

The Importance of Acoustics in Healthcare

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The Importance of Acoustics in Healthcare

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Purpose and Learning Objectives

Purpose:

Beneficial acoustic environments are especially important in healthcare facilities as inappropriate acoustics can be damaging to patients and stressful and tiring to staff. Because a beneficial acoustic environment plays an important role in supporting health, safety, and well-being for all occupants, acoustic issues are now a key component of healthcare design guidelines. This course explores the impacts of acoustics on healthcare, outlines the relevant acoustic standards and guidelines, and describes the methods by which designers can address the issues and improve healthcare facility conditions for patients, families, and healthcare workers.

Learning Objectives:

At the end of this program, participants will be able to:

- recall those aspects of acoustics that are detrimental to health when designing healthcare facilities
- specify design approaches and materials that improve healthcare acoustic environments
- design healthcare facilities that meet or exceed all applicable acoustic standards and guidelines, and
- utilize the results of healthcare assessments to prioritize acoustic design solutions.

Contents

Introduction

Healthcare Assessments, Acoustic Measurements, Standards, and Guidelines

Sound Measurement

Addressing Acoustic Issues and Standards Through Design and Operation

Design Strategy Case Study

Resources





Introduction

The Importance of Appropriate Acoustic Environments

An appropriate acoustic environment is important to every situation as excessive levels of sound/noise can create extra stress, fatigue, misunderstandings, or even damage to hearing. A good acoustic environment is especially important in healthcare situations where an inappropriate environment can affect the care, recovery, and health of patients as well as the performance, quality, and accuracy of care administered by healthcare staff.



The Importance of Appropriate Acoustic Environments

Hospitals are most often noisy environments. A 2005 study by Busch-Vishniac et al. noted sound pressure levels (SPLs) had risen significantly and consistently since 1960 and that daytime levels had risen 0.38 dB (decibels) and nighttime levels had risen 0.42 dB every year. These findings were valid for every type of facility tested.

The same study found that sound levels throughout Johns Hopkins Hospital were, on average, at least 20 dB(A) louder than the recommendations of the World Health Organization (WHO). Other studies noted that peak levels often exceed 85 dB(A), which has a sound pressure 100,000 times that of 35 dB(A)—the recommended daytime level for patient areas.

Hospital Acoustic Environments and Issues

Although hospital staff typically move quietly, there are often numerous conversations taking place in any one hospital area. The background noise from HVAC systems, numerous alarms, ventilators, and monitors running at any one time, beepers, rolling carts and stretchers, televisions, dripping taps, sudden emergency announcements over the public address system, noise entering the hospital from outside through louvers and other wall openings, and hospital cleaning staff working in corridors and rooms all contribute to hospital noise.

These sounds are generated in environments that usually consist primarily of hard, reflective surfaces, and this “hard” environment amplifies the sounds further.



Photo by Natanael Melchor on Unsplash

Impact on Patients

Poor acoustic conditions may have a negative impact on patients' physiological health, increase the length of their recovery and length of stay, and increase their chances of being readmitted to the hospital. Acoustics can also impact perceptions of privacy, comfort, safety, and security for patients and their families.

Sudden noises such as a dropped tray, slammed door, or alarms can generate a startle reflex, which may cause grimacing and increased blood pressure and respiratory rates. Sounds that increase apprehension can also increase the need for patient restraints, pain medication, and nursing assistance calls.

Prolonged loud noises can lead to memory issues, impaired pain tolerance, and isolation perceptions. Sleep disruption and deprivation, which can be caused by excess noise, are frequently cited issues of concern in healthcare environments. Poor sleep can lead to longer healing times and even cause delirium. Disrupted and/or limited sleep has been demonstrated to have adverse impacts on several important health measures and outcomes including blood pressure, weight gain, heart disease, pain, stress levels, and inflammation.

Findings suggest that raised voices can have a negative impact, especially at night when background noise is reduced.

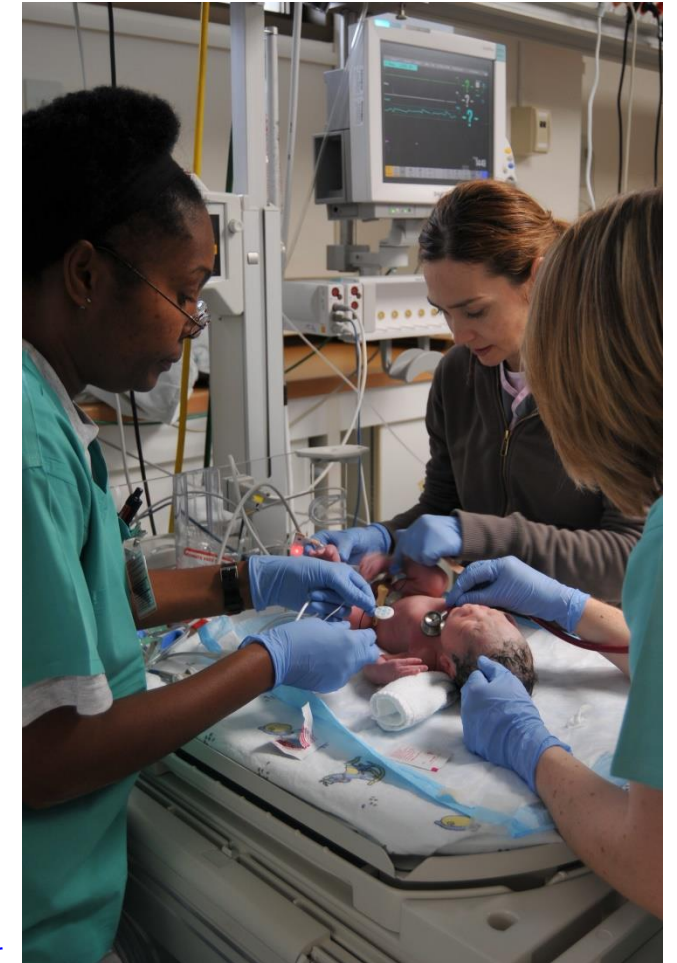
Impact on Patients

Reduced noise levels, especially in intensive care units (ICUs), can help patients to sleep better and foster a more regular sleep cycle.

Heart attack patients have been found to have higher pulse amplitudes in a poor acoustic environment.

Equipment noise contributes to the sound environment, also. Low-frequency noise from mechanical systems can be a source of annoyance, raise patient blood pressure, and interrupt or prevent sleep. The noise of respirators, heart monitors, and automated beds can also be disturbing to patients.

Often, the loudest areas are those that are closest to the patients and their families.



Neonatal Intensive Care Unit by Philip A. Jones. Army Medicine [CC BY 2.0](#) via [Flickr](#)

Impact on Patient Care Teams (PCTs)

The WHO considers a poor acoustic environment to be an occupational health hazard in every work situation. Healthcare workplaces have their own unique acoustic requirements that are necessary to maintain good working conditions.

While it is possible for PCTs to work in a high noise environment, it is likely that it will require more effort to do so, and that in turn, they will become fatigued earlier. When inappropriate acoustic conditions exist, poor psychological conditions can easily occur even for highly trained healthcare professionals who are prepared to deal with stressful situations.



