NOISE REDUCTION IN A HOSPITAL SETTING USING EDUCATION BASED ON A CULTURAL CHANGE MODEL

by

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The purpose of this study is to evaluate the effect of a Tranquility Training program on reducing unit noise and changing nurses' perception of organizational culture, knowledge of noise awareness, noise reduction strategies, and unit noise levels. The study is a time series, prospective, quasi-experimental pilot study. The Tranquility Training Program was implemented on the Pulmonary Telemetry Unit {PTU} at a 300-bed community hospital. Another Intermediate Care Unit {IMC} in the same hospital with a similar architectural layout, patient population, and nurse staffing ratio served as a control group. Noise was measured at three separate time periods: pre-intervention, one month after the intervention, and six months after the intervention. Staff surveys were completed before the intervention and six months after the intervention. At the one-month post-intervention follow-up, participants in both units demonstrated a desire to reduce noise and felt empowered to make an impact in noise reduction. These perceptions were sustained through to the six month follow-up. Both units reduced noise levels at the one-month follow-up but did not approach the levels recommended by the Environmental Protection Agency for hospitals. Although there was an increase in noise at six months from levels observed at one month, both units sustained a quieter level than baseline. There were no group (education vs. no-education) differences in noise or staff perception measures. It appears that the process of measuring noise over time may have resulted in noise reduction on both units.

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PREFACE

The author thanks her mentor- Heidi Donovan PhD, RN, Assistant Professor, Department of Acute and Tertiary Care as well as Susan Sereika PhD, Associate Professor, Director Center for Research and Evaluation at the University of Pittsburgh and Peter Draus PhD, Assistant Dean, School of Adult and Continuing Education; Assistant Professor of Organizational Studies; Robert Morris University. In addition, the author thanks Nurse Managers Linda Cline RN, BSN, Pam Marshall RN, BSN, and Rhonda Lang RN, BS, the dedicated nurses who provide patient care on IMC and PTU, and Chief Nursing Officer, Joan Massella RN, MS, MBA at St. Clair Hospital for their participation in the project. Finally, the author thanks Peggy Jenkins RN, MSN, CMSRN for assisting with noise measures and Deborah Lages RN, MSN for editing.

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1.0 INTRODUCTION

The Environmental Protection Agency (EPA) recommends that hospitals maintain noise levels below forty-five decibels (dB) during daylight hours and thirty-five dB during the night. The World Health Organization has published research on hospital noise levels. They report that while normal conversations occur at fifty-six to sixty dB, conversations in hospitals generally occur at higher levels due to the louder baseline noise from equipment and hospital activity. They recommend that noise levels in patient rooms be maintained at levels at or below 35 dB. Campbell (1983) describes this background noise as “chronic, negatively valued, nonurgent, physically perceptible, and intractable to the efforts of individuals to change them.” Continued exposure to excessive hospital noise has a physiological and psychological impact on patients. Research has identified a correlation between excessive noise and delayed wound healing, decreased REM sleep, interrupted circadian rhythms, tachycardia, reduced digestive secretions, increased oxygen consumption, elevated blood pressure, and impaired immune response (Everson, 1997; Krachman, 1995; Nicholas, 1993; Homberg 1999.) Continuous, undesired noise can cause irritation, difficulty in concentration, headache, and anxiety.

Some sources of noise in hospitals include equipment, alarms, pneumatic tube systems, elevator buzzers, printers, ice machines, food carts, intercom systems, paging systems, call bells, telephones, televisions, and staff conversations. Environmental modifications can effectively decrease noise levels, yet the process of caring for hospitalized patients necessitates frequent and ongoing interpersonal dialogues. Minimizing the patient exposure to interpersonal communications between employees requires a change in employee behaviors (Moore, 1998.)

1.1 SPECIFIC AIMS

Hospital based studies have reported some success in reducing noise levels by establishing equipment and purchase standards related to noise and designing units to control sounds (Mazer, 2002.) While effective, structural changes and equipment purchases can be cost prohibitive for many facilities. Other studies have focused on controlling the noise at the patient level by providing earplugs, introducing "pink" background noise, or providing musical selections (Mazer, 2002; Wallace, 1999.) These interventions have been effective in short-term situations, where the patent's stay is time-limited, such as recovery room and outpatient surgical suites. While studies demonstrated improved patient outcomes in using these devices, none of the studies included a follow up to evaluate the nursing staff commitment to continuing to provide patients with the devices once the research project was completed. Studies have found reductions in noise after employee education, but the studies did not report sustained noise reduction beyond the timeframe of the study (Cmiel, 2004; Moore 1998.) These studies had developed educational programs based on individual learning models. Others have found no effective noise reduction related to employee education. While noise reduction has been studied with various outcomes, no study combines theory guided nursing education, measurement of noise levels, and measurement of the nurses' intention and motivation to implement noise reduction techniques. Ryan, Brigham, and Elkins (1995) developed questionnaires to evaluate the nurse's satisfaction with and commitment to utilize information received during staff training. Validity and reliability of the instruments has been tested (Ryan, Campbell, & Brigham, 1999). Two of these surveys titled Social System of the Organization (SSO), which assesses the extent that subjects believe their organization is supportive of change and Educational Offering and Change (EOC), which assesses the extent subjects perceive that the change will be beneficial were used in the study. The SSO and EOC, and a Noise Perception Instrument designed by the PI, were completed at baseline and six months after the intervention. Shanley (2004) effectively combined an organizational change perspective with an individual learner perspective to develop a program which effectively changed nursing practice. The process uses staff participation in problem solving, development of organizational support systems, and structured training for new employees to maintain the practice change. The goal of this pilot study was to develop, implement and evaluate an educational program on noise reduction using the model developed by Shanley (2004). The educational program, entitled Tranquility Training, will focus on reducing noise pollution. The specific aims of this pilot study were to:

1. Compare one and six month changes in unit noise levels between a nursing unit receiving the Tranquility Training program and a unit that did not receive the program.
2. Analyze results of the SSO, EOC, and Noise Perception surveys at baseline and six month after the intervention to compare changes in nurses’ perception of organizational culture, knowledge of noise awareness, and noise reduction strategies between a nursing unit receiving the Tranquility Training program and a unit that did not receive the program.

2.0 REVIEW OF THE LITERATURE

Noise, vibrations that produce a sound, is audible to the human ear at a level of fifteen dB. The frequency of the sound wave, vibration speed and the pitch of the resultant sound influence the human perception of noise as positive or intrusive. The intensity of the sound wave produces pressure on the eardrum, resulting in a perception of volume. Decibels are measured in logarithmic scales; thus, an increase of noise from twenty dB to thirty dB would be perceived as ten times louder. Background noise of fifty dB would be considered normal and acceptable.

Numerous investigational studies have measured noise levels in hospital settings and found that they often exceed the EPA recommended range of thirty-five to forty-five dB (Helton, 1980; Stephens, 1995; Kahn, 1998; Holmberg, 1999; Allaouchiche, 2002; Morrison, 2003; Cmiel 2004). The maximum noise levels recorded in these studies was ninety dB with a mean level of fifty to sixty dB. The noise was attributed to both equipment and conversations (Allaouchiche, 2002.) Although background noise is often intractable, it affects both psychological and physiological stasis. Excessive noise levels have been linked to stress, anxiety, annoyance and decreased patient satisfaction (Morrison, 2003). Excessive noise has also been linked to physiological interruptions in circadian rhythms, sleep patterns, and healing processes (McClaugherty, 2004; Gabor, 2003). Noise research in hospital settings has been studied from two different perspectives, reducing noise levels and minimizing the noise irritations perceived by patients. By reducing the noise related irritations, researchers have demonstrated success in affecting both the psychological perceptions and physiological responses to noise. A study by

Topf (1992) showed a decrease in noise-related annoyance when the individual had some control over the noise. The psychological impact of the noise was lessened, as demonstrated by subject feedback, but the physiological stress was not lessened, as evidenced by levels of urinary epinephrine. In a study by Byers (1997), intervention with music selections and headphones lessened both physiological and psychological distress for cardiac surgery patients. The patients rated the music intervention as highly enjoyable. Both heart rate and blood pressure decreased from baseline during the music intervention. Wallace focused on reducing environmental noise perceptions for patients by supplying earplugs during normal sleep times. He demonstrated improved sleep in critically ill patients who wore earplugs while in an intensive care unit. Measures of rapid eye movement latency were significantly lessened in patients using earplugs.

