

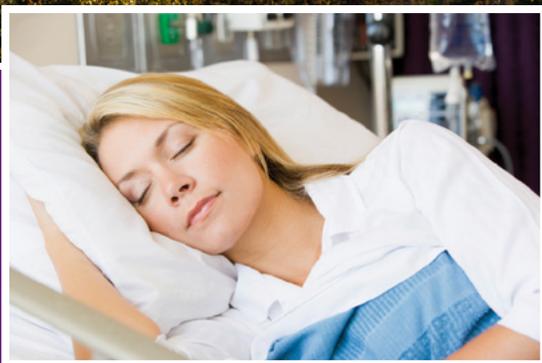
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Hospital Noise & the Patient Experience

By Susan E. Mazer, Ph.D

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ABSTRACT

HCAHPS scores have affirmed that noise remains a challenge for patients and hospitals. And although many studies and companies offer diagnostic and statistical ways to measure noise, solutions are lacking, especially long-term solutions that survive time and the attention fatigue of staff. This paper provides an overview of the challenge and a set of solutions that look first at the culture and then offer a methodology to temper the sound environment and improve the patient experience.

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In her seminal work, *Notes on Nursing*, Florence Nightingale wrote, "Necessary noise is that which damages the patient." Pushing the issue further still, she added, "Unnecessary noise is the cruelest absence of care." (Nightingale, 1859) As confronting as her words were at the time, they summarize the findings of empirical research that would come over 150 years later.

While the case could be made that mid-19th Century auditory standards are unrealistic in a 21st Century world of highly advanced institutional care, if she were here now, Nightingale would most likely be even more emphatic. She may well confirm that, even with these considerations, the impact on patients has not nor will ever change. She would have been unrelenting in her lack of tolerance for noise or any other environmental stressor so obviously hostile to the recovery process. Furthermore, if Nightingale were here today, she might pointedly ask why noise has become the norm for patient care while quiet remains the exception.

Your Hospital: Can You Hear the Healing?

Let's assume that your nurses are of the highest competence and your physicians' skills are without dispute. That your organization is efficient and effective and your technologies are the best and newest, and, further that your leaders approve funding for exemplary architecture and interior design. The question remains: How does the hospital sound? Ask yourself if these same high standards are reflected in the sounds that resonate throughout your rooms and corridors and in the words heard and overheard by suffering patients and frightened families. Are the highest standards of caring heard as well as seen? Declaring a commitment to provide

excellent care has yet to guarantee that all facets of the patient experience are optimal.

This is hardly a new issue. In a 2008 study of noise on the intensive care unit, patients were disturbed and distracted mainly due to noise from the nurse station, visitors, and other non-clinically relevant events. (Akansel, 2008) In another study that looked at obstacles to nurses providing the best care, noise was listed among other environmental stressors. (Gurses and Carayon, 2009) The fact is that unnecessary noise to an acute care patient is more than irritating: It is damaging. Whether the result of people or technology, hospital noise that serves no purpose is indifferent to patients' needs and represents the same indifference in the staff. It contributes to patient suffering and discomfort rather than relieving it.

One-Size Fits Anyone?

By the very nature of institutional care, hospitals are designed to be "one-size-fits-any-and-all" kinds of places. As a result, the clinical character of a healthcare facility can feel generic and impersonal.

Nonetheless, while the hospital is most commonly thought to be about beds, walls, windows, floors, ceilings, and technology, it is also about people, clutter, and noise. In fact, according to patient satisfaction surveys, the quality of the healthcare experience is often evaluated according to the hospital's dynamic environment -- those circumstantial and changeable components that are caused and impacted by people, change throughout the day, and are within the control of the staff.

Whether inadvertent, unavoidable, or accidental, noise is one of the most invasive aspects of the hospital environment. (Joseph, 2006) The sounds of suffering

and trauma, of machines and technologies, that are overheard through thin walls, curtains, and open doors become the context in which patients and their families undergo their own healthcare experiences.

In 2000, Press Ganey found that patients complain about noise two times more often than about anything else in a hospital, including the food. (Fick and Vance, 2000) In a 2015 report in the Kaiser Health News, noise remained at the top of the list of patient complaints and at the bottom of HCAHPS scores on the national survey.

