FINDINGS

GOING QUIET:

Best Practices

An Issue Brief on Noise Reduction

INSIDE YOU WILL LEARN ABOUT:

How excessive noise can negatively impact patients and staff in the hospital environment.

Ways to improve patients' perception of sound.

Low-cost, medium-cost, and high-cost design strategies that can reduce noise.

This issue brief was created as a benefit for the **Affiliate+** *Program.*

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Going Quiet: Best Practices

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Executive Summary

In FY2014, organizations began receiving Centers for Medicare and Medicaid Services (CMS) reimbursement based on formulas established through the Value-Based Purchasing (VBP) Program and Total Performance Score (TPS). Thirty percent of the TPS is associated with the patient experience, as measured by the HCAHPS survey. According to the most recently published results (Capachi, 2012; Centers for Medicare & Medicaid Services, 2014), "How often was the area around your room quiet at night?" remains the lowest-scoring component of the HCAHPS survey: In the U.S., on average, only 61% of respondents answer "always." As an underlying condition of the overall patient experience, noise can affect patient safety and patient health as well as staff satisfaction, health, productivity, and efficiency.

Noise is defined as an auditory stimulus that bears no informational relationship to the task at hand (United States Pharmacopeia (USP), 2010). *Sound* is a change in volume that has some informational relationship to the task at hand (Andringa & Lanser, 2013; Flynn et al., 1996).