The second approach, limiting environmental noise levels, has also demonstrated areas of success. Using guidelines to limit noise in a surgical intensive care unit made a statistically significant decrease in noise levels in one study (Walder, 2004). Specific time restrictions for providing routine care and adjustment of alarm levels produced a decrease in the peak noise levels, yet background noise measurements were unchanged. A study in Australia linked environmental changes and a continuous quality improvement initiative with positive decreases in underlying noise levels and peak noise levels (Stephens, 1995). This had a beneficial impact for both patients and staff satisfaction. A similar study by Cmiel (2004) used a multifaceted approach in reducing noise levels and measured both background noise and patient's perception of noise and ability to sleep. The investigator combined an analysis of noise sources, staff education, and equipment modifications to reduce noise. One study, in a Rhode Island facility had found levels significantly greater than EPA recommended levels. Kahn, et al (1998) focused measurements and interventions at those sources creating peak levels of more than eighty dB. After determining the most common sources of peak noise, staff conversations, and television, they developed an intervention based upon theories of behavioral modification. Through behavior modification, the investigators were able to reduce noise levels on day and evening shifts and the twenty-four hour mean peak noise level. The investigators provided education on noise pollution and the impact of noise on patients and staff. They also educated physicians and respiratory therapists. All participants were provided with handouts describing the rational for the study and a grid listing common sounds and their corresponding decibels. The investigators felt that the handouts had a positive influence on staff cooperation with the initiative. The majority of the research conducted on noise reduction has focused in critical care units; yet critical care beds comprise only twenty to thirty percent of most acute care hospitals. The remaining patient care areas are general medical or surgical floors or step down areas.

While the studies have demonstrated initial success in decreasing environmental noise and patient irritation, none of the studies has measured ongoing effectiveness. Some studies provided staff with noise reduction techniques but failed to measure staff commitment to reduce noise. In addition, the studies have not used education models as a structure for educating staff.

2.1 THEORETICAL BASIS LINKING EDUCATION AND BEHAVIORAL CHANGE

In the rapidly advancing, technological setting of healthcare, adjustment and change occurs with some frequency. It is imperative to establish solid, theoretical basis for change. According to Olsson (2004), “When change projects fail, investments such as time, money, and human resources are wasted and organizational willingness to embrace other change initiatives diminishes. The negative effects of unsuccessful change projects can be seen as decreased staff satisfaction, increased stress, and frustration.” Multiple theories exist to address how and why change occurs. Rogers’ model of innovation and change focuses on the dissemination of information and the acceptance or utilization of the new concept. An individual accepts or rejects the concept based on his experiences, values, and environment in which the change occurs. Marsick and Watkins (1990) have a very different focus in their action technologies model. The model promotes change by using the resolution of actual problems to create a laboratory of learning. The group learns by using a cyclical model to frame the problem, experiment, reflect, and reframe the issue. This model includes social, cultural, historic, and economic influences of the organization. Bushy (1992) refers to change management as “an art and a science because of the complexity of the process and the wide range of human responses to change.” This complexity may be minimized by following a model of change, which includes the learner in the change process. Cervero (1984) has defined seven methods of evaluating the effectiveness of educational programs and application of behavioral changes related to continuing education programs in professional practice. The three methods that focus on behavioral changes related to continuing education are self-reports, observation, and archival analysis. When the effectiveness of change is measured using self-reports, one analyzes individual perceptions and recall to determine is change has occurred. This method is the least costly, and can provide individualized results. Instrument validity is of concern when interpreting results from this method. Observation, while more costly, provides more objective results as long as methods to minimize observational bias are instituted. The third method, archival analysis extracts data from written records (Cervero 1984.)

Shanley (2004) used an organizational change perspective in staff development program to promote change. His model, in the early testing phase, is congruent with theories developed by Rogers (1962) and Marsick and Watkin (1990). Shanley’s seven characteristics link the dissemination of information and adoption of change present in Roger’s model with the organizational influence of Marsick and Watkin’s model to develop a format for the nurse educator to influence organizational change through education. Shanley (2004) shifts the focus of education from the individual learner to encompass organizational characteristics. The educator not only provides the education but also involves the learner in the problem resolution, identification of necessary support systems, and determination of outcome measures. By engaging the learner in the process, the educator moves beyond providing information and skills training, creating a strategy that will influence the nursing process. The learners can provide realistic interpretations of the work environment, identify values and attitudes, which will promote or deter the change process, and create clinical systems, which will support the change. Shanley (2004) identified seven characteristics used to incorporate organizational change perspectives into staff development programs (Shanley, 2004.)

1. **Become familiar with issues in the workplace.** This phase involves investigation into the current processes and includes policy review, staff and management opinions of the current process, and a thorough review of the available research and theory regarding the issue.
2. **Gain support from management.** Support from management has been identified as a major influence in effecting change (Price, 2000.) Interventions should align with the philosophy and focus of the organization. Summaries of potential benefits should include outcome measures that will support the manager's goals.
3. **Gain support from learners.** Just as managers need to know the benefits, staff needs to be apprised on how the program will affect them. Anticipating benefits for staff and minimizing any detriments will help gain the interest and commitment of the learners.
4. **Introduce systems for ongoing use in the workplace.** Providing tools and systems that will support the intervention is a critical component of sustained change. This might include policies, protocols, guidelines, and training packets for new employees.

5. **Encourage a comprehensive analysis of existing systems.** Using the information obtained in the first phase, the educator involves the staff in developing a realistic solution to the problem. Using an organizational focus, the staff identifies how existing processes affect the issue. Marsick and Watkin (1990) refer to this as critical reflectivity, looking beyond the norm and considering the problem from different perspectives. The educator must encourage staff to consider the issue from different units within the organization not just from the clinical or patient perspective. It is imperative for staff to account for staffing, time constraints, existing policies and regulations, and other departments. Goldman (2004) involved staff in an organizational change initiative. The process included establishing rapport with staff, identifying staff goals, which could be used as motivation, and asking staff what barriers they faced and how they could contribute to the success of the program. The program outcomes were so successful that additional facilities have been included in the training.
6. **Provide resources for training other staff.** This may involve a train-the-trainer approach, independent study packets, or on line learning.
7. **Provide directed support to learning in the workplace.** The educator facilitates the change behavior by supervising the learners in the workplace. This can help minimize reflective rationalization, holding oneself blameless by excusing lapses in behavior (Marsick & Watkin, 1990.) The educator provides feedback, coaches the staff, and models the behavior. This intervention is supported by the social cognitive theory; individuals learn by their own experiences and by observing the actions of others and the results of those actions. Encouraging the senior nurses on the unit to role model the noise reduction strategies may influence others to use the behaviors as well (Curry, 2001.)

