and patient morbidity and mortality related to high noise levels and miscommunication in the operating room. By educating staff, complications, errors, and interrupted communication may decrease. Patient and staff safety may increase by better communication, correct communication of diagnosis, decreased incorrect surgical instrument counts, and decreased overall noise levels (Gawande et al. 2003; Greenberg et al. 2007; Katz, 2014).

Needs Assessment

The Association of periOperative Registered Nurses (AORN) suggested one of the most complex work environments in health care is the perioperative setting ("AORN

position statement," 2014). Operating room staff's task oriented objectives are dependent on uninterrupted communication in the perioperative setting (Christian, Gustafson, & Roth, 2006). Noise and distractions are common in the perioperative setting due to a technology-rich setting. Noise creates a distraction that may cause missed monitor alarms or missed orders which have the potential to increase the risk for error (Beyea, 2007; Gawande et al., 2003). Noise has the ability to decrease communication and make it difficult to interpret information such as a misdiagnosis of benign or malignant (Renshaw, 2013). Noise must be managed to maintain concentration and safety ("AORN position statement," 2014).

High noise levels in the perioperative setting may negatively affect patient and staff safety by noise-induced hearing loss and miscommunication of instruments leading to patient harm or even death (Gawande et al. 2003; Greenberg et al. 2007; Joseph & Ulrich, 2007). A prospective study suggested that increased noise levels correlate to increased surgical site infections leading to patient harm (Kurmann et al., 2011). Noise has also been contributed to poor task performance and poor concentration of staff members in the operating room ("AORN position statement," 2014). Noise has been contributed to decrease one's ability to perform problem-solving tasks (Conrad et al., 2009). Noise is also associated with burnout, emotional exhaustion, illnesses, irritability, tachycardia, fatigue, stress, anxiety, job dissatisfaction, and injury (Joseph & Ulrich, 2007). These symptoms may lead to increased medical leave among staff and an increased risk of patient morbidity and mortality (Joseph & Ulrich, 2007).

Theoretical and Conceptual Framework

Neuman's systems model was the framework used for this study. Neuman's model focuses on environmental stress that can disrupt an individual's homeostasis (Martin, 1996). Individuals related to this DNP project are patients and operating room staff. Neuman's model also promotes different viewpoints to consider when addressing data, such as, potentially hazardous noise levels in the operating room. Neuman's systems model promotes prevention as an intervention. Prevention is a major emphasis of this DNP project to help decrease noise levels in the operating room and increase safety.

Neuman's model includes primary, secondary, and tertiary prevention (Martin, 1996). Teaching hospital staff about noise and its affects in the operating room would be an example of primary prevention. Determining how often noise in the operating room correlates to miscommunication and hearing loss would be an example of secondary prevention. Tertiary prevention would include removing unnecessary noise in the operating room.

DNP Essentials

DNP Essential I is the scientific underpinning for practice. This essential was met by utilizing Neuman's system model as a theoretical framework for this DNP project. Neuman provides a great framework and different viewpoints to consider when tackling data associated to potentially hazardous noise levels in the operating room. Neuman's model focuses on the client who for this DNP project relates to patients and operating room staff. Also, Neuman's system focuses on prevention as an intervention, and prevention is a major emphasis of this DNP project.

DNP Essential II is the organizational and systems leadership for quality improvement and systems thinking. This essential was met by utilizing a website to provide education and improve staff and patient safety in health care systems. Also, decreased adverse events in the operating room were detailed in this DNP project.

DNP Essential III is the clinical scholarship and analytical methods for evidence-based practice. A review of the literature was utilized to determine the best evidence for practice. Website feedback along with practice change proposal feedback was analyzed by myself prior to September 8, 2016. Evidence-based interventions are provided on the website as well as the practice change proposal.

DNP Essential IV is the information systems and technology and patient care technology for the improvement and transformation of health care. This essential was met by extracting data from databases and utilizing technology to disseminate information through the Internet. Also, analyzing and communicating critical data through the use of a practice change proposal meet the criteria.