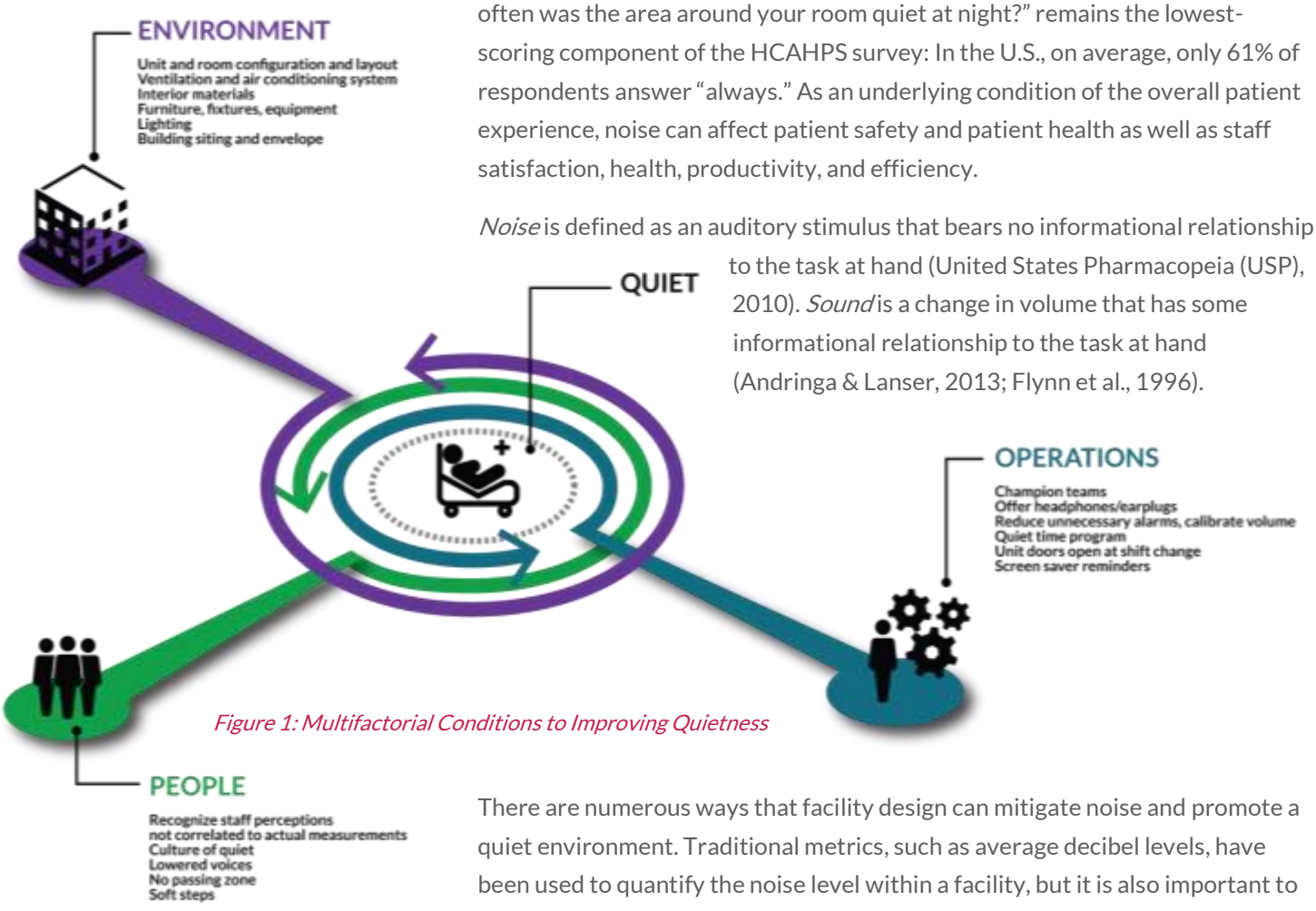


Figure 1: Multifactorial Conditions to Improving Quietness

There are numerous ways that facility design can mitigate noise and promote a quiet environment. Traditional metrics, such as average decibel levels, have been used to quantify the noise level within a facility, but it is also important to

IMPACT OF NOISE

Research indicates that the excessive noise found in hospitals can cause many serious problems, such as:

- Sleep disturbance and deprivation
- Psychological stress/anxiety/ annoyance
- Aggressive behaviors
- Interference with communication
- Increased use of medication
- Higher rates of re-hospitalization

understand the perceptions of noise levels and sources. For example, sudden increases (peak noises) can have a more disruptive effect than continuous elevated background noise levels. Interventions include noise source control, sound absorption, and noise blocking, as well as sound masking (playing pleasant recordings to override background noise) and providing information on the source(s) of noise. As part of a multifactorial solution, the built environment should be considered a means to supplement operational and behavioral methods to reduce disruptive noise.

Background

This paper outlines issues related to the current state of Value-Based Purchasing and the patient experience domain (as measured through HCAHPS) as it relates to noise. The HCAHPS score on quietness in the hospital environment has typically been among the lowest-rated patient experience dimensions. According to the most recent HCAHPS survey results, the average score of nearly 4,000 hospitals nationwide for this dimension was only 61%, compared with 64–85% for other dimensions (Centers for Medicare & Medicaid Services, 2014). For individual hospitals, it makes sense to focus on improving environmental quietness, which may result in significant financial gains by increasing both the HCAHPS base score and consistency score. For a brief primer on VBP and HCAHPS, see Appendix 1.

This summary includes implications for patient and staff health, with a focus on built environment strategies that might be considered to improve healthcare acoustics for better outcomes, such as patient satisfaction and comfort, patient and staff communication, staff satisfaction, and staff efficiency and productivity. While not the focus of this brief, the healthcare acoustic environment may also indirectly influence the new HCAHPS outcome domain through improved patient health outcomes.

The Impact of Noise

Impact of Noise on Patient

Recent research indicates that the excessive noise pervasive in hospitals across the country is associated with many serious problems, including:

- Sleep disturbance and deprivation (Buxton et al., 2012; Li, Wang, Vivienne Wu, Liang, & Tung, 2011; Parthasarathy & Tobin, 2012; Solet, Buxton, Ellenbogen, Wang, & Carballiera, 2010; Yoder, Staisiunas, Meltzer, Knutson, & Arora, 2012);
- Psychological stress/anxiety/annoyance (Weiland et al., 2011);
- Detrimental physiological responses (e.g., high blood pressure, low oxygen saturation) (Parthasarathy & Tobin, 2012; Peng et al., 2011; Ryherd, Okcu, Hsu, & Mahapatra, 2011);
- Aggressive behaviors (Short, Short, Holdgate, Ahern, & Morris, 2011);
- Interference with communication (Pope, Gallun, & Kampel, 2013);
- Increased use of medication (Bartick, Thai, Schmidt, Altaye, & Solet, 2010; Buxton et al., 2012); and
- Higher rates of re-hospitalization (Hagerman et al., 2005).