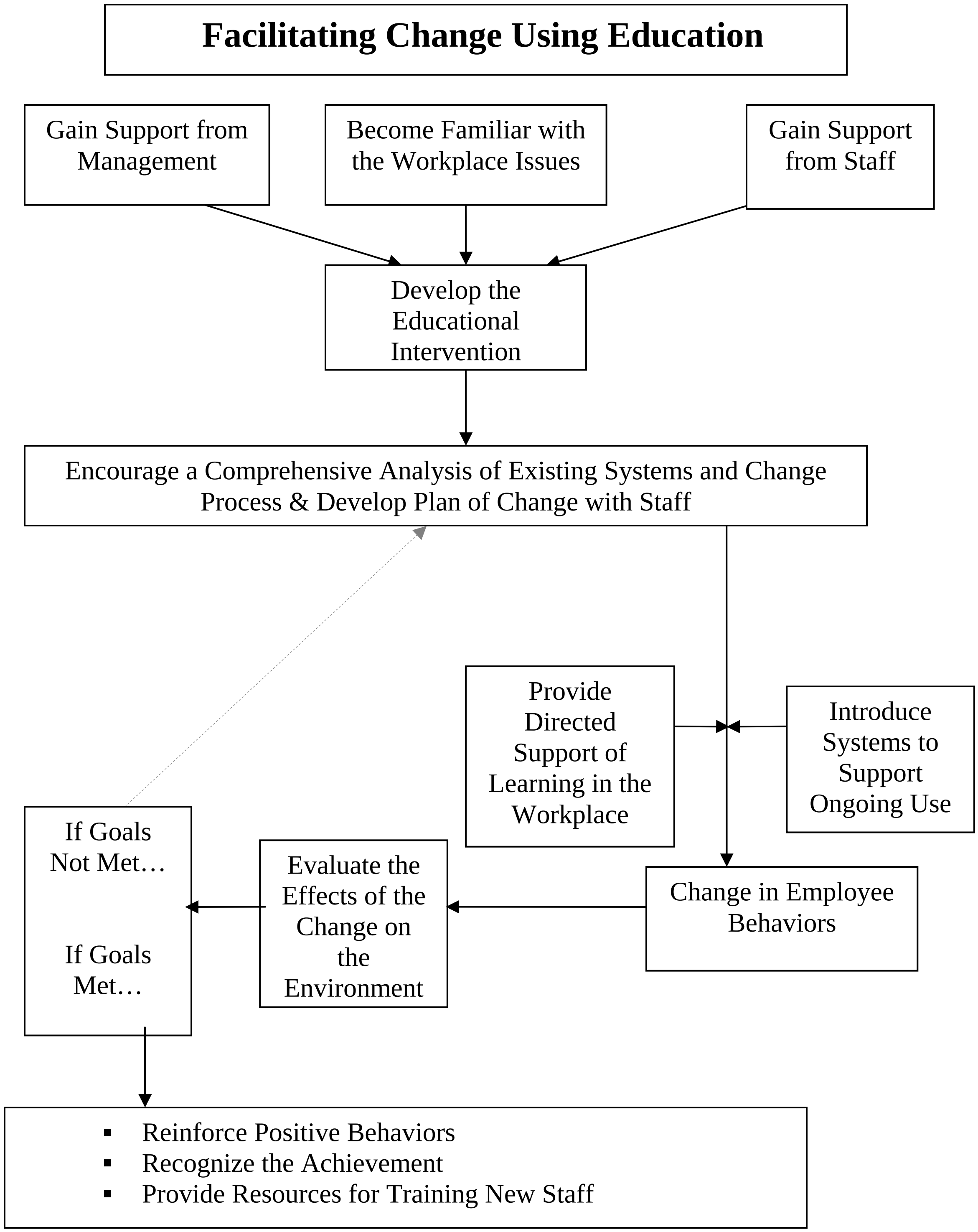


Figure 1. Education Model

3.0 RESEARCH DESIGN

The study used a time series, prospective, quasi-experimental design which received Institutional Review Board approval from both St. Clair Hospital and the University of Pittsburgh. Because noise is conducted over specific ranges, it is imperative to isolate the study area. It would be impossible to measure the effectiveness of noise reduction techniques of individuals randomly spread throughout the organization. To this end, targeting educational initiatives towards staff of specific units allowed the PI to more easily manipulate the independent variable than randomly selecting staff to participate in the study.

Table 1. Study Design

	Intervention Unit	Control Unit
December 2005	• Pre-intervention noise measurements obtained • Subjects receive letter explaining the study and inviting them to join	• Pre-intervention noise measurements obtained • Employees receive letter explaining the study and inviting them to join
January 2006	Tranquility Training for employees on PTU who agree to participate with initial staff survey completion	No intervention
February 2006	• Provide directed support in the workplace • Continued recruitment of PTU staff to complete surveys	Initial staff survey completion
February 2006	Post-intervention noise measurements	Post-intervention noise measurements
August 2006	• Post-intervention noise measurements • Staff surveys	• Post-intervention noise measurements • Staff surveys

3.1 SETTING

The Tranquility Training Program was delivered to staff on the Pulmonary Telemetry Unit (PTU) at a 300-bed community hospital. Another Intermediate Care Unit (IMC) with a similar architectural layout, patient population, and nurse staffing ratio was selected to serve as a control group. This comparable control group helped determine the likelihood that extraneous variables occurring in the organization influenced noise levels. The facility participating in the study was built in stages over the last fifty years. Architectural and structural design varies throughout the organization, depending upon the date of construction. The control unit was structurally similar to the study unit in both layout and design; and therefore minimized variations in noise conduction between the two units. Additionally, the two units have similar nurse to patient ratios and patient acuity. Because the number of staff present on the unit may affect the overall noise level, balancing the number of patients and nursing staff should provide comparable data. Finally, both patient populations wear telemetry monitoring. The incidence of alarms and other noise associated with cardiac monitoring should be similar.

3.2 RECRUITMENT

An informational letter was mailed to each staff member on the PTU and IMC via the interdepartmental mail system of the facility. The employees also received a letter from the unit manager indicating that there were no negative outcomes for staff that chose not to participate in the study. Two days before the class each participant who registered was sent an electronic mail reminder about the class. During the class session the participants on the PTU completed the initial surveys. During the two weeks of classes for the intervention unit, the staff on the control unit was mailed the surveys. At the end of the two week class sessions, final reminders and duplicate surveys were sent to members of both units as a final recruitment effort.

Five months after the educational session was completed, follow up surveys were sent via interdepartmental mail to all individuals who completed baseline measures. Individuals who did not return these surveys within two weeks were sent a reminder letter and duplicate surveys.

3.3 SAMPLE

Registered Nurses, Unit Secretaries, and Nurse Aids employed on PTU and IMC were included in the sample. The intervention unit, PTU, a 36-bed, step-down unit, admits a variety of patients, but primarily patients with chronic pulmonary disease admitted to an acute care facility for a variety of reasons. The unit provides telemetry monitoring in addition to standard nursing care.

The control unit, IMC, a 30 bed step-down unit, admits a variety of patients, but primarily patients admitted with cardiac symptoms. The unit provides telemetry monitoring in addition to standard nursing care.

The inclusion criteria were all employees who were regularly scheduled to work on PTU or IMC. New hires onto the units did not receive an intervention. There were no exclusion criteria. The number of PTU employees available for participation was 33 individuals; five unit secretaries, nine certified nurse aids, one unit manager, and twenty-eight registered nurses. The number of IMC employees available for participation was 40 individuals; four unit secretaries, nine certified nurse aids, one unit manager, and thirty-one registered nurses. The target sample size was 77 individuals, 100% of staff on the two units.

Unfortunately, many staff members did not participate in the educational intervention for the PTU. Fifteen of the thirty-three staff members on the intervention unit attended the training and an additional four individuals completed the surveys but did not attend class for an initial survey completion rate of 58%. Follow-up surveys were completed by twelve individuals for a 37% drop out rate. Three of the individuals on the intervention unit were not available to complete follow-up surveys due to staff turnover or leave-of-absence.

There are forty staff members on the control unit, yet only nine individuals completed the surveys for a 23% initial response rate. Follow-up surveys were completed by six individuals, producing a 34% drop out rate. There were no changes in staff from the control unit throughout the time of the study. Those who participated in the study were asked why other staff did not participate. Most replied that their peers were so busy; they did not want to add one more thing.

The majority of the participants on both units were female (96%) and Caucasian (100%). All of the staff who participated on the control unit had more than four years of experience in healthcare with 62% having four to ten years experience and the remaining 38% having eleven to twenty years experience. On the intervention unit 21% of the participants had zero to three years experience, 42% had four to ten years experience and 37% had more than eleven years experience. The units had comparable educational backgrounds with 38% Bachelor’s and 50% Associate’s Degrees in the control unit and 26% Bachelors and 53% Associate’s Degrees in the intervention unit. The intervention unit had a younger nursing staff than the control unit with 37% under the age of thirty compared to 12% on the control unit. The Fisher’s Exact Test indicated that there were no differences between groups on these demographic variables.

Table 2. Demographics

No. (%) of staff				
	Control n=9	Intervention n=19	Total n=27	Fishers Exact Test
Employment Status				
Full-time	7 (78)	14 (74)	21(78)	0.60
Part-time	2 (22)	5 (26)	7 (26)	
Gender				
Female	8 (88)	19 (100)	26 (96)	2.19
Male	1 (12)	0	1 (4)	
Experience in Healthcare				
0-4 years	0 (0)*	4 (21)	4 (15)	1.83
4-10 years	5 (62) *	8 (42)	13 (48)	
>11years	3 (38) *	7 (37)	10 (37)	
Education				
Bachelor’s	3 (38) *	5 (26)	8 (30)	0.97
Associate’s	4 (50) *	10 (53)	14 (47)	
Diploma	1 (13) *	3 (16)	4 (15)	
High school	0	1 (5)	1 (4)	

Table 2. Demographics (continued)

Age				
<30 years old	1 (12) *	7 (37)	8 (30)	2.86
31-40 years old	1 (12) *	4 (21)	5 (19)	
41-50 years old	4 (50) *	4 (21)	8 (30)	
>51 years old	2 (25) *	4 (21)	6 (22)	
Role				
Registered Nurse	8 (88)	14 (74)	22 (81)	1.36
Unit Secretary	0	3 (16)	3 (11)	
Nurse Aid	1 (12)	2 (11)	3 (11)	

*1 demographic survey was incomplete

3.4 STUDY APPROVAL

This study was approved as exempt by the University of Pittsburgh Institutional Review Board (IRB). Once the University of Pittsburgh approved the study, St. Clair Hospital IRB reviewed the proposal and approved the study as well.

3.5 INTERVENTION

The principal investigator (PI) offered the two hour Tranquility Training program at various times over a two-week period in order to reach staff working on all shifts. An outline of the Tranquility Training program is detailed in Appendix 5. A provocative lecture method supported by PowerPoint was used to disseminate the information. Provocative lectures are used to convey information then engage the participants in dialogue before transitioning to the next topic. The Tranquility Training included information on noise pollution and the psychological and physiological effects of noise on patients and employees. In addition, after watching a customer service video entitled, "It's a Dog's World," staff compared the convenience and warmth of the veterinary care with the bureaucratic, fragmented healthcare system, specifically identifying ways our hospital might be viewed by patients. The employees were given information on the baseline noise measurements from their unit. The group then engaged in discussion focused on reflecting on current practice, framing the problem, and developing an action plan to address specific noise issues. Without commitment of staff, the transfer of knowledge may not be effective in changing practice. By involving the staff in the development of noise reduction protocols the process was personalized and the facilitator was able to identify barriers and issues present in the workplace. Role-playing was used by the staff to practice how they would interact with peers who were creating excessive noise. The group felt obtaining an objective measure of noise was an important element that should be the focus of these dialogues. After the Tranquility Training, staff was given handouts of the rationale for the study and a grid depicting common noise levels.

