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SAMPLE TOOLBOX RESOURCES

Affiliate**+** members have access to in-depth, high-value, leading-edge content, organized by topic to address the most pressing facility design issues impacting health outcomes and healthcare costs.

On the following pages are four examples – a case study, an expert interview, a lessons learned summary, and a deep-dive issue brief – representing the quality and some of the types of content available exclusively to The Center's Affiliate**+** members. Organized by topic, each Toolbox contains a library of expert insights, case studies, research data, strategies and tools which can be shared and used by your entire organization.

Palomar Health Communicates Its
Commitment to Patients Through

"HOSPITAL OF THE FUTURE"

A Case Study on Communication at Palomar Health, San Diego, CA

INSIDE YOU WILL LEARN ABOUT:

How Palomar Health facilitated an improvement in patient-provider and staff communication.

The multiple benefits of the organization's new decentralized nursing stations.

How the newly designed healing environment contributed to patient comfort and satisfaction.

This case study was created as a benefit for the Affiliate+ *Program.*

Palomar Health Communicates Its Commitment to Patients Through "Hospital of the Future"

Palomar Health, San Diego, CA
Architecture/Design Firm: Co-Architects, Los Angeles, CA

Designing a State-of-the-Art Hospital That Responds to Patients' Needs

As the largest public healthcare district in California, Palomar Health's mission is to heal, comfort, and promote health in the communities it serves. Yet back in 2002, one of its three inpatient locations was struggling, its patient satisfaction ratings hovering at an all-time low. Further, the facility required a number of upgrades to meet the state's building codes to withstand potential damage from earthquakes.

Recognizing that the hospital had outgrown its current footprint, the leadership decided to build a modern hospital at a new location. This offered a host of opportunities for the facility to rethink its built environment and incorporate best practices into the new space.

The executive team collaborated closely with the architectural firm Co-Architects of Los Angeles, along with engineers and consultants, over a 10-year period to create the Palomar Medical Center in Escondido, California, just outside of San Diego. The new hospital, which consists of 740,000 square feet, 11 floors (9 currently in operation), and 288 patient beds, officially opened its doors to patients in August of 2012.

The Challenge

Throughout the planning, design, and construction stages of Palomar Medical Center, commonly referred to as the "Hospital of the Future," the staff had a big challenge to address. Before they moved to the new location, their Press Ganey scores were at an all-time low, coming in at just the 7th percentile for communication overall, and with similarly poor marks in communication with physicians and nurses. Therefore, when designing the new building, they needed to find ways to incorporate research-based and patient-centered practices to facilitate

THE QUESTION

Palomar's Press Ganey scores were at an all-time low before the new building opened. Could the new space help to facilitate better patient-provider communication and improve satisfaction ratings?

THE GOAL

Palomar Health wanted to create a state-of-the-art environment where patients could access high-quality care in a healing space.

KEY FINDINGS

1 Incorporating nature into patient and staff spaces helps to create a more healing environment.

2 Positioning nurses outside patient rooms makes it easier to provide care as needed.

3 Having doctors and nurses round together in the new space helps everyone stay on the same page with respect to the patient's plan of care.

4 Press Ganey communication scores increased from 7% to 89% satisfaction in the new space.

The hospital offers terraces, spacious windows, light wells, and lush garden spaces for patients and their families to connect with the natural setting.

improved patient-provider and staff communication, and to optimize the patient experience. They also had to get all staff on board to accept new ways of providing patient and family-centered care.

In addition to creating new modes of communication, the design team wanted to create a healing environment incorporating a number of important aesthetic details that would express the hospital's commitment to patients and their health, as well as maximize comfort for both patients and their families.

Results

"We incorporated all of the evidence-based design principles known at that time," explains Lorie Shoemaker, RN, MSN, DHA, NEA-BC, who currently serves as the hospital's Vice President and was involved in the project throughout the decade-long planning and design process.

One of the most striking components of the building is that it's designed to bring the outside in, making impressive use of light and the natural environment. The hospital offers terraces, spacious windows, light wells, and lush garden spaces for patients and their families to connect with the natural setting. These features are incorporated into all of the patient and staff spaces. There are also family zones and spacious patient rooms that allow families to be part of the care process—and couches that convert into comfortable beds for them to stay overnight.