Hsu, Ryherd, Waye, & Ackerman (2012) also found that outcomes such as gastric response and wound healing may be impacted by noise.

Impact of Noise on Staff

As a well-recognized environmental stressor, noise also has implications for staff (Choiniere, 2010; Healthcare Acoustics Research Team, n.d.; Mazer, 2012). Noise may cause:

- Stress symptoms (e.g., irritation, fatigue, tension headaches, difficulty concentrating);
- Emotional exhaustion and burnout that, in turn, contributes to low job satisfaction; and
- High turnover.

In addition, elevated background noise levels may impede audio communication and monitoring (Way et al., 2013; Weiland et al., 2011). Unexpected or irrelevant noises may distract the attention of pharmacists and surgeons from medication dispensing or surgical tasks, thus causing medical errors or near misses (Flynn et al., 1996; Pluyter, Buzink, Rutkowski, & Jakimowicz, 2010). In certain areas, high peak noises could even be physically harmful, potentially causing hearing loss (Yassi, Gaborieau, Gillespie, & Elias, 1991).

The impacts of noise on staff may consequently contribute to impaired quality of care, because staff well-being and satisfaction impact patient outcomes (Leiter, Harvie, & Frizzell, 1998). According to the American Nurses Association National Database of Nursing Quality Indicators (NDNQI), positive patient outcomes are strongly tied to nurse satisfaction (Anonymous, 2013c). A recent study also investigated corridor layout as it pertains to nurse ability to respond to auditory cues like alarms. Less elongated and more fragmented unit floor-plates were associated with reduced reverberation times (Okcu, Ryherd, Zimring, & Samuels, 2011).

Built Environment Considerations

In terms of noise representing "unwanted sound," certain sounds (e.g., talking) may be unwanted and perceived as noise by some individuals but not others (e.g., individuals engaged in the conversation) (Andringa & Lanser, 2013; Flynn et al., 1996). Most published papers studying noise in hospitals indicate that the