Over the course of the next two weeks, numerous issues that negatively affected noise were corrected per the staff requests during class. Signage directing staff, visitors, and patients to be conscious of noise levels were placed throughout the unit, and some unit practices were modified, such as telephone ringers. Plans were put in place to deal with interpersonal issues among the staff by leaving an inexpensive noise meter on the unit so staff could keep track of times when noise was high and have an objective value when reminding staff to lower their voices. A detailed list of changes is included in the appendix 7.

3.6 MEASURES AND DATA COLLECTION PROCEDURES

3.6.1 Noise Measures

Noise can be measured in two ways with a sound level meter or a dosimeter. A sound level meter provides a reading of sound heard at a specific moment. A sound level meter will not accurately reflect noise levels if the sound level fluctuates. Dosimetry monitoring provides information on the exposure to noise that an individual would experience over a specified amount of time. It accounts for both the volume of sound and the duration of sound. Because sound is based on a logarithmic scale, it cannot be added or averaged in the usual way. Metrosonic's Noise Dosimeter provides readings of noise taking into account whether the noise is consistent, variable, or intermittent by using a variety of noise related categories that considers volume and time. All the noise readings were done using the slow response rate and an "A" weighted scale, so only sounds perceived by the human ear were included in the noise measures. Results were recorded as average sound level (LAV), which averages all noises heard over the measurement period. If a specific noise lasts 60 seconds, the dosimeter calculates the impact of that sound during the 45-minute period, factoring in how long different *specific* sounds last.

The Projected TWA (PTWA) is calculated using the projected time of eight-hours. This value represents what the listener would hear if noises present in the 45-minute sample based on LAV, were duplicated over a specific amount of time.

Exceedance level (EL) was also measured. The EL was set at 45 dB; the meter provided a reading in percentages of the amount of time the noise level exceeded the desired level of 45 dB. For example if the noise level remained below 45 dB for half of the reading, the EL would be 50%.

Noise was measured at three separate time periods: pre-intervention, and one- and six-months post intervention. Each measurement period lasted forty-five minutes. Measures of noise with Metrosonic's Noise Dosimeter were collected on each unit in various patient rooms in the general proximity of the patient's head of bed as well as in the nursing station.

Figure 2. Metrosonic's Noise Meter

The device was angled and centered to duplicate the position of ear canal closest to the door of a patient resting in bed. Noise measures were also taken in the nurses' station. In this area, the device was angled and centered to duplicate the position staff members assume while documenting and transcribing orders in the workstations. Several control variables (room zone, time and day of the week) that were posited to affect noise on the units were factored in when randomly generating the data collection scheme in order to ensure similarity of noise measurements between the two units:

3.6.1.1 Room Zone

Three measurement zones were identified based on their location or proximity to high traffic areas (elevators, entrance doors utility rooms). Zones 1-3 are associated with more activity by hospital staff. Proximity to these areas would potentially increase noise levels.

- Zone One- these rooms are adjacent or across from the nurses' station and were expected to be the loudest areas for patients in the unit.
- Zone Two- comprised of rooms that are near traffic areas but not at locations where staff are likely to congregate and were expected to be the second loudest areas for patients.
- Zone Three- the nurses' station where telephone and computer access is located. Charts are stored here as well as unit stock medications.
- Zone Four- comprised of rooms located away from traffic areas and functional areas. These locations were expected to be the quietest areas. These zones were not measured.

3.6.1.2 Day of the Week

Days of the week were divided into three different categories. Each weekday zone was differentiated according to number of admissions and discharges and days of lower census.

- More admissions and discharges occur on Mondays and Fridays.

- Tuesday through Thursday remains relatively stable in regards to admissions, discharges and census.

- Lower census occurs on Saturdays and Sundays. This was anticipated to be the quietest times, thus noise was not be measured during the weekend.

3.6.1.3 Time of Day

Times were divided into categories based on activity levels in the unit.

- Busy Times- hours when meal delivery, scheduled laboratory testing and medical imaging testing are routine. [08:01-09:00, 12:01-13:00, 17:01-18:00, 04:01 to 07:00]

- Shift Changes- the thirty to sixty minutes when shifts overlap to provide report [07:01-08:00, 15:01-16:00, 19:01-20:00, 23:01-24:00]

- Routine Activities- no anticipated activity or noise generating events occur during the remaining times. [09:01-12:00; 13:01-15:00; 16:01-17:00; 18:01-19:00; 20:01-23:00; 00:01-04:00]

Date, time, and location of measures were randomly assigned following the scheme in the following table, where: C=Control Unit; I = Intervention Unit, combined with zone/day/time codes detailed above. This ensured that each combination of day/time/location was sampled 2 times on each unit.

Table 3. Noise Measures Plan

Monday or Friday	Zone 1	Zone 2	Nurses Station
Busy Times:	**1**	**2**	**3**
Routine Activities	**4**	**5**	**6**
Shift Changes	**7**	**8**	**9**
Tuesday, Wednesday, or Thursday	Zone 1	Zone 2	Nurses' Station
Busy Times	**10**	**11**	**12**
Routine Activities	**13**	**14**	**15**
Shift Changes	**16**	**17**	**18**

Randomization Schedule
Set #1: C6, C14, I16, C13, I13, I4, I7, C16, C17, I8, I12, I17, C9, I14, C4, I6, C18, I11, C11, C10, C1, C7, C12, I10, C5, C15, I18, I3, I1, I2, C3, C8, I15, I5, I9, C2
Set #2: C18, I12, I6, I1, I2, I17, I9, C14, I10, I5, C4, C15, I8, I7, C7, I3, I16, C6, I15, C3, I14, C11, I13, C5, C16, I4, I18, C2, C10, C8, I11, C9, C13, C1, C12, C17

3.6.2 Measures of Staff Perception

Survey Instruments were used to measure staff knowledge and attitudes towards noise reduction techniques. The instruments were completed by nurses on both units. To maximize participant confidentiality, a unique identification code was assigned to each participant. The code enabled comparison of responses over time, yet enabled anonymous submission of data. A log containing the participant name and identification code was kept by the PI and was destroyed upon completion of the data analysis. The log was maintained in a secure location and accessible only to the PI. Surveys were also used to measure the cognitive and affective outcomes after the Tranquility Training. All surveys were adapted with permission from the tools used by Ryan, Brigham, and Elkins (1995) to reflect the goals and content of the Tranquility Training program.

Validity for the original instruments was established through review by a national panel of ten content and research design experts (Campbell, 1995.) Revisions were made in scale items, scale format, and scoring. The instruments were again reviewed by a research design consultant and revisions were made in scale items (Campbell, 1995.) Internal consistency reliabilities are reported from a study conducted by Campbell (1995) (N=52) using Cronbach alpha technique. Although the subject nouns were changed, the sequence, content, descriptors, and verbs were not modified. A panel of three experts in educational survey design and research methodology from the University of Pittsburgh evaluated the content validity of the amended tools and the congruence between the original and modified measures.

3.6.2.1 Social System of the Organization (SSO) (Ryan, et al., 1995)

This 21-question instrument assesses the extent to which subjects believe that their organization is supportive of change. Subject respond to each item on a five-point Likert Scale ranging from Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5). The scores range from 21 to 105, with 105 being most characteristic of the social system of an organization that is supportive of positive change. Statements written with negative connotations were reverse scored. Individual scores were computed by summing item responses after reverse scoring. Good instrument reliability is supported in three studies: Campbell and Wolfe each reported internal consistency reliabilities of alpha= .87 in their studies (Campbell, 1995; Wolfe, 1996). Elkins (1996) reported a test-Retest reliability of r=.83. In this study, the SSO demonstrated reliability with a Cronbach's alpha of 0.84; this is greater than the 0.80 goal for an established instrument.

3.6.2.2 Educational Offering and Change (Ryan, et al., 1995)

This 13-item scale measures perceptions of change on a five-point Likert Scale. The scores can range from 13 to 65 points with sixty-five being the most positive perceptions of change. Response options are on the same five point scale ranging from Strongly Disagree (1) to Strongly Agree (5). The statements written with negative connotations were reverse scored prior to creating a sum scale score. Higher scores [closer to sixty-five] indicate that the employee perceives reducing noise on the unit as a positive change. Internal consistency and test-retest reliabilities have been supported in three studies (Campbell, 1995; Wolfe, 1996; Elkins, 1996.) This survey demonstrated internal consistency with a Cronbach's alpha of 0.81 in this study.