This setting provides the perfect backdrop for a new bedside nursing care delivery model that is integrated into the units, made possible thanks to decentralized nursing stations outside of every patient room. These individual stations are stocked with supplies so nurses can more effectively

Palomar's innovative care model also relies on state-of-the-art technology.

and efficiently attend to their patients. Spreading out nursing support in this way both increases patient comfort, reassuring them that the nurses are readily available, and minimizes noise in the units. Shoemaker admits this was one of the most controversial features in the design plans, but the executive team advocated for the concept as a way to improve patient care and safety. Overall, the staff has adapted well to these changes.

Palomar's innovative care model also relies on state-of-the-art technology that facilitates communication between patients and nurses. A nurse call system was configured to allow patients to use call buttons positioned on their pillow speaker for different functions, such as water, bathroom, pain, and nurse. The page goes to the appropriate

person's phone. The call system also helps to coordinate nurse and physician rounding together. When physicians enter a patient's room, they press a button indicating their location; this calls the nurse to join them. Shoemaker says this system has made a significant difference in encouraging rounding and improved nurse and physician communication.

Conclusion

With the integration of so many exciting new features that put patients and their families first, Shoemaker says that she and her colleagues expected an initial increase in patient satisfaction ratings. But once

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they were situated in the new, highly modern facility, the numbers continued to climb, reaching a high of 89th percentile overall.

"We realized it isn't just the building that's prompting these results; it's also the way that people provide care in the building," she stresses.

As a result of their success, Palomar Medical Center has achieved not only a new care delivery model and high satisfaction ratings from its patients, but also a number of awards and recognition—including the 2014 Press Ganey Success Story Award.

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To Thrive,
Healthcare Organizations Will Have to Act More Like
CONSUMER BRANDS

An Interview on Healthcare Reform With Jason Girzadas

INSIDE YOU WILL LEARN ABOUT:

The key issues facing healthcare administration as a result of healthcare reform.

Forward-thinking strategies to manage the challenges associated with healthcare reform.

The ways healthcare architects and designers can help envision future healthcare enterprises.

This interview was created as a benefit for the Affiliate+ Program.

To Thrive, Healthcare Organizations Will Have to Act More Like Consumer Brands

Jason Girzadas

Jason Girzadas, Deloitte Consulting LLP, serves as Managing Director of the U.S. Life Sciences & Health Care Practice. With over 20 years of experience, he helps many of the nation's top healthcare organizations navigate challenges including implementing the latest technologies, creating operating efficiencies, improving performance, and addressing industry reform. Passionate about others' success, he has played a variety of talent development roles for Deloitte.

Tell me a bit about your background and your interest in Healthcare Reform.

I am responsible for the overall Life Sciences & Healthcare Consulting practice at Deloitte. The clients we serve include Life Science companies, hospitals, healthcare systems, and physician groups, as well as managed care companies and health plans. As a firm, Deloitte has a very large healthcare commitment, history, and presence, so we felt a great obligation to mobilize understanding around healthcare reform—being able to think through its application and being prepared to help our clients navigate it successfully. In my formal role as a consultant in the Life Sciences & Healthcare practice, I have had a hand in all of these efforts.

What do you see as the key issues for healthcare administration (C-suite, facility operators, architects, designers, and healthcare manufacturers/vendors)?

For hospitals and health systems, it boils down to three big areas of impact. One, all the healthcare executives we work with are trying to do more with less. From here on out, those individuals who are designing, operating, and sustaining healthcare facilities and delivery organizations are going to feel immense pressure to drive efficiency and cost—everything from the footprint of facilities to how they support the business processes. A second big implication is around the so-called "consumerization" of healthcare. Many healthcare systems and hospitals have not had a history of being particularly consumer-friendly and focused. The impact on architects and designers will be to integrate consumer-friendly, consumer-savvy attributes and capabilities into design, operations, and management processes because facilities are increasingly going to have to execute against that business objective. The third issue is around team-based care—connecting care and integrating care more effectively. That's everything from the home, the office, hospital to mobile, digital, virtual care, and the self-monitoring that comes with that. We are seeing a broadening definition of what healthcare is, and in order for these hospital health systems to be effective, they

are going to have to integrate care across all these sites and have the technologies and processes to do that.