Impact on Patient Care Teams (PCTs)

Speech clarity is critical to PCTs in healthcare environments as they must be able to understand and quickly respond to private conversations and announcements. Speech recognition systems rely heavily on clear speech intelligibility to ensure accurate understanding of foreign languages, accents, varying speech patterns, and speech hampered by medical conditions. Failing to address speech intelligibility may negatively impact patient care and safety.



The Importance of Privacy

Maintaining speech privacy in healthcare settings reduces medical errors stemming from miscommunication or limited communication. When conversation does not feel private, patients and their families will often hold back important information about medical histories that healthcare workers should have, and thus they potentially endanger their own health even further.

Overhearing conversations between nearby patients and their families or healthcare workers can also be upsetting to patients.

The Health Insurance Portability and Accountability Act (HIPAA), initiated by the U.S. Department of Health and Human Services (DHHS), requires pharmacies and healthcare providers in the U.S. to provide privacy for patient health information (e.g., medication, symptoms, health conditions) in electronic, written, and oral formats in order to prevent intentional or unintentional privacy breaches. HIPAA privacy standards apply to both new construction and renovations of all types.

Patient-Centered Care

The IOM (Institute of Medicine) defines patient-centered care as: “Providing care that is respectful of, and responsive to, individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions.”

In an era where hospital costs and profits are a major issue, and at a time when patient engagement technology is being increasingly implemented, numerous healthcare agencies are also increasing their focus on patient-centered care. Providing the appropriate acoustic needs and preferences, especially close to the hospital bed, is part of the exercise of responding to individual needs.



Patient-Centered Care

Some of the principles that are the basis of patient-centered care (PCC) as researched by the Picker Institute and Harvard Medical School are the following:

- Respect for patients' values, preferences, and expressed needs: This includes involving patients in decision-making, which increases the need for conversational privacy between doctor and patient.
- Coordination and integration of care
- Information and education
- Physical comfort: This includes physical surroundings and environment.
- Emotional support and alleviation of fear and anxiety: We have noted earlier that certain sounds can heighten anxiety.
- Involvement of family and friends: The presence of families at one bedside can disturb a patient in a nearby bed if acoustics are not controlled.
- Continuity and transition
- Access to care

The Importance of Patient-Centered Care

Patients often have considerable fear and anxiety about medical procedures, especially if they do not fully understand them, and they may even refuse necessary procedures and treatment as a result.

In the PCC model, patients remain in complete control in terms of making decisions about their own care and treatment. This infers that they need to fully understand the procedures and treatments they will undergo and that the healthcare staff must, in turn, provide complete, clear, and honest information. Comfort in knowing that there is conversational privacy is critical for such frank exchanges, especially for a complicated or painful illness or injury.



Patient Experience vs Patient Satisfaction

PCC significantly affects the patient experience. Patient experience includes all the interactions that patients have with healthcare, including the care provided through health plans and by doctors, nurses, and hospital healthcare workers.

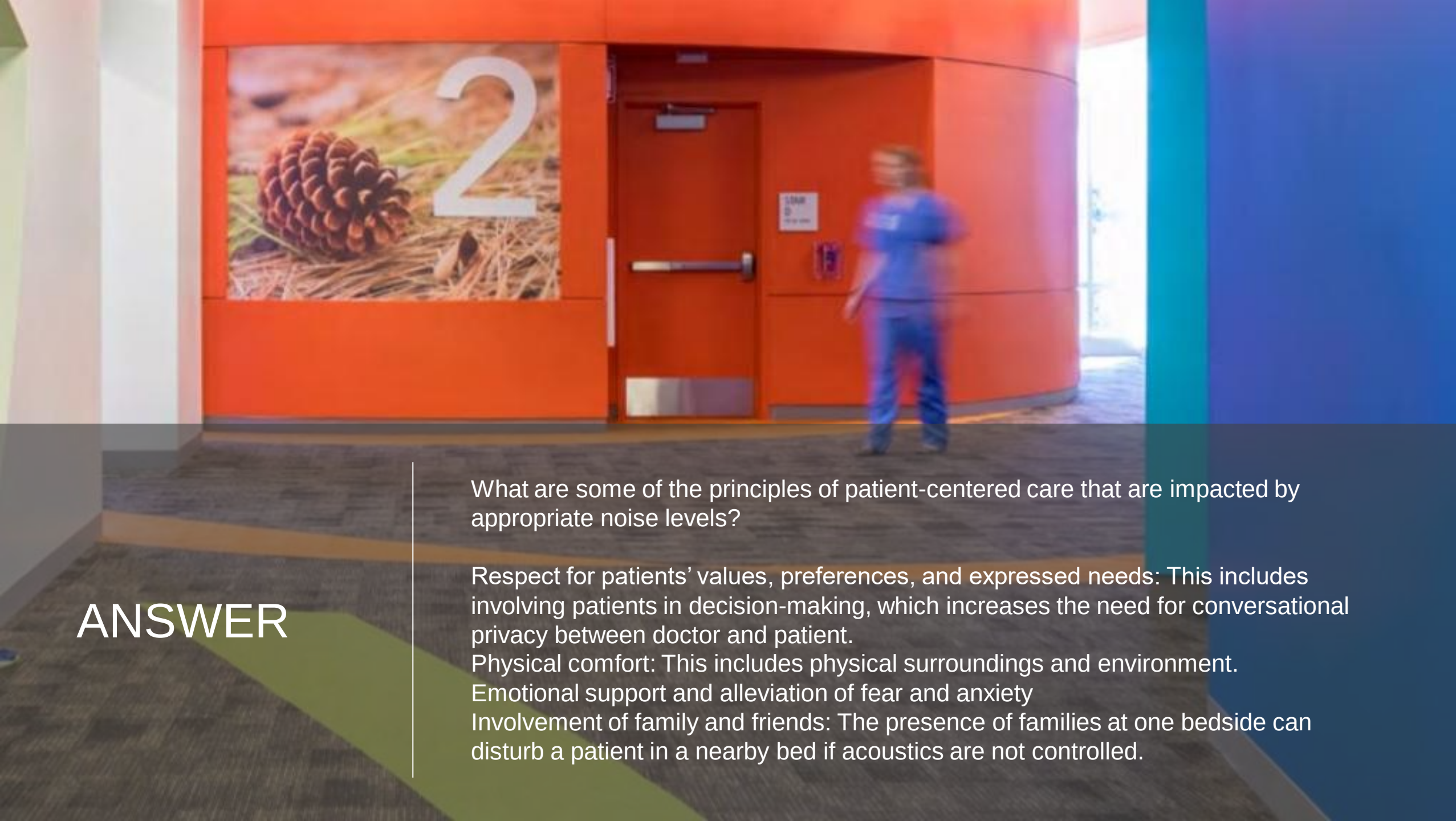
Patient experience includes various aspects of healthcare delivery such as timely appointments, ready access to information, and once again, good communication with healthcare providers. Examining various aspects of patient experience facilitates the assessment of whether patients are receiving care that is both respectful of, and responsive to, specific individual patient preferences, needs, and values. Such assessment is critical to providing a complete picture of healthcare quality.