DNP Essential V is health care policy for advocacy in health care. A practice change proposal was created and encourage changes in practice. The proposed changes in practice have the ability to increase patient and staff safety.

DNP Essential VI is interprofessional collaboration for improving patient and population health outcomes. Interprofessional collaboration is critical in educating all operating room staff of recent data. In order to develop practice change after delivery of the practice change proposal, interprofessional collaboration must occur among surgeons, anesthesia providers, and operating room managers.

DNP Essential VII is clinical prevention and population health for improving the nation's health. This essential was met by analyzing scientific data in the review of the literature. Interventions were developed in the practice change proposal to improve patient and staff safety in the operating room.

DNP Essential VIII is advanced nursing practice. Designed therapeutic interventions that were placed in the practice change proposal is how this essential was met. By creating a website therapeutic relationships with other professionals can facilitate optimal operating room conditions.

CHAPTER II – REVIEW OF LITERATURE

Noise levels in the operating room have been increasing over the past 40 years (Katz, 2014). Throughout this time period, many advances have been made in surgical tools to help decrease noise levels (Katz, 2014). Staff members in the modern operating room are subject to pneumatic or power drills, saws, cutting tools, monitor alarms, dropped instruments, and metal on metal contact (Chen et al., 2012). These tools alone can create more than 90 decibels (Chen et al., 2012). All of these events occur in somewhat small rooms, which leads to sound waves echoing for a longer period of time (Shambo et al., 2015). Due to these confined rooms ambient noise levels can reach 120 decibels which is equivalent to a rock concert ("Occupational Safety," 2008; Way et al., 2013).

AORN suggests one of the most complex work environments in health care is the perioperative setting ("AORN position statement," 2014). Performance and safety are dependent on uninterrupted communication in the perioperative setting (Christian et al., 2006). Noise and distractions are common in the perioperative setting due to a technology-rich setting (Beyea, 2007). Noise creates a distraction that may cause missed monitor alarms or missed orders which have the potential to increase the risk for error (Beyea, 2007). Noise has the ability to hinder communication and make it difficult to interpret information possibly resulting in misdiagnosis of patient conditions (Renshaw, 2013). Noise must be managed to maintain operating room staff concentration by avoiding missed oxygen saturation alarms leading to patient morbidity or mortality. ("AORN position statement," 2014; Gawande et al., 2003).

Baseline Noise Levels in the Operating Room

Baseline noise levels in hospitals average 45 decibels ("AORN position statement," 2014). Researchers at a large, metropolitan hospital measured sound levels before, during, and after surgical procedures to determine noise levels during various types of surgeries (Kracht, Busch-Vishniac, & West, 2007). Orthopedic surgeries were determined to have the highest average sound levels at 66 decibels. Average decibel levels for urology, cardiology, and gastrointestinal procedures ranged from 62 to 65 decibels. Orthopedic and neurosurgery cases have higher sustained noise levels and peak sound levels that exceed 100 decibels more than 40 percent of the time (Kracht et al., 2007). Noise levels are higher in orthopedic and neurosurgery cases due to the instruments used during these surgeries (Silverdeen, Ali, Lakdawala, & McKay, 2008). The average noise level for a pneumatic saw is 95 decibels, a drill is 90 decibels, and a K-wire driver is 85 decibels (Silverdeen et al. 2008). The highest peak levels recorded during surgery exceeded 120 decibels (Kracht et al., 2007). A decibel level of 120 is similar to a jet airplane take-off ("Occupational Safety," 2008).

According to Way et al. (2013), noise in the operating room can be categorized into two groups. Group one is equipment related noise that consists of anesthesia equipment, suction, alarms, drills, cautery devices, and metal tools. Group two is staff-created noise that consists of staff conversations, ambient music, overhead pages, and doors opening and closing. According to Way et al. (2013), these sources of noise contribute to an average noise level in the operating room of 65 decibels, with peak levels reaching 120 decibels.

