Music, Noise, and the Environment of Care : History, Theory, and Practice

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Music, Noise, and the Environment of Care: History, Theory, and Practice

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Abstract

Music and noise would seem to be polar opposites: One is thought to be disruptive, whereas the other is assumed to have pleasant, positive influences. The two are, however, conjoined in the ear of the listener, often begging the question of whether a sound is music or noise. The historical background and sources of music and noise as environmental influences have changed as sound levels have increased, as the industrial and digital revolutions have afforded each a wider reach, and as music has become ubiquitous with the advent of recording, distribution, and playback technologies. In spite of ample research, the relationship of music to background sounds commonly found in hospitals has not been thoroughly examined. This article is a historical review of the theories and science of noise and music in relationship to patient outcomes, considers the ways patients make meaning from what they hear, and provides a critique of research and practices with consideration to optimizing the auditory environment for hospitalized patients.

Keywords

hospital noise, acoustics, healing environments, music therapy, Florence Nightingale, NICU

Music: A Long History of Being Therapeutic

The potential for music to be used therapeutically is in alignment with the beliefs of earlier philosophers and the practices of early healers and physicians. For example, the Greeks used all the arts, including music, to shift illness into healing (Cole, 1993; Helmut & Huchzermeyer, 1974). The mythology that surrounded music in early history continues to this day, with a merging of philosophies, beliefs, and spiritual practices. If anything, the myth has grown, as has access to music. Ancient Greek philosophers Pythagoras and Plato, and Chinese philosopher Confucius, all wrote about the impact of music on the mind, spirit, and behavior of individuals (Lippman, 1994; Thomas, 1927).

Rather than claiming that music is universally beneficial, Confucius pointed to the precarious nature of its impact when he wrote, "Music, being an energy source, would do something for good or ill to those listening" (as cited in Cole, 1993, p. 24). Similarly, Plato was convinced that music could affect character for better or worse and, ultimately, be a plausible threat to society. Predating both of these men, Greek philosopher Pythagoras was the first among the Greeks to develop the idea of music as ethical and therapeutic, capable of strengthening or restoring harmony to the soul. He believed that music could be used to attain virtue and that it provided a catharsis or purification of the soul, a vital psychic and physical force (Allen, 1939).

That music could be beneficial is difficult to debate; that music could be harmful and could be used malevolently to succeed in this objective speaks to how influential musicians and their role in society was and continues to be. That all nonreligious music has again been banned in Iran (BBC, 2005) is an indication that the belief in the political power of music remains viable. In Afghanistan, music was heard legally for the first time in two decades following its liberation from the Taliban in 2003. In contrast, Hindustani music has long been assumed to be a direct link to God and has never been separated from the social construct of Hindu culture (Ruckert, 2004).

The testament to the consistent observed impact of music is that each of these philosophers and scientists came to similar conclusions while separated by hundreds of years and thousands of miles.

Background: Person-Environment Unity

At the time of the Aesculapian temples (3rd century BCE), the world was quieter and the places of healing were primitive. The history of hospitals is one that is born on the reality that people went there to die, as medicine could do little for them. In Europe, until the late 18th century, hospitals were run by

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religious women and governed by the church. Myths were replaced with liturgical scripture, and comfort was for the soul more than the body (Chattopadhyay, 2007; Donahue, 1996; Eijt, 1993; Goldin, 1985; Marshall & Wall, 1999).

Florence Nightingale first identified the environment of care in the mid-19th century when she defined the ''sick room'' as a risk factor (Meyer & Bishop, 2007). She claimed that the room itself was a threat to the patient if it was not manipulated to be therapeutic. She described in specific detail everything from how large the bed needed to be to the distance between beds to issues of cleanliness and hygiene. Using deductive reasoning, she theorized that morbidity was often not a result of diagnoses:

> [The] sufferings generally considered to be inevitable and incident to the disease are very often not symptoms of the disease at all, but of something quite different—of the want of fresh air, or of light, or of warmth, or of quiet, or of cleanliness, or of punctuality and care in the administration of diet, of each or of all of these. (Nightingale, 1860, p. 2)

With the addition of technologies and the complexities of large institutions of the 21st century, the five factors that Nightingale identified as composing the environment of care in the middle of the 19th century well describe hospital challenges being confronted by patients, families, and providers. Nonetheless, the ''quiet'' to which Nightingale referred does not exist in contemporary society. Rather, it is idealized and conditioned as a balance of several factors qualified into the categories of music or noise, desirable or undesirable, helpful or toxic. Whereas Nightingale was concerned about squeaky floors, overheard whispers, and noisy dresses, today's hospitals are more concerned about monitors, beepers, pagers, vacuum cleaners, construction, and nurses' stations.

