MEASURING AND REDUCING NOISE LEVELS

IN THE OPERATING ROOM DURING

INDUCTION AND EMERGENCE

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Dedication and Acknowledgments

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Abstract

This DNP project seeks to apply the existing evidence linking noise and workplace distractions to safety in the operative room and use an educational intervention to address knowledge deficits to change practice to reduce distractions during induction and emergence from anesthesia. Decibel monitors were placed in select operating rooms at the community hospital at two different times, two weeks before and two weeks after an educational intervention for perioperative staff. The resulting sound levels were predominately within the recommended governmental standards of noise. Mean sound levels before the intervention (57.8dB) and after the intervention (58.8dB) showed a statistically significant difference, potentially attributable to the time-sensitive nature of this project and lack of one-on-one communication with perioperative staff. These findings suggest alternative approaches to sound level reduction should be considered when educating perioperative personnel. Perioperative staff should remain vigilant with noise reduction techniques to reduce communication limitations during induction and emergence.

Key Words: noise, distractions, operating room, anesthesia

Background and Significance

The operating room is a high-stakes environment that requires diligent situational awareness and effective communication among team members to provide optimal patient care. Medical equipment and numerous personnel with varying roles contribute to high noise levels and distractions. Noise and distractions can compromise team communication and jeopardize patient safety (The Joint Commission, 2017). Noise pollution in healthcare environments is not a new problem. Elevated decibel levels have been observed in the perioperative environment, making communication ineffective (Stringer, Haines, & Oudyk, 2008; Wright, 2016). Excessive noise levels also impair team member performance, increase occupational stress, and contribute to poor quality of care (Fu et al., 2020; Hogan & Harvey, 2015). Reducing noise and distractions in the operating room is important for promoting patient safety. Thus, perioperative staff should be made aware of their contribution to noise in the operating room and consider making changes to reduce noise and distractions in the operating room.

Induction and emergence are considered the most critical moments of anesthesia. During these times, anesthesia providers must assess and intervene to support their patients quickly. Additionally, anesthesia providers often communicate needs that require prompt intervention to other staff members. Any potential delays can interfere with patient care, and distractions should be minimal. Beyond a general concern for noise in the operating room, surgeons and anesthesia providers are often the most affected by noise distractions (Keller et al., 2018). Noise can distract the anesthesia provider during critical times and impair the anesthesia provider's ability to hear and respond to monitors and alarms (Hogan & Harvey, 2015). Unfortunately, operating room noise is louder during critical anesthesia components than during other perioperative times (Ginsberg, 2013). Thus, it is vital to implement noise reduction techniques in the operating room.

Providing pertinent noise reduction education to perioperative staff can assist with reducing noise in the operating room. Importantly, operating room noise levels can be easily measured during induction and emergence of anesthesia.

Purpose

The purpose of this project is to apply the existing evidence linking noise and workplace distractions to safety and use an educational intervention to address knowledge deficits to change practices to reduce distractions.

Review of Current Evidence

Literature Search

A comprehensive search of literature exploring noise pollution in the operating room occurred through a review of articles, research reports, systematic reviews, and other published works applicable to the topic of interest. Works within the past ten years were included in the initial search. Particular attention to the impact of noise reduction during induction and emergence from anesthesia in the operating room was considered. An initial search was conducted in the CINAHL database using the keywords noise pollution and operating room. This produced nine articles, four published in the past ten years, directly applicable to the topic of interest. Subsequent searches for more comprehensive topic coverage included keywords with Boolean operators of (1) anesthesia AND noise, (2) noise reduction AND operating room, (3) induction AND emergence AND noise, and (4) healthcare noise. Ten additional articles were selected and incorporated into this review by searching through the resulting abstracts and associated articles. Inclusion criteria included English and full-text-only articles. Exclusion criteria involved eliminating articles greater than ten years old and without application to the topic of interest. Key findings and conclusions from each article were entered into an article matrix and reviewed for thematic analysis, resulting in three themes: noise in the workplace, noise in anesthesia, and educational interventions to reduce noise.

Noise in the Workplace

General

The Center for Disease Control through the Occupational Safety and Health Administration (OSHA) (2022) expressed concerns about extended periods of exposure to elevated noise levels and the risk of hearing loss. Of particular interest to this project, intermittent or persistently high noise levels negatively impact workplace performance in communication-intensive workplaces (Ajala, 2012; Gyllensten et al., 2023). This is a cause for concern, as effective communication is vital to teamwork in a functional healthcare environment. Additional concerns include workplace quality, proper teammate communication, negative team member performance, and increased occupational stress (Ajala, 2012; Fu et al., 2020; Gyllensten et al., 2023; Hogan & Harvey, 2015; The Joint Commission, 2017).