In this time of change and unpredictability, it's hard to know what services to offer or what to build. What suggestions or approaches can you offer organizations to help them plan a forward-thinking strategy?

Healthcare reform is about more than the Affordable Care Act, although that is the signature piece of legislation. There is also the federally mandated conversion to the ICD-10 diagnostic and procedural codes, Meaningful Use Mandate, and HITECH Act, all of which have impacted healthcare organizations. So the first step is to do an assessment of what healthcare reform means to the enterprise across all relevant dimensions: What is its impact on strategy, finance, operations, and care, as well as technology? Secondly, it's important to make sure that all stakeholders in the enterprise are aware of and participate in understanding the impact. It's critical to make sure physician communities and stakeholders—including vendors, suppliers, and the workforce—are involved and understand the changes that are afoot.

The next piece is to prioritize and effectively manage portfolio initiatives. Some of the leading organizations we have worked with have created a centralized group that manages the healthcare reform program or initiatives and are thinking about them in an interdependent way so the executive team has a handle on current status and progress as well as trade-off decisions.

How can architects and designers help?

There is so much capital and operating pressure on health systems that dollars are going to have to go further. Designers and architects are really going to bring innovative thinking to healthcare and push the thinking around what the future health enterprise looks like from a physical plant and physical layout perspective. The notion of building towers and towers of bed capacity is really being challenged. There is going to be much more emphasis on convenience and on being where consumers and patients are, as well as the actual experience itself. I don't think that's at the forefront of healthcare design to the extent that it will need to be in the near future. We're going to see health systems

> Designers and architects are really going to bring innovative thinking to healthcare and push the thinking around what the future health enterprise looks like from a physical plant and physical layout perspective.

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> The clients we are working with are embarking seriously upon technologies that will increase their brand, improve convenience, and build relationships more along the lines of what you'd expect from consumer brands and products. There's a gap today, but the gap will continue to be challenged—and the organizations that don't close the gap will suffer.

competing on a brand basis, a cost basis, and a service/quality basis for your and my dollars—and all of these factors are going to be part of the decision-making.

According to 4 years of Deloitte's consumer surveys, three in four consumers gave the healthcare industry a poor report card grade. How much of a role do you think the consumer will play in defining what happens in the healthcare industry?

Our study and many others make the point that as consumers shoulder more and more of the cost of healthcare, they are going to have a lot more to say in terms of the choices they make. They are going to expect more in terms of transparency of cost, as well as service and quality trade-offs. Today it's a work in progress, but we are clearly on the path, with tools to help consumers make decisions vis-à-vis cost trade-offs, quality trade-offs, as well as comparative information for hospitals and physicians. The clients we are working with are embarking seriously upon technologies that will increase their brand, improve convenience, and build relationships more along the lines of what you'd expect from consumer brands and products. There's a gap today, but the gap will continue to be challenged—and organizations that don't close the gap will suffer.

How can the industry move forward to better meet the consumer's expectations and demands?

It isn't just technology capabilities that matter, such as price transparency or information sharing. It can also be the service mindset and the service-oriented culture, as well as having the right systems in place to support the staff in delighting the consumer. Architecture and design also play into this. How do you architect an experience? What's the level of your concierge-like care, and how do you navigate a health episode or choose the best care for whatever condition you have? There are many aspects to having a consumer orientation.

As we approach the 4-year anniversary of the Affordable Care Act, what are some new or disruptive healthcare models you have seen or think might happen to make the shift from volume to value?

I think there are all kinds of interesting disruptions going on. Some quite interesting models include these so-called retail clinics, which are everything from a nurse practitioner/primary care-type model to others that are in community-based settings. This is both an opportunity and a challenge. Some of

Smaller organizations, in particular, will be challenged to fund their technology needs moving forward, as well as to have the capabilities to manage population health and data on clinical and financial performance. Those are not trivial capabilities, and I don't think they lend themselves to smaller entities going it alone.

these models involve partnering and collaborating with traditional healthcare systems, while others do not. Another example is around very cutting-edge mobile physician consultations where you can have a real, live consultation or physician visit online through a mobile device. We're just starting to see what it means to integrate that kind of care into what we consider mainstream care.