The Active Role of the Environment

The role of the ''built environment'' in how individuals evaluate and live their experience is well documented. Rather than passive, the relationship of individuals to their environment is transactional and integrated, one that involves diverse and complex objective events merged with subjective perceptions (Craik, Price, & Walsh, 2000). An environment is not experienced, however, as a series of individual, unique factors. Instead, it is an integrated experience, a space and time made up of the physical, interpersonal (social), sociocultural elements that merge into a whole (Bothe, 2004; B. A. Schneider & Pichora-Fuller, 2000; Timko, Moos, & Finney, 2000).

To the hospitalized patient, sensory acuity during hospitalization can be both heightened and impaired. Environments do not adapt to the needs of patients; rather the inability for a patient to navigate the environment is symptomatic of their condition (Molnar, 2004). Anxiety can move patients into acute distress, heightening all responses. At the same time, their specific diagnoses can alter or diminish their ability to respond to their surroundings. Applying Craik et al.'s theory (2000), the environment of care is so integrated into the human experience that it is inseparable from the effects of medication, diagnoses, stress, anxiety, pain, and similarly, noise and music.

J. J. Gibson, whose work in ecological psychology placed the environment above cognition, claimed that our senses are not mutually exclusive but, rather, make up a complex ''sensory system'' providing multisensory data from which we make meaning of our environment (Gibson, 1961, p. 1). Person-environment theory suggests that the whole person is embedded into his or her immediate environment, which is pluralistic and inclusive of a complex physical, interpersonal, and sociocultural system (Craik et al., 2000, p. 26). Critical to this discussion, the unification of sensory perceptions with the patient experience becomes the core point of interest.

Similarly, sound is heard, understood, and perceived within a social and physical context. Florence Nightingale considered harmful any sound that creates anxiety or fearful expectation for a patient for whom the worst is often the most feared. She went on to claim that it is rare that the volume of a sound is what causes the disturbance. Rather, she wrote that the factor is more qualitative, that ''apprehension, uncertainty, waiting, expectation, fear of surprise, do a patient harm'' (Nightingale, 1860, p. 14).

The polarized relationship between music and noise is one that clearly indicates the power struggle between perception and cognition. While listening and hearing are each about a single sense, they are qualitatively different. Hearing is about sensory arousal; listening is about perception and cognition, making meaning from what is heard. Noise that is irrelevant to the patient's recovery is not only disturbing but also inappropriate and difficult to modulate. Music that is inappropriate to the patient, indeed, becomes noise to the patient's experience.

Taking a closer look at the ways patients make meaning of what they hear, Guski (1999) provides substantive qualitative factors that ground these concerns regarding personal social dynamics that inform an individual's response to noise, here edited to accommodate the health care focus:

> Noise annoyance is considered to be the . . . negative evaluation of [hospital] conditions with respect to noise. This evaluation is . . . dependent on attitudes and expectations. . . . The personal factors influencing the evaluation . . . are: Sensitivity to noise, fear of harm connected with the source, personal evaluation of the source, and coping capacity with respect to noise. The social factors . . . are: General (social) evaluation of the source, trust or misfeasance with source authorities, history of noise exposure, and expectations of [patients]. (p. 14)

These factors bring more than annoyance into the discussion about hospital noise; this implies that the noise is experienced as symptomatic of other nonauditory issues that play into the patient experience in ways expressed and unexpressed, measured and immeasurable. Furthermore, Guski discusses annoyance as a characteristic of noise that can be moderated by modification of these personal and social factors to improve coping mechanisms and minimize disturbance.