It is important to understand that patient experience is not synonymous with patient satisfaction. Patient satisfaction is related to meeting a patient's expectations about their healthcare. Different patients who may receive the same care may express different levels of satisfaction in regard to how that care should have been delivered.



REVIEW QUESTION

What are some of the principles of patient-centered care that are impacted by appropriate noise levels?



ANSWER

What are some of the principles of patient-centered care that are impacted by appropriate noise levels?

Respect for patients' values, preferences, and expressed needs: This includes involving patients in decision-making, which increases the need for conversational privacy between doctor and patient.

Physical comfort: This includes physical surroundings and environment.

Emotional support and alleviation of fear and anxiety

Involvement of family and friends: The presence of families at one bedside can disturb a patient in a nearby bed if acoustics are not controlled.



Healthcare Assessments, Acoustic Measurements, Standards, and Guidelines

Standards and Guidelines

There are a number of standards and guidelines that are used to set the performance levels of healthcare facilities in general, as well as acoustic performance in particular. These standards and guidelines can be used by designers to ensure that they meet or exceed the level of performance that will result in appropriate settings for patient care and recovery.

There are also review mechanisms that assess patient satisfaction and that help pinpoint those aspects of healthcare that are important, and also those that may require attention and modification. The results of these surveys can also be used to guide healthcare facility design.



Assessments: The HCAHPS Survey

The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey consists of 27 questions related to patient satisfaction. It is conducted with adult patients (except psychiatric patients) who have spent at least one night in a hospital, and it is conducted between 48 hours and six weeks after discharge. It asks well-tested questions using a consistent methodology across a large sample of respondents in order to provide the most reliable results.

It addresses:

- communication with doctors and nurses
- communication about medicines
- 3-item care transition
- responsiveness of hospital staff
- hospital cleanliness and quietness
- discharge information, and
- overall rating of the hospital.

Assessments: Purpose of the HCAHPS Survey

The HCAHPS survey is intended to:

- produce comparable data on the patient's perspective of the care that they received that will facilitate objective comparisons on topics that are important to consumers
- create incentives for hospitals to improve quality of care based on public reporting of the survey results, and
- enhance public accountability in healthcare by increasing transparency through public reporting of the survey results.

The different aspects of care included in the HCAHPS score make up the person and community engagement domain. This is part of what CMS (Centers for Medicare and Medicaid Services) uses to measure hospital effectiveness. CMS is a federal agency within the United States Department of Health and Human Services that administers the Medicare program and works in partnership with state governments to administer Medicaid.

CMS uses this domain, along with three others, to arrive at an overall measure of hospital performance. The person and community engagement domain makes up a full 25% of a hospital's performance tally. Other domains, including safety, clinical care, and efficiency and cost reduction, are calculated and combined to arrive at an average hospital score.

Assessments: Purpose of the HCAHPS Survey

CMS rewards and reimburses hospitals based on their performance scores. The quality of care provided to Medicare patients, together with how closely best clinical practices are followed and how well a facility enhances the patient experience of care, is used to determine how much a facility receives in Medicare reimbursement.

These surveys are available publicly, so a high score also attracts other funders, high-quality care givers, and more patients.

Noise has been the lowest-scoring category in the HCAHPS survey since 2007, thus indicating that creating quiet hospital environments is a challenge. Of particular importance is the score for quiet at night. In this context, the survey asks this question: “How often was the area around your room kept quiet at night?” Patients are asked to answer this question using the following scale: NEVER – SOMETIMES – USUALLY – ALWAYS. Only about 58% nationally answer this question as ALWAYS.

It obviously is important that each facility score well in these surveys, and therefore, a good acoustic performance, especially a good nighttime experience score, becomes a critical part of the overall performance.

Standards and Guidelines: HIPAA

The Health Insurance Portability and Accountability Act (HIPAA) is a federal law requiring the creation of national standards to protect sensitive patient health information from being disclosed without the patient's consent or knowledge. Its creation and existence underscores the importance of privacy within the hospital itself as well as of the security of patient records.

The privacy rule also contains standards for individuals' rights to understand and control how their health information is used. As stated previously, reaching proper understanding often involves full and frank dialogue conducted at the bedside.



Standards and Guidelines: WHO

While the WHO recommends that continuous background noise in patient rooms not exceed 35 dB and that nighttime noise not exceed 40 dB* (equal to the hum of a refrigerator), many studies conducted in hospitals have found average background noise ranges between 45 dB and 68 dB, peaking at more than 90 dB. The same organization in a 1999 document entitled “Guidelines for Community Noise,” created by an international body of experts, stated that treatment and recovery rooms should simply have the lowest noise level possible. Community noise includes noise generated within a facility.

Many studies found that hospitals routinely exceed WHO recommendations:

- One 2018 study at Kings College in London, England, found that even in intensive care units, noise levels over 100 dB have been measured. This is the equivalent of loud music through earphones.
- Another 2018 study by the Washington University School of Medicine of noise in a neonatal intensive care unit found that all recorded sound levels exceeded the recommended noise level of 45 dBA. The open-pod environment was 58.1 dBA, while the private room was 54.7 dBA, and the average level of acoustic events was 11–14 dB higher than the background noise.
- A study by Orellana, Busch-Vishniac, and West in 2007 found sound pressure levels (SPLs) in Johns Hopkins Hospital to be 5–10 dB(A) higher in emergency departments than the inpatient units in the hospital.

*They note that anything more than the murmur of a typical office space disturbs sleep, raises blood pressure, and can even increase the incidence of heart disease.

Standards and Guidelines: FGI

The Facility Guidelines Institute (FGI) is responsible for the production of an industry-standard document focused on the design and construction of healthcare facilities in the United States. In terms of acoustics, FGI prioritizes:

1. site exterior noise
2. acoustic surfaces
3. room noise levels
4. interior wall and floor/ceiling constructions
5. speech privacy, and
6. building vibration.



