

How Health Care Facility Managers Cure Four Acoustical Challenges

By Karen Kroll - October 2011

Considering that health care facilities are intended to be places of healing and recovery, they can get awfully noisy. In an often-cited article in the New England Journal of Medicine from 1993, "Pandemonium in the Modern Hospital," Gerald Grumet, M.D, notes that in many hospitals, "the previously serene milieu is gradually being debased by a sonic assault on the ears and psyche."

In a health care setting, noise is more than just an irritation. Some reports have indicated that the acoustical environment can affect patients' recovery. A [2008 study](#) by Neriman Akansel, Ph.D., RN, and Senay Kaymakçi, Ph.D., RN, and published in the Journal of Clinical Nursing, found that noise levels in an intensive care unit could hit 89 decibels — about as loud as the inside of a bus, according to the Occupational Safety and Health Administration. Patients closer to the nurses' station, and thus nearer to one source of activity and noise, were more affected.

Making health care facilities quieter isn't easy. In addition to the noise that may emanate from building systems, many of the machines that help patients get better also generate beeps, buzzes and alarms. Most surfaces are hard, to make the environment less hospitable to germs, and thus reflect any sound that occurs. Health care professionals and patients talk louder in order to be heard above the din.

Given all that racket, facility managers increasingly recognize that a calmer, quieter hospital environment is more conducive to healing and may reduce the mistakes that can occur when doctors and nurses are unable to hear clearly what their coworkers are saying.



Achieving appropriate sound levels in a health care setting requires identifying the sources of the noise, and the potential options for either eliminating it at the outset or minimizing it. It's also important to recognize that the optimal acoustical environment may change from one area of a hospital or clinic to another, says Gina Ramirez, an acoustical engineer with HDR.

Here are four of the main acoustical challenges to overcome in a health care facility.

1. Building System Noise

A primary source of noise is building systems. One way to measure building system noise is through the NC, or noise criteria rating, says Fred Shen, an acoustician and president of Shen Milsom Wilke. The NC rating measures "the steady state ambient noise produced by the mechanical and electrical equipment," he says. NC doesn't factor in conversations or human activity. For patient rooms, the goal typically is an NC rating of about 35. The goal might be a little higher — say 40 — for nurses' stations.

One way to reduce noise from building systems is to place them as far as possible from patient rooms, allowing equipment sounds to dissipate as they travel. This typically is less expensive than trying to mitigate sound from equipment located near patient and staff areas.

Distance is especially important since many tools designed to reduce mechanical system noise, such as duct liners, aren't allowed in health care settings, due to concerns about the potential for a buildup of bacteria. "One challenge is the need for acoustical treatments to conform to infectious control codes and regulations," says Seth Harrison, an acoustics engineer with KJWW.

Special duct silencers are another option. "Silencers placed between terminal boxes and the rooms they serve reduce terminal box noise by aerodynamically channeling airflow past perforated metal wedges filled with sound absorptive fill material," says Benjamin Davenny, a senior consultant in acoustics with Acentech. In health care applications, a film facing usually sits between the fibrous fill and the airstream.

Another option is flexible duct connectors, which force the sound to twist and turn, dispersing it. "The flexible ducts allow sound to leak over the ceiling, so they're not channeled into the room via the duct," Davenny says.

Duct work can also be designed so that it increases and then decreases in size, says Harrison. This approach reduces noise generated by the flow of air. However, this design can require more room than often is available above the ceiling, he says.

It's not always possible to locate heating and cooling systems far away from patient areas, or to design a route requiring many flexible connectors. And codes limit the amount of energy a building can use. "That forces engineers to design the duct work system to minimize losses from sharp turns in the duct work," Harrison says. Longer duct runs can

mean greater loss of energy. "Very short duct runs are energy efficient, but also efficient at transmitting noise from HVAC units," he says.

2. Protecting Privacy

Health care facility managers should be aware of HIPAA, or the Health Insurance Portability and Accountability Act of 1996, which protects the privacy of individually identifiable information. "Hospitals need to be leery of violating patients' privacy rights," Harrison says. Patient, procedure and consultation rooms need to be designed so that they provide speech privacy, he adds.

This doesn't mean that rooms need to be soundproof, but that speech is unintelligible, Shen says. Other occupants may be aware of a conversation, but are unable to decipher what's being said.

One solution is to raise the background sound level in the room through the introduction of masking sound. Sound masking makes it more difficult to hear other sounds or decipher others' conversations. The use of masking sound is generally less expensive than embarking on construction projects to eliminate or reduce the noise itself.

Many of the tools used for noise control, such as upgraded wall construction, absorptive finishes, and sound masking, can help provide speech privacy. Another option is what's known as mass-loaded vinyl, which absorbs sound, Ramirez says. It can be hung between the deck and the ceiling to provide sound isolation between rooms in which there is an open plenum. Some manufacturers provide ceiling tiles that come with mass-loaded vinyl or acoustical backing.

Sound Advice

>> Sound & Vibration: Design Guidelines for Health Care provides guidelines on the acoustical environment within health care settings. Some states adopt these guidelines as code, says Seth Harrison, an acoustics engineer with KJWW. Find it at: www.fgiguilines.org/interim_pubs.html

To really achieve speech privacy, Harrison typically recommends that private areas be separated from public areas; simply using dividers won't suffice.