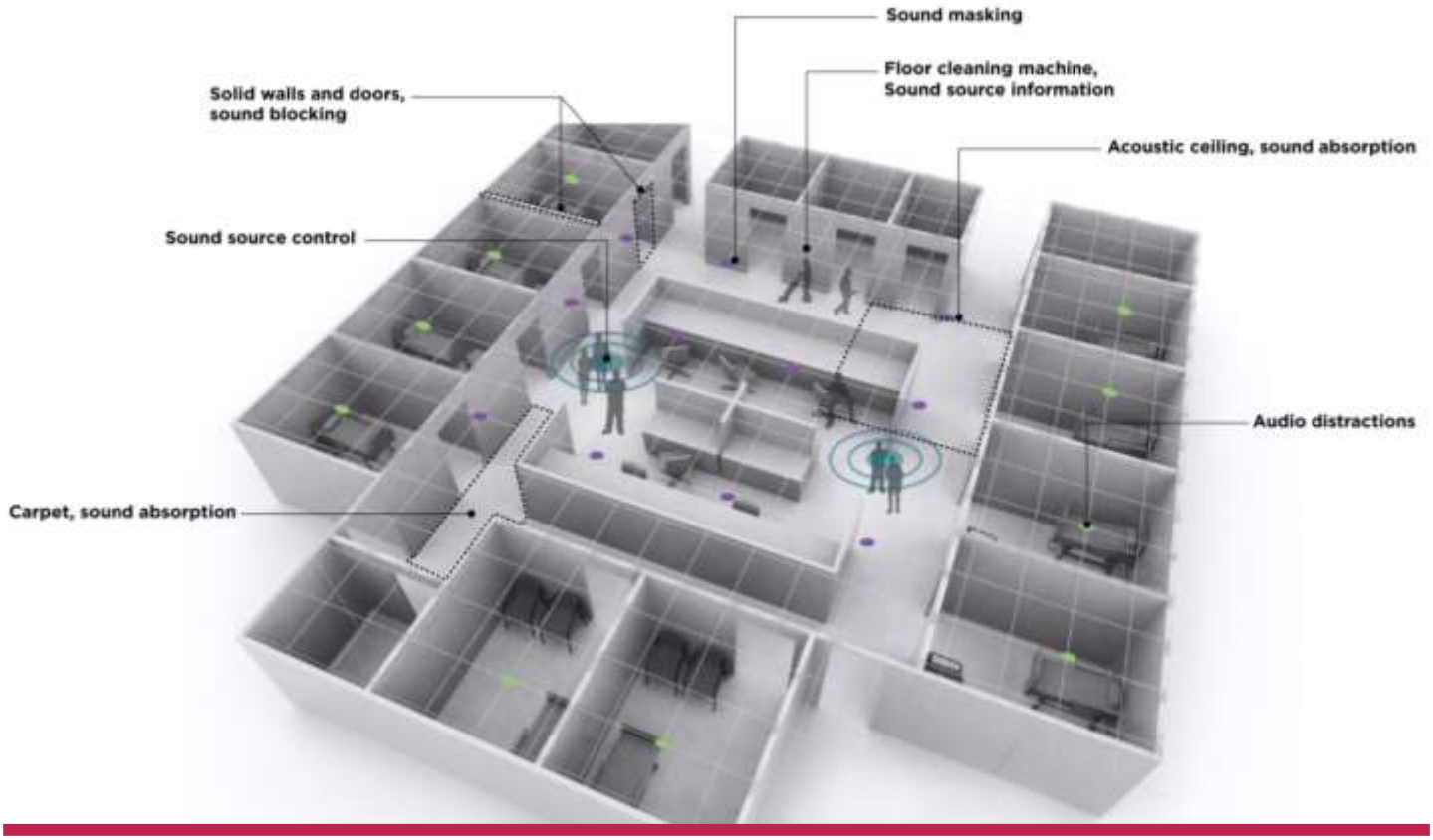


Figure 2: Built Environment Considerations

high continuous background noise level recorded in healthcare settings exceeds WHO recommended levels. This causes an increased volume of "wanted" sounds, such as alarms, monitoring devices, and conversations, which may be perceived as "noise" by other occupants of the healthcare environment and may contribute to higher continuous sound levels (Mackrill, Cain, & Jennings, 2013).

ENVIRONMENTAL MEASURES TO REDUCE NOISE

1. Sound source control
2. Sound absorption
3. Sound blocking

Noise Reduction

Many environmental measures have been shown to be effective in reducing noise, including sound source control, sound absorption, and sound blocking.

Sound Source Control

Sound source control, through both environmental and operational measures, has been frequently used to reduce noise. Many healthcare organizations have examined the sources of noises (e.g., medical monitoring devices, conversations, and housekeeping) in the patient care areas and then either removed or relocated the noise sources (e.g., using soundless paging or other communication systems; moving patient monitoring alarms to centralized locations away from patients), or reduced the sound level of the noise sources (e.g., using quieter automatic door openers) (Anonymous, 2013b; Solomon, 2012). In addition, many organizations implemented a "quiet time" policy to modify staff and visitor behavior by dimming light during night hours, posting signs as reminders, and using sound level monitors to remind staff and other individuals to lower their voices (Bartick et al., 2010; McKinney, 2013). Research has shown the effectiveness of sound source control measures. For example, the average noise level decreased from 58 to 56.4 dBA in the newborn intensive care unit after a noise-sensor light alarm was installed to monitor the sound level and remind nurses to lower their voices and control other noise sources (Chang, Pan, Lin, Chang, & Lin, 2006). Sudden peak noises in this study decreased from 630 to 185 times per day in the incubator area.

Sound Absorption

Sound-absorbing finishing materials can reduce noise levels by absorbing a large percentage of sound waves coming in to contact with the material surfaces. The ability of sound absorption of a particular material can be measured by Noise Reduction Coefficient (NRC) ranging from 0 (totally reflective), to 1 (perfectly absorptive). The sound-absorptive nature of carpets and acoustic ceiling tiles is often employed by healthcare organizations as a

means to reduce noise (Anonymous, 2013a; Capachi, 2012). Scientific studies have evaluated and demonstrated the effectiveness of sound-absorbing materials. For example, replacing sound-reflecting ceiling tiles with sound-absorbing ceiling tiles resulted in a reduction of reverberation time and improvement in speech intelligibility, and also led to reduced work demands, pressures, and strain as reported by staff (Blomkvist, Eriksen, Theorell, Ulrich, & Rasmanis, 2005). In another study, patients experienced lower stress levels (as indicated by lower pulse amplitude), reduced hospitalization, and improved perceptions of staff attitude (Hagerman et al., 2005).