Standards and Guidelines: FGI

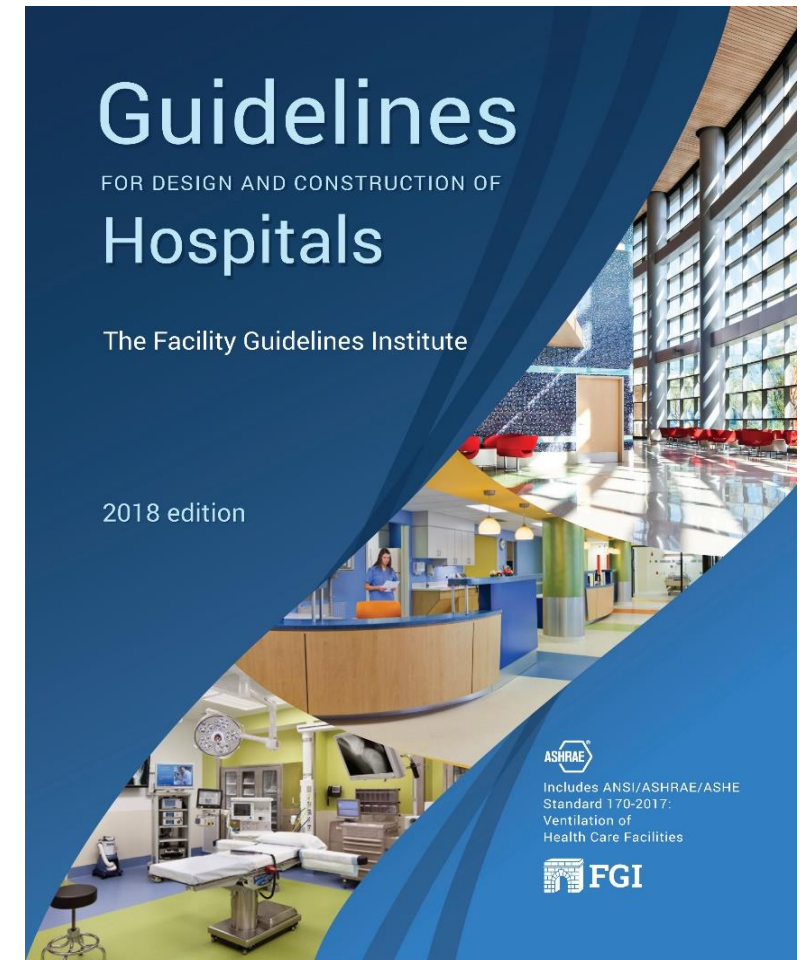
FGI provides their advice through the *Guidelines for Design and Construction* document. The 2018 edition is in three volumes: a volume for hospitals, a volume for outpatients, and another for residential health, care, and support facilities. Each volume provides information on planning, design, construction, and commissioning as well as minimum standards that should be met.

FGI also offers a library of materials that exceed minimum standards and a cost-benefit report that outlines costs and benefits of the major changes in the guidelines for hospitals and outpatient facilities. These guidelines have been adopted in whole or in part by 42 states.

For more information, the guideline can be accessed here:

<https://fgiguideines.org/guidelines/2018-fgi-guidelines/>

(Accessed June 2020)



Standards and Guidelines: LEED®

LEED v4 for healthcare references the FGI as follows: Design the facility to meet or exceed the sound and vibration criteria outlined below, which are adapted from the 2010 FGI *Guidelines for Design and Construction of Health Care Facilities* (“2010 FGI Guidelines”) and the reference document on which it is based, *Sound and Vibration: Design Guidelines for Health Care Facilities* (“2010 SV Guidelines”). It also defines speech privacy as “techniques...to render speech unintelligible to casual listeners” (ANSI T1.523-2001, Telecom Glossary 2007).

Achieving speech privacy is worth one credit. Utilizing acoustic materials and minimizing the effects of outdoor noise on patients is worth a second credit.

In addition to naming specific sections of the FGI guidelines that apply to healthcare acoustic issues, LEED also references other standards that should be followed to achieve credits in this category. They include:

- ASHRAE *Handbook*, 2011, Chapter 48, “Sound and Vibration Control,” and
- ASTM E966, “Standard Guide for Field Measurements of Airborne Sound Insulation of Building Façades and Façade Elements.”



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Standards and Guidelines: Green Guide for Healthcare

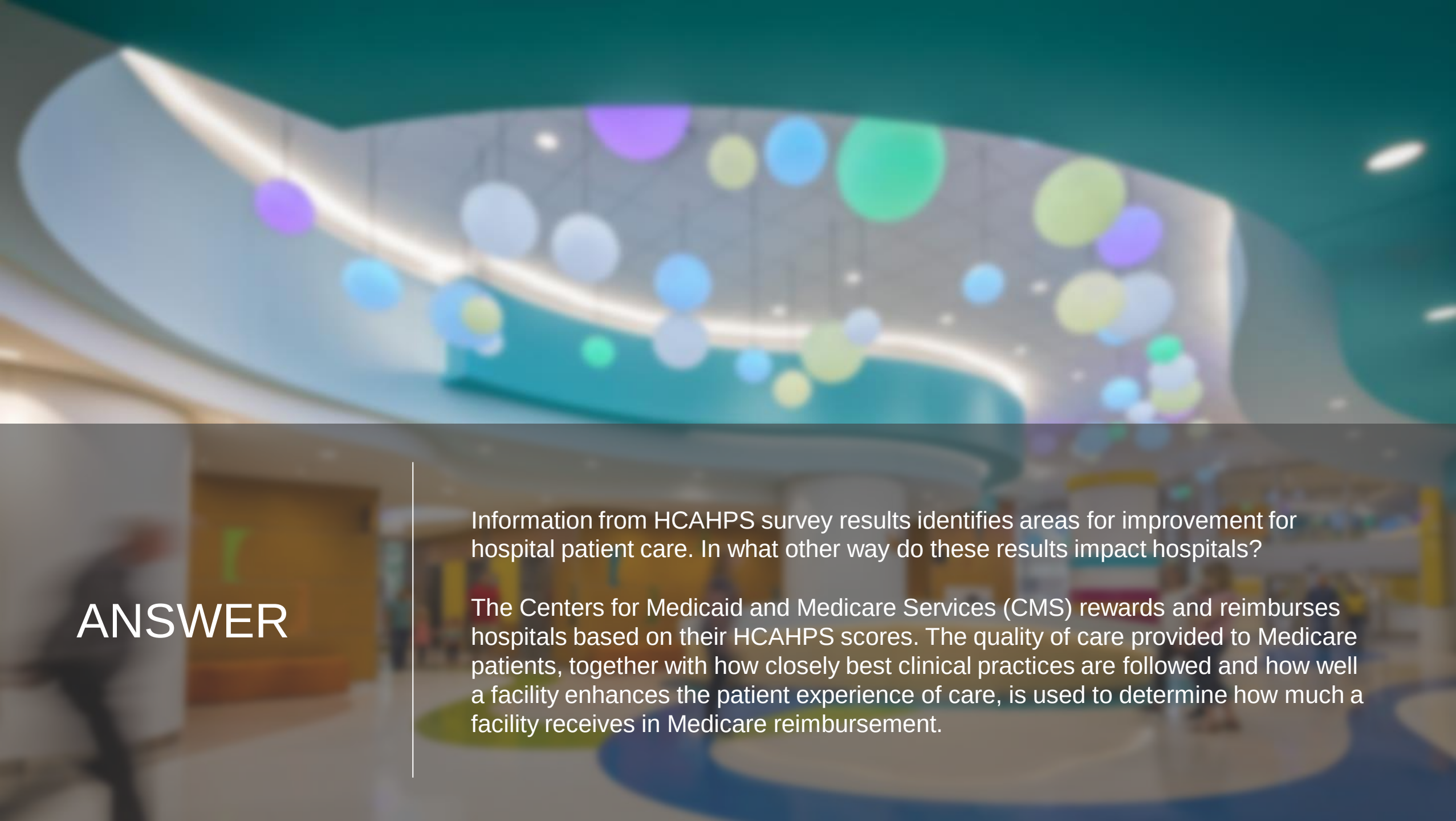
The Green Guide for Health Care™ v2.2 includes a two-point credit for improving the acoustic environment in healthcare settings. It recommends that acoustical issues related to exterior noise, acoustical finishes, room noise levels, sound isolation, paging systems, and building vibration be addressed in healthcare facilities.





REVIEW QUESTION

Information from HCAHPS survey results identifies areas for improvement for hospital patient care. In what other way do these results impact hospitals?