3.6.2.3 The Program Evaluation (Ryan, et al., 1995)

The program itself is evaluated on the following components:

(a) Design of the offering;

(b) Content;

(c) Adult education principles;

(d) Speaker's presentation.

This 16-item scale measures perception of the program on the same five-point Likert Scale with response option ranging from Strongly Disagree (1) to Strongly Agree (5). Scores can range from 16 to 80, with higher scores reflecting a more positive evaluation of the program. There is no reverse scoring with this instrument. Instrument reliability has been evaluated in three studies: r=.92 (Campbell, (1995) r=.91 (Wolfe, 1996), Test Retest r=.84 (Elkins, 1996). The Program Evaluation demonstrated reliability in this study with a Cronbach's alpha of 0.98.

3.6.2.4 Noise Reduction Perceptions

This ten-item survey, developed by the PI, uses a visual analog scale to solicit the participants' ideas about noise reduction. The tool was reviewed for validity by a three member panel of doctorally prepared educators at the University of Pittsburgh.

Participants were instructed to mark the survey based on their perception of events over the past week. The noise reduction elements that are measured include:

- Current efforts
- Benefits
- Ownership or responsibility
- Noise perceptions

These statements were designed to provide insight on participants' baseline perceptions and the change in perceptions after education, directed support, and systems augmentation in the work place. The visual analog scale is five inches long. Measurements to the center of the "x" indicate the employee's perception. Scoring is determined through summation of items one through eight and individually on items nine [noise perception] and ten [ideal noise level.]

- Frequency of activities to reduce noise by self and peers is scored as "never to always" with "sometimes" as a middle selection. The higher the numeric response to this question the more activities the employee recalls performing in the last week in an effort to reduce noise

- Relationship between noise reduction and patient and employee satisfaction is scored as a “very negative effect” to a “very positive effect” with “no effect” as a neutral selection in the middle of the scale.
- Comparing ability of staff and management to be successful in reducing noise is scored as a “not at all successful” along the left side of the scale, with “somewhat successful” in the middle of the scale, and “completely successful” on the far right of the scale.
- Perception of current and ideal noise levels on unit are scored on a continuum with “silent” in the far left position followed by “library,” “crowded restaurant,” “vacuum,” and “motorcycle” in the far right position.

In this study, the Noise Reduction Perceptions Survey items one through eight had a Cronbach’s alpha of 0.62. This is an acceptable score for a new instrument.

3.6.2.5 Data Entry and Analysis

The PI entered the data from the surveys directly into SPSS for Microsoft Windows (version 14.0. SPSS INC., Chicago, IL.) using SPSS Data Editor. After all data was entered, the PI visually verified entries by comparing to source documents for 20% of the data. For any errors the previous five entries were verified until no errors were found. Data management was the responsibility of the PI and her advisor, Dr. Donovan, with the assistance of Dr. Sereika as needed. Procedures are in place in the Center for Research and Evaluation (CRE) in the School of Nursing and in St. Clair Hospital to maintain the security and confidentiality of subject information. Multiple levels of password protection were employed to ensure data security. All study data were backed up nightly. No subject identifiers other than the subject's assigned unique study identifier were contained in any of the data files. A list of subject names which is linked to the subject identification code numbers was kept in a locked file accessible only to the PI and her mentor. This list will be destroyed upon completion of data analyses.

Data were analyzed using SPSS for Microsoft Windows (version 14.0. SPSS, INC., Chicago, IL.) Appropriate descriptive statistics were used to categorize demographic characteristics of staff on each unit given the variable's level of measurement and empirical dispersion. For continuous descriptors, means and medians were used as measures of central tendency and standard deviations and ranges provided summary measures of dispersion. Frequency counts and percentages were used to summarize categorical descriptors and the mode was used as a measure of central tendency. Fisher's exact test was used to compare categorical descriptors while the Mann-Whitney U-test was used to compare continuous type descriptors. Exploratory analyses, including computation of descriptive statistics, were also conducted on measures of noise levels (LAV and PTWA) based on location and time of day on the two units. Analysis of variance was used to compare units based on key variables (unit noise levels, nurses' perceived noise levels, nurses' perception of organizational culture, knowledge of noise awareness, effects of noise, and noise reduction strategies) will be described for each of the two nursing units.

Finally, the effect size of the educational program was determined by comparing mean change scores on the noise variables between the unit where nurses received the program and the control unit. Specifically, for each variable, the estimated effect size, standardized difference of the means, was determined by subtracting the mean change score on the control unit from the mean change score on the intervention unit, and dividing this by the full sample standard deviation.

4.0 RESULTS

4.1 NOISE

On the intervention unit, the baseline LAV noise levels of 67.41 dB showed a negligible decrease to 67.39 dB at four-weeks and then a slight increase to 68.82 dB at six-months. The control unit LAV started at 66.73 dB and decreased to 65.7 dB at four-weeks, with an increase to 69.06 dB after six months (See Table 4). The intervention effect size for baseline to one month is -0.23 showing an increase in noise levels on the intervention unit compared to the control unit. The intervention effect size for baseline to six months is 0.24showing an increase in noise levels on both units.

Table 4. LAV Noise Level at Baseline, 1- and 6-Months, n=36

Unit	Baseline Mean(SD)	1 Month after Intervention Mean(SD)	6 Months after Intervention Mean(SD)
Intervention Unit	67.41(3.86)	67.39 (3.17)	68.82 (3.02)
Control Unit	66.73 (3.76)	65.7 (6.17)*	69.06 (4.93)

* n=35

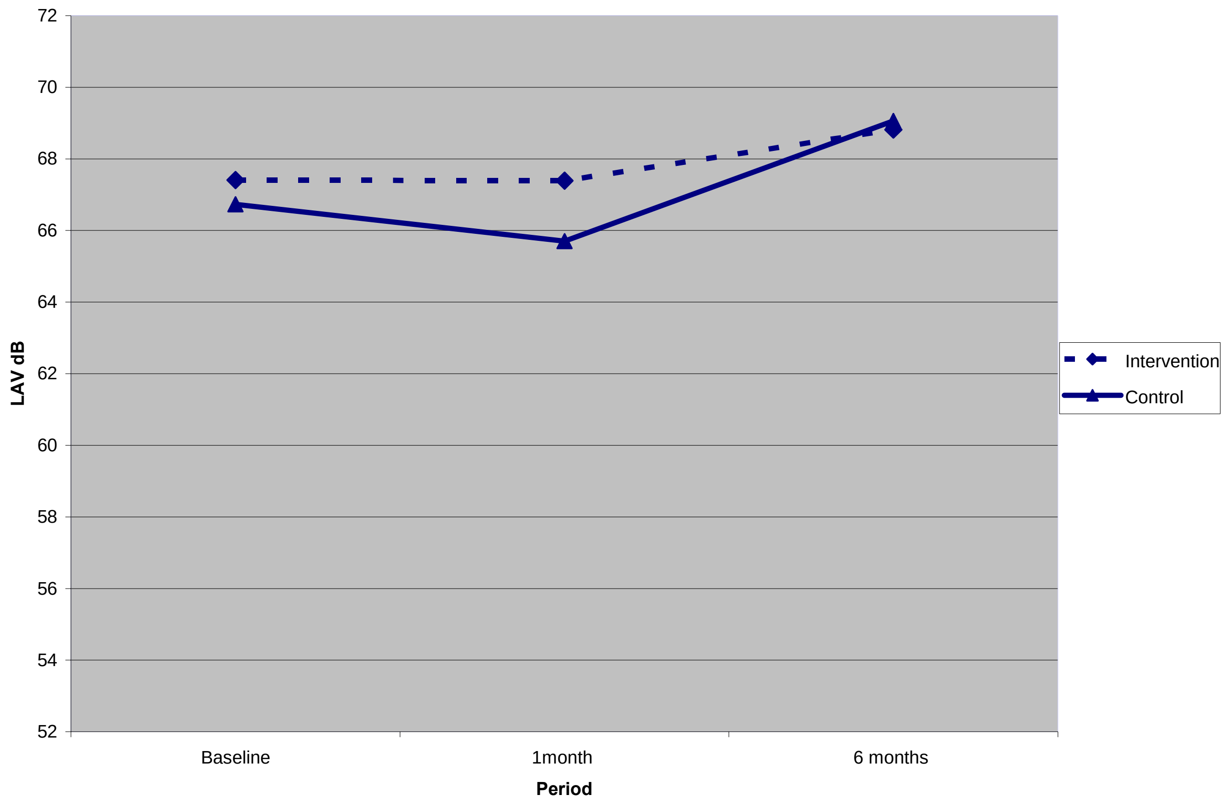


Figure 3   Estimated Marginal Means for LAV by Unit

The LAV Estimated Marginal Means (See figure 3) depicts the decline in noise at one month on both units, with the slight increase after six-months.