Constant Alarms Becoming a Noise Problem

>> A type of noise that's been capturing attention recently is "clinical alarm fatigue." Some reports indicate that an alarm goes off every ten seconds in a hospital, says Seth Harrison,

an acoustics engineer with KJWW. Reducing the number of alarms may enhance patients' experience. One way to mitigate clinical alarm fatigue is through wall and door construction that isolates the sound.

Some solutions are non-acoustical, says Benjamin Davenny, a senior consultant in acoustics with Acentech. For instance, providing better training to the nurses that apply sensors should mean that fewer will detach from the patient or otherwise malfunction. An alarm management system can direct an alarm just to the medical professionals working with a specific patient. In addition, staff can examine the level of alarms that are necessary, says Gina Ramirez, an acoustical engineer with HDR.

"The goal is to only sound alarms when there's a real problem," Davenny says.

— *Karen Kroll*

3. Ensuring Intelligibility

Intelligibility is another concern, Ramirez says. Operating and procedure rooms are prime examples, as they often house equipment that generates noise. In addition, most of the surfaces are hard and reflective, contributing to the build-up of noise. The result is that it's often difficult for the medical staff to hear each other.

At the same time, acoustics usually is not the top priority; infection control is, Harrison says. Next in line is temperature and humidity control, and then lighting. Acoustics is fourth. As a result, he says, "there are limited options for adding absorptive materials in operating rooms." Instead, the facility designers can try to construct walls to provide cavity absorption, and design HVAC systems to be as quiet as possible.

Some sound absorbing surfaces, such as rubberized flooring or ceiling materials that feature higher noise reduction coefficients, or NRCs, may be suitable in operating rooms, Ramirez says. The NRC indicates how much sound the material is absorbing.

4. Vibrations

Vibrations from fans, chillers and other equipment also can present challenges. "If vibration gets into a structure, it becomes noise," Shen says. Vibrations also can hamper the functioning of some equipment, such as MRI machines. One way to solve that problem is to locate sensitive medical instruments away from the source of vibrations. Mounting equipment on vibration isolators can reduce the transmission of vibrations by 90 to 95 percent, Shen says.

The need for isolators will vary with location of equipment and power of the motors, Davenny says. If equipment is on a slab on grade or rigid foundation, it will need less isolation than if it's on the roof. "No raised floor or roof is as rigid as a slab on grade," he says. The more powerful the equipment, the more isolation required.

Activity noise is another concern. Construction materials offer one way to mitigate it. For instance, adding gypsum board to the wall construction can make it more difficult for sound to travel.

In hallways, nurses' stations and patient areas, surfaces, such as wall and floor finishes, that are more sound absorptive than reflective can reduce sound transmission, Shen says. But they also need to be easily cleanable.

An often-overlooked surface is the ceiling, which is almost never touched. "If we can make it highly absorptive, it helps to negate the need for absorptive materials on the floor and walls," Shen says. That can mean using material with an NRC in the range of .8 to .95.

Many health care facilities also are looking at new ways to reduce noise levels at nurse stations, Ramirez says. For instance, some are partially enclosing the stations. That way, any alarms can be quieter, since they'll have fewer other sounds to overcome. In addition, the doors on patient rooms located near a nurse's station may be outfitted with viewing windows, Ramirez says. The room doors can remain closed, while the windows allow the medical staff to monitor the patients.

Reducing noise in most health care environments requires carefully balancing competing design priorities. "It's a challenge for the entire design team to meet all the design criteria for a project, including storage, ventilation and lighting, and then still have a quiet facility that provides a restful environment," Harrison says. At the same time, a growing body of research is showing how reducing noise and sounds in a health care environment can enhance patients' recovery and health.

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Experience Shows That Improving Acoustics Can Be a Complicated Matter

>> It seemed like a good idea. To cut down on noise coming into patient rooms, Froedtert Health St. Joseph's hospital in West Bend, Wis., designed doors on those rooms to be closed all the time. The strategy was part of St. Joseph's overall focus on safety and patient comfort.

But the closed doors didn't make patients happier, says John Balzer, vice president, facility planning and development, Froedtert Health. St. John's was built before it was acquired by Froedtert Health. While the design did cut down on noise in the patient rooms, patients didn't like feeling closed off from the rest of the hospital.

"The feedback we got from our patients was very negative," Balzer says. "Bottom line is, they wanted to feel connected to the caregiver. They felt too isolated, particularly the elderly patients.

"We would have patients almost get scared; they would feel that they were abandoned

because it was so doggone quiet and so isolated in the patient room. Sometimes a little bit of activity and connection — just seeing the doctors and nurses going up and down the hallway — can be reassuring to patients."

>> Froedtert Health has a strong focus on having good acoustics in all its facilities, Balzer says. Strategies such as carpet in hallways, sound-absorbing ceiling panels and buying equipment with low noise ratings helps with that goal. But facilities are only one side of the story.

"People tend to really focus on the facility component, and that's certainly an important piece of it with flooring materials and walls and ceiling materials, but we found that you've really got to keep a well-rounded, blended approach to it," Balzer says. "Probably the most important piece of it is the staff piece." Balzer says that the medical staff has embraced the idea that by being mindful of the noise level, they can help improve patient comfort.

>> For facility managers looking to improve their acoustics, Balzer has one more piece of advice: Pay attention to the little things, like the small rubber door silencers that are almost universal on patient room door frames.

"It's amazing how that is forgotten," he says. "In a matter of two or three years, those things are worn away to nothing. And when they're worn away, the door makes a god-awful racket when you close it."

— Casey Laughman, managing editor