ANSWER

Information from HCAHPS survey results identifies areas for improvement for hospital patient care. In what other way do these results impact hospitals?

The Centers for Medicaid and Medicare Services (CMS) rewards and reimburses hospitals based on their HCAHPS scores. The quality of care provided to Medicare patients, together with how closely best clinical practices are followed and how well a facility enhances the patient experience of care, is used to determine how much a facility receives in Medicare reimbursement.



Sound Measurement

AC and CAC

There are a number of sound measurement approaches, categories, and terms that are useful for the designer to be aware of when creating healthcare facilities. These include:

Articulation Class (AC)

AC is a measure used to rate the speech privacy performance of acoustical ceilings or acoustical screens in open-plan environments. Privacy increases as the AC value increases, generally ranging from 100 to 250. A ceiling must be at least 9' high to perform according to the AC rating it is given.

Ceiling Attenuation Class (CAC)

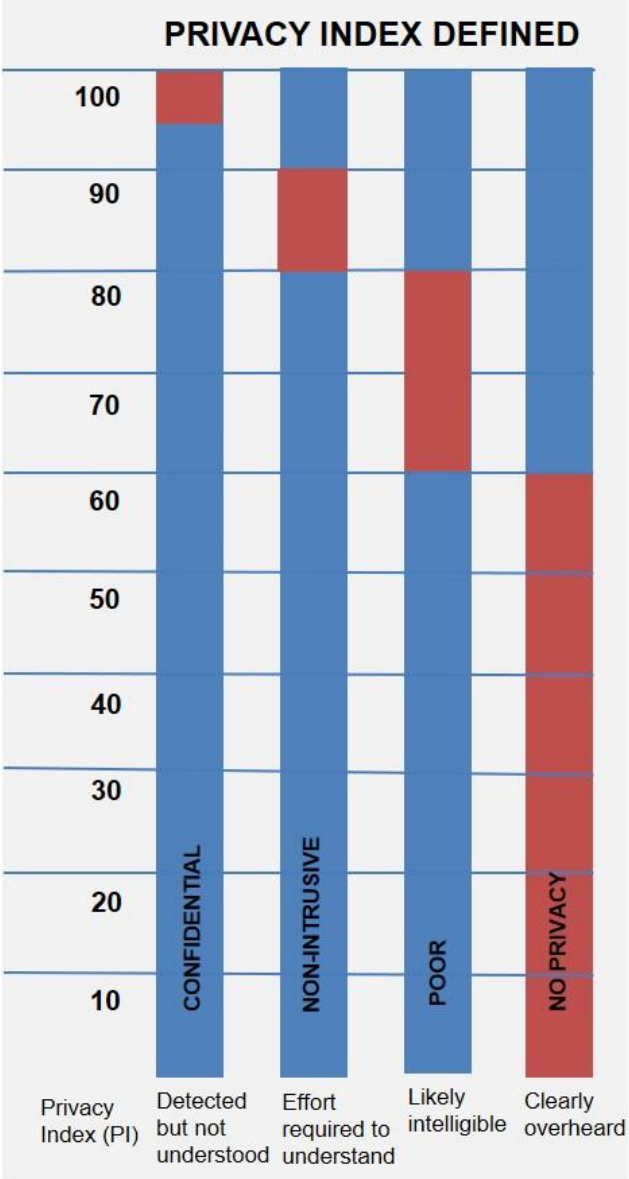
CAC is a rating of a ceiling system's ability to reduce sound transmission. It represents, in decibels (dB), how much sound will be attenuated between rooms sharing a ceiling plenum.

Higher numbers indicate better performance. Ceilings with a CAC less than 25 are considered poor barriers of sound intrusion, while ceilings with a CAC of 35 or greater are considered very good barriers of sound intrusion. Oftentimes, a ceiling with a high CAC (i.e., creates a good sound barrier) can have a low NRC (i.e., absorbs little noise). Some ceiling panels are produced with both high NRC and CAC values.

PI

Speech privacy index (PI) is generally focused on sound transmission between spaces and across curtains and is calculated from the sound transmission measurements using “normal speech levels” completed per ASTM E1130, “Standard Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation Index,” and ANSI S3.5-1997, “Methods for Calculation of the Speech Intelligibility Index.”

PI is a measure used to rate the speech privacy in a given space and is calculated based on an older metric called the articulation index. Spaces with a PI of 95% to 100% are considered to have confidential speech privacy. Spaces with a PI of 80% to 95% are considered to provide “normal” speech privacy, meaning that conversations in the space may be overheard but will not be fully intelligible. Spaces with a PI of 60% to 80% are considered to provide only marginal speech privacy, and spaces with a PI less than 60% are considered to have no speech privacy.



SII

The speech intelligibility index (SII) is also derivative of the articulation index. It was defined in ANSI S3.5 and provides a method to calculate speech intelligibility using speech spectrum level, noise spectrum level, hearing threshold level, and a modulation transfer function.

SII is a quantification of the amount of speech that is audible and useable. An SII of 0 means that none of the speech information is audible and useable. An SII of 1.0 means that all the speech information in a given setting is both audible and useable.

NRC and STC

Noise Reduction Coefficient (NRC)

NRC is a number rating that indicates a material's sound-absorbing properties, based on the average absorption for the material over primary speech information frequencies (250 Hz to 2,000 Hz). The higher the NRC rating the more efficient the material is at absorbing sound. For example, a material with an NRC of 0.70 absorbs approximately 70% of sound energy, while the remaining 30% reflects back into the space. NRC values below 0.50 indicate minimally absorbent surface materials, while NRC values greater than 0.80 typically indicate very absorbent materials.

Sound Transmission Class (STC)

STC is a comparative value that indicates the efficiency of building materials (e.g., walls, ceilings, floors, glazing) to reduce sound transmission. The larger the number the more successful the material is at preventing noise from passing through. STC ratings should be determined before partitions are specified by considering the budget and the importance of each performance factor (i.e., controlling background noise, minimizing distractions, and promoting privacy) for a given space. Wall systems with STCs lower than 35 are considered poor sound barriers, while those with STCs at or above 55 are considered very good sound barriers.



Addressing Acoustic Issues and Standards Through Design and Operation

Addressing Acoustics

There are many strategies in relation to both facility operation and design that can be employed to reduce and mitigate the impact of noise. It is not the intention of this course to identify each one but rather to highlight a few that should be most useful to a designer.



Photo by Hush Naidoo on Unsplash

Operational Strategies

Paging

Reduce overhead paging by identifying the individuals and departments that are paged most often and utilize alternative communication methods. These may include:

- reduced noise or noiseless paging systems
- a nurse call and patient telemetry system
- wireless communication devices (e.g., hands-free two-way technology, IP phones, communication badges)
- wireless asset tracking technologies to track staff, patient, and equipment, and
- vibrating beeper systems.

Alarms

Place alarms in remote locations at nurses' stations.

Assess alarm levels, and if possible, reduce their volume to increase patient comfort. Be aware that alarms are often unnecessarily left at their factory-set level.

Specify alarms with variable volumes, with loudness indicating the urgency of the problem.