Acuity vs. Capacity

When patients' acuity is high, their adaptive capacity is low, resulting in heightened sensitivity to many kinds of environmental stressors. Far from harmless, erratic sounds that create apprehension can contribute to the need for restraints, more pain medication, and frequent nursing assistance calls. The negative effects of noise "may arise as a direct consequence of exposure to noise or may be mediated by reactions to noise such as annoyance and dissatisfaction...The evidence suggests that negative subjective reactions to noise predict health outcomes over and above the prediction available from noise exposure itself." (Job, 1996)

Both casual and confidential conversations between and among patients, staff, and visitors, as well as the sounds of slammed doors, carts that are in need of repair, phones, beepers, buzzers, and paging make up the "sound environment." Here is where stress, competence, caring, compassion, and concern are qualitatively demonstrated. Therefore, leaving the sound environment to chance, or allowing it to be a random consequence of institutional care, places at risk the outcomes that help determine the quality of healthcare. Further, with a higher level of acuity, accuracy of perception declines and with it, cognition. (Schneider, 2000) This speaks to the ineffectiveness of assuming that patients understand what they are hearing and why, basically hoping to mitigate institutional practices and interpret sounds that are annoying or distracting to them through adaptation.

Whether by accident or incident, the accumulation of noise, gossip, and unwanted distraction adds up to stress, anxiety, and, in total, an unacceptable, unsatisfying, and risk-laden health experience. So, how can the auditory environment of hospitals be improved, specifically at the bedside?

It's the Culture!

Noise is a human outcome. Noise is a cultural tolerance. Noise that disrupts the primary purpose of an organization exists only because there are underlying cultural norms that permit and tolerate the disturbance. Adapting and adjusting to ongoing inappropriate noise levels serves to continue the problem.

Every organization has its own sound, whether loud or quiet. And, every organization has its own pacing, the times when activities are heightened and other times when a kind of busy quiet dominates.

The solutions to the hospital noise issues can be found inside the culture, exactly where they are birthed. Yes, mechanical fixes are needed and can help, as can acoustic improvements. However, what are left are the people: people noise, people annoyance, and patients who have little control over their own circumstances.

In the hospital, the pacing of patients competes with the pacing of the hospital. The day-night cycle is disturbed because rounds take place according to the norms of the hospital. Patients are forced to continually adapt to an environment that promises to serve them, but winds up serving their diagnosis.

Unless there is a clear understanding of when these conflicts occur, or methods are put in place to accommodate the needs of the patient, and the accountability for the auditory environment is with the staff, the noise issue will belong to no one.

Here are 7 steps for addressing hospital noise and establishing a strategy for ongoing oversight:

1. Get Everyone Involved: Establish a Sound Quality Committee

The sound environment is uniquely expansive, including not only the sounds at the bedside, but also sound from outside the patient room. Because nurses are performing duties, both inside and outside of patient rooms, they are in the best position to assess the circumstances surrounding the patient and family. Establish a multi-disciplinary Sound Quality Committee that is driven by nursing but includes representation from the facility management staff, environmental services and housekeepers, volunteers, administration, and ancillary staff. This effectively spreads the accountability for the sound environment of the facility to those who have direct contact with patients. Physicians should also be included, despite the fact that they spend the least time with the patient.

The challenge with teaching hospitals, however, centers during Grand Rounds. Tribes of physicians and residents move through the halls and patient rooms with little regard to the auditory impact they have on the environment. The benefit for physicians, nonetheless, is felt directly with better patient outcomes.

Patients who would otherwise be sleep deprived, agitated, or confused fare far better in an environment that is directly supportive of their needs over the full 24-hour day in ways beyond medication and evaluation. Therefore, including representation from physicians and residents will draw them into the fold more than might be anticipated.

Facilities management is also critical to understand comprehensive protocols for managing hospital noise within the built environment. For the 2010 edition of the Guidelines for Design and Construction of Health Care Facilities, the Facilities Guidelines Institute (FGI) ratified and published new acoustic standards for HIPAA compliance that are relevant to not only noise standards, but also speech privacy. These

new standards bring further weight to the critical nature of hospital noise and finally link the issue to operations and regulatory compliance. (Note: To download a read-only version of Sound & Vibration: Design Guidelines for Health Care Facilities that was updated for the 2014 edition of the Guidelines, visit the Resources section of the FGI website at www.fgiguideelines.org).