The History of Noise Abatement

The earliest record of noise abatement policies for an industrial complex is in 720 BCE, when the Greek colony Sybaris "prohibited industrial noises in residential areas." Several complaints are documented from ancient Rome, where traffic complaints were registered (Bijsterveld, 2003). Complaints about loud music also have a history. In 1864, philosopher Charles Babbage published a pamphlet titled *A Chapter on Street Nuisances*, in which he stated,

> The great encouragers of street music belong chiefly to the 'lower classes of society,' such as tavern-keepers, servants, visitors from the country and 'Ladies of doubtful virtue.' The instruments of 'torture,' which they seemed to love, destroyed 'the time and the energies of all the intellectual classes of society.' (Campbell-Kelly, 1989)

The Austrian anthropologist Michael Haberlandt (1900) simply claimed that the more noise a culture could bear, the more "barbarian" it was; in contrast, tranquility was "the womb of all higher intellectuality" (as cited in Bijsterveld, 2003, p. 166).

In recent history, nuisance ordinances have been passed to protect the tranquility of nonindustrial, urban areas. Even with government sanctions, whether music is considered a "nuisance" is complaint driven, not statute driven. In industrialized communities, auditory consequence of high-traffic environments, including both air and road transportation systems, raised the issue of noise abatement to the point of demanding national government policies. The risk of work-related hearing damage further resulted in standards for auditory exposure, with the development of accompanying noise control devices and paraphernalia.

Sensory Dominance

Patients come into hospitals having experienced relatively normal lives that have included noise, music, family dinners, parties, and holiday celebrations. Depending on the nature of their community, if they come from an urban setting, quiet may be foreign to them. If they come in from a rural setting, urban noises are foreign to them. In either case, the sounds of hospitals are foreign, out of their control, and often an insult to an already challenging situation (Topf, 1983, 1992).

Although environments are experienced as a whole, different sensory modalities can be prioritized according to the sensitivities and capacity of the individual. Studies have shown that visual stimuli are more dominant than either aural or haptic (Hecht & Reiner, 2009). Haptic stimuli are more localized, as is taste; visual stimuli are limited to line of sight; smell moves around and is stimulated almost as quickly as it succumbs to habituation. Touch is assisted by sight (Klatzky, Lederman, & Matula, 1993). Nonetheless, sound is a contentious, robust primary sensory interface, providing cognitive information, emotional context, and spatial and temporal data, often pairing with other senses to make sense out of what is going on. Perception and interpretation of auditory information play a dominant role in how individuals evaluate their own circumstances, because sound provides more comprehensive data than other senses.

Furthermore, many patients are too ill to use any sense other than hearing to interface with their environment. For a high-acuity patient in varying states of consciousness, aural information takes priority over visual stimuli and makes the issue of the auditory environment ever more critical. Nonetheless, whether a sound heard by a patient is comforting or agitating is determined, in part, by the patient's acuity (Carr, 1935). According to the listener-driven definition of noise, if a hospital is experienced as "noisy" by the patient, then it is. As an outcome of what is referred to as "the Lombard effect" (Junqua, 1993), noise thrives on itself, increasing the volume levels of conversations and threatening privacy as well as increasing stress. Therefore, the auditory environment of the hospital is dynamic and changeable.

In an environment characterized by foreign, sometimes hostile, auditory stressors, patients work overtime trying to make sense of what is happening to them. Gibson (1966) refers to the consequences of inadequate information, describing well the efforts to compensate:

> The observer keeps trying to see even in a dense fog, and he also does so at night in anything less than complete darkness. Similarly, he tries to hear even with little or no sound in the air. In darkness and silence, men . . . may, of course, simply go to sleep and relax all attention, but so long as the individual stays awake and alert his exploratory attention persists. (p. 303)

Add to this medication, pain, anxiety, and other symptoms related to the patient's diagnosis, and the result is what Schneider and Pichora-Fuller (2000) call "perceptual stress." Regarding the strain and toll noise takes on patients, in their work about sensory decline of aging persons, Schneider and Pichora-Fuller point out that "perceptual stress consumes resources" (Schneider & Pichora-Fuller, 2000, p. 202). Similarly, Nightingale claimed that it is critical not to tax the energies of the patient in ways that distract from the task of healing. In her *Notes on Nursing*, Nightingale (1860) frames her theory around the assumption that environmental stressors divert the patient's resources from what is needed to recover and, therefore, pose a serious risk. She also claims that normal stress is far more challenging to the ill, with the sick "suffering in a greater proportion than the well from precisely the same causes" (Meyer & Bishop, 2007, pp. 240).