Operational Strategies

Enforce Quietness

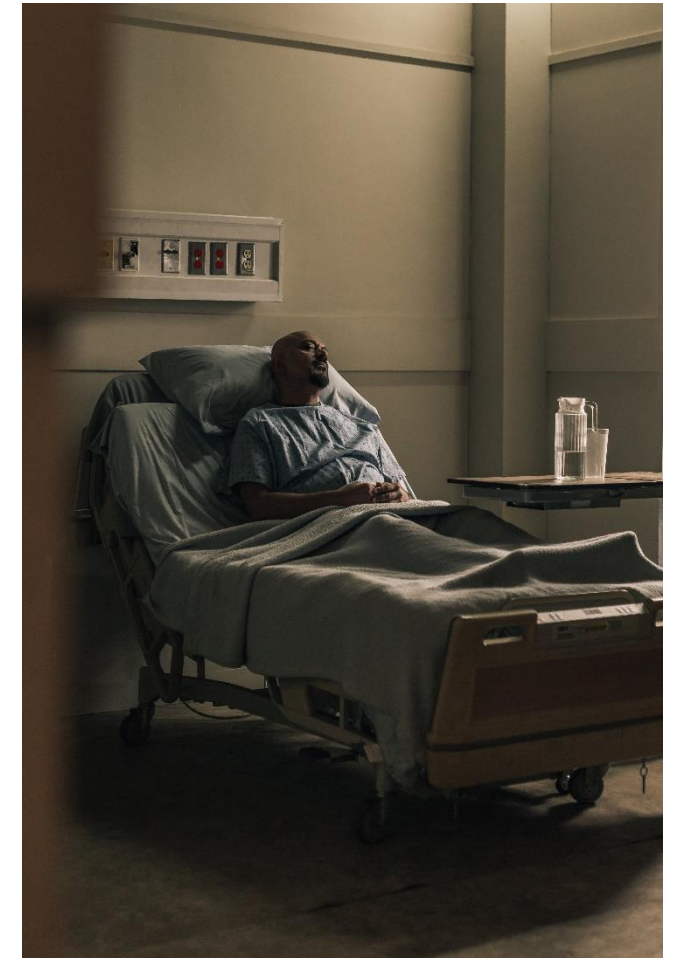
Introduce quiet times with lowered light levels and signage to advise visitors.

Noise monitoring devices may be used to enforce these quiet periods.

Install soft wheels on carts, etc.

Suggest patients bring their own music (use headphones) or provide a selected music radio channel.

Close patient doors (with permission).



Design Strategies

Space Planning

Placing staff rest areas away from noise sources, providing “quiet rooms” for private conversation and rest, and specifying low-noise machines can all help reduce noise levels in hospitals.

For patient rooms, consideration of floor layout impacts noise levels. Same-handed rooms ensure maximum distance between doors, which helps reduce sound transmission between rooms. Toilet rooms placed on a corridor wall can act as an acoustic barrier between the bed area and the corridor.

For either same-handed or mirrored room layouts, the walls separating the spaces require high levels of sound isolation—in one case to adequately mitigate the impact of service penetrations, and in the other to mask the sound of bathroom facilities adjacent to a sleeping area.

Separating nurses’ stations into a number of smaller units has the benefit of not only keeping staff closer to patients but also limiting the number of nurses congregating in one place.

Design Strategies

Locating Spaces

Noise-sensitive areas, such as neonatal intensive care units, wards, and sleep-study areas, require a high level of acoustic isolation from the noisier activities within a hospital such as a helipad, medical imaging equipment, HVAC plant rooms, and public areas. Achieving acoustic isolation can be costly; therefore, it is critical that their location is carefully planned to achieve suitable acoustic separation from noisier areas of the hospital.



Design Strategies

In addition, the designer can employ the appropriate combination of any of the following approaches or materials.

Understand Sound

All building materials are acoustical; all affect how sound is reflected, absorbed, or transmitted. Through materials, sound can be sustained via reflection or made to dissipate via absorption.

Controlling reverberation through appropriate finish selection, like sound-absorbing wall panels or rubber flooring (shown at right), is important for optimizing speech intelligibility, creating a restorative environment, and limiting noise transmission.



Design Strategies

Understand Sound

Transmission touches on how much sound is permitted to pass through the material or materials of a wall or other room boundaries, such as curtains. There are a number of design directions and materials that can be utilized to mitigate the negative aspects of sound transmission.

Many of the design strategies used for infection control in healthcare environments can have a negative effect on the acoustic environment if not carefully considered. While hard surfaces are often specified for their cleanability, they also reflect sound and create reverberation.



Design Strategies

Absorbent Surfaces

Integrate absorbent materials (such as acoustic wall panels in larger open areas) to curtail excess reverberation. These materials should be placed as close as possible to noise sources.

Sound-absorbing ceilings and wall panels that are washable and that incorporate infection control agents have been developed for use in hospital environments. Utilize these surfacing materials in lieu of hard, reflective surfaces.

Acoustic Ceiling Tiles

Acoustic (nonreflective) tiles deflect and distribute sound more evenly. If the NRC on a ceiling tile is greater than 0.50, it is generally considered suitable for sound attenuation and is not reflective. Absorbent ceilings are especially effective over nurses' stations and in corridors.



Design Strategies

Acoustic Doors

Sound transmission control doors offer a higher STC rating than standard doors. Doors should be selected with an STC rating equivalent or in excess of the adjacent wall STC rating. The table at right shows the amount of sound control delivered by varying STCs.

STC	Performance	Description
50-60	Excellent	Loud sounds heard faintly or not at all
40-50	Very Good	Loud speech heard faintly
35-40	Good	Loud speech heard but hardly intelligible
30-35	Fair	Loud speech understood fairly well
25-30	Poor	Normal speech understood easily and distinctly
20-25	Very Poor	Low speech audible

Design Strategies

Acoustic Doors

Acoustic doors are tested as an assembly, using putty for a static test, or gaskets, door bottoms, and sills for the operable test. Sound transmission loss is measured using a range of frequencies. The operable rating presents a more realistic figure than the static rating.

When purchasing acoustic doors, always purchase the doors along with the gaskets tested.



Design Strategies

Quiet Rooms

Special consulting spaces should be allocated for nurses in which voice-based information can be transferred away from open hall areas, yet not far from nurses' stations. As well, quiet rooms where medical staff can confer at length with families and patients can be provided.

Maintain a composite STC and A-weighted background noise level of at least 75 dB(A) in enclosed spaces where confidential speech privacy is required. To accomplish this, ensure walls include airtight, resiliently sealed penetrations around conduit, ductwork, etc. since any open-air pathways will dramatically reduce the effectiveness of sound-rated partitions.

Design Strategies

Integrated Design Process

As is the case with most complex design projects, the creation of a fully integrated team and design process can identify and solve potential acoustic issues before expensive errors must be corrected.

The proper usage of this process can also lead to lower construction and operating costs.



Design Strategies

Masking Noise

Ambient background noise can be added to a space to reduce the ability to overhear conversations. Such noise should not be intrusive or detrimental to concentration. If background (masking) noise is used at bedsides to reduce the impact of alarms and signals, the appropriate level will likely lie between 40 and 60 dB(A). Avoid using music as ambient noise, as the sound varies in frequency and loudness and is therefore not guaranteed to provide speech privacy. Avoid using such systems in corridors or over nurses' stations as they may interfere with patient monitoring.