While the standards deal specifically with the physical plant, the outcome is based on the interface between the built environment and those who live, work, and heal within it. Again, because noise is a cultural outcome, setting new standards is about cultural change. And, cultural change happens over time, and demands consistency and patience.

It should be noted that the Sound Environment Committee cannot fix the noise problem. Noise must be managed, modeled, and be subject to a cultural norm that supports healing. The Committee is established to prioritize the issue, bring weight to the goals it holds, and to facilitate cultural change.

2. Assess the Sound Environment: How Noisy Is It?

Once established, the committee should determine a protocol for initial assessment of the sound environment. Including details about the sources of noise and contributing factors are critical to this work.

While using a decibel meter may provide insight into how loud is loud, the reality of loudness is best understood and accessed as it is heard in real time. This requires the committee to literally go to units they do not work in and observe what they hear. They should note what they hear at the farthest room from the nurses' station and the nearest, from the elevator and every entrance, from the inside of a patient room, and simply walking down the hall. Further, this should happen at different times of day, during different shifts because the very character of the unit changes over the full 24-hour day.

Waiting rooms perhaps hold the greatest anxiety and suffering for families. Therefore, sitting in a waiting room for 1-2 hours at a time the way families do is the only way to grasp the challenge posed by noise,

televisions, conversations, lack of confidentiality, and anonymity created by the situation itself. So, take note if the environment is vacuous, offering nothing to help the time pass and relieve stress.

The experience of noise should also be understood from the point of patients and families. This is more than the singular question HCAHPS offers, which is limited to quiet at night. This can be done by survey or talking with patients and staff. Again, ask questions about different times of day, ask what they heard at night, and what annoyed them the most.

Also, without question, a nighttime environment that is painfully silent, amplifies even the softest of sounds -- like a ticking clock (which, although outdated, remains a standard of quiet!). Because nights are so difficult for patients under the best of circumstances, and HCAHPS Quiet at Night question scores are universally low, noise at night needs to be assessed separately and not be assumed to fall in line with the other hours of the day. It is not uncommon for nights to be too quiet, leaving the auditory environment too transparent. Indeed, darkness makes all sounds louder.

Decibels are objective, quantitative measures equal to pounds measured on a scale. All they can do is report "how much." Patient perception of sound measures "how much" subjectively, inside the context of where they are, how they feel, and their own prognosis and fear. Noise is not only subjective, but also fluid and changeable. Measuring the objective volume of equipment to the patient's ear may offer some insights.

However, because perception is actually what matters, the use of dB levels has limited value in understanding what disturbs patients. Specifically, dB levels are best used when looking medical and cleaning equipment, HVAC systems, and more. This is because these are unvarying sounds that inform the human experience of hearing and speaking.

Other factors that should be considered include functional noise levels of all mobile devices, door-closures, paging system volume levels (both frequency of use and intelligibility), medical monitors,

and other technological sound sources. Include speech privacy to your criteria. Listen to what you are hearing and decide whether it is appropriate.

When you listen to conversations and babble, the crowd sound -- indistinguishable in meaning, but collectively identifiable as a group of people talking -- listen for audibility, intelligibility, and appropriateness. If you can fully hear confidential information that is not meant for your ears, know that others can hear it also. And, from the patient's perspective, hearing what is irrelevant to them makes them feel irrelevant.

Noise begets noise and noise makes everyone talk louder. This is called the Lombard Reflex, named after psychologist Etienne Lombard, who published his work in 1911. Lombard described the automatic response when "speakers increase their vocal levels in the presence of a loud background noise and make several vocal changes in order to improve intelligibility of the speech signal." (Lombard, 1911) It is an involuntary response and, therefore, if the hospital corridor or nurses' station is noisy, everyone in the vicinity will talk still louder.

When setting policies for noise reduction, keep in mind that the environment is in control, it will determine all speech volume. The "noise floor" is the level of sound in any area that exists prior to anyone speaking or any human activity. The most common ongoing contribution to the noise floor is the HVAC system. Another could be the ice machine.