Healthcare

Concerns for noise pollution in healthcare environments are overwhelmingly negative. Unfortunately, noise levels in hospitals across the globe frequently exceed the World Health Organization recommendations of 35-45 dB during the day and 30-35 dB during the night (Cranmer & Davenport, 2013; Halm, 2016). When evaluating a noise reduction intervention, Hinkulow (2014) determined that unnecessary and excessive noise were significant causes of dissatisfaction for patients and nurses in the clinical setting. Similarly, Waller-Wise (2019) found that noise reduction interventions such as quiet time in a labor-deliver-recovery unit improved patient experiences, e.g., increased breastfeeding time. Comparable findings also occurred in examining nurses' perception of distractions from patient-centered care, where excessive noise negatively influenced patient-centered care (Kollstedt et al., 2019). Overall, noise in the healthcare environment negatively influences employees, patients, and the healthcare environment.

Operating Room

The operating room is a unique high-stakes environment with its concerns with noise pollution. The Association of Perioperative Registered Nurses (2014) strongly recommends reducing noise and distractions in the operating room. Limiting noise and distractions is imperative since the perioperative setting is a highly complex environment where communication between team members is critical. Noise distractions reduce the ability of providers to multitask (Plaxton, 2017). Noise in the operating room significantly influences communication, employee health, and patient safety (Stringer, Haines, & Oudyk, 2008; Wright, 2016). Concerns regarding noise in the operating room also include music as a potential source of staff distraction. Select facilities have shown dB levels exceeding 100 dB more than 40% of the time in orthopedic rooms and some higher than 120 dB (Shambo et al., 2015).

Noise in Anesthesia

Induction and emergence are critical periods in the delivery of anesthesia. The ability to assess patients promptly and intervene effectively is paramount to patient safety. Noise and distractions may divert the anesthesia provider's attention, potentially compromising patient care.

Most research studying the influence of noise in the operating room involving anesthesia providers is qualitative, focusing on distractions and effective communication. Keller et al. (2018) found that noise levels exceeded 55 dB at least 50% of the time. Moreover, anesthesia providers were one of the groups affected most by noise distractions (Keller et al., 2018). Hogan and Harvey (2015) reported similar findings with average noise levels of 60 dB to 70 dB and intermittent levels as high as 95 dB. Additionally, Ginsberg (2013) found that noise levels tend to be elevated during induction and emergence, which are of greatest concern to anesthesia providers. Current research supports noise reduction interventions in the operative setting.

Educational Interventions to Reduce Noise

Interventions to reduce noise are primarily geared toward educating personnel on reducing environmental noise. Interventions to reduce noise include minimizing irrelevant conversation, behavior modification, and careful design of the operative suite to limit noise (Katz, 2014). The Joint Commission (2017) articulated additional suggestions to help address noise levels in the operating room, including no-interruption zones, alternative equipment, simulation training to reduce noise, and practicing effective communication.

There are a limited number of reports in the anesthesia literature concerning noise reduction during induction and emergence. Hogan and Harvey (2015) found significantly reduced sound levels during induction and emergence after implementing noise reduction education. Interventions for noise reduction included avoiding unnecessary communication, not playing music, avoiding opening and closing draws, etc. There are additional reports for areas beyond the operating room, specifically the PACU. Sarkar et al. (2020) implemented structural changes to reduce noise in the PACU, decreasing noise levels and improving patient satisfaction. Similarly, Cvach et al. (2020) provided staff with noise reduction education, including alarm adjustments. Ultimately, staff found the workplace quieter and more pleasant after the intervention. These studies illustrate how staff education and purposeful interventions to reduce noise led to noise reduction in a specific setting. These interventions are transferable to the operating room and may produce results similar to those of Hogan and Harvey (2015). Further research in noise and distraction reduction during induction and emergence is needed.

Conceptual Framework

This DNP project was developed based on the framework of Lippitt's Change Theory. To influence a change in operating room staff practice during critical phases of anesthesia practice, the principal investigator (PI) followed the seven stages of Lippitt's Change Theory (Lippitt, Watson, & Westley, 1958). The first step involves diagnosing the problem. Proper diagnosis is required to guide the formation of the project. Second, the capacity for change is determined. Searching the literature to find evidence to support problem exploration occurs. Third, an assessment involves the PI's resources and motivation to instill a change. Action plans to influence the change are established in step four. This is where the intervention is implemented to prompt change. Step five outlines the role of the change agent, giving clear direction to the PI's role in the project. Step six involves maintaining the change, while step seven rounds out the framework with a gradual removal of the change agent (PI) over time. Ideally, the change that occurs becomes part of the organizational culture.