Ginsberg et al. (2013) conducted a prospective, nonrandomized study with 23 cardiac surgical patients to determine if noise levels differ in the cardiac operating room at various critical points. Noise levels were monitored throughout each of the 23 surgeries and compared to baseline noise levels at rooms setup. The highest noise levels were recorded at induction, emergence, and transport. During these critical times, noise levels ranged from 84-94 decibels (Ginsberg et al., 2013). While tools were used during these surgeries, it was found that the healthcare providers in the room contributed to the highest noise levels during these cases (Shambo et al., 2015).

Noise Level Standards

The Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health Administration (NIOSH) have strict guidelines on recommended noise levels and when safety protection should be worn. The law requires employers to adhere to the OSHA permissible exposure limit (Chen et al., 2012). OSHA identifies a permissible exposure limit of 90 decibels as an eight-hour time-weighted average. OSHA also uses a five-decibel exchange rate for calculating the permissible exposure limit (Table 2). The five-decibel exchange rate starts at 90 decibels for an 8-hour day. For every five decibel increase in sound, the time limit each day is halved. Therefore, exposure to 95 decibels should be limited to four hours each day.

Table 2

Five-decibel Exchange Rate

Decibel Level	Allowable Time
90 decibels	8-hour day
95 decibels	4-hour day
100 decibels	2-hour day
105 decibels	1-hour day
110 decibels	30 minutes

115 decibels	15 minutes
120 decibels	7 minutes 30 seconds

NIOSH recommends hearing protection for continuous exposure of more than 85 decibels for an eight-hour time period (Katz, 2014). NIOSH also uses a three-decibel exchange rate compared to OSHA five-decibel exchange rate. NIOSH is stricter than OSHA with a three-decibel exchange rate that starts at 85 decibels for an eight-hour day. According to NIOSH, for every three decibel increase over 85 decibels the amount of time each day is halved. Therefore, exposure to 88 decibels should be limited to four hours each day. According to Mazer (2012), the Environmental Protection Agency (EPA) and World Health Organization (WHO) recommend ambient noise levels to remain between 35 and 45 decibels. These recommendations are not required and therefore are often ignored (Mazer, 2012).

Music in the Operating Room

Music in the operating room is a choice. According to Way et al. (2013), more than 60 percent of operating room personnel listen to music while performing surgery. Fifty percent of those persons prefer to listen to music at medium to high levels (Way et al. 2013). Music alone can add 87 decibels or more inside the operating room (Katz, 2014).

In a prospective study by Way et al. (2013) 15 surgeons were recruited to assess the effect of operating room noise on auditory function. All 15 surgeons were tested and reported to be free of neurologic and otologic impairment prior to the study. The Speech In Noise Test-Revised was utilized. The Speech In Noise Test-Revised detects one's ability to accurately understand speech in the presence of background noise (Way et al.

2013). The surgeons were asked to repeat the last word in each sentence under four different conditions. The four conditions consisted of quiet, filtered, filtered plus operating room noise, and filtered plus operating room noise plus music. It was determined that the best performances were produced in the quiet setting ($p < 0.003$). Performance in the quiet setting was superior to performance in noise setting ($p < 0.005$) and performance in noise plus music setting ($p < 0.008$). Way et al. (2013) concluded that to avoid miscommunication in the operating room, attempts should be made to reduce baseline noise levels.

A controlled clinical trial suggested that music has benefits for surgeons and operating room staff by decreasing stress and improving efficiency (Siu, Suh, Mukherjee, Oleynikov, & Stergiou, 2010). Ten medical students volunteered to perform two inanimate surgical tasks, suture tying and mesh alignment, using the da Vinci Surgical System. While performing the two tasks, the participants were subjected to jazz, classical, hip-hop, and Jamaican styles of music. As a control measure, participants were subjected to silence. The time of task completion and total travel distance of the flexor carpi radialis and extensor digitorum on the dominant hand of each participant were measured. It was determined that the time of task completion was significantly shorter when listening to hip-hop ($p = 0.036$) and Jamaican ($p = 0.001$) music compared to no music (Siu et al., 2010). It was also determined that the shortest distance traveled was performed while listening to Jamaican ($p = 0.038$) music (Siu et al., 2010). The results of this study suggest there are benefits to having music during surgery.