Specify ceiling-housed, sound-masking systems in open areas where walls are minimal (e.g., waiting rooms) that cover the speech frequency range at the lowest volume.

Design Strategies

Acoustic Louvers

It has been noted that sounds entering the hospital from outside (traffic, aircraft, mechanical equipment, construction, etc.) are also disturbing to patient recovery.

Where sounds from the outside environment are an issue, acoustic architectural louvers can be used. Architectural louvers not only provide airflow and prevent water penetration, but also, when acoustic louver products are specified, contribute to sound attenuation—an often-overlooked benefit.



Design Strategies

Acoustic Louvers

Designing for this issue is dictated by the exterior site noise exposure category and the requisite outdoor/indoor transmission class (OITC) rating, which establishes the building façade composition. Acoustic louvers can reduce the level of the sound entering or leaving the building or passing to spaces within a structure.

These louvers are typically solid louvers filled with fiberglass insulation that provides a noise reduction (NR) between 14 and 23 depending on the frequency of the sound. As an example, the acoustic louver shown has an average noise reduction of 18.5 across all eight octave bands.



Design Strategies

Quiet HVAC Systems

In addition to reducing incoming noise with acoustic louvers, there are a number of options in equipment choice and duct layout that can lower noise levels and that should be discussed with the HVAC engineer.

Reduce or eliminate vibration by isolating equipment with resilient mounting or hanging techniques.

Sound Isolation

Sound isolation focuses on keeping noise contained within an interior space, so a patient is less disturbed from activity noise generated beyond their walls. During design, the acoustical consultant must first identify the STC rating of the adjacent spaces in order to assess the sound isolation characteristics of a wall, floor, and other building assemblies.

Design Strategies

Building Vibration

Designing to control vibration includes isolating mechanical equipment on mounts or hangers so vibrations from equipment operation are not transferred to the structure. Vibration can also occur from footfall, rolling carts, and general human movement, which can be disturbing to patients and bothersome to doctors during surgery.

In addition, much of the medical equipment is sensitive to a small amount of vibration that is not necessarily detectable by an individual. Therefore, portions of the building where this sensitive equipment is located may need special structural design considerations so vibrations do not exceed equipment supplier limits.

FGI's standards include maximum floor vibration peak velocity (measured in micro-inches per second) for various areas, such as patient rooms, treatment rooms, operating rooms, and administrative areas.



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Design Strategies

Acoustical Privacy Curtains

As noted previously, the acoustic environment at patient bays is critical for speech privacy and intelligibility, muting sound, and maintaining suitable sleeping and resting/recovery conditions. One effective method to improve this environment is through the use of acoustical privacy panels.

These panels:

- are HIPAA compliant
- improve HCAHPS scores, especially the score for quiet at night, by lowering noise levels and increasing patient privacy
- improve communication between staff and patients due to the decreased noise and increased speech intelligibility
- reduce overall workplace noise and distraction
- lower the rate of staff fatigue by decreasing noise levels
- install without interfering in hospital operations or infrastructure, and
- are available in a clean-in-place version that can save the time, money, and interruptions attributable to removing curtains for laundering.



Design Strategies

How Privacy Curtains Work

The panels feature absorptive inserts that enable the curtains to provide a noise reduction coefficient (NRC) of 0.95 and an STC of 11. The panels muffle noise by slowing the reflective velocity.

Using the curtains as acoustic material requires no extra space, and more acoustic material can be installed per hospital area since it is double sided. They can be included in new designs or provide a simple retrofit for an existing site with no disruption or closure. The curtains can also aid in patient privacy, which helps with HIPAA compliance.

Panels are available in a wide range of colors and patterns, which can provide a visual setting that helps elevate patient spirits.



Design Strategies

Acoustical Privacy Curtains

The curtains feature a traditional mesh header with grommets for traditional track systems or for hookless tracks. The curtains are easily cleaned with existing laundry services or in place, depending on the fabric.



Design Strategies

Acoustical Privacy Curtains

Privacy curtains are most commonly specified in neonatal units, intensive care units, ambulatory surgical centers, and as seen here, emergency rooms.

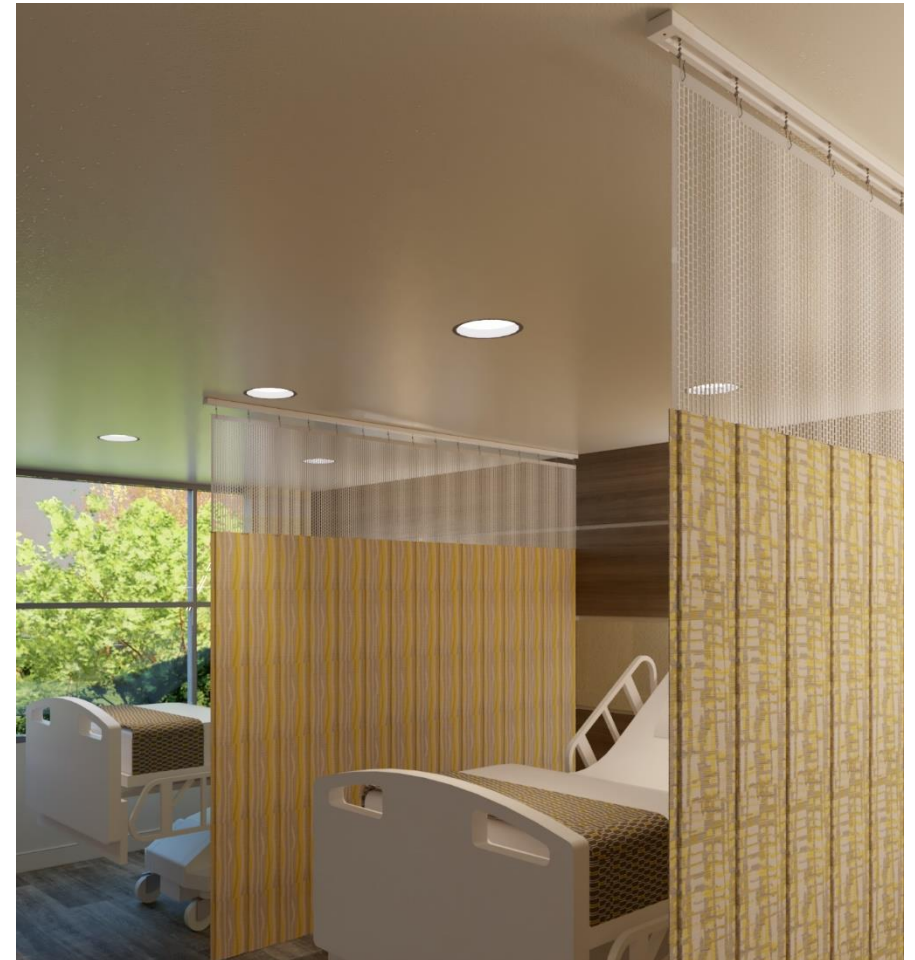


Design Strategies

Acoustical Privacy Curtains in Patient Areas

Patients state that they get a feeling of calm and a sense of being in their own private room, and staff members say they can “hear themselves think” again.