Methods

The purpose of this project is to apply the existing evidence that links noise and workplace distractions to safety and use an educational intervention to address any existing knowledge deficits to change practice to reduce distractions. Current literature supports making changes to reduce noise and distractions in the operating room. Quantitative data was collected using electronic decibel (dB) meters in various operating rooms. Two weeks after pre-intervention data collection, an educational intervention was offered to all operating room staff, including all perioperative personnel and anesthesia providers. After the intervention, dB levels were again monitored two weeks post-intervention with subsequent statistical comparison for pre and post intervention.

Design

This project is a quantitative QI educational intervention comparing noise level data pre and post-intervention. This project evaluates the impact of noise and distraction reduction in the operating room. Decibel (db) levels were recorded with specific analysis during induction and emergence. The educational intervention was offered over two weeks. Statistical analysis between the pre and post-intervention occurred, providing insight into the effectiveness of the QI intervention.

Translational Framework

The Iowa Model of Evidence-Based Practice (EBP) was developed to serve as a guide for nurse researchers to use to help improve patient care. It involves several steps that focus on an application-oriented EBP process (Cabarrus College of Health Sciences, 2022) and has three primary decision points (Iowa Model Collaborative [IMC], 2017). The first step involves the identification of a problem, which can be from either a problem or knowledge focus. Problem-based triggers stem from financial or clinical problem data, whereas knowledge-focused triggers come from new research findings (Brown, 2014). Revisions of the IOWA model include other triggering issues and opportunities, such as accrediting requirements and care philosophy (IMC, 2017). The next step requires a proper statement of the question or purpose with subsequent decision-making on whether the topic is indeed a priority (IMC, 2017). If deemed a priority (first decision point), a team is formed, and the team affirms the need to continue this inquiry process (Brown, 2014). At this juncture, systematic research is conducted with appropriate appraisal and synthesis of research. With sufficient evidence (second decision point), the team proceeds with

EBP design and piloting of a practice change. If the practice change is deemed appropriate for adoption into practice (third decision point), the change is then integrated, evaluated, and sustained if possible. Dissemination of results is the final step in the framework (IMC, 2017).

The Iowa Model of EBP fits well with the proposed project as it provides a systematic approach to support evidence-based practice with a logical flow. In developing the PICOT question for this project, more quantitative support in the literature reviews explicitly about anesthesia concerns during induction and emergence is needed. With this additional information, greater emphasis can be placed on developing an EBP project. The next step of forming a team was primarily to support the educational delivery. Additional individuals will assist with the analysis of collected data. Practice change is the goal of this EBP project, which also coincides with the IOWA model. Dissemination would then occur through a repository submission of DNP projects and the potential of scholarly articles and presentations.

Setting

This QI project will be implemented in a North Carolina community hospital with 238 beds and ten operating rooms. Surgical services include orthopedics, general surgery, gynecology, obstetrics, and pediatrics. The site was selected based on the prevalence of noise and distractions during critical times in anesthesia. The PI has personal exposure to noise and distractions at this site through a clinical rotation. Input from CRNAs at the site also supported the prevalence of these occurrences. Additional buy-in from the Chief CRNA provided willingness for change, which conforms to Lippitt's Change Theory.

Population

The population for this project is the perioperative staff at the project site. For this QI project, the sample is comprised of approximately 80 encounters in the operating room reviewing noise levels in the operating room during induction and emergence. After the educational intervention, approximately 80 more encounters were recorded. Only cases considered general anesthesia with a documented induction and emergence will be analyzed. Spinal anesthetics and monitored anesthesia care cases were excluded. Operating room selection was randomly generated using a random number generation. Cases in each room were convenient samples.

Project Implementation

The PI placed decibel monitors in each selected operating room. These monitors have the capability of recording decibel levels over time. Times will be connected to documented induction and emergence times, recording at eight-second intervals. This QI project is designed to promote change through an educational intervention by influencing perioperative staff and their compliance with noise and distractions during induction and emergence. The educational intervention to assess for reducing noise and distractions was implemented for a pre-post analysis.