Communication

According to Way et al. (2013), miscommunication is the most frequent contributor to medical errors. High levels of background noise obstruct effective communication that must exist among nurses, technicians, surgeons, and anesthesia providers (Way et al., 2013). Staff performance, such as operating room turnaround, is also directly related to impaired communication (Hasfeldt, Laerkner, & Birkelund, 2010). Speech must be 10-15 decibels above ambient noise levels for a 90% accuracy of speech understanding (Way et al., 2013). Therefore, staff must raise their voices leading to an increased noise level in the operating room (Hasfeldt et al., 2010). Visual cues, such as reading lips, are used to improve understanding when hearing has become impaired (Way et al., 2013). Visual cues are blocked in the operating room due to surgical masks worn during surgery.

Patient and Staff Implications

Patients along with operating room staff are subject to dangers when noise levels are increased in the operating room (Katz, 2014). It is suggested that more than one-third of patients perceive the operating room as noisy (Hasfeldt et al., 2010). Sixteen percent of these patients felt stressed due to the noise. Kurmann et al. (2011) suggest that noise levels may play a role in surgical-site infections. In this study, sound levels were measured during 35 elective open abdominal surgeries (Kurmann et al., 2011). Sound levels were above the median (43.5 decibels) in over 22 percent of patients with surgical-site infections compared to 10.7 percent in those without ($P = 0.029$) infections. It was also determined that operating room staff talking about non-surgical topics resulted in a significantly higher sound level ($P = 0.024$). Kurmann et al. (2011) suggests that

increased noise levels, lack of concentration, or increased stressful environments lead to surgical-site infections.

According to a benchmark study by Willett (1991), noise induced hearing loss is common among operating room staff. In this study 27 senior orthopedic staff were assessed by audiometry to determine if hearing loss was present. It was determined that half of the participants exhibited noise-induced hearing loss. Noise-induced hearing loss has the potential for miscommunication and potential errors in the operating room (Willett, 1991).

The pulse oximeter is possibly the most important piece of anesthesia equipment providers use (Stevenson, Schlesinger, & Wallace, 2013). The anesthesia provider often relies on the auditory perception of the pulse oximeter to determine heart rate, rhythm, and arterial oxygen saturation (Stevenson et al., 2013). In a study by Stevenson et al. (2013), 33 resident anesthesiologist were subjected to six tasks focusing on attention load and noise concentration. Attentional load consisted of individual letters presented to the participants in a rapid series (Stevenson et al., 2013). It was determined that the participants were less likely to detect oxygen saturation changes as noise and attentional load increased (Stevenson et al., 2013). Also, participants were slower to respond to changes in oxygen saturation in noisy and high-attentional situations (Stevenson et al., 2013). Reducing environmental factors should be an important priority for increasing patient and staff safety (Stevenson et al., 2013).

Surgical care attributes to more than half of hospital adverse events (Gawande et al., 2003). Gawande et al. (2003) interviewed 38 surgeons to determine factors leading to medical errors. A total of 146 incidents were reported from the surgeons (Gawande et al.,

2003). Sixty-six percent of the incidents occurred intraoperatively (Gawande et al., 2003). Permanent disability occurred in 33% of patients and 13% resulted in patient death (Gawande et al., 2003). Miscommunication was cited as the contributing factor in 43% of errors reported (Gawande et al., 2003). According to Gawande et al. (2003), more than half of surgical adverse events are preventable. Therefore, a decrease in noise levels may decrease miscommunication, preventing patient morbidity and mortality in 43% of surgical cases (Gawande et al. 2003; Way et al. 2013).

According to Greenberg et al. (2007), miscommunication results in surgical miscounts of instruments or sponges in 14% of cases. In the malpractice claims examined, reoccurring patterns of miscommunication resulted in patient injury (Greenberg et al., 2007). Miscommunication results in patient harm during the intraoperative period in 75% of malpractice cases (Greenberg et al., 2007). An inaccurate surgical count that is noticed leads to extra health care costs such as x-rays to rule out retained surgical instruments (Greenberg et al., 2007). An inaccurate surgical count that is unobserved can possibly lead to increased health care costs due to a prolonged hospital stay and retained surgical instruments causing serious patient harm (Greenberg et al., 2007).

