

Curing The Noise Epidemic

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ABSTRACT

Facility design does not stop when the fixed architectural and acoustical components are in place. Spaces live and breathe with the people who reside in them. Research and examples show that noise — auditory clutter — thrives on itself in hospitals. Whether the result of the wrong conversation in the wrong place or the right conversation in an unfortunate place, talk mixed with sounds of technology is shown to cause its own negative symptoms. Noise contributes to heightened anxiety and stress, medical errors, staff burnout, non-compliance with the dictates of the Health Insurance Portability and Accountability Act (HIPAA), and sleep deprivation. This paper offers ideas on how to reduce noise by design of the dynamic environment – equipment, technology, and staff protocols.

1. INTRODUCTION

In her *Notes on Nursing*, Florence Nightingale provided a detailed description of the environment of care. Using protocols and generic references to a 19th century built environment, she addressed everything from the air quality to the size of the bed, the ways in which patients were to receive information, and the nurse's schedule.

The concerns Nightingale expressed about noise were not subtle. Rather, they were direct in describing potential and anticipated harm that could come to patients due to their responses to erratic or unexpected sounds regardless of the source. She wrote that “necessary noise, that which causes anxiety or expectation, is what causes damage to the patient...unnecessary noise is the cruelest absence of care.” This definition sums up the annoyance response that, to this day, is difficult to measure or resolve. The solutions and practices prescribed in Nightingale's theory put the onus on the caregiver and the environment itself, not the building architect or engineer.

This said, Nightingale moved further in becoming directly involved with hospital design. She reviewed the blueprints for Johns Hopkins Medical Center and, as well, worked with the government of India to control public health epidemics that had been shown to be preventable. Regardless of her extending the responsibility of the patient environment into the engineering and construction arena, she never removed or lessened the overall responsibility of the nurse to assess and manipulate the built environment on a continual basis in order to ensure its therapeutic function. She held that what happened at the bedside was as much or more a part of environmental design as any wall.

The EPA recommended guideline values for continuous background noise are 45 decibels during the day and 35 decibels at night in patient rooms. However, a review of the literature by Ulrich and Zimring [1] indicates that many studies have shown that noise levels in most hospitals are much higher.

As Ulrich and Zimring point out, there are two general reasons why hospitals are excessively noisy. First, the noise sources are numerous and loud. They include paging systems, alarms,

bedrails, telephones, staff voices, ice machines, pneumatic tubes, carts, and noises generated by roommates. Second, the surfaces in hospitals – floors, walls, and ceilings – usually are hard and reflect sound rather than absorb it. They cause sounds to echo, overlap, and linger.

A third reason why hospitals are noisy might also be that there are few effective behavior protocols in place to make staff aware of their own noise levels on a continual basis. Occasional concern arises only in response to patient dissatisfaction, or incidental complaints by the staff. However, these are seldom linked to actual clinical outcomes in spite of research that shows a direct correlation. In defense of the staff, if the background noise level is high, so will follow conversation levels. Therefore, behavioral controls yield to verbal responses and speech intelligibility needs, and healthcare facilities are unable to set pre-determined volume limits.

Noise is one of the dynamic components in the hospital environment in that it is variable rather than fixed. Unlike the “built environment”—walls, ceilings, fixtures, furniture, and flooring—these transient factors are presumed to be under the collective control of the hospital staff. Therefore, according to patient satisfaction data, the entire organization can easily be judged according to its management or lack of management of sound.

Indeed, the challenge for the engineer is complex. Is noise an engineering problem or a cultural milieu gone astray? Are hospitals noisy cultures by tradition and practice or are they victims of poor design? Is noise to be handled solely within domain of acoustic treatment or does it require a more complex marriage between behavioral, technical, and physical components? If the latter, how does an engineer gain access and credence in organizational and behavioral domains that have, until now, not be considered engineering?

2. BACKGROUND

Noise is a primary cause of sleep deprivation and disturbance among patients [2]. It increases their anxiety and decreases their confidence in the clinical competence of the staff. It contributes to patient falls, causes confusion, and results in increased medication and restraint use. Furthermore, noise-induced stress is contagious, impacting the attendant family member who eventually winds up at the nurses’ station complaining about a variety of issues, each worsened by extraneous noise.