In terms of the volume to value shift, Medicare has been a leader in this—but increasingly it will be more and more prevalent on the commercial and other populations in healthcare. Health enterprises, particularly hospitals and health systems, are going to be challenged to think about the best way to approach different populations, rather than just about the volume of care provided.

Health systems are on the verge of rapid consolidation driven by significant regulatory changes, technological innovations, financial pressures, and market dynamics. How far might health system consolidation go? What does the consolidated world look like?

Healthcare systems see consolidation as a way to band together to collectively address some of the challenges we've been discussing. The investments required for Meaningful Use—that is, the use of electronic health records to improve patient safety and outcomes, increase transparency, and provide greater data inter-operability are quite overwhelming. Smaller organizations, in particular, will be challenged to fund their technology needs moving forward, as well as to have the capabilities to manage population health and data on performance. Those are not trivial capabilities, and I don't think they lend themselves to smaller entities going it alone. With that backdrop, I think we'll see more and more consolidation.

You just released your Technology Trends report. What impact do you think that technology brings to the healthcare industry?

I think we'll be seeing more and more "consumerization" of everything from personal apps—such as nutrition tracking—to communities for people with certain chronic health or acute care conditions, to wearable Quantified-Self clothing or other devices. The consumer movement is exploring a whole host of digital technologies, and social/mobile/analytic-type applications are proliferating.
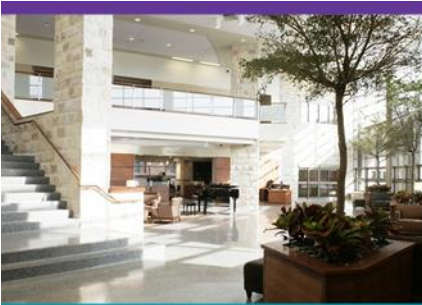
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We are working closely with Singular University in Silicon Valley to understand so-called exponential medicine. This is focused on the most cutting-edge technologies like AI, robotics, advanced analytics, bio engineering, genetic engineering, and others. This is an area of focus for us. We're excited to understand how to harness exponential technologies, which we feel will be a major part of healthcare moving forward.

What do you see as next steps for the industry?

The intersection of technology and team-based care aimed at driving real improvements in population health is going to be a really critical business area for leading health enterprises. It's an exciting and interesting challenge for the design/build community to engage with their clients to see how they play a role in that. It's an area where hospital and healthcare organizations are going to need all the help they can get.

LESSONS LEARNED
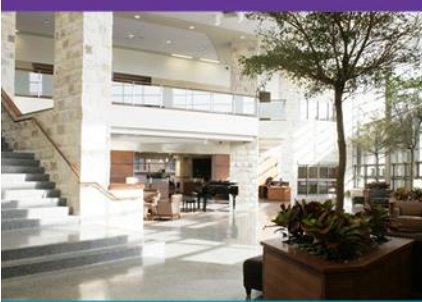
Incorporating Infection Control Strategies into the Built Environment

1. Many studies have shown that conventional cleaning methods used in hospitals are effective but can still leave contamination. Conventional cleaning methods aren't enough on their own; they must be part of a broader infection control strategy.

2. Hydrogen peroxide vapor (HPV) is an effective strategy for killing pathogens, but the process requires the room to be vacated and sealed off.

3. Another method to reduce or kill pathogens is ultraviolet germicidal irradiation (UVGI). The main disadvantage is that UVGI only kills pathogens where the light can reach. Furthermore, UVGI light bulbs must be changed regularly to maintain efficacy.

4. Since infection can spread through the air, it's essential to install safe air handling systems in your facility. These should include proper ventilation and filtration along with designated isolation rooms that don't share air with other spaces.

5. Hand washing compliance is one of the most important measures to reduce the spread of infection in the healthcare setting. Many clinicians and front-line staff members still do not follow this recommendation.

6. Sink location is a key design element to consider in the built environment. Installing sinks close to the door in patient rooms can encourage hand washing, while locating them away from the bed may prevent any splashing from reaching the patient. Faucets should not spray straight into the sink trap, as this can cause splashing. Hand hygiene stations should also be placed at convenient locations.