Noise as a Risk Factor

More than merely annoying, noise in hospitals has been shown to be identified with specific risks. For example, noise is the single most prominent cause of sleep deprivation (Baker, 1993; Cmeil et al., 2004; Lester, 1962; Mazer, 2006; Ulrich et al., 2008; Zimmerman, Pierson, & Marker, 1988). Low patient satisfaction ratings, medical and nursing errors, and medication errors are also related to noise in hospitals (Tijunelis,

Fitzsullivan, & Henderson, 2005). Studies and patient satisfaction surveys have identified noise as a major cause of pain exacerbation and heightened disorientation (Patzer, 1996). For the staff, noise increases stress levels, contributes to medical errors, and affects safety. Noise is also a contributor to delirium (Meagher, O'Hanlon, O'Mahony, & Casey, 1996).

Although there is a definitive historical reference to theories about sound, the qualitative valuing of sound—discriminating between pleasant and noxious sounds and their respective effect on cultures—is lacking. As the antithesis of music, noise creates another kind of environment and experience that has its own implications. These two counterparts coexist and compete in defining cultural values. However, to the listener, unwanted, disliked, secondhand music is noise.

Health care settings, including acute care hospitals, clinics, ambulatory surgery, and other settings, provide valid examples of environments serving a widely diverse population, with complex auditory environments that serve multiple purposes, and where both music and noise coexist. For this discussion, we are dealing with noise as experienced by the patient rather than noise as merely an acoustic event. In spite of fame and tradition, Beethoven, Bach, and Bon Jovi could each be considered noise to someone at some time. Therefore, any sound has the potential to be perceived as noise, and any noise can be benign or irrelevant to the listener.

Beyond the health risk of hearing loss, the U.S. Environmental Protection Agency (EPA) has defined noise as ''any sound that may produce an undesired physiological or psychological effect in an individual or group'' (http://www.nonoise.org/library/handbook/handbook.htm). This operational definition is relevant to health care organizations, given that their goal is to minimize, if not eliminate, physical and psychological stress.

Although the EPA has released specific recommended decibel levels for hospitals, this broader definition sets up a two-tiered challenge. The first, and perhaps the most predeterminant, test is listener impact. The second concerns the limitations of quantitative measures, decibels, in determining qualitative characterization of the sound environment. Appropriate volume levels are therefore ambiguous, and what is appropriate must be contextually determined. Nurses, visitors, physicians, housekeepers, and other nonpatient personnel are not necessarily aware of how loud their activities are. Hospitals that have taken on the task of noise reduction have done so because there were complaints about it or patient satisfaction surveys indicated that there was a problem. Whether they investigate the noise in terms of qualitative and quantitative measures is based on the determination as to the cause (Yanagihashi et al., 1997). Although research has been consistent in pointing to the negative impact of noise, it is the operational outcomes that drive change.

Hospitals: Where Music Plays a Very Different Role

In the allopathic model, for music to have any relevance to clinical practice, its use as an intervention must meet the same medical standards as other treatment protocols. Unlike prior historical periods where the use of music has been based on belief and/or philosophical dictates, rigorous examination of any medical claim regarding music has become requisite. The academic and clinical field of music therapy, recognized only for the past 70 years, has provided such studies, documenting the effects of music in alleviating pain and anxiety, in assisting stroke patients in straightening their gait, and in assisting demented patients in engaging with people around them (Ahmad, Brophy, Grant, & Brandstetter, 1999; Bechtold, Perez, Puli, & Marshall, 2006; Fukamizu, En, Kano, & Arikawa, 2009; Stuhlmiller, Lamba, Rooney, Chait, & Dolan, 2009; Munro & Mount, 1978; Wood, 2004; Zarate & Diaz, 2001; Ziporyn, 1984). Other studies done by physicians and nurses not related to music therapy have looked at the effect of music on specific diagnostic groups, conditions, and symptoms. Chlan, Engeland, Anthony, and Guttormson (2007) studied the psychological responses to music of patients requiring ventilation, showing that it improved their status. Coughlan (1994) investigated the effects of music therapy in the intensive care unit, which reaffirmed its positive impact in the critical care setting. Studies have been done using music in palliative care to reduce anxiety and agitation for both children and adults (Daveson & Kennelly, 2000; Horne-Thompson & Grocke, 2008; Magill, 2009; Munro & Mount, 1978).