PTWA measures showed reductions in mean sound levels from baseline to one month after the intervention on both units. While each unit had an increase in dB from one month measures to six month measures, both remained quieter than at baseline (Table 6). However EL at baseline, one month and six months after the intervention for both units was 100%. Closer examination of the serially collected noise data showed that at no time during the total 9675 minutes when noise was measured did the noise level lower to the EPA recommended level of 45 dB.

Table 5. PTWA Noise Level at Baseline, 1- and 6-Months, n=36

Unit	Baseline Mean(SD) {EL}	4 Weeks after Intervention Mean(SD) {EL}	6 Months after Intervention Mean(SD) {EL}
Intervention Unit	65.64 (4.49) {100%}	57.95 (2.55) {100%}	59.73 (3.02) {100%}
Control Unit	64.35 (4.77) {100%}	55.9 (7.88) {100%}*	60.26 (3.62) {100%}

*n=35

The PTWA Estimated Marginal Means (See figure 4) depicts the decline in noise at one month on both units, with the slight increase after six-months.

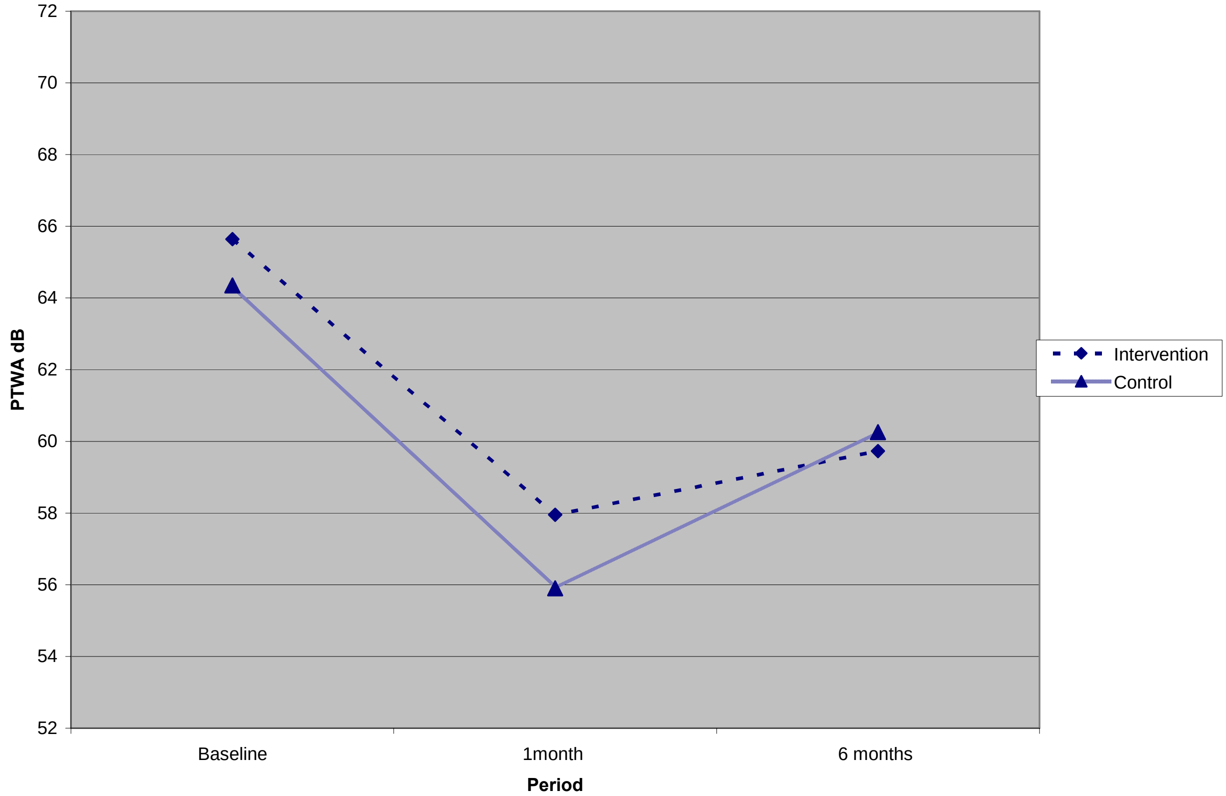


Figure 4. Estimated Marginal Means for PTWA for Unit

4.2 STAFF PERCEPTIONS

Based on F-test from one-way ANOVA, there were no significant between-group differences in means or medians from the summed scores for SSO, EOC, Noise Perception, and Program Evaluation surveys when compared based on age, role, education, part-time versus full-time status, or years hospital experience with the exception of Summed Scores for EOC and part-time or full-time status. Only the intervention unit had a statistically significant increase in SSO over time (Mean change score =8.25, SD=8.07, n=12, t(11)=3.54, p=.005). All other changes within groups were not significant. The effect size for the change in SSO for the intervention unit was d=1.02 (in SD units). This is large by behavioral science standards.

4.2.1 SSO Survey

Summary scores for the SSO survey ranged from 60 to 86 with a mean score of 72.8 for those who attended the Tranquility Training. After six months the scores ranged from 67 to 92 with a mean score of 79.7. For the control unit, sum scores for the SSO Survey ranged from 48 to 84 with a mean score of 74. After six months, control unit scores ranged from 72 to 94 with a mean score of 81.5.

4.2.2 EOC Survey

Sum scale scores after reverse scoring for the EOC Survey ranged from 47 to 57 [ceiling score 65] with a mean score of 50.9 for those who attended the Tranquility Training. After six months the scores ranged from 42 to 58 with a mean score of 49.4. For the control unit, sum scores for the EOC Survey ranged from 35 to 59 with a mean score of 38.37. After six months, control unit scores ranged from 42 to 58 with a mean score of 48.13.

4.2.3 Noise Perception Survey

Summary scores for the Noise Perception Survey ranged from 18.85-32 [ceiling score 40] with a mean score of 27.08 for those who attended the Tranquility Training. After six months, the scores ranged from 23.2-32.5 with a mean score of 28.76. For the control unit, sum scores for the EOC Survey ranged from 22.55-34 with a mean score of 26.46. After six months, control unit scores ranged from 24.05-33.9 with a mean score of 28.42.

4.2.4 Program Evaluation

Scores for the Program Evaluation survey for the intervention unit ranged from 60 – 80 with a mean score of 71.93 for those who attended the Tranquility Training suggesting that the staff who attended perceived the program as a positive experience.

Table 6. Descriptive Statistics of Nursing Surveys- Baseline and 6- months

	Intervention Unit Mean (SD) observed range	Control Unit Mean (SD) observed range
Social System of the Organization		Possible Range 21-105
Baseline Mean (SD) Observed Range	72.8 (7.48) 60-86 n=19	74.0 (11.92) 48-84 n=9
6-months post intervention Mean (SD) Observed Range	79.7 (7.42) 67-92 n=12	81.5 (9.58) 72-94 n=6
Education and Change		Possible Range13-65
Baseline Mean (SD) Observed Range	48.84 (4.43) 40-57 n=19	47.0 (8.35) 34-59 n=9
6-months post intervention Mean (SD) Observed Range	48.92 (5.02) 42-58 n=12	48.67 (6.06) 42-58 n=6
Noise Perception Survey		Possible Range 0-40
Baseline Mean (SD) Observed Range	27.08 (3.15) 18.85-32 n=19	26.46 (4.79) 22.55-34 n=9
6-months post intervention Mean (SD) Observed Range	28.76 (3.02) 23.2-32.5 n=12	28.42 (3.28) 24.05-33.9 n=6
Program Evaluation		Possible Range 16-80
Intervention Unit Immediately after Training	71.93 (7.53) 60-80 n=15	NA

Only the intervention unit had a statistically significant increase in SSO over time (Mean=8.25, SD=8.07, n=12, t(11)=3.54, p=0.005). The effect size for this change was large at d=1.02. Table 7 summarizes change scores, t-statistics, p-value and effect size of the change for each survey.

Table 7. Summary Statistics of Nursing Surveys- Baseline and 6- months

	Mean change score	SD	t(df)	p	Effect size (d)
Control Unit					
SSO	5.00	6.39	t(5) =1.92	0.11	0.78
Educ & Change	-1.17	5.27	t(5) = -0.54	0.61	0.22
Sum of BC scale	0.63	3.12	t(5) = 0.49	0.64	0.20
Intervention Unit					
SSO	8.25	8.07	t(11) = 3.54	0.005	1.02
Educ & Change	-0.83	6.44	t(11) = -0.45	0.66	0.13
Sum of BC scale	1.06	4.78	t(11) = 0.77	0.46	0.22

4.2.5 Noise Perception Statistics

Findings from the final two elements of the Noise Perception Survey using visual analog scales to establish ideal noise levels and perceptions of noise levels on the units indicated that staff in both groups felt they had reduced noise. A perceived noise level on the intervention unit at baseline was 6.42, at six months staff perceived a level of 4.22 (on a 0-10 scale). On the control unit, staff perceived noise at baseline was 7.2 out of ten, at six months staff perceived a level of 6.23 (out of a maximum of ten.) The positive change score indicates that the change was in the desired direction. Change scores did not differ by unit for either perceived current noise level [t(16) = =.79, p = .44] or for ideal noise level [t(16) = -.54, p=.60].