Sudden noises, such as a dropped tray or slammed door, may cause a “startle reflex” in patients, resulting in physiological responses such as facial grimacing, muscular flexion, increased blood pressure, higher respiratory rate, increased heart rate, and vaso-constriction [2]. Patients exposed to continuous extraneous noise can also experience altered memory, increased agitation, less tolerance for pain, and feelings of isolation. These environmentally generated symptoms are often medicated or otherwise treated in ways unrelated to their cause.

People who work in noisy environments for long shifts, day in and day out, also have similar stress-induced experiences [3]. They report everything from exhaustion, to burnout, depression, and irritability expressed at home. Interfering and distracting sounds have been shown to contribute to medical and nursing errors. The Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) [4] mentions noise as a potential risk factor related to

medical and nursing errors, stating that the ambient sound environments should not exceed the level that would prohibit clinicians from clearly understanding each other.

In answer to a reader question about the effect of music in the operating room, the editors of the *AORN Journal* [5] reported a surgical episode in which the music was so loud that surgeon's directions to the anesthesiologist regarding heparin levels were misunderstood by 8,000 units. Thus, beyond annoyance, within the sound environment lie potential safety risks that are often unidentified or ignored.

Sleep deprivation for hospitalized patients, particularly in the ICU, has been linked to ICU psychosis. Reflecting the populations of urban areas, hospitals located in urban areas have higher noise levels than those in rural areas and, therefore, patient risks are higher. [6]

Also, because noise affects patient outcomes and privacy, it has both clinical and regulatory implications. The auditory environment plays a big role in the confidentiality compliance that HIPAA now requires. In pure fact, absolute auditory confidentiality does not exist anywhere because hearing acuity is uncontrollable and immeasurable. Hearing impaired patients mis-hear words, are distracted and agitated from unwanted sounds. In the hospital setting, nurses and physicians exchange critical information in what is now labeled as the wrong place. While HIPAA uses a standard of "reasonableness" regarding auditory privacy, obviously there is nothing reasonable about unnecessary noise.

3. REDUCING AND MANAGING NOISE

In its efforts to provide empirical standards and at the same time address the ambiguity of this issue, the EPA defines noise as "any sound that may produce an undesired physiological or psychological effect in an individual or group." This definition accompanies the recommendation that volume levels be limited to 45dB during the day and 35dB at night.. What is clear here is that there are two tests, not one, to determine whether and to what degree noise is an issue. Based on the fact that noise is evaluated by patient satisfaction measures, the EPA verbal definition supersedes the dB level standards as volume alone does not necessarily define noise. [14]

In the way that absolute silence does not exist, neither is noise is not an acoustic property. While there are ways of measuring decibels below a reading of zero, noise, being a perception, is never silent. Rather, it is defined in its perception, which is subjective. For patients and families, "noise" is a distracting annoyance that is seldom justified or excused because they hold the hospital fully responsible for acting appropriately and providing the optimal setting to deal with critical health issues. Basically, the only sounds that are understandable (if not acceptable) are those directly related to providing care, and those should be controlled so that one patient's 'noise' is not impinging on that of another.

Since empirical specifications fall into the heart of engineering skills, it would seem that it would be easy to arrive at the standards that can hold an organization to account. However, it has yet to be shown that noise control is merely a physically dominated process or that its solution is one based solely on acoustic measures.

The first step to reduce noise and improve the auditory environment is to specify and operationalize standards that are as stringent as all other environmental standards impacting patient safety. These standards must be directed at people, technologies, traffic patterns, and the physical plant.

Determining the auditory impact of each piece of equipment used in patient care areas is also crucial. Regardless of where the patient is, equipment dominates the current hospital experience. The heavily orchestrated environment includes multiple monitors, beepers, buzzers, paging, telephones, carts, wheelchairs and gurneys, electric hospital bed motors, pillow speakers, nurse call systems, IV poles that roll on tiled floors, doors that close abruptly, and carts that squeak. All of this happens prior to one word being spoken or one person walking past the patient's room.

To minimize the potential for negative impacts of equipment and facility noise, standards or goals must be set to establish appropriate sound levels. This includes recommendations for modifying, maintaining, and purchasing equipment. In addition, repair and maintenance policies should be reviewed to respond to a higher quality of functionality that includes quieter operation. An auditory impact query needs to be part of every remodel, construction, piece of equipment, and staff event.