7. Designing rooms with furnishings and surfaces that can be cleaned easily with just one or two products can facilitate and speed up the work of environmental services staff.

8. Some hospitals are using antimicrobial materials in their surfaces and furnishings. Although it is assumed that this helps to reduce the spread of infection, many antimicrobial products have not been tested in real-life settings.

Further, they don't eliminate the need for thorough and proper cleaning on the part of environmental services staff.

9. While many infection control approaches have been deemed effective, additional research needs to be undertaken to understand the direct impact of individual interventions on reducing the spread of hospital-acquired infections.

10. It is essential to include an interdisciplinary team of designers, architects, healthcare providers, and environmental services staff in planning for infection control to determine how best to implement evidence-based design solutions.

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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 hospital environments.

The various ways to improve patients' perception of sound.

The specific 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.

Going Quiet: A Best Practices

AUTHORS

Ellen Taylor, AIA, MBA, EDAC
Director of Research

Xiaobo Quan, PhD, EDAC
Senior Researcher

Anjali Joseph, PhD, EDAC
Director of Grants and Research
Advisory Services
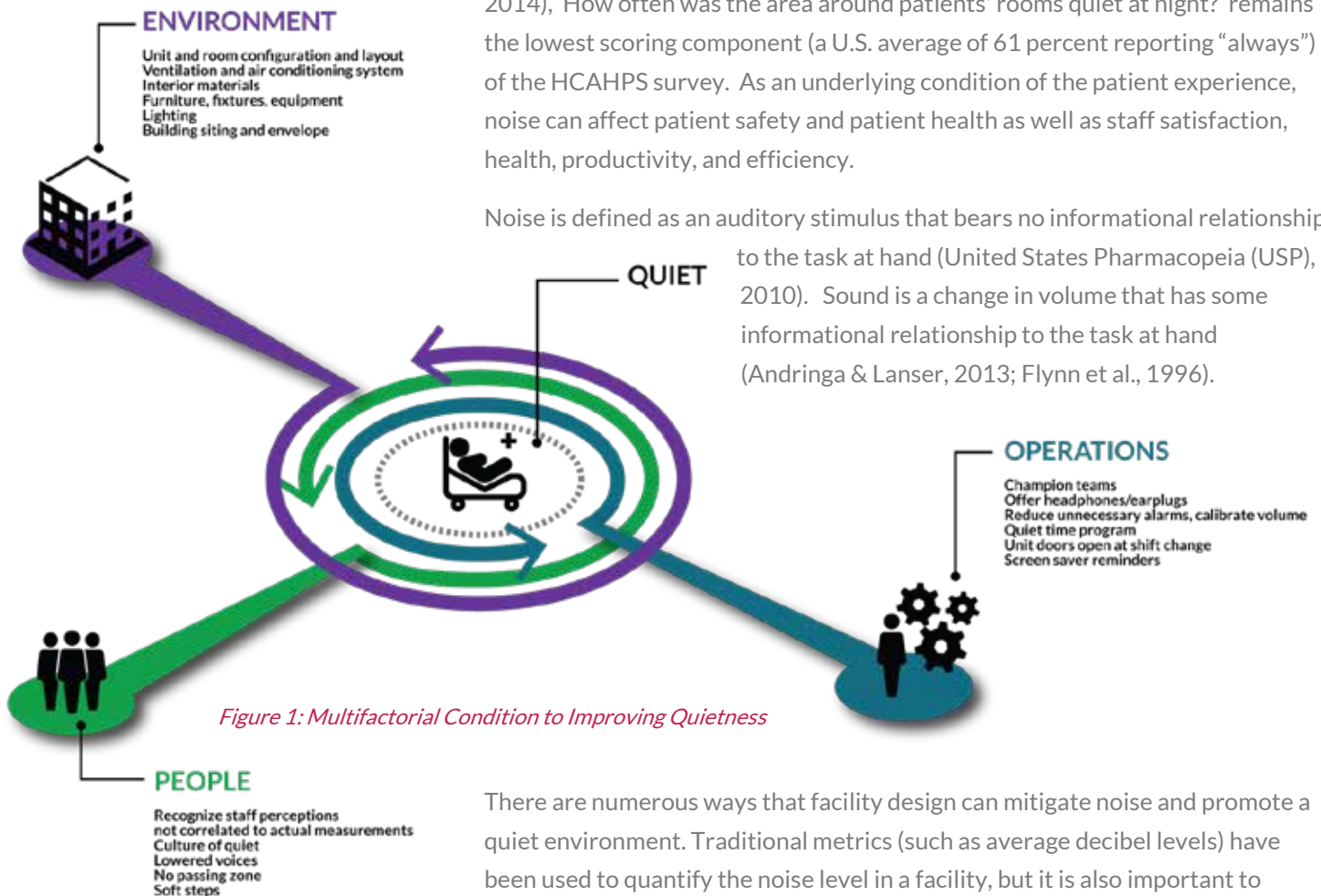
Terri Zborowsky, PhD, EDAC
Research Associate