Document all experiences by place, date, time of day, and then note what you heard, including the character of the noise floor.

3. Establish Sound Standards

After the data has been collected, the Sound Quality Committee should establish qualitative sound standards that can be measured and maintained. These should not be one-size-fits-all. Rather, each specific unit should have its own auditory pacing and definition of homeostasis, when it is at an appropriate sound level.

Sound levels vary, with the "noise floor" being the level of continuous sound that characterizes an area at any given time. Other sounds, to be perceived,

must rise above this “floor.” If a sound increases to 30dB above the noise floor, it can cause a “startle response.” However, if the sound level is too quiet, conversations and unavoidable sounds become distractions.

The goal is to condition the sound environment to be appropriate to the needs of patients and staff. Silence is neither realistic or desirable. Patients need to hear life, hear that you are there for them. Conditioning the sound environment means just that: adding positive sounds where needed, reducing unnecessary and necessary noise where needed, and masking extraneous when possible.

Enhancing the sound environment with music is a viable option if used appropriately. As shown in other industries, foreground music can mask other irrelevant sounds and maintain an appropriate noise floor. In hospital settings, music combined with images of nature has been shown 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.

Custom-distributed sound systems designed to optimize the experience for the patients and families, can provide a more pleasing noise floor than one produced mechanically. They can enhance the quality of music and offer local volume controls in waiting areas. St. Charles Medical Center in Bend, Ore., Oconomowoc Cancer Center in Oconomowoc, Wis., and Sacred Heart Medical Center of Eugene, Ore., have invested in such systems to provide music in alignment with their mission of healing. These systems are parallel to, but distinct from, their emergency paging systems; are of higher quality; offer full-frequency; and are acoustically designed to support listening over many hours. They bring comforting “intention” into otherwise impersonal corridors.

To clarify the efforts to standardize noise levels by numbers, the World Health Organization set dB recommendations in 1999. However, today, those measures, which suggest 35DbA, are neither realistic nor possible as hospitals are now serving a greater population and using different technologies. (Hill and LaVela, 2015) In addition, other acoustic factors, such as reverberation (how the sound travels and where it lands) impacts the perception of volume and, more telling, determines whether speech privacy is a reality or fantasy. (Konkani, et al, 2014)

A Case Study: Tuality Health

Tuality Health's efforts to reduce noise and improve its HCAHPS scores around noise included multiple modalities. Improvements and repairs in all equipment used on patient floors, including housekeeping and lab carts, reduced hallway noise. Tuality also introduced The C.A.R.E.® Channel nature video and music programming to provide a positive distraction and help mask extraneous noises. In addition, it made a public effort to promote quiet with signs and other notices. Tuality encouraged nurses to introduce The C.A.R.E. Channel upon admission and use it to mask noises and create a healing environment.

By doing all this, Tuality was able to move its scores on noise satisfaction from well below the national average to 58 and then to 65, which well exceeded its own goals.(The Beryl Institute, 2014)

4. Establish Equipment Maintenance & Purchasing Standards

Once standards or goals have been set, recommendations should be made for modifying equipment, adjusting staff practices, and enhancing purchasing policies. In addition, repair and maintenance policies should be reviewed to respond to a higher quality of functionality that includes quieter operation.

Ongoing sound of medical or operations equipment becomes the noise floor, merging with the HVAC system and forcing all the volume levels to increase. To avoid the escalating volume syndrome, develop an auditory impact specification for each piece of equipment that is measurable. This should include expected range of sound levels to the person operating the equipment and to the patient. This may

involve setting comparative goals that respond to the known decibel levels of equipment, clinical areas, and times of day. A level of acceptability, i.e., one at which the equipment has little to no impact on the environment and patient, should be determined. This specification should be listed and highlighted on all RFPs for equipment purchases.

Much of the noise caused by the auditory predators in the hospital environment can be significantly reduced by mechanical adjustments, maintenance, or purchasing new equipment where possible. The auditory impact of equipment can be reduced by changing wheels, applying padding, repairing or replacing door bumpers, using sound-absorbing flooring, and installing effective acoustic ceiling tiles.