The Neonatal Intensive Care Unit (NICU): Where Noise and Music Are Both Questioned

Although there is a plethora of research that verifies the positive impact of music for patients, there are critical challenges to its scientific validity. Specific to music therapy studies in the neonatal environment, critics have questioned their scientific rigor, methodology, controls, and lack of adequate randomization (Philbin & Gray, 2002). Factors either not accounted for or undervalued as relevant have included NICU sound levels, gender, foundational scientific theory, acoustic factors, and adequate sample size, among others (Graven, 2000).

One foundational concern is the debate regarding the neurological capacity of the preterm infant to process complex auditory information. Therefore, whether a sound in an NICU is perceived by the infant as noise rather than music remains a question. Philbin and Gray (2002) have looked at overall sound levels of an NICU, determining overall decibel levels of staff behavior and technology and to what extent they respectively affect the sound level of the unit. Other studies have considered noise in the NICU and basically all agreed that the overall sound level exceeds recommendations (Byers, Waugh, & Lowman, 2006; Darcy, Hancock, & Ware, 2008; Lasky & Williams, 2009; Walsh, McCullough, & White, 2006). Additional studies that have considered both music for neonates and ambient noise in the NICU argue that there is enough evidence to support music protocols with the caveat that the music be selected in accordance with documented research (Neal & Lindeke, 2008; Standley, 2003b).

The PATTERNS (Preventive Approach to Traumatic Experience by Resourcing the Nervous System) NICU music therapy model optimizes the auditory and dynamic environment as a critical component in the treatment protocol for neonates (Stewart, 2009). As a preemptive treatment program to prevent and treat potential trauma incurred by neonates during their time in the NICU, a prime objective is to avoid heightened arousal and the complications that accompany it. PATTERNS recognizes the complex circumstances that affect the infant, family, and staff as a cohesive whole; deconstructs the events and factors that could lead to trauma; and designs a prevention protocol. Because, in this model, the challenge of noise and the use of music are integrated into the whole experience of the infant, family, and staff, music is used to soothe and mask, whereas noise is avoided or at least minimized.

Music vs. Noise: Do Infants Know the Difference?

I have had direct experience with conflicting points of view regarding NICU studies and protocols as I managed the technological design and development of the pacifier-activated lullaby (PAL), based on the research of Standley (2000), as well as managing the process of its acceptance as a Food and Drug Administration–approved medical device.

Early in the development of the PAL, I spoke with Drs. Philbin and Graven regarding the studies on which the PAL was based. In these discussions, it was clear that whether the PAL was effective in reinforcing non-nutritive sucking was secondary to the larger issue of the risks to the infant. Concerns about volume levels, overstimulation, and uncontrolled sound exposure were among the concerns expressed. Given that the PAL involved recorded music, Graven expressed concern about potential developmental risks and the lack of evidence as to the benefits or liabilities of the use of this technology with preterm infants. He was most concerned about inappropriate, if not dangerous, use of headphones and other consumer technologies on neonates (Graven, 2000). (Note: The PAL was designed with redundant safeguards for limited volume levels to the infant's ear and limited length of continuous-play options and provided for binaural hearing with external speakers, not headphones.) The studies on which the PAL was based provided compelling and substantive data regarding its efficacy. Subsequent studies using the PAL have supported its use with neonates for improvement of nonnutritive sucking, improved feeding and weight gain, and calming and pain management (Standley, 2003a, 2003b; Whipple, 2008).

Nonetheless, ongoing studies that have considered sound levels in the NICU do not distinguish between pleasant and noxious sound, as these are perceptual indicators. Nor do they separate continuous and erratic noises, but they instead look at sound level ranges, lows to highs, including peaks. Furthermore, there is no distinct discussion regarding the startle reflex, which is caused by a sudden loud sound and causes physiological changes.

The fundamental question regarding how a preterm or term infant perceives a sound or whether a sound is noxious cannot be resolved solely on the basis of acoustics or physics, nor can it be measured by a dosimeter. Rather, objective analyses of behavioral and physiological responses offer the most immediate and relevant indicators. Schneck, Berger, and Rowland (2006) point out most succinctly that emotional engagement with music shows itself physiologically—that the human body responds and its status changes in measurable ways. At the same time, not unlike in studies regarding pain and pain control, the effect of music is evidenced symptomatically.