March 2014

Executive Summary

In FY2014, organizations began receiving Centers for Medicare and Medicaid Services (CMS) reimbursement based on formulas established through the Value Base 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 national results (Capachi, 2012; Centers for Medicare & Medicaid Services, 2014), 'How often was the area around patients' rooms quiet at night?' remains the lowest scoring component (a U.S. average of 61 percent reporting "always") of the HCAHPS survey. As an underlying condition of the 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).

ENVIRONMENT
Unit and room configuration and layout
Ventilation and air conditioning system
Interior materials
Furniture, fixtures, equipment
Lighting
Building siting and envelope

QUIET

OPERATIONS
Champion teams
Offer headphones/earplugs
Reduce unnecessary alarms, calibrate volume
Quiet time program
Unit doors open at shift change
Screen saver reminders

Figure 1: Multifactorial Condition to Improving Quietness

PEOPLE
Recognize staff perceptions
not correlated to actual measurements
Culture of quiet
Lowered voices
No passing zone
Soft steps

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 in a facility, but it is also important to

IMPACT OF NOISE

Research indicates that the excessive noise found in hospitals causes many serious problems such as:

- Sleep disturbance and deprivation

- Psychological stress/ anxiety/ annoyance

- Aggressive behaviors

- Interference with speech 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 more of a disruptive effect than continuous elevated background noise levels. Interventions include noise source control, sound absorption, and noise blocking as well as sound masking and the provision of pleasant sounds and sound source information. As part of a multifactorial solution, the built environment should be considered as a means to supplement operations and behavior of the people occupying the facility.

Background

This paper outlines issues related to the current state of value-based purchasing (VBP) and the patient experience domain (as measured through HCAHPS) as it relates to noise. The HCAPHS score on quietness of the hospital environment has been typically among the lowest rated patient experience dimensions. According to the latest published HCAPHS survey results, the average score of nearly 4,000 hospitals nationwide for this dimension was the lowest among all HCAPHS dimensions – 61 percent, versus 64 percent to 85 percent on other dimensions (Centers for Medicare & Medicaid Services, 2014). For individual hospitals, it makes sense to focus on improving the environmental quietness, which may result in significant financial gains by increasing both the HCAPHS base score and the 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 emphasis 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 evidence clearly indicates that the excessive noise found in hospitals causes many serious problems such as:

- 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 speech 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, et al., (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 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 in concentration)
- Emotional exhaustion and burnout that in turn contributes to low job satisfaction
- 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 and near misses (Flynn et al., 1996; Pluyter, Buzink, Rutkowski, & Jakimowicz, 2010). In certain areas, high peak noises could be harmful and potentially cause hearing loss (Yassi, Gaborieau, Gillespie, & Elias, 1991).