Purchasing new equipment based not only on function and price but also on this new auditory impact specification is another way of standardizing and maintaining an optimal auditory environment. Biomedical engineering departments that evaluate all patient care equipment prior to its use should test for its auditory impact, as well as for safety and operation. For maintenance equipment, such as floor buffers and vacuum cleaners, decibels should be measured and their operation schedules coordinated with the nursing staff to ensure that the auditory disturbance to patients is minimized.

5. Be the Patient Advocate: Attenuate Sound for Equipment

Medical Alarm Fatigue has become a safety issue, with a study done at The Johns Hopkins Hospital showing that in one month, there were more than 59,000 alarm conditions over a 12-day period—or 350 alarms per patient per day. (Sendelbach and Funk, 2013) Checking and adjusting monitors to avoid unnecessary alarms will undoubtedly reduce unnecessary noise exposure and distraction. This cannot be done “ad hoc.” Rather, the attenuation of the monitors should be individual based on clinical evaluation of patients and agreement between nurse and physician.

Johns Hopkins Hospital’s alarm improvement efforts began in 2006. Since then it has seen:

- A drop in total number of monitor alarm conditions and signals from monitors hospital-wide
- 43% reduction in high priority alarm conditions during an 18-day period – 16,952 to 9,647 alarm conditions on a medical progressive care unit
- 24 to 74% reduction of alarm conditions on six ICU and IMC units analyzed pre and post default parameter change
- 47% reduction in total alarm conditions per bed per day on two pilot units performing daily electrode change
- Decrease in amount and duration of lead-fail and arrhythmia-suspend alarm conditions using disposable leads

(Johns Hopkins Medicine, 2016)

The risk to a patient subject to monitoring equipment that triggers the startle response, causing agitation and sleep disturbance is well documented. (Hsu, et al, 2010; Sasso, et al, 2016) Hsu, Lasso, et al reported that the irritations and startle responses were easier measured on heart monitors and blood pressure gauges than by listening to where the volume was.

Evaluating the patient’s capacity to manage auditory stimuli will help minimize startle response and agitation if each monitor is personalized according to the patient’s condition. The higher the acuity, the lower the ability of the patient to adapt to the environment. Therefore, attending to all technologies from the point of experience of the patient is critical to reducing noise and improving sleep.

Sounds that travel to the patient from beyond his or her room or line of sight also require attention. Using barriers, such as doors and curtains, to provide both visual and auditory protection will begin the process of controlling sounds that resonate from one area to another.

At Northside Hospital in Atlanta, Ga, for example, the sonorous sound of the pneumatic tube system (an old and still functional technology) caused sudden disturbance to nearby ICU patients. The decibel level was brought down to 50dB (over 400% quieter) by the careful use of padding. And of course, any kind of padding or acoustic material used had to conform to fire and infection control regulations.

6. Educate Staff: Model Sound-Sensitive Behavior

Given that noise is a cultural outcome and noise levels are an organizational norm, mandating a change in staff behavior has long been known to be the least effective method of managing noise. (Konkani, et al, 2014) Rather than being mandated, behavioral standards should be modeled and extended organizationally. This includes both policies and practices regarding private or confidential discussions that take place in public areas, use and methods of paging, and use of mobile devices, nurse call systems, and the telephone.

Empower all of your staff members to contribute information to the Sound Quality Committee. Provide a means for them to contact you with issues they find compelling and acknowledge receipt of their suggestions. Proactive participation among your staff is critical for long-term success. You may want to set up a separate email address for the committee such as soundcommittee@yourhospital.org. This can be forwarded to the head of the committee without naming anyone.

Once someone sends a recommendation, respond to let him/her know you received his/her input, and that you will get back to him/her with a response regarding what to do. And then, do what you say. If this dialogue is not ongoing, the whole effort will lose credibility and ultimately fail.

If you do a search on YouTube for “hospital noise,” you’ll find several excellent videos made by hospitals on reducing noise. Because it is so much easier to judge and consider the behavior and actions of people outside your own organization, viewing these videos at your meetings may be an effective way to strategize on ways to improve.

There are also kinder and gentler methods to give the message to visitors. Longmont Hospital in Longmont, Col., greets staff and visitors with a picture of a child in a colorful nursing uniform holding one finger to her lips and saying “Shhh!” Northside Hospital created signs and buttons saying “Quiet Please: Healing in Progress,” reinforcing the awareness that a hospital needs first and foremost to be a place of recovery.