Table 8. Changes in Perceived Noise dB by Unit from Baseline (T1) and 6- Months (T2)

	Unit	n	Mean Change Score	Std. Deviation	t(df); p
T1-T2 Change Scores Perceived Noise Level	Intervention	12	0.4	0.81	t(11)=1.74; p=0.11
	Control	6	0.69	0.53	t(5)=3.19; p=0.02
T1-T2 Change Scores Ideal Noise Level	Intervention	12	0.21	0.64	t(11)=1.16; p=0.27
	Control	6	0.38	0.52	t(5)=1.78; p=0.14

5.0 DISCUSSION

It is important to differentiate between LAV and PTWA calculations when considering the results from this study. The LAV levels did not demonstrate much change over time, while the PTWA levels showed improvement that remained to some degree 6-months later. The difference between these two types of measures is that LAV takes into account the average sounds during the forty-five minutes of dosimetry measurement while PTWA indicates what the noise level would be if that intensity continued for an eight-hour period. PTWA factors in quiet times and projects how the high and low levels would be perceived by the listener if the 45-minute sample was repeated for the ensuing 8-hours. One possible explanation for the lowered PTWA values is that consistent lowered background noise on the unit when averaged over eight-hours was more significant than when averaged over only the forty-five minutes. This reduction in PTWA of six to nine dB on each of the units should make a noticeable impact, since a reduction of six to ten dB is perceived by the human ear as ten times quieter.

Baseline noise levels were significantly louder on both units than the usual conversant level of 56-60dB. This data support the results of numerous studies showing that conversations in hospitals occur at levels louder than normal (Hilton, 1985; Stephens, 1995; Kahn, 1998; Holmberg, 1999; Morrison, 2003; Cmiel 2004). Interestingly, noise levels (as measured by PTWA) decreased on both units over time. One possible explanation for reductions in noise levels across both units over time is that the frequent monitoring of noise levels on the units acted as an intervention in itself. The peer dynamics to promote a healing environment or to at least score well were readily evident during the measures on both units. When the noise measurement was started on the control unit, the staff would ask others to be quiet because the measure was being taken or remark that they were going somewhere else since did not want to "get in trouble for being too loud." The remarks on the intervention unit usually dealt with outcomes; often the staff would ask how they were doing or if they were quieter than the control unit. Because the staff was engaged in the intervention and invested in the outcomes, they did not view the noise measures as punitive but embraced the opportunity to improve.

The data from the Noise Perception surveys are consistent with these PTWA findings as nurses on both units perceived that noise levels were decreased from baseline to the one- and six-month measures. It is very interesting to note that noise levels remained consistently above the EPA recommended range of thirty-five to forty-five dB, as evidenced by the EL scores of 100% across all measures. This is consistent with other studies on hospital noise levels; no studies to date have reported levels below the EPA standard. While the EPA recommendation may be an ideal level, it may not be attainable in current hospital environments.

Both groups in this study identified excessive noise as a significant issue on their units and indicated a desire to lower noise levels as evidenced by high scores in the EOC surveys. The increasing scores in the SSO surveys demonstrated that both groups felt that the culture of the hospital empowered nurses to impact their unit environments. The sum scores for the SSO on both units increased over the six months between the baseline and the follow up noise measures indicating a culture more supportive of change. This variance may be explained by the hiring of a new Chief Executive Officer in the hospital. Additionally the intervention unit hired a replacement Nurse Manager between baseline measures and six month follow up measures. Both units had an increase in sum scores of the NP surveys indicating an increase in activities and valuing of noise reduction.

The intervention group reported satisfaction in the Tranquility Training; with the highest scores in items conveying an environment of trust, actively engaging in the learning process, and relating this project to their past experiences. These elements are critical to the success of a cultural change program. At the six month follow up, the staff surveys indicated that they were still committed to reduce noise, motivated to change, and perceived that the environment was conducive to change. With such a supportive staff an extension of this intervention would be feasible.

In order to optimize the impact of a follow up study, increasing staff recruitment in the efforts would be of paramount importance. Another improvement in the study would be to extend the education to other departments who perform activities on the unit, such as dietary, pharmacy, and maintenance. Although more than half of the staff on the intervention unit attended the Tranquility Training, those who did not attend could have a significant impact on noise levels and cultural change. This limited participation may have been a major factor in the lack of statistical significance in noise level reduction. The study could also be duplicated hospital-wide with a similar hospital as a control group or as a time series design without a control group, simply comparing noise levels over time. The noise study most similar to this design was conducted by Kahn, et al in1998. This study used behavioral modification to effect noise levels. While the study demonstrated successful reduction in noise; there was no follow up on its effectiveness over time.

The detailed data on noise levels provide a rich frame of reference for other organizations that may want to reduce their noise levels. Noise data from most other studies were obtained from specialty units such as intensive care or post anesthesia recovery. Any unit's baseline levels can be compared to those noted in this study in order to determine if specific issues exist in nursing units near doors and elevators, in or near the nurses' station, on specific days of the week, or during specific unit activities. Although those factors did not influence noise levels in this study, if identified as an issue, the unit could focus activities on reducing this impact.

There were limitations in the study including a small and homogenous sample which may not be representative of Registered Nurses and in-patient hospital staff especially in regards to age, race, and gender. Many extenuating factors were introduced over the course of the study such as a new Chief Executive Officer in the hospital and a change in Nurse Manager on the intervention unit. The impact of these organizational changes cannot be determined. The surveys were disseminated and colleted by the PI, and this method of distribution may have introduced a bias. As a result it is difficult to determine if participants were completely objective in their disclosure. In addition, the study is limited because of the small sample size and response rates from initial survey distribution and follow up surveys.

In repeat studies, elimination of the staff evaluation surveys would decrease contamination of the control group. In addition, discrete capturing of noise measures would make the noise measures more representative.

6.0 CONCLUSION

Prior to the initiation of this study, the intervention unit had been attempting to reduce noise as part of a customer service initiative. The manager provided staff with a list of strategies including:

- Using “inside voices”
- Holding discussions in the nurses’ station instead of hallways
- Reducing unnecessary conversations
- Eliminating the use of the intercom system after 21:00
- Closing doors, when appropriate, at 21:00

The plan included one element to evaluate effectiveness: “Night shift will be reminded about patient complaints regarding high noise levels on their shift.” No other measures of effectiveness were established.

The control unit had also been attempting to reduce noise prior to the initiation of this study. The manager had discussed these strategies during a staff meeting:

- Relocating the unit secretary to a secluded location
- Reducing unnecessary conversations
- Closing doors, when appropriate, at 21:00

No measures of effectiveness of this initiative were established.

While the nurses and management staff had plans and interventions to reduce noise, the lack of objective measures creates a nebulous goal with no ability to evaluate if specific interventions are affective or not. This study provides the units with a format for evaluating noise levels, a cultural change model for engaging staff, and a frame of reference for comparing noise levels on in-patient units. By using cultural change theory to guide unit level changes and including the staff surveys in the follow up, we were able to measure staff commitment and motivation with the project in addition to the noise levels. Ingersoll, et al (2000) advised hospitals to, “Empower nurses to create and manage their own healthy work environments” in order to promote recruitment and retention. Since this staff was invested in the process, the model designed by Shanley was an ideal format to implement this change. Noise monitoring also gave staff an objective mechanism for measuring their successes in reducing noise.

Whether nursing education and cultural support can impact noise reduction remains a valid question that requires further research. This study supports ongoing monitoring of noise levels with immediate feedback to staff and other individuals on the unit. Certainly maintenance issues that contribute to noise should be routinely corrected, ideally at scheduled intervals and staff should continue to participate in discussion on how to improve unit environments. As new structures are built or existing units are renovated inclusion of noise reducing materials and designs should be included to reduce extraneous sound. Innovative communication devices that do not contribute to background noise should also be investigated such as text messaging devices. Awareness of noise levels and knowledge of ongoing monitoring made an impact in noise reduction and should be included as part of routine unit processes.

APPENDIX A. Social System of the Organization

The following questions relate to the social system of your work environment. Consider initiatives to reduce noise when answering these questions. Please place an "X" in the box that corresponds to your opinion of the work environment.