The impacts of noise on staff may subsequently 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), data show that 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 such as 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 consisting of "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
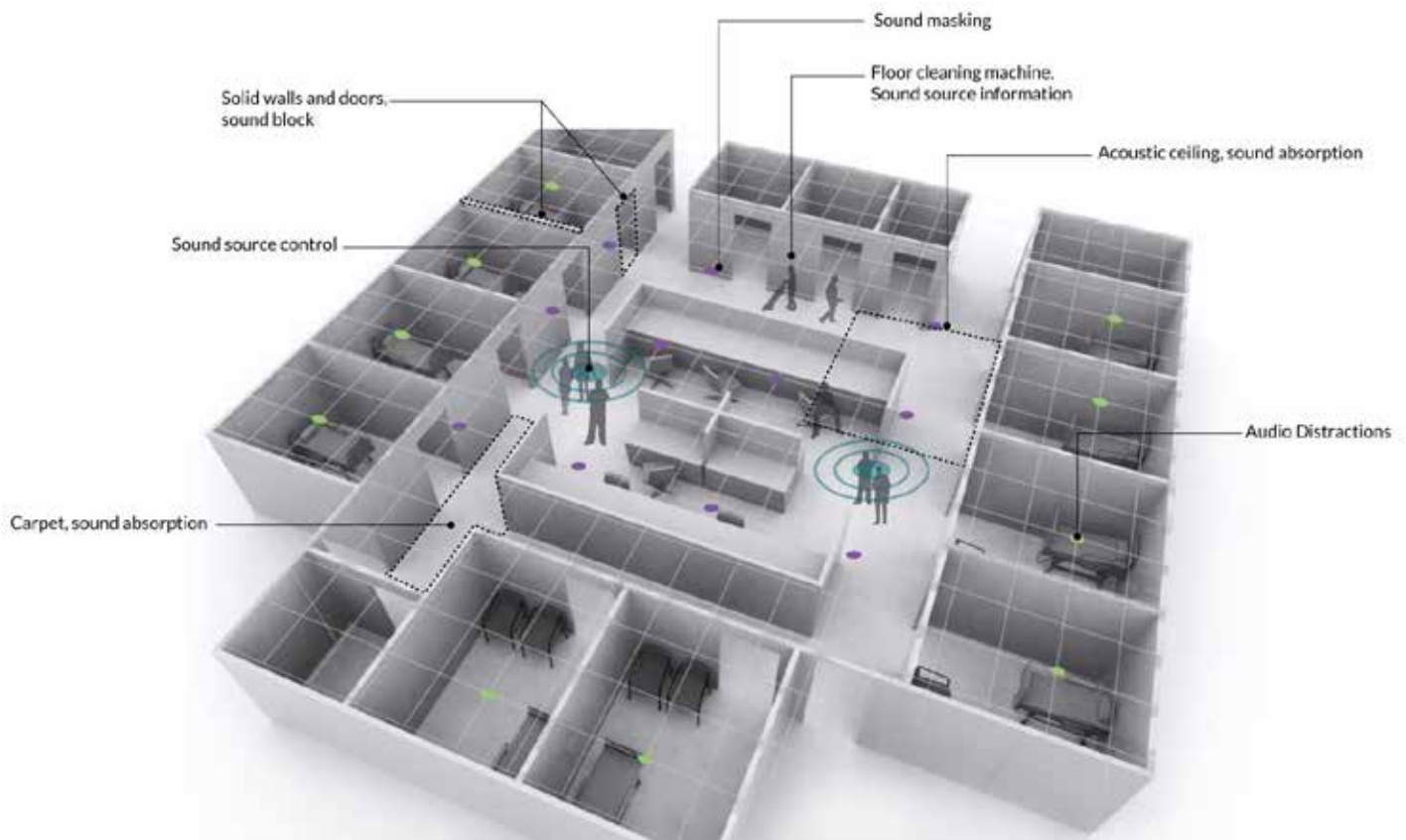

Figure 2: Built Environment Considerations

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

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, talking, 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 behaviors by dimming light during night hours, posting signs as reminders, using sound-level monitors to remind staff and other individuals to lower voices (e.g., 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 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 finish materials are able to reduce noise level by absorbing a large percentage of sound waves coming into 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

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ENVIRONMENTAL MEASURES TO REDUCE NOISE

1. Sound source control

2. Sound absorption

3. Sound blocking

---

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

Sound Blocking

The sound-blocking method aims at reducing 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 than 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 blocking sound. Many healthcare organizations have begun to explore alternative ways of patient monitoring and at the same time offer patients the choice of keeping doors closed (Rodak, 2013; Solomon, 2012).

Sound Perception Improvement

The acoustic experience of patients is complex and depends on the sound level and the quality of sound, 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

Improve perceived quietness through:

» Audio distractions

» Noise masking

» Sound source information

following methods have been used or recommended to improve perceived quietness.