Ways to Improve Noise Levels

Suggestions have been made on ways to decrease noise levels in the operating room. Staff members should make sure existing instruments are operating at optimal conditions (Chen et al., 2012). Also, collaborate with facility engineers to research new instruments that produce less noise (Chen et al., 2012). Chen et al. (2012) also suggest wearing hearing protection during loud activities and keeping music volumes low during

surgery. However, hearing protection such as ear plugs cannot be used intraoperatively due to the inability to hear pertinent alarms. Hearing protection with built in microphones are readily available and are a more feasible option in the operating room. Katz (2014) states that most noise generated is by operating room staff and can be avoided by removing nonessential personnel or decreasing nonessential conversations. Testing acoustics in the operating room and implementing an alarm system configuration may also decrease noise levels in the operating room (Mazer, 2012).

The majority of anesthesia related accidents are a result of compounding small errors (Stevenson et al., 2013). Small errors consist of not detecting changes in oxygen saturation (Stevenson et al., 2013). Improving monitoring performance and decreasing small errors may lead to a reduction in accident rates (Stevenson et al., 2013). Recommendations for operating room staff and managers can be placed in the following categories: information and awareness, equipment, organization of operating rooms, health surveillance, and reviews (Silverdeen et al., 2008). Information and awareness consists of how noise levels affect hearing, how to reduce risks, rights and responsibilities of the employer and employee, and the importance of routine hearing tests. Equipment consists of providing correctly fitting and properly maintained hearing protectors for staff and patients, utilizing battery-powered tools rather than pneumatic tools, and regular maintenance of tools or machinery. Organization of operating rooms consists of removing all non-essential personnel from the operating room. Health surveillance consists of regular auditory testing for exposed employees and maintaining health records for all employees. Review consists of having regular reviews to evaluate

the effectiveness of current methods, and to make changes when necessary (Silverdeen et al., 2008).

CHAPTER III – METHODOLOGY

Setting

The practice change proposal was presented to the operating room nurse manager at a Level II trauma center in Mississippi.

Target Outcomes

The desired outcome of the project was to increase awareness of noise levels in operating rooms by educating operating room nurse managers and staff. A practice change proposal and a website were created to educate operating room nurse managers and staff. The purpose was that operating room managers would initiate a change in practice after education of the practice change proposal and reviewing the website.

By educating operating room staff, there is a possibility to avoid errors and increase safety in the operating room. Noise levels in the operating room have been increasing over the past 40 years (Katz, 2014). Also, when national safety noise levels are exceeded in the operating room, miscommunication, permanent patient disability, and patient death may occur (Gawande et al., 2003). These negative events are preventable, which makes education of utmost importance.

Barriers

The main barrier to this DNP project is the inability of most operating room staff to determine actual decibel levels in their operating rooms. Due to timing there was an inability to hold a staff meeting to educate operating room staff members. Most operating room staff prefer to have music playing during surgical procedures so they may not want to change practice or policy. Also, there are limited articles directly linking noise levels to increased health care costs. The website can only be accessed with the

most updated internet browsers available. Internet browsers are updated frequently to provide stronger security and ease of access while online. Some healthcare facilities do not allow downloads or updates by users on facility computers. Therefore, if the user is unable to update their web browser they will be unable to view the information on the website.

Population

The population for this DNP project are operating room nurse managers and staff. The sample for this DNP project was a local operating room manager at a Level II trauma center. An operating room manager was selected due to that person's ability to create change in the operating room suites. An operating room nurse manager has the task to direct, supervise and evaluate work activities of nursing, technical, clerical, and other personnel ("Medical and Health Services," 2016). Also, an operating room nurse manager must analyze risk to minimize losses or damages. A letter of support (Appendix A) was also obtained from the chief anesthesiologist at this facility. Without the support and contribution of the staff, the study would not have been complete.