Key: 1=Strongly Disagree (SD) 2=Disagree (D) 3=Neutral (N) 4=Agree (A) 5=Strongly Agree (SA)	SD	D	N	A	SA
The organization encourages staff participation in the decision making process.	1	2	3	4	5
This nursing department values staff development.					
Leaders in nursing do not support change.					
I usually participate in my unit's decisions.					
Important information is seldom shared on my unit.					
Communications are usually effective in the organization: top-down, bottom-up, & laterally.					
Reducing the noise on our unit will be seen as benefiting the care delivery system.					
Reducing noise on our unit will be seen as negative by my colleagues.					
Feedback is given to staff after leaders seek input about ideas.					
Departmental councils/committees participate in decision-making process.					
Major change is manageable in this size of an organization.					
There are personal rewards for me to participate in reducing noise					
Staff on my unit value change to keep pace with trends.					
This organization has the flexibility to allow this change to be implemented.					
This institution does not value change.					
There are no monetary incentives to reduce noise on our unit					
Change is a norm in our environment.					
The philosophy of this institution supports change.					
Staff seeks input regarding organizational decisions.					
Generally, administrators in nursing are supportive of change.					
There are staff incentives to implement noise reduction strategies.					

<u>Comments</u>

Developed by M. Ryan, C. Brigham, and P. Elkins (1995). Edited and used with permission.

APPENDIX B. Educational Offering and Change

This questionnaire examines your perceptions of the program on noise reduction in relation to change. Directions: Read each statement and reflect on how it lends itself to the change process. Place an "X" in the box that represents your response.

Key: **1=Strongly Disagree (SD)** **2=Disagree (D)** **3=Neutral (N)** **4=Agree (A)** **5=Strongly Agree (SA)**					
Results of reducing noise are observable in practice.	**1**	**2**	**3**	**4**	**5**
Reducing noise is consistent with my values.	**1**	**2**	**3**	**4**	**5**
Attempts to reduce noise can be tested on one unit.	**1**	**2**	**3**	**4**	**5**
The nursing staff on 4-B can discusses the concept of reducing noise in language we understand.	**1**	**2**	**3**	**4**	**5**
Ways to reduce noise on our unit can be explained relatively easily.	**1**	**2**	**3**	**4**	**5**
Reducing noise on our unit is simple to understand.	**1**	**2**	**3**	**4**	**5**
Reducing noise on our unit can be broken down into components, which can be tried.	**1**	**2**	**3**	**4**	**5**
Other staff members will benefit from reducing noise on our unit.	**1**	**2**	**3**	**4**	**5**
Reducing noise on our unit is too complicated.	**1**	**2**	**3**	**4**	**5**
Reducing noise on the unit builds on my past experiences.	**1**	**2**	**3**	**4**	**5**
Reducing noise on our unit is advantageous to me	**1**	**2**	**3**	**4**	**5**
Reducing noise on our unit does not fit my needs.	**1**	**2**	**3**	**4**	**5**
Our current method of reducing noise is effective	**1**	**2**	**3**	**4**	**5**

Comments:

APPENDIX C. Permission

July 19, 2004

BRONWYNNE CARPICO RN BSN CCRN
214 ADELINE AVE
PITTSBURG PA 15228-2316
lilacRN@verizon.net

Dear Bronwynne:

The purpose of this letter is to grant permission to use the instruments developed by Ryan, Brigham, Elkins & Campbell to measure behavior changes following continuing education offerings for your thesis at University of Pittsburgh.

Social System of the Organization
New Ideas & You
Educational Offerings & Change
The Continuing Professional Education Offering
Program Skills Self-Evaluation (Quantitative)
Program Skills Self-Evaluation (Qualitative)

As requested in your letter, you may use the instruments for your research study. I would appreciate feedback from you on how the instruments work for your project.

I wish you continued success with your thesis and graduate studies.

Sincerely,

Marilyn Ryan
Marilyn Ryan, EdD, RN
Professor and Associate Director Graduate Program
MR/dp

Enclosures

APPENDIX D. Noise Reduction Perceptions

This survey evaluates your perception of noise on your unit. Please place an "X" along the line in a way, which best captures, your thoughts on noise reduction.

1. Identify how frequently you actively attempt to reduce noise on your unit

Never | Sometimes | Always

2. Identify how frequently others have encouraged you to reduce noise on the unit

Never | Sometimes | Always

3. Identify how noise reduction would affect patient satisfaction

Very Negative Effect | No Effect | Very Positive Effect

4. Identify how noise reduction would affect patient health outcomes

Very Negative Effect | No Effect | Very Positive Effect

5. Identify how noise reduction would affect employee satisfaction

Very Negative Effect | No Effect | Very Positive Effect

6. Identify how noise reduction would affect employee performance

Very Negative Effect | No Effect | Very Positive Effect

7. How successful can staff be in reducing unit noise

Not at All Successful | Somewhat Successful | Completely Successful

8. How successful can managers and administrators be in reducing noise

Not at All Successful | Somewhat Successful | Completely Successful

9. Identify the current noise level on your unit

Silent | Library | Crowded Restaurant | Vacuum | Motorcycle

10. Identify the ideal noise level on your unit

Silent | Library | Crowded Restaurant | Vacuum | Motorcycle

APPENDIX E. Educational Plan

- Verbalize sources of excess noise on their unit
- Identify opportunities for reducing noise on their unit
- Develop a plan for noise reduction
- Demonstrate approaches to align other staff in noise reduction strategies [role play] when their behavior produces excessive noise

- Educate the patient on the effects of noise on their recovery
- Involve the patient in decisions to minimize the impact of noise on their recovery
- Demonstrate noise reducing behaviors
- Align other employees on the noise reduction strategies when their behavior produces excessive noise
- Evaluate the effectiveness of noise reduction behaviors during their shifts

1. Complete pre-intervention surveys Time 15 minutes

2. Open with the vet-hospital video Time 30 minutes

3. Discuss some elements of nursing care that are sacrificed due to lack of time. Discuss the importance of those elements Time 15 minutes

- "Lack of time is not an excuse for mediocrity"
- True they are very busy, instead of excusing behavior develop a plan to change

4. Power Point Presentation Time 20 minutes

- Cost of an unhappy patient
- Effects of noise on patients
- Effects of noise on staff (Nicholas, et al. 1993.)
- Sources of noise [staff ideas] Do staff admit there is a problem?
- My role

5. Their role Time 30 minutes

[This portion will be led by the PI, who will document the contributions of the staff and summarize the notes from all sessions. A written summary will be provided to all staff with specific list of behaviors]

- Positive elements in place

- Areas to improve [compare ideal to real]
- Plan for change [policies, procedures, equipment, signs, obstacles to remove, develop goals
- Change theory
- How will they measure effectiveness

6. Role play scenarios to influence staff behaviors   Time 15 minutes
7. Summarize lecture content, plan, and employees role   Time 10 minutes

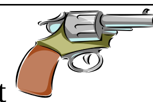
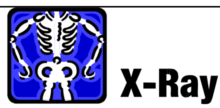
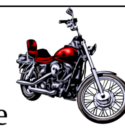
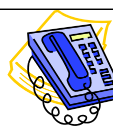
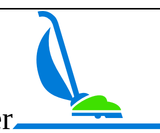
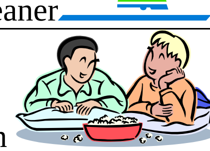
I will provide written guidelines, policies, directions, signs, after all sessions.

8. Post Intervention Survey Results   Time 15 minutes

Total class time   **2 hours**

Survey time   **30 minutes**

APPENDIX F. Sound Level Comparisons

Hospital Levels	Sound Level in A dB	Common References
	140	Gunshot 
	130	
	120	
	110	
 Portable X-Ray Machine	100	
	90	Motorcycle 
 Telephone Ring	80	Heavy Truck Traffic
PTU 67 decibels→ **IMC-66 decibels→**	70	Vacuum Cleaner 
	60	Conversation 
	50	Library 
35-45 EPA Recommended Level for Hospitals 	40-Day	
	30-Night	
	20	Whisper
	10	
	0	

APPENDIX G. STAFF IDEAS TO REDUCE NOISE

- All wheels on carts used for blood pressure equipment and bladder scanner were repaired and lubricated
- Supply doors in patient rooms were leveled, lubricated, and a buffer was placed along frame
- Medication cupboards in patient rooms were leveled and lubricated. Support staff was unable to place buffering material along the door frame since this prevented the automatic lighting mechanism in the cupboards from illuminating.

- All telephones with in the nursing station were adjusted so only ringers on phones used by Unit Secretary & Charge Nurse would sound.
- Telephone ringer volume was lowered.
- Television sound remained on pillow speakers. Directions for closed caption sound were placed in the unit to provide adjuncts to sound for patients who are hearing impaired.
- Staff were encouraged to communicate to patients and families that dimmed hall lights at 21:00 meant quiet time

- Yellow tape reading, “Quiet please, you are in a Healing Zone” were placed on the outside of every patient room.

- Nurses were instructed to keep patient doors closed
- A notice was placed on call light stations when a patient was hearing impaired or not able to speak directing the staff member to respond in person.
- Research articles were posted throughout the unit on how to calm a dementia patient with advisors such as soothing music on the CARE Channel, pharmacy medication review, familiar environments and schedules, etc.
- The staff opted to keep an inexpensive noise meter on the unit to trend noise levels and provide an objective reference when asking others to modify their speaking levels.

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