Can Music Therapy Outcomes Be Generalized?

The lack of generalizability of music therapy outcomes has contributed to the challenge of including these studies in the framework of evidence-based practices. Measures or controls, such as dosage (i.e., how long music is played, how often, whether the same music or different music), remain describable but not absolute in application.

In addition, the question remains as to how to isolate the effect of a human response to a variety of sounds while accounting for the complex and immediate environmental system that makes up the circumstances of a patient. Neal and Lindeke (2008) describe the differences between noise and music as one being patterned and the other not, one potentially annoying and the other pleasant, stating, ''Some music may be considered noise'' (p. 319).

Environmental music therapy (EMT) is designed to address the ''environmental sounds that exist without controls for volume, duration or cause and effect relationships which are perceived as noise'' (Kemper & Jennings, 2005, p. 60). In the medical setting, EMT is the use of music played in the moment by a trained music therapist who seeks to meld and soften the often acoustical barrage of noise caused by machinery and voices in critical care settings. ''A music therapist can play *with* (as opposed *to*) the environment'' (Stewart & Schneider, 2000). The EMT therapist purposefully improvises musical structures and textures sonically harmonious with the environmental sounds to aesthetically mask ambient noise (Schneider, 2005).

Stewart and Schneider (2000) measured the effect of music therapy on the sound environment in the NICU at an inner-city hospital. They investigated the impact of live music on the neonates (heart rate and respiratory rate) awake and asleep as well as on staff through survey. They also viewed the noise level with a sound meter before and after live music within a 5-week period and found benefits for the patients and staff. EMT's influence on the sound environment was evident as noise levels decreased (Stewart & Schneider, 2000).

Although the value of qualitative or quantitative studies in music therapy is not the focus of this article, it should be noted that in placing music therapy inside the folds of science, the need for empirical, measurable, and replicable studies places a burden of evidence on researchers that may not be satisfied on an absolute basis. Rather, in keeping with Schneck et al. (2006), although each study reveals more about the human response to music, offering some predictability, it must still

allow for the uniqueness of each individual and his or her circumstances.

The Sounds of Diversity

The hospital population is diverse not solely in regard to ethnicity or race, gender, or culture. Rather, the diverse health care setting comprises patients, visitors, family members, other patients, nurses, physicians, therapists, phlebotomists, clerks, housekeepers, facility managers, administrators, and a list longer than need be fully listed here. Therefore, when music is added on a global level, where proximity, not merely choice, determines who is the listener, there is little parity of response or meaning.

Environmentally, the use of music to change the context of care is now becoming a more common practice for therapeutic purposes, and music is used in response to the increase in noise levels. Although nontraditional in its application, treating the sound environment with music in the hospital setting is borrowing from the successful use of background music in other industries. Music has been effective in reducing anxiety while patients are waiting prior to treatment or examination (Cooke, Chaboyer, Schluter, & Hiratos, 2005). This use is contextual and differs from a direct music intervention or EMT in that the objective is to condition the environment rather than treat a patient.

Although music serves an active environmental function, often spoken of as background or foreground music, its use in health care settings is relatively undocumented in relationship to its use in other industries. Although the background-foreground phenomenon usually refers to visual perception, the auditory scene analysis (ASA) remains the way in which perception puts together multiple sensory events at one time (Bregman, 1990). Using Bregman's (1990) theory, ASA involves being able to separate the various parts of the sound, integrate them into a cohesive unified experience, and then separate out what one chooses to focus on. Bregman found that temporal differentiation—when a new sound started—added into the volume of the new sound and duration determined whether the original sound could be heard. What is relevant here is that constant noise in the hospital, often referred to as the noise floor, functions as background to discussions or other events that are noncontinuous. An erratic sound that has substantive volume, such as an alarm, a slammed door, or a scream, will take away that focus for a brief time or totally mask the original sound if it is too long in duration. Another factor that contributes to how sounds are prioritized is the onset of habituation. This refers to the desensitization of the ear to an unchanging, continuous sound, which results in diminishing perception of volume and, in turn, diminished response (Pfleiderer, Ostermann, Michael, & Heindel, 2002; Rabat, Bouyer, Aran, Le Moal, & Mayo, 2005).