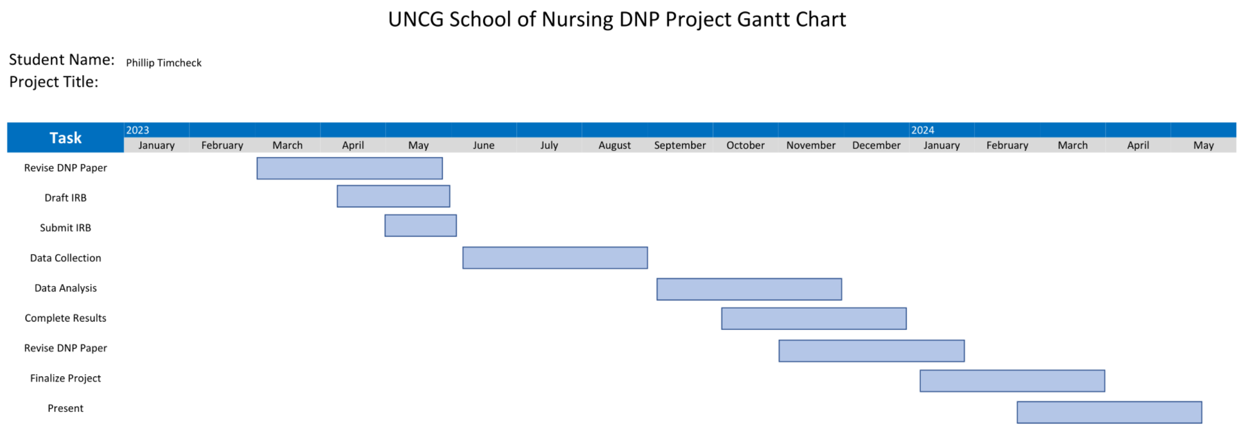
Tools

The primary education tool for this EBP project is an educational handout that outlines common sources of noise, noise effects on OR staff, noise affects patients, and methods to reduce excess noise (Appendix A). An educational session was offered to accompany the distribution of the educational handout during a weekly staff meeting. Copies of the handout were be provided by the PI. Time for questions was provided during these sessions. PI contact information was also provided. Handouts were posted in break rooms to assist with providing this information to those who could not attend the live session.

Timeline and critical milestones

Figure 1 outlines anticipated project development through project completion.

Figure 1.



Barriers to project implementation include poor attendance at the chosen weekly meeting, resulting in less direct exposure to the interested independent variable. To help mitigate this concern, clear and frequent communication between the PI and Chief CRNA occurred. Another concern is the lack of cases that are considered general anesthetics. An appropriate number of general anesthetics were present during the pre and post-data collection periods.

Steps implemented

The DNP project chair approved the project topic of interest and subsequent development of project purpose, methods, and associated literature support. Preliminary acceptance of the QI project was obtained from the Chief CRNA at the site of interest. IRB approval was received at the PI's institution, the University of North Carolina at Greensboro. Healthcare system approval of the QI project was then be obtained as a final clearance to begin. Discussion with the Chief CRNA occurred, determining specific implementation dates and education dates.

Data Collection

Data was collected in four operating rooms with dB meters in each room. The PI obtained the dB meters and placed on top of each anesthesia machine. The first round of data collection occurred over three days. Subsequent data collection occurred two weeks after the intended educational intervention, also over three days. This data was downloaded to the PI's computer for analysis with Microsoft Excel.

Data Analysis

Microsoft Excel was used to analyze the collected data with the support of a university-sponsored statistician. Descriptive statistics was used to describe the sample. A two-sample t-test was used to compare noise levels from pre and post-intervention data. A p-value of <0.05 was utilized for statistical significance.

Results

After applying inclusion criteria, the resulting sample for this project yielded 15 pre-educational intervention recordings of induction and emergence and 21 post-educational recordings of induction and emergence. The pre-education induction sample ($n = 436$) had a mean sound level of 57.8 dB ($SD = 4.64$) and a range of 44.5-80.1 dB. The post-education induction sample ($n = 684$) had a mean sound level of 58.8 dB ($SD = 4.88$) and a range of 50.1-85.6 dB. Comparing pre-education and post-education induction sound levels through a t-test assuming equal variances (confirmed with an F-Test two sample for variances), sufficient evidence exists to conclude that the true means are significantly different for the respective population. The pre-education emergence sample ($n = 397$) had a mean sound level of 59.7 dB ($SD = 4.81$) and a range of 45.4-84.5 dB. The post-education emergence sample ($n = 1165$) had a mean sound level of 60.8 dB ($SD = 5.13$) and a range of 51.4-92.4 dB. Comparing pre-education and post-education emergence sound levels through a t-test assuming equal variances (confirmed with an F-Test two sample for variances), sufficient evidence exists to conclude that the true means are significantly different for the respective population.