Research Strategies

To determine if operating room noise levels exceed national standards and create a hazardous environment, a review of literature was conducted. A literature review is a report that focuses on a research question and evidence significant to the question. Inclusion criteria were primary research, benchmark studies, peer review, and expert opinion articles published from 1991-2016. Exclusion criteria were non-English language articles and non-benchmark articles published prior to 2003. The following search terms were used: "noise", "operating room", "hearing loss", "miscommunication",

“mortality”, and “music” alone and in combination. A total of 21 articles met the inclusion requirements.

Procedures

After obtaining institutional review board (IRB) approval at The University of Southern Mississippi (Appendix B), the project was implemented. The initial step in the implementation process was summarizing evidence from the review of literature. A practice change proposal (Appendix C) and website were created with the summarized evidence from the review of literature. Also, a consent form (Appendix D) and an evaluation tool (Appendix E) were created. After consent was obtained, the practice change proposal was presented and evaluated by the operating room nurse manager in Mississippi.

A website was created in order to disseminate information to a larger population. The information gathered from the review of literature was placed on the website. A web page counter was applied to the bottom of the home page of the website. A web page counter keeps track of how many times the website has been viewed by visitors. Also, a link was created on the homepage for visitors to email their feedback. The website can be accessed at brennonsloan.wixsite.com/noise.

CHAPTER IV – DISCUSSION

Noise levels in the operating room have been increasing over the past 40 years (Katz, 2014). Despite many advances in surgical tools, noise levels continue to rise (Katz, 2014). Staff members in the modern operating room are subject to pneumatic or power drills, saws, cutting tools, monitor alarms, dropped instruments, and metal on metal contact (Chen et al., 2012). These tools alone can create more than 90 decibels (Chen et al., 2012). All of these events occur in somewhat small rooms, which leads to sound waves echoing for a longer period of time (Shambo et al., 2015). Due to these confined rooms ambient noise levels can reach 120 decibels and contribute to miscommunication errors in the operating room (Way et al., 2013). Thus, education of noise levels and miscommunication occurring in operating rooms is needed to protect staff and patients from noise-induced hearing loss, increased patient health care costs, and patient morbidity and mortality.

Once the practice change proposal was presented to the operating room manager an evaluation tool was completed. The nurse manager would consider a practice change based on the information that was provided. First, it was stated that the nurse manager would hold a staff meeting that includes a presentation of the findings. This meeting would be utilized to teach the importance of monitoring and reducing noise levels in the operating room suites. Second, the manager would encourage staff to undergo hearing tests to form a baseline hearing level. The staff would also undergo follow-up testing to determine if hearing deficits were occurring. Third, the manger would monitor the operating rooms for compliance with noise reduction strategies and evaluate for effectiveness.

The website was published on August 28, 2016. After ten days of being published the website was visited 141 times. This suggests that there is a population of interest looking for more information regarding noise in the operating room. To avoid outdated information, the website will be updated, by Brennon Sloan, annually as new literature is published. No visitor feedback has been provided via email. The website requires zero operating costs and can be sustained indefinitely.

Limitations

The limitations of this project include the population and time. More practice change proposal presentations to operating room nurse managers would allow for more data and input. A longer time period would allow for more sites to be visited out of the local area.

Future Directions

This project has the potential to evolve into practice guidelines. The evaluation tool determined that operating room nurse managers believe changes need to occur. In the future, guidelines can be created and reassessed to determine if a positive change has occurred in the operating room. As the literature evolves related to noise in the operating room, the website will be updated to reflect this information. The website link can also be sent via email to members of professional health care groups for larger a dissemination.

Conclusion

The incidence of hazardous noise levels in the operating room remains a safety concern in modern operating rooms. The amount of published literature supports the need for practice change in modern operating rooms (Appendix F). Through practice

change, patient and staff safety may increase by better communication, increase ability to hear and interpret patient safety alarms, correct communication of diagnosis, decreased incorrect surgical instrument counts, and decreased overall noise levels (Gawande et al., 2003; Greenberg et al., 2007; Katz, 2014). Further research needs to continue along with education of patients and staff. Further research and education can improve safety and decrease miscommunication among staff, ultimately providing a higher level of care to patients.