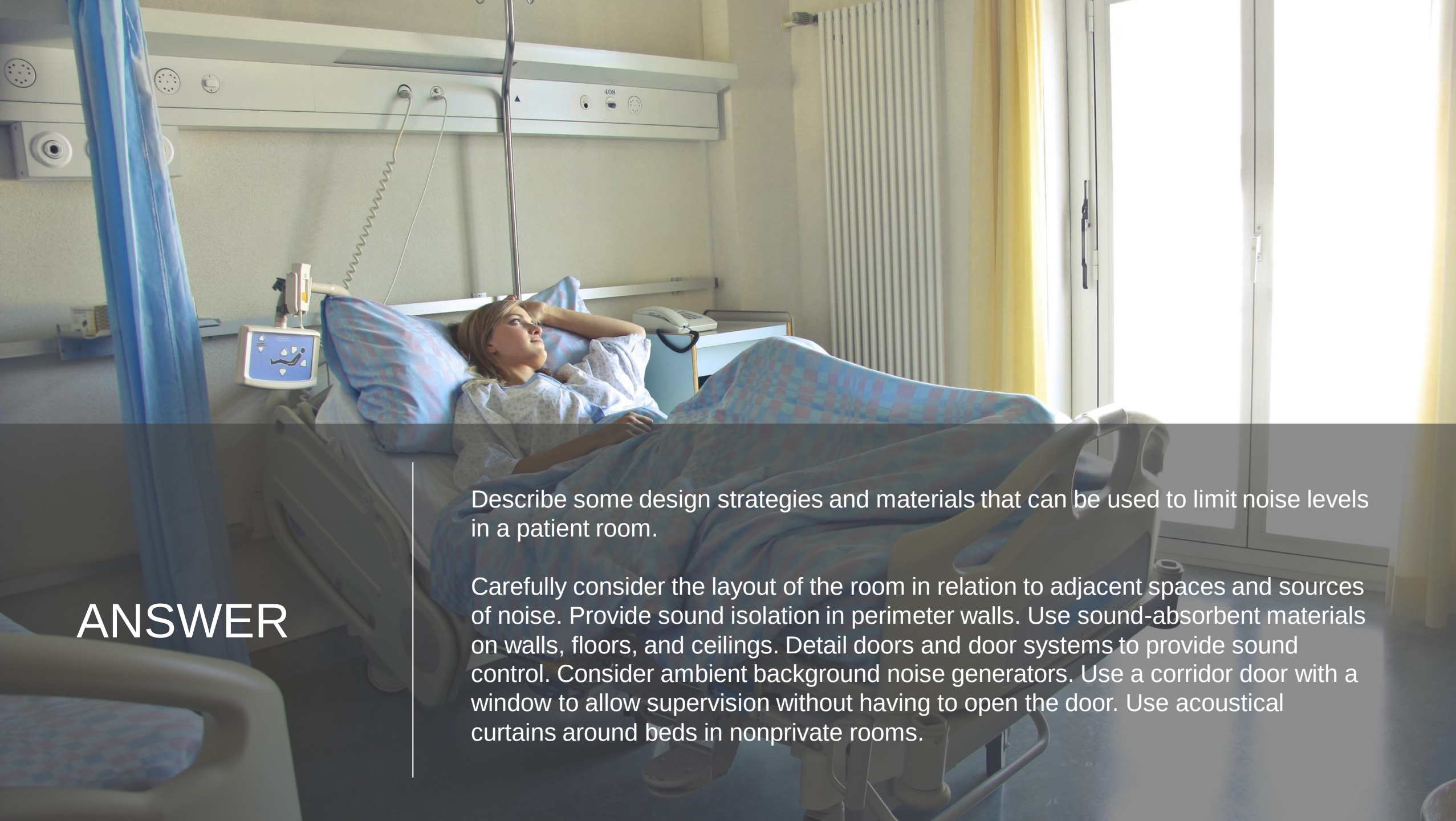
The panels give families and medical staff a “normal” level of speech privacy. This means that when the curtain is closed for an alcove or pod, words will only be perceived when someone is trying to attentively listen but will not be intrusive. The sounds from alarms and crying will not be attenuated to a level that will put any patients at risk but will be reduced yet clearly audible.



A photograph of a hospital room. A young woman is lying in a hospital bed, looking towards a window on the right. The bed has a blue and white patterned blanket and a matching pillow. To the left of the bed, there is a medical monitor on a stand displaying a diagram of a human body. Above the bed, there is a white medical equipment rack with various outlets and a coiled cable. A blue privacy curtain is partially visible on the far left. The room has a light-colored wall and a window with yellow curtains on the right. The floor is a light blue linoleum.

REVIEW QUESTION

Describe some design strategies that can be used to limit noise levels in patient areas.

A photograph of a hospital room. A young woman is lying in a hospital bed, looking towards a large window on the right. The room features medical equipment, including a monitor and a wall-mounted unit with the number 408. The window has yellow curtains. A semi-transparent dark grey box covers the lower half of the image, containing text.

ANSWER

Describe some design strategies and materials that can be used to limit noise levels in a patient room.

Carefully consider the layout of the room in relation to adjacent spaces and sources of noise. Provide sound isolation in perimeter walls. Use sound-absorbent materials on walls, floors, and ceilings. Detail doors and door systems to provide sound control. Consider ambient background noise generators. Use a corridor door with a window to allow supervision without having to open the door. Use acoustical curtains around beds in nonprivate rooms.



Design Strategy Case Study

Case Study: Acoustic Assessment of Speech Privacy Curtains

In a study done by Diana Pope and Erik Miller-Klein in 2016, a medical center had the opportunity to evaluate the effectiveness of an enhanced acoustical privacy curtain within standard and newly refurbished care areas. The focus of the investigation was to determine whether the SII and sound transmission differed significantly between usual fabric privacy curtains and the enhanced acoustical privacy curtains, and to determine whether the effect was significant in a nursing unit that already had improved average sound absorption. In other words, was there still an additional acoustic benefit in using the enhanced privacy curtains?

Three rooms on a refurbished unit and five on a standard nursing unit were selected for the study.



Case Study: Acoustic Assessment of Speech Privacy Curtains

In general, the study showed that acoustically enhanced privacy curtains can provide additional auditory protection for patients, though the overall speech privacy and sound reduction performance was impacted by the architectural and overall acoustical design of the patient rooms and facility and the background noise level.

In a multibed room, speech privacy was enhanced 7–14% between patient beds when comparing no curtain and the standard curtain. Privacy measures improved by 18–40% when comparing the standard curtain and the acoustically enhanced curtain. Beds adjacent to each other exhibited limited privacy levels even with the acoustically enhanced curtain; however, beds across the room through two curtains showed 32–41% improvement in speech privacy. This changed perceived speech privacy from “marginal” to “normal” (0.10 SII to 0.45 SII).



Case Study: Acoustic Assessment of Speech Privacy Curtains

Where a room already had relatively low reverberation times, the acoustically enhanced curtain improved the average sound absorption by 20–30% . As we have seen, the specific results depended on the orientation, configuration, and location of the rooms being tested.

For more detailed information the study can be found here:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4918673/?report=printable>

(Accessed June 2020)



Resources

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Conclusion

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