Sound Blocking

The sound blocking method aims to reduce sound transmission between rooms and spaces. A building material's ability to reduce sound transmission is often measured by Sound Transmission Class (STC). One example of sound blocking in healthcare was the use of solid walls and doors between patient beds instead of soft curtains. Many research studies show that solid walls and doors significantly reduced sound transmission between patient cubicles/rooms and provided better protection for speech privacy than soft curtains (Barlas, Sama, Ward, & Lesser, 2001; Karro, Dent, & Farish, 2005). One major advantage of providing single-bed rooms is the reduction of sound transmission between patients. Research found significantly lower sound levels in single rooms compared with multi-bed rooms (Gabor et al., 2003). Patients in single rooms tended to be more satisfied than patients in multi-bed rooms in terms of perceived noise level (Ulrich et al., 2008). However, even in single rooms, a common practice was to keep patient doors open for the convenience of patient monitoring, which defeated the purpose of sound blocking. Many healthcare organizations have begun to explore alternative ways of patient monitoring and, at the same time, offer patients the option of keeping doors closed (Rodak, 2013; Solomon, 2012).

Sound Perception Improvement

The acoustic experience of patients is complex, depending on both the sound level and quality, as well as the patient's subjective cognition of the healthcare acoustic environment (Andringa & Lanser, 2013; Mackrill et al., 2013; Pope et al., 2013). Although this area requires further research, the following methods have been used or recommended to improve perceived quietness.

Improve perceived quietness through:

- Audio distractions
- Noise masking
- Sound source information

Audio Distractions

The benefits of positive visual (e.g., nature images) and audio (e.g., music, sound recordings of nature) distractions on both patients and staff have been well documented. For example, music was found to help reduce potentially harmful physiological responses due to anxiety experienced by patients undergoing mechanical ventilation (Chlan et al., 2013; Han et al., 2010; Korhan, Khorshid, & Uyar, 2011). Research suggested that when patients' attention was distracted from stressors and directed to more pleasant environmental stimuli, patients tended to experience less stress and use less pain medication (Lee et al., 2004; Mackrill et al., 2013). It is hypothesized that providing pleasant sounds preferred by patients may help to direct their attention away from negative noise sources, resulting in perceived quietness and other positive effects (Mackrill et al., 2013). Some healthcare organizations have provided music and other pleasant sounds through headphones to prevent these sounds from becoming "noise" for other patients (Rodak, 2012).

Noise Masking

Noise masking refers to the addition of natural or artificial sound (e.g., white noise, pink noise—a variation of white noise) to cover up noises. Rather than reducing the sound level, sound masking increases the continuous sound level of the background so that peak noises become less noticeable. Research indicates that the occurrence of patient sleep arousal is more closely related to the change in sound from continuous background to peak sound level than to the peak sound level itself (Stanchina, Abu-Hijleh, Chaudhry, Carlisle, & Millman, 2005). The use of sound masking (e.g., white noise generator) could help reduce the disturbing effect of peak noises on patients. Because of the lower disturbance, patient perception of quietness may be improved (Capachi, 2012; Cordova et al., 2013). Some patients, notably, prefer music over white noise (Cruise, Chung, Yogendran, & Little, 1997).

Sound Source Information

Research has also found that unfamiliar sound from certain sources (e.g., floor cleaning machines, trolleys, loud talking) could be initially perceived negatively by patients but became less disturbing when patients learned about the sources of sounds (e.g., tea trolley moving) (Mackrill et al., 2013). This suggests that explaining sound sources to patients may help improve patient noise perception

because information about noise sources may increase the sense of environmental control (Mackrill et al., 2013).