By creating a healing culture that respects the environment as a primary caregiver (especially the auditory environment being the one 24-hour factor from which patients have no relief), your efforts will be successful over time.

7. Measure Results

The process of measuring results is similar to that of the initial assessment. However, here patient and staff outcomes should be considered: quality of patient sleep and staff stress, for example, should be included in reviewing the effectiveness of steps taken. Use both quantitative and qualitative measures, decibel levels, patient satisfaction surveys, amount of pain and sleep medication needed, etc. Looking at the number of nursing calls at night, complaints during the day, and medication use for anxiety and pain will help give you an idea of what has improved or not.

Make a comparative analysis to determine how far you have come and which aspects of the sound environment have yet to reach the established goals. Some survey organizations offer customized questionnaires that specifically focus on the environment of care. Noise, however, is dealt with in an overall question, not specific to its impact, which is comprehensive. Before and after baseline data is the most helpful.

In measuring your results don’t ignore speech privacy as a direct outcome of the sound environment. Providing a balanced sound environment means one that is neither too noisy nor too quiet. Speech privacy is obviously an outcome of a healthy, dynamic sound environment and best practices.

Conclusion

When Florence Nightingale took on the task of defining nursing, she had little technology to manage or depend on. Rather, it was the environment, the “sick room,” that was the most effective protocol and provided both challenges and solutions to patient morbidity and mortality. Today, we can add nursing and medical errors to the list of risks posed by a noise-laden environment. Even with digital technologies used to control drug distribution and accuracy, sound-alike drugs become almost indistinguishable when amassed with auditory clutter.

Mobile devices provide an ever more complex set of challenges in both maintaining privacy and also protecting speech privacy. Cell phone users speak as loud as they need to in order to hear themselves, often resulting in a private phone exchange becoming public.

The auditory environment must exemplify the highest and most compassionate standards of patient care. Setting sound standards for equipment, technology, and design makes it possible for a patient to move through the healthcare system, from department to department, experiencing the same standards of care.

Nursing excellence, from Nightingale up to the present, addresses the whole person, the medically mandated care and the patient experience. Aim for more than auditory neutrality as the myth of “do no harm” when it comes to noise and distraction, by providing music and nature, fountains, or other pleasant sound sources that can improve the quality of the healthcare experience.

In your own hospital, stop and listen. What you hear should reflect the same values and standards as the clinical care you provide.

References

- Akansel N., K. S. (2008). Effects of intensive care unit noise on patients: a study on coronary artery bypass graft surgery patients. *J Clin Nurs*. Jun; 17(12): 1581-90. Surgical Nursing, Uludag University School of Health, Department of Nursing, Görükle-Bursa, Turkey, nakansel@uludag.edu.tr
- Anari M., Axelsson A., Eliasson A., Magnusson L. (1999) Hypersensitivity to sound questionnaire data, audiometry and classification. *Scand Audiol*. 28(4): 219-30.
- Baker C.F. (1984) Sensory overload and noise in The ICU: Sources of environmental stress. *Critical Care Quarterly*; 6; 66-80.
- The Beryl Institute, (2014). Reducing hospital noise and improving the patient experience using relaxation programming for patient television. Retrieved from <http://www.theberylinstitute.org/default.asp?page=CASE0514>
- Biley F.C. (1994). Effects of noise in hospitals. *Br J Nurs*. Feb 10-23; 3(3): 110-3. Review.
- Cmiel C., Karr D., Gasser D., Oliphant L., Nevau A. (2004) Noise control: A nursing team’s approach to sleep promotion. *American Journal of Nursing*.104(2).
- Currie K., Ruddy A., Mohammed T.A. (2014) Improving the in-patient experience by reducing avoidable night-time noise: Concurrent implementation and evaluation of service development. *RCN International Nursing Research Conference The University of Glasgow*, 2-4th April 2014. p. 34. Available at https://www.rcn.org.uk/__data/assets/pdf_file/0010/569215/2014_RCN_research_4.6.1.pdf (accessed 21 October 2015).
- Fillary, J., Chaplin, H., Jones, G., Thompson, A., Holme, A., Wilson, P. (2015). Noise at night in hospital general wards: a mapping of the literature. *Br J Nurs*, 24(10), 536-540. doi:10.12968/bjon.2015.24.10.536
- Gurses, A. P., Carayon, P. (2009). Exploring performance obstacles of intensive care nurses. *Appl Ergon*, 40(3), 509-518.