Discussion

The results from this project show that recorded dB levels were within reasonable levels most of the time during the induction and emergence periods, before and after the educational intervention, with means ranging from 57.8 dB to 60.8 dB. These readings fall within the recommended levels of occupational exposure under 75 dB over 8 hours (CDC, 2018). The findings from this project were also consistent with findings by Keller et al. (2018), with noise levels exceeding 55 dB at least 50% of the time but lower than the findings of Hogan and Harvey (2015) with 60 dB to 70 dB average readings. Based on the standard deviations for each statistical test, limited periodic exposures to elevated noise levels occurred. This is also a positive finding as elevated noise levels can impact performance in communication-intensive professions and contribute to increased occupational stress (Ajala, 2012; Fu et al., 2020; Gyllensten et al., 2023; Hogan & Harvey, 2015; The Joint Commission, 2017).

However, increased sound levels occurred when comparing pre and post-educational intervention measures during induction and emergence. This suggests the educational intervention was ineffective in reducing operating room sound levels. Some changes that could have been made to improve the educational intervention include the following:

- Additional education intervention frequency – multiple visits
- Alternative approaches to instruction
    - Small group discussion
    - One-on-one interview and consultation
- Direct involvement from the change agent
    - i.e. have anesthesia leadership present on the importance of the topic

Additional frequency with education and alternative approaches such as one-on-one discussion may prove useful, as a group approach may not have conveyed the importance of the matter as effectively (Cvach et al., 2020; The Joint Commission, 2017; Katz, 2014). The time-sensitive nature of this project also limits this project's effects. Providing education over a longer period with multiple iterations and strong input from change agents could provide different results in noise level reduction, enhancing Step 5 of Lippitt's change theory. (Lippitt, Watson, & Wesley, 1958).

Additional recommended changes with the project design include:

- Involve multiple sites
- Increase amount and variability of operating rooms measured
- Increase frequency of recordings
- Consider direct observation to ensure accurate record-keeping of critical events

The results of this project occurred at one site and have limited generalizability outside of this site. With a limited number of studies that speak directly to noise levels during induction and emergence, replicating this project in multiple settings with additional frequency may prove helpful (Hogan & Harvey, 2015). Increasing the frequency of recordings (less than every eight seconds) may also provide additional information not found in this project. It is also essential to consider that this project's design relied on nurse anesthetists correctly documenting induction and emergence times. If this project is replicated, the PI could ensure these times are recorded accurately through direct observation. Operating room cases were also not controlled in this setting. Types of procedures can play a significant role in varying degrees of noise. Repeated intervention with controlling type of case may affect results. Other variables beyond the project design's control included the malfunction of an anesthesia machine and its subsequent removal without PI knowledge.

Conclusion

Overall, this quality improvement project showed that observed sound levels in the operating room during induction and emergence pre-, post-, and educational intervention were not elevated to unacceptable levels. Findings were broadly consistent with those found in existing literature. This project's post-educational intervention observed an increase in sound levels, suggesting that alternative approaches to noise level reduction should be considered when educating perioperative personnel. Repeating this project in different settings and reducing design limitations may provide different results. Additional interventions in this environment could promote limiting noise in the operating room. Perioperative staff should remain vigilant with noise reduction techniques to reduce communication limitations during induction and emergence.

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Appendix A
HOW LOUD IS TOO LOUD?

What's the problem?

Have you ever felt like it was so loud that you can't think clearly? The World Health Organization (WHO) recommends that noise levels should not exceed 70dB over a 24 hour period and 85 dB over a 1 hour period to avoid hearing impairment. As we all know, the operating room (OR) is a complex and noisy environment. Believe it or not, a study found that noise levels on average were 92.9 dB during induction of anesthesia, 89.6 dB throughout cases, and 94.2 dB during patient emergence from anesthesia.

Why does it matter?

Response time, mental efficiency, and short-term memory of the anesthesia provider were negatively affected by excessive distractions. Fatigue, increased stress, and inefficient communication were also commonly reported.

Patients have not only recalled the noisy OR environment, but were observed to experience physiological side effects such as pupil dilation, peripheral vasoconstriction, hypertension, and corticosteroid release.

Examples of noise in the OR

- Cell phones and/or pagers
- Automatic doors
- Conversations unrelated to patient care
- Suction
- Staff changes for breaks or shift change
- Unnecessary monitor alarms
- Equipment malfunctions
- Music
- Equipment preparation
- Overhead announcements
- Patient moaning from discomfort

Suggestions for Improvement

- Do not enter the room unless necessary.
- Lower voices
- Avoid conversations that do not pertain to patient care.
- Prepare all equipment in advance (as able)
- Silence cell phones
- Decrease music volume.
- Count instruments before the patient enters the room.
- Do not break down or dispose of equipment until the patient has left the room.