APPENDIX A– Letter of Support



July 19, 2016

I, Dr. Joe Campbell, MD support Brennon Sloan's capstone project focusing on noise in the operating room.

Sincerely,

A handwritten signature in black ink, appearing to read 'Joe Campbell', is written over the word 'Sincerely,'.

Dr. Joe Campbell, MD

8
6
6

A black rectangular redaction covers the bottom left corner of the page. To the right of the redaction, the numbers '9' and '201' are printed on two separate lines.

9
201

APPENDIX B – IRB Approval Letter



INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.5997 | Fax: 601.266.4377 | www.usm.edu/research/institutional.review.board

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.
Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 16080504
PROJECT TITLE: Noise: Its Impact in the Operating Room
PROJECT TYPE: New Project
RESEARCHER(S): Brennon Sloan
COLLEGE/DIVISION: College of Nursing
DEPARTMENT: Nursing
FUNDING AGENCY/SPONSOR: N/A
IRB COMMITTEE ACTION: Exempt Review Approval
PERIOD OF APPROVAL: 08/15/2016 to 08/14/2017
Lawrence A. Hosman, Ph.D.
Institutional Review Board

APPENDIX C – Practice Change Proposal

Practice Change Proposal

Ambient noise levels in the operating room can reach 120dBA (Way et al., 2013)

Noise levels louder than baseline at room setup, surgical skin incision, and 60 min into surgery

- Induction, emergence, and transport were the loudest times (Ginsberg, 2013)

Staff members are exposed to pneumatic drills, power instruments with sawing, drilling, and cutting, monitors, instruments falling, metal on metal contact

- Orthopedic saws = 90db

Occupational Safety and Health Administration (OSHA) standards

- Recommend hearing protection
 - 90 decibels for 8-hour day
 - 95 decibels for 4-hour day
 - 100 decibels for 2-hour day
 - 105 decibels for 1-hour day
 - 110 decibels for 30 minutes
 - 115 decibels for 15 minutes
 - 120 decibels for 7.5 minutes
- Common decibel levels
 - 60 decibels – normal conversation
 - 74 decibels – vacuum cleaner
 - 94 decibels – lawnmower
 - 112 decibels – ambulance siren
 - 120 decibels – rock concert
 - 140 decibels – threshold of pain
 - 170 decibels – shotgun blast

22 orthopedic surgeons were tested for noise induced hearing loss (Willett, 1991)

- It was determined that half of the participants exhibited noise induced hearing loss

Ways to decrease noise

- Make sure instruments are operating at optimal conditions (Chen et al. 2012)
 - Research new instruments
 - Wear protection during loud activities
 - Keep music volumes
- Most noise is generated by operating room staff (Katz, 2014)
 - Remove all nonessential personnel
 - Decrease nonessential conversations
- Test acoustics in the operating room (Mazer, 2012)
 - Implement an alarm system configuration
- Utilize decibel meter applications on smart phones
 - Allows staff to get an idea of how loud activities are in the operating room
- Regular hearing checks for exposed employees (Silverdeen, 2008)

APPENDIX D – Consent Form

LETTER OF CONSENT

The purpose of this form is to assure that you are given adequate information to make an informed decision as to your agreement to be a subject in a study involving research. Brennon Sloan, hereafter referred to as the researcher, is conducting a study entitled “*Noise: Its impact in the operating room.*” Your participation will involve a meeting of which you will be informed of a practice change proposal. Additionally, you will be asked to complete an evaluation questionnaire at the conclusion of the meeting.

The procedures in this study are not considered experimental. There are no further risks or discomforts associated with the procedures involved in this study than those encountered in daily life or during the performance of routine physical or psychological examinations. There may only be educational benefits directly related to your participation in this research.

Any information that you provide during the duration of this study will be documented in such a manner that your identity will remain confidential. Information will be securely stored in a locked cabinet at the residence of the researcher for 3 years as per provincial law, then destroyed. Your identity will not be revealed and the information about the study will be reported only in-group form.