- Hewart, C., Fethney, L. (2016). Improving patients' sleep: reducing light and noise levels on wards at night. *Nurs Manag (Harrow)*, 22(9), 18-23. doi:10.7748/nm.22.9.18.s27
- Hill, J. N., LaVela, S. L. (2015). Noise levels in patient rooms and at nursing stations at three VA medical centers. *HERD Journal*, 9(1), 54-63. doi:10.1177/1937586715592635
- Hsu, S. M., Ko, W. J., Liao, W. C., Huang, S. J., Chen, R. J., Li, C. Y., Hwang, S. L. (2010). Associations of exposure to noise with physiological and psychological outcomes among post-cardiac surgery patients in ICUs. *Clinics*, 65(10), 985-989. doi:10.1590/S1807-59322010001000011
- Job, R.F.S., (1996) The psychology of reactions to environmental agents. *Environment International*, Volume 22, Issue 1, pp. 93-104.
- Johns Hopkins Medicine. Using data to drive alarm improvement efforts. Retrieved from https://www.hopkinsmedicine.org/news/using_data_to_drive_alarm_improvements.html
- Joseph, A. (2006) The role of the physical environment in promoting health, safety, and effectiveness in the healthcare workplace. The Center for Health Design, Issue Paper #3, Concord, CA.
- Konkani, A., Oakley, B., Penprase, B. (2014). Reducing hospital ICU noise: a behavior-based approach. *J Healthc Eng*, 5(2), 229-246. doi:10.1260/2040-2295.5.2.229
- Lane, H., Tranel, B. (1971). The Lombard sign and the role of hearing in speech. *Journal of Speech and Hearing Research*, Vol. 14, pp. 677-709.
- Luthra, S. (2015). For hospitals, sleep and patient satisfaction may go hand in hand. *Kaiser Health News*.
- Litton, E., Carnegie, V., Elliott, R., Webb, S. A. (2016). The efficacy of earplugs as a sleep hygiene strategy for reducing delirium in the ICU: A systematic review and meta-analysis. *Crit Care Med*, 44(5), 992-999. doi:10.1097/ccm.0000000000001557
- Lombard, E. (1911). Le signe de l'elevation de la voix, *Annals maladiers oreille, Larynx, Nez, Pharynx*, Vol. 37, pp. 101-119.
- Pope, D. S., Gallun, F. J., Kampel, S. (2013). Effect of hospital noise on patients' ability to hear, understand, and recall speech. *Res Nurs Health*, 36(3), 228-241. doi:10.1002/nur.21540
- Nightingale, F. (1859) Notes on nursing. Self published.
- Okcu S., Shpuza E., Ryherd R., Zimring C. Linking acoustics and floor-plate shape qualities of healthcare settings. *Arch Sc Rev* 2013;56:315-32.
- Sasso, L., Bagnasco, A., Aleo, G., Catania, G., Dell'Agnello, D., Currie, K., Timmins, F. (2016). Editorial: Noise on hospital wards – what have we learned? *Journal of Clinical Nursing*, 25(7-8), 891-893. doi:10.1111/jocn.13200
- Sendelbach, S., Funk, M. (2013). Alarm fatigue: A patient safety concern. *AACN Advanced Critical Care*, 24(4), 378-386.
- Schneider, Bruce A., Pichora-Fuller, Kathleen M. (2000). Implications of perceptual deterioration for cognitive aging research. From Craik and Salthouse, *The Handbook of Aging and Cognition*, pp. 155-220. Lawrence Erlbaum Associates, Mahwah, N.J.
- Vinodhkumaradithyaa, A., Srinivasan, M., Ananthalakshmi, I., Kumar, D. P., Jeba Rajasekhar, R. V., Daniel, T., Thirumalaikolundusubramanian, P. (2008). Noise levels in a tertiary care hospital. *Noise Health*, 10(38), 11-13.

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