Most music therapy studies have referred to direct listening of music rather than indirect or incidental exposure. However, there are relevant conclusions that can be made from studies whose implications are broader. Music used to soothe that is played for a limited length of time has been shown to be effective (Kaminski & Hall, 1996). Standley and other researchers who worked with neonates demonstrated that infants could respond to music, express preference, and use it as a biofeedback tool for soothing and other developmental functions (Bo & Callaghan, 2000; Caine, 1991; Golianu, Krane, Seybold, Almgren, & Anand, 2007; Joyce, Keck, & Gerkensmeyer, 2001; Kaminski & Hall, 1996; Standley, 1986, 1998, 2002, 2003). This would imply that the music, which was necessarily louder than the background sound and that of the incubator itself, was distinguished and generated a measurable arousal. Furthermore, when the music, which was played for 10 to 15 seconds, stopped, the silence was then stimulating and caused the infant to again suck, which would trigger the music.

Patient agitation, the use of restraints, and aggressive behavior have each been attributed in part to hospital noise, regardless of whether it is necessary or unnecessary (Nivison & Ednresen, 1993). The studies that have considered noise have differentiated between background, foreground, and erratic sounds. Without exception, the erratic sound was the most agitating, sometimes triggering the startle response (Grumet, 1993; Westman & Walters, 1981).

On the other side of these negative outcomes caused by noxious sound, evidence has shown that when appropriately used, music can lessen aggression, reduce agitation, and in turn, lower the use of restraints (Cepeda, Carr, Lau, & Alvarez, 2006; Janelli, Kanski, & Neary, 1994; News, 2006; Robinson et al., 2006).

In this article, the history of the therapeutic use of music has been supported not only by practice and cultural expression but also by the empirical data that have emerged from controlled studies. Because of the dominant role of hearing as an environmental interface, immediate and surrounding sounds inform the musical experience. Although the use of headphones has provided a means of isolating music from background sounds, they are not used universally and may exacerbate agitation in the elderly (Gerdner, 2007).

Music therapy, whether involving live or recorded music, is subject to the respective auditory context, including ambient noise. The challenge remains, therefore, that both music and noise reside in the same auditory space, often playing interchangeable roles depending on who is subjected to what sounds. Therefore, it is not possible to effectively use music in the hospital without addressing or, at the minimum, taking into account ambient noise. Furthermore, adding music to an already stressful auditory mix of friendly and hostile sounds requires sensitivity to the culture of the hospital and the immediate circumstances of the patient. Noise reduction is not a linear process. It requires more than merely directing people to keep their voices and actions down or asking a housekeeper to vacuum at a different time.

Causes of Noise

Seeking to understand the relationship between factors in the built environment and specific patient outcomes, environmental

psychologists Ulrich and colleagues did seminal research quantifying the impact of environmental stressors on patient outcomes (Ulrich, 1997, 2000; Ulrich et al., 2008). Regarding noise in the hospital, they point out that there are two general reasons 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.

In a report published by the Center for Health Design, Joseph and Ulrich (2007) outline the intermixed relationship between noise, speech privacy, speech intelligibility, and music, with the objective being to balance operational needs, patient care, the acoustic requirements of the built environment, patient safety, privacy, and the use of music. Although their recommendations include staff education, their bias toward the built environment as key to both cause and cure of hospital noise minimizes the gap between the physical components of the environment and the hospital and community culture, which may ignore the inadvertent toleration or habituation to high, albeit unacceptable, noise levels.

Significant to the issues at stake in bringing music to patients is that none of the studies on noise in hospitals specifically mentions or exempts music from being a contributor, nor do they specifically identify televisions as being a component. In the case of television, this is a continual sound unless turned off. In addition, the television is a source of talk, music, and sound effects related to drama and is broadcast at extremely varying dynamic levels (i.e., commercials vs. program material). Subsequently, habituation or ''tuning out'' television programming can be interrupted with sudden jumps in volume and auditory content. In the hospital room, visitors or families may also want to watch the television, requiring increased volume from the bedrail or pillow speakers designed for the patient.