Audio Distractions

The benefits of positive visual (e.g., nature images) and audio distractions (e.g., music, nature sound recording) 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 studies suggested that when patients' attention was distracted from stressors 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 noise sources, resulting in perceived quietness and 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 sound level, sound masking increased the background continuous sound level so that the peak noises become less noticeable. Research indicates that the occurrence of patient sleep arousals is more closely related to the change in sound from continuous background sound level 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 peak noises' disturbing effects on patients. Because of the lower disturbance, patient perception of quietness may be improved (Capachi, 2012; Cordova et al., 2013); patients prefer music over white noise (Cruise, Chung, Yogendran, & Little, 1997), as well.

Sound Source Information

Research also has found that unfamiliar sound from some 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 multi-factorial 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:
  - Repair squeaking doors and carts
  - Reduce nurses congregating in one area
  - Minimize overhead paging
- Sound absorption: Sound-absorbing flooring tiles
- Sound blocking: Earplugs
- Sound masking: 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" (e.g., 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 MEASURMENTS 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 survey on perceived noise

- Environment inspection/ audit of noise sources and frequencies

(Quan, Joseph, Malone, and 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 and intermediate skill level), and advanced (high cost and accuracy, requiring experts to perform) (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 answer the question of how to reduce noise in healthcare environments, but a number of multi-factorial 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 with behavioral modifications, along with operational policies that support reduced noise, should be part of an organization's program to enable a culture of quiet, improve the patient experience, and ultimately contribute to the bottom line.
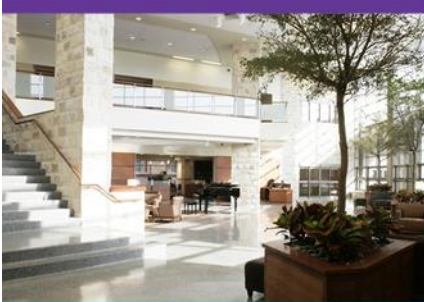
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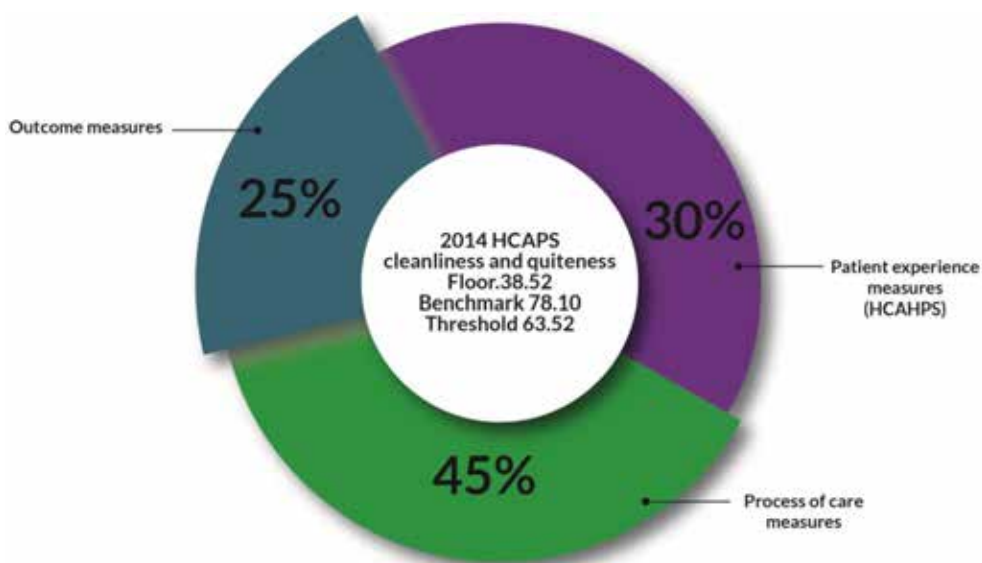
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Appendix 1

HCAHPS and Hospital Value-Based Purchasing

In FY 2014, the Total Performance Score associated with CMS reimbursement and the Hospital Value-Based Purchasing (Hospital 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 (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

Outcome measures — 25%

Patient experience measures (HCAHPS) — 30%

Process of care measures — 45%

2014 HCAPS cleanliness and quiteness
Floor.38.52
Benchmark 78.10
Threshold 63.52

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 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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