Best Practice Acoustic Interventions

The acoustic intervention packages implemented by healthcare organizations are often combinations of built environment and operational measures. It was reported that such a multifactorial intervention led to a significant improvement of HCAHPS scores on room quietness (Capachi, 2012). For example, the following measures were implemented in one hospital's acoustic improvement program:

- Sound source control (e.g., repair squeaking doors and carts, reduce localized nurse congregations, minimize overhead paging);
- Sound absorption (e.g., sound-absorbing floor tiles);
- Sound blocking (e.g., ear plugs); and
- Sound masking (e.g., TV channel with white noise).

The table below summarizes some of the common acoustic interventions (both environmental and operational) recommended and/or implemented in healthcare settings (Anonymous, 2011, 2013a, 2013b, n.d.; Bartick et al., 2010; Boehm & Morast, 2009; Capachi, 2012; Cordova et al., 2013; McKinney, 2013; Rodak, 2012, 2013; Solomon, 2012).

Table 1: Best-Practice Acoustic Interventions and Corresponding Estimated Order of Magnitude Cost

	$ High cost	$ Medium cost	$ Low cost
Sound source control	Replacing overhead staff paging systems with wireless headsets; Moving overhead paging to hallways instead of patient rooms; Creating smaller nursing stations staffed by fewer nurses to avoid staff gathering places closer to patients' rooms /avoiding nurses congregating in one area; Dedicating elevators for high-traffic areas like the X-ray and CT scan departments; Quieter mechanical equipment (e.g., HVAC, elevators)	Dimming lights in the evening, using a portable lantern to illuminate only the area where employee is working; Reducing the frequency and intensity of medical alarms; Installing a noise monitor or "sound ears" (Yacker Trackers) to identify when noise needs to be diminished; Evaluating all transport carts, replacing noisy wheels/casters; Using quieter-model dust pans/vacuum cleaner; Specifying door hardware/gaskets to limit latch noises, repairing squeaking doors, door pads for frequently used doors, quieter automatic door openers; Avoiding sound sources with "shifting contours" (towel dispenser, door close, toilet flush, ice machine)	Designating sleep hours during which there are no routine checks of vital signs unless necessary; Asking staff to talk quietly; Offering headsets for TVs and iPads; Performing housekeeping work using heavy equipment during the daytime only; Setting wireless phones on vibrate for nurse communication; Setting telephones to stop after a specific number of rings; Displaying "Quiet" messages at elevators and other public places ("Do Not Disturb" sign on patient room door); Establishing peer accountability for "Culture of Quiet"
Sound absorption	Providing sound absorption of HVAC noise	Using high-performance sound-absorbing ceiling tiles and flooring (e.g., carpets; rubber flooring); Using heavy, floor-to-ceiling curtains designed to absorb sound and protect patient privacy	
Sound blocking	Using private rooms; Locating elevators away from patient care areas	Specifying door hardware/gaskets to limit transmission between patient room and hallway (e.g., sound seals on doors); Locating noisy equipment (e.g., heart alarm monitors, ice machines) especially those with "shifting contours" (i_e., changing loudness) in centralized, enclosed locations	Allowing patients to close their doors; Providing patient "Quiet Kits" with sleep masks, earplugs and distractions (e.g., crossword puzzles)
Audio distractions			Programming TVs with calming music and images; Offering patients head phones and relaxing music
Sound masking	Installing ambient white noise machines		Programming TVs with white noise channel
Sound source information			Providing patients with a notice of construction or repair work that may create noise or vibrations; Educating patients about noise sources

NOISE MEASUREMENTS IN EBD RESEARCH

- Sound levels
  - » Equivalent sound pressure level (LAeq) (weighted average sound pressure level: dBA)
  - » Minimum and maximum sound levels
  - » Reverberation time
  - » Speech privacy
  - » Speech communication
  - » Across multiple days and locations
- Videotape recording of unpredictable/controllable/uncontrollable sounds
- Questionnaire on perceived noise
- Environment inspection/audit of noise sources and frequencies