As more research is done to understand how patients, staff, and families perceive their surrounding and how music can mitigate some of the negative effects of noise, the auditory environment of care can be used more proactively to, as Nightingale (1860) wrote, ''put the patient in the best possible position for nature to act upon him'' (p. 46).

Discussion: Validity of Research Over Time

Theories and studies regarding music and noise measure various acoustic, physiological, and psychological outcomes. Although the descriptive details, including frequencies, volume levels, hearing acuity, and circumstance, may vary, what does not vary is that auditory stimulus generates a response. Studies have looked at the effects of sound in different environments with different age groups, often narrowed by acuity, gender, culture, and ethnicity. The studies have reinforced that sensory arousal caused by a sudden, unexpected noise changes the physiological and psychological status of patients and increase risks of errors among the staff (Redding, Hargest, & Minsky, 1977).

The circular nature of noise abatement policies, when they are put in place and then ignored, indicates that there remains a lack of understanding about the exact and universal toll on patients, staff, and families (Donchin & Seagull, 2002; *Journal of the American Medical Association*, 1951; Mazer, 2008).

In 1981, Westman and Walters wrote, ''Research upon, and efforts to prevent or minimize the harmful effects of noise have suffered from the lack of a full appreciation of the ways in which humans process and react to sound'' (p. 294). In 1993, in the *New England Journal of Medicine* article ''Pandemonium in the Modern Hospital,'' Grumet (1993) stated, ''The hospital, designed as a place of healing and tranquility for patients and of scholarly exchanges among physicians, has become a place of beeping, buzzing, banging, clanging, and shouting'' (p. 433). Both of these articles state similar physiological statistics, and both identify the human cost while expressing serious concerns about the issue with limited hope of resolutions.

The studies cited in this article cover a substantial number of decades, during which time technologies and noise levels have increased. Nonetheless, there is consistent agreement regarding the risks noise poses to patients who are subjected to environments over which they have limited or no control. However, without additional studies and research that consider the larger auditory environment and its impact on patients, the use of music environmentally will be challenged or ineffective.

Perhaps the most telling factor regarding this discussion is the lineage of collected data regarding both noise and music therapy. Documented evidence amassed for decades has not yet been brought to the fore in improving patient outcomes, nor can one realistically claim that the absence of adequate auditory standards, in this case, reflects a lack of research. Rather, the presence of noise indicates a culture that has set aside the most basic of human responses, that of comfort and positive experiences to assist and support recovery. In keeping with current use of the term, the abatement of noise is an evidence-based mandate.

Guidelines for improving the sound environment are available that balance the roles of the built environment and the hospital culture, technology, and people (Mazer, 2008). Acoustic recommendations are available that are based on studies that indicate the value of retrofitting halls to improve the acoustic character of an otherwise difficult space (Blomkvist et al., 2005; Busch-Vishniac et al., 2005; Hagerman et al., 2005; Leroux, 2006).

The critical rationale for understanding and managing the auditory environment is because it interacts with the therapeutic protocol. Therefore, the responsibility of setting the stage for optimal clinical outcomes belongs to everyone who provides care or is inside the environment of care. Although there may be some individual or personal resistance to being asked to speak more softly or to maintain quiet in public areas, there is seldom any debate about the request being in alignment with quality-of-care standards. During physician rounds, meal times, shift changes, peak visitor times, and housekeeping activities, consideration of the impact on the overall

environment and on the patients most closely affected is essential. Hospital construction and renovation are also a major auditory predator that can be addressed in advance. A music therapist has a strong case for advocating noise controls, because the music intervention lives in the same auditory space of all noise, whether ongoing, chronic, or incidental.

There is no question that creating an appropriate, functional, and therapeutic auditory environment remains a current challenge and has become even more difficult as the culture has grown louder. Rather than budget being the primary barrier to improvement, the nature of highly populated, diverse, and complex organizational cultures that characterize current hospital climates unknowingly pushes the noise issue down the list of priorities as the volume increases. It would be advantageous for physicians, nurses, phlebotomists, and music therapists, among all the others who interface with the hospital environment, to become proactive in monitoring their own contribution to the auditory environment and to enlist their associates in reducing unnecessary noise. Therefore, being more mindful of the risks to everyone involved, especially the patient, will certainly be a positive step in revisiting the tranquility so characteristic of hospitals in the past and so needed in hospitals of the present.

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Bio

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