One more significant factor is the Lombard Effect, whereby voices are raised in relationship to background sound levels to increase speech intelligibility. Some studies have shown that people with voice training are less susceptible to the Lombard Effect. However, the population of the average hospital is diverse in training and role, and is unlikely to have any professional speaking skills. They will respond to the environment as it is and try to be appropriate for where they are. This includes responding to a crisis, trying to stimulate or quiet a patient, dialoguing with a hearing-impaired patient or family member, getting the urgent attention of a physician, and exchanging confidential patient information. Thus, the challenges of controlling the environment to control behavior in order to control the environment can be endless. However, non-human sounds can worsen or at the least set the stage for how loud one must speak to effectively communicate in all circumstances.

Ventilation systems, fans, hydraulic doors, florescent lights, and rolling carts are within the domain of facilities management. They establish the noise "floor" (i.e., the minimum noise level). Reviewing placement of vents and ducts, checking doors closures, automatic door bottoms, seals, and fixtures on a regular basis, as well as ensuring that in original designs purchasing is based on minimizing noise is mandatory.

A recent study by Blomkvist et al. [8] examined the effects of poor versus good sound levels and excessive reverberation on coronary intensive-care patients in a large university hospital in Stockholm, Sweden. The ceiling tiles were periodically changed from sound-reflecting to sound-absorbing tiles to gauge the effect on patients. When the sound-absorbing ceiling tiles were in place, patients slept better, were less stressed, had lower sympathetic arousal, and reported that nurses gave them better care.

Moving equipment and going from centralized nurse stations (where nurses tend to congregate and talk) to decentralized nurse stations can also help reduce noise. The Karmanos Cancer Institute in Detroit, MI, experienced a 30 percent reduction in medical errors on one unit after it

installed acoustical panels and went to decentralized nurse stations [9]. Methodist Hospital in Indianapolis, IN, attributes its improved medication error index on a redesigned coronary critical care unit with decentralized nursing and carpet in the hallways [9]. It is also well documented that single-bed patient rooms also are quieter than multi-bed rooms [1]. Patient satisfaction data from Press Ganey [8] also shows that patients in single-bed rooms are more satisfied with the noise levels in and around their room than those with a roommate.

In addition, replacing (or masking) noxious sounds with pleasant sounds moves the sound environment from being a challenge to a therapeutic modality. Enhancing the sound environment with music is a viable option if used appropriately, not in nursing stations where boom-box radios and CD players have been inappropriately broadcasting into hospital corridors. Commercial background music companies have long provided not only the content but the distributed sound system to broadcast music. . However, much of what might be appropriate in a shopping mall is inappropriate on an oncology unit or in an ICU.

St. Luke's Episcopal Hospital in Houston, TX installed a custom sound system in three of its ICU units in 1994. The hospital is still using the system, and has trained its staff as to how to manipulate the auditory environment using music to reduce agitation and stress. When St. Luke's first installed the system, the nurse manager immediately reported that the overall noise level seemed lower. [10] In the case of noise, perception is its own reality. Calmer can be interpreted as quieter. [11]

Henry Ford Hospital in Detroit, Michigan also installed a custom sound system, trained 96 critical care staff members, and implemented environment protocols. The nurse manager, Kathleen Vollman, reported in a case study presented at the Symposium on Health Design, that overall surveys taken nine months later showed a drop in the use of restraints which was unexpected. She had been looking at the use of narcotics over a period of 12 months as an indicator. [12]

St. Charles Medical Center in Bend, OR, whose goal to create a healing environment also included providing music at the bedside, reported that a survey on desired methods of pain relief Showed that music came up as equal to the use of medications. [13]

As shown in other industries, foreground music can mask other irrelevant sounds while maintaining an appropriate noise floor. In hospital settings, music combined with images of nature has been shown [12] to reduce the amount of requested pain medication and/or improve its analgesic effect. In addition, when used appropriately, music acts as an effective audio-anxiolytic, improving restfulness and the quality of sleep, and inducing relaxation.

Another important step is staff education and new employee orientation to make staff aware of where they are and their accountability for maintaining an appropriate sound environment. While mandating staff behavior has long been known to be the least effective method of managing noise, behavioral standards should nevertheless be modeled and extended organizationally. This is no different than instituting dress codes and mandatory practices for infection control.

Sound control must be taken seriously. This includes governing the baseline noise level, setting policies regarding private or confidential discussions that take place in public areas, and

establishing protocols for the use and methods of paging, cell phones, nurse call systems, and telephones. As noise crosses pathways so does the responsibility for controlling it.