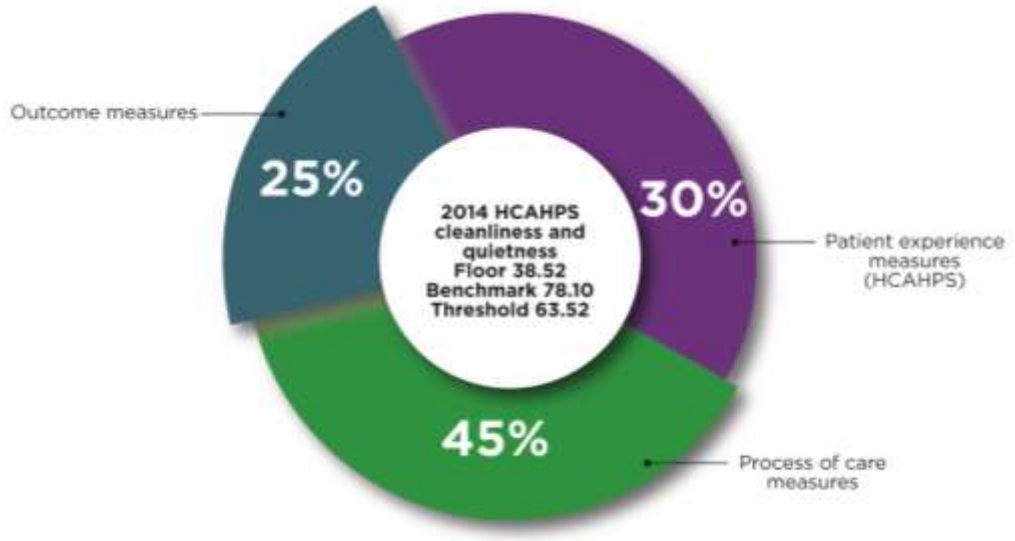
(Quan, Joseph, Malone, & Pati, 2011).

Taking It to the Next Level: Measuring Noise

Noise measurement can be complex. There are numerous acoustical studies in healthcare environments that define protocols and metrics, but it is important to note that quantitative measurements should be supplemented by a qualitative review of perceptions and an identification of noise sources. According to ASHRAE, typical measurement protocols include three levels: basic (low-cost and simple); intermediate (medium-cost, requiring intermediate skill); and advanced (high-cost and high-accuracy, requiring operational expertise) (Moiseev, 2011). Some studies provide basic information on using sound-level meters and noise dosimeters, while providing guidance for positioning microphones in studies (Good & Roy, 2010; Gray & Philbin, 2000), and healthcare environmental variables can be found in *An Evidence-Based Design Glossary* (Quan, Joseph, Malone, & Pati, 2011). Additional technical detail on building measurement protocols can be found in *Performance Measurement Protocols for Commercial Buildings* (ASHRAE/USGBC/CIBSE, 2010).

Conclusion

There is no single-source solution to reduce noise in healthcare environments, but a number of multifactorial best practices are well documented. Because perceptions of noise are inextricably linked to the patient experience as reflected in current HCAHPS scores for the environment dimension, a combination of built environment solutions, behavioral modifications, and operational policies supporting noise reduction should be part of every healthcare organization's program to enable a culture of quiet, improve the patient experience, and ultimately contribute to the bottom line.



Appendix 1

HCAHPS and Hospital Value-Based Purchasing

As of FY2014, the Total Performance Score associated with CMS reimbursement and the VBP Program includes the Clinical Process of Care domain (13 measures, 45 percent), the new Outcome domain (three mortality measures, 25 percent), and the Patient Experience domain (eight dimensions, 30 percent) (Centers for Medicare & Medicaid Services, 2013). The Patient Experience of Care domain is measured through the percentages of the most positive HCAHPS survey responses in eight dimensions:

1. Communication With Nurses
2. Communication With Doctors
3. Staff Responsiveness
4. Pain Management
5. Communication About Medicines
6. Discharge Information
7. A composite of Cleanliness and Quietness items
8. Overall Rating of Hospital

According to CMS, the Patient Experience of Care domain score is the sum of two scores: the HCAHPS base score (the sum of the eight dimensions through improvement or achievement points), and the HCAHPS consistency score (based on a given hospital's lowest-rated dimension, with the worst-performing hospital's performance rate in the baseline period). The consistency score is intended to incentivize hospitals to improve on the worst-performing HCAHPS dimension.

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