Your participation in this study is strictly voluntary. If you choose to participate, you may change your mind at anytime and up to one week after the meeting and withdraw your consent. There will be no penalty of loss of benefits to which you are otherwise entitled to if you decide to withdraw from the study, or if you choose not to participate.

If, during the course of study, you have questions about the research, tasks, or activities you are asked to perform or complete, or your rights as the research participant, you may contact Dr. Marjorie Geisz-Everson, Capstone Chair, at (601)2665454, or via e-mail at Marjorie.GeiszEverson@usm.edu and your questions will be answered.

You are receiving two copies of this form. Return the signed copy to the researcher and keep the other form for future reference. If you would like to receive a summary of the results of the study after completion of the study, record your full address on the reverse side of this form.

My signature below indicates that I understand the procedures to be used in this study, all my questions concerning the study have been answered to my satisfaction, and I agree to be a participant in this study. I also agree to allow the researcher to present her findings publicly or privately, in written and or oral form.

Participant’s Signature

Date

APPENDIX E– Evaluation Tool

1. Are you over the age of 18? **YES** or **NO**
2. Do you consent to the use of the results of this questionnaire being included in the Capstone project by Brennon Sloan? **YES** or **NO**
3. Would you consider a practice change based on the information that was provided today?
YES or **NO**
4. If you answered YES to question 3, what would your practice change include?
Please answer in a few sentences below.

APPENDIX F– Literature Review

AUTHORS (YEAR)	DESIGN	SAMPLE	FINDINGS	CONCEPT
“AORN position statement,” 2014	Literature Review	32 articles assessed	Baseline noise levels and factors contributing to distractions discussed	Baseline noise levels
Beyea, 2007	Literature Review	5 articles assessed	Current knowledge and interventions to decrease noise levels	Ways to improve noise levels
Chen et al., 2012	Experimental	9 employees	Evaluation of noise in operating rooms and ways to increase safety	Ways to improve noise levels
Christian et al., 2006	Observation	10 general surgery cases	Identify system features that influence patient safety	Baseline noise levels
Conrad et al., 2009	Experimental	8 surgeons	Music and its effect on task completion and accuracy	Music in the operating room
Gawande et al., 2003	Experimental	38 surgeon interviews	Identifying surgical errors and contributing factors	Communication
Ginsberg et al., 2013	Observation	23 cardiac operating rooms	Difference in noise levels throughout surgery	Baseline noise levels
Greenberg et al., 2007	Experimental	444 surgical malpractice claims	Communication breakdown leading to patient harm	Communication
Hasfeldt et al., 2010	Literature Review	18 articles assessed	Current knowledge and provided sources for new research	Communication
Katz et al., 2014	Literature Review	26 articles assessed	Current knowledge and provided sources for new research	Baseline noise levels
Kracht et al., 2007	Observation	38 operating rooms	Determined baseline noise levels in operating rooms	Baseline noise levels

Kurmann et al., 2011	Pilot study	35 abdominal procedures	Surgical site infections related to noise levels in the operating room	Patient and staff implications
Mazer, 2012	Expert Opinion	N/A	Sources of noise and its impact on staff and patients	Patient and staff implications
Renshaw, 2013	Expert Opinion	N/A	Miscommunication between surgeons and pathologist leading to misdiagnosis	Patient and staff implications
Shambo et al., 2015	Literature Review	24 articles assessed	Current knowledge of noise levels and the impact music has on them	Music in the operating room
Silverdeen et al., 2008	Experimental	25 orthopedic operations	Sound levels generated by certain surgical instruments	Baseline noise levels
Siu et al., 2010	Experimental	10 medical students	The effect of music while performing tasks with a surgical robot	Music in the operating room
Stevenson et al., 2013	Experimental	33 anesthesiology residents	Response to pulse oximeter changes while multitasking	Patient and staff implications
Way et al., 2013	Experimental	15 subjects	Impact of noise on operating room staff	Communication
Willett, 1991	Experimental	27 senior orthopedic personnel	Noise-induced hearing loss among orthopedic staff	Patient and staff implications

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