4. CONCLUSION: ENGINEER AS SCIENTIST AND ADVOCATE

Summarizing the overview of noise in the healthcare setting and the role of the engineer, it is impossible to separate the defining tasks of engineering and its limitations. If the healthcare organization does not understand where engineering solutions stop and organizational/cultural practices dominate, the environment will be far from optimal. Setting acoustic standards, and optimizing the healthcare facility to minimize reflective, reverberant spaces is requisite. However, ensuring privacy in an institutional culture where the population density varies and people are in close proximity to each other requires careful planning and continual assessment.

Noise is not just a problem. It is an outcome. Either continuous or chronic, its effects are varied and often unpredictable. Auditory acuity varies in the hospital setting as much as the population varies. Because of the very nature of the hospital and its culture, resolving noise issues involves understanding the macro and micro cultures that function within it.

In a dynamic setting such as a hospital, where communications are urgent at the same time they are private, confidential yet spoken in public, and always critical, the auditory environment must be responsive. Facility design and functionality must take into account the operations of each department, traffic patterns, the nature of congestion in patient care areas and the impact of mechanical noise floors. Without evaluating what is happening where, the auditory impact, and who is affected, efforts to resolve auditory clutter will be frustrated. Furthermore, given that sound has a major role in providing care, consequences of generic solutions may be risky.

The environment of care must provide for diverse activities and support restfulness. It must meet the test of appropriateness as a therapeutic and effective clinical setting. At any given time, this may be measured in dB levels, but its impact is as much qualitative, circumstantial, and functional. Ultimately, the goal must be to minimize auditory risk factors without compromising communications, functions, or other critical operations.

While outside the common scope of practice, noise-control engineers would do well to educate architects and healthcare managers regarding organizational outcomes related to acoustics and the parameters that must be addressed for the optimal auditory environment. In healthcare, these issues un-addressed are risk factors that will impact not only confidentiality, but medical and nursing errors, privacy, and patient recovery. Within the sound of the hospital lies the lives of patients, staff, and those in the communities they serve. Healthcare gives greater credence to science than opinion, and engineers have the science. If the human and organizational risks are not integrated into the data in a meaningful and direct manner, the science will be rendered insignificant or will be minimized. It is the engineer who effectively provides and accounts for the comprehensive issues behind noise control that will provide the best service and outcomes.

REFERENCES

1. Ulrich, R., and C. Zimring. 2004. "The role of the physical environment in the hospital of the 21st century." The Center for Health Design, Concord, CA.
2. Cmiel, C.A., Karr, D.M., Gasser, D.M., Oliphant, L.M., and Neveau, A.J. 2004. "Noise control: a nursing team's approach to sleep promotion." *American Journal of Nursing* 104(2):40-48.
3. Penney, P.J., and Earl, C.E. 2004. "Occupational noise and effects on blood pressure: exploring the relationship of hypertension and noise exposure in workers." *AAOHN Journal*. 52(11): 476-80.
4. Joint Commission on the Accreditation of Healthcare Organizations. 2004. *Comprehensive Accreditation Manual for Hospitals*.
5. *AORN Journal*. November 2002. Letter to the editor.
6. Gelling L Causes of ICU psychosis: the environmental factors Nurs Crit Care. 1999 Jan-Feb;4(1):22-6. PMID: 10358540 [PubMed - indexed for MEDLINE]
7. Pimentel-Souza, F., J.C. Carvalho, P.A. Alvares, C.J. Rodrigues and A.L. Siqueira "Noise and sleep quality in two hospitals in the city of Belo Horizonte, Brazil," <http://www.icb.ufmg.br/lpf/2-19.html>.
8. Blomkvist, V., Eriksen, C. A., Theorell, T., Ulrich, R. S., and Rasmanis, G. (in press). "Acoustics and psychosocial environment in coronary intensive care." *Occupational and Environmental Medicine*.
9. The Center for Health Design. 2004. "Business case for better buildings." Presentation sponsored by Turner Healthcare, Indianapolis, IN.
10. Press Ganey, Inc. 2003. National patient satisfaction data for 2003.
11. Quoted from unpublished report, Rick Pozda at St. Luke's Episcopal Hospital. (1994)
12. Vollman, K. 1999. Case study presented at Symposium on Healthcare Design. San Francisco, CA.
13. Moore, N, 1999, Case study presented at Symposium on Healthcare Design, San Francisco, CA.
14. Environmental Protection Agency, 1977