SONICU™
Monitoring Measured

Quieting the NICU

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"Silence is a source of great strength"

Lao Tzu, Chinese poet and philosopher.

Quiet Healing: An overlooked consideration

If silence is a source of great strength as Lao Tzu suggests, studies also show silence is a source of healing.

Unfortunately silence is difficult to come by where it's needed most: the halls and rooms of modern American hospitals. The myriad of technology, resources and personnel we currently bring to bear against disease and illness brings with it a clamor that is anything but healing.

Noise permeates the hospital environment. Beepers, alarms, machines, voices, telephones and mechanical clatter.

In 2014, the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) responses tallied from more than 3 million hospital patients throughout the country indicated the overall quietness of the hospital environment was unacceptable. In fact, all but one of the HCAHPS categories received less top box scores than the responses to "Quietness of the hospital environment."

The World Health Organization has found hospital noise levels exceed the organization's standards by a factor of two for continuous noise in patient rooms. Depending on the patient's age, condition, hearing acuity and other factors, hospital noise might even be antagonistic, which could worsen an already difficult situation.[1] At the very least, noisy hospital wards and rooms are not allowing patients to heal effectively.

A significant body of medical research has established the detrimental effect of high noise levels on patients and staff who are attempting to recover and work in U.S. hospitals and health institutions. Despite those findings, however, hospital noise levels continue to rise and register well above guidelines set by the federal and medical regulators and governing bodies.

The EPA and American Academy of Pediatrics recommend that hospital noise not exceed 45

db during daytime hours and 35 db at night. OSHA recommends protective hearing equipment to prevent hearing loss for continual noise levels at 80 db and above.

Despite those regulations and guidelines, however, current hospital noise levels have been measured as high as 90 to 140 db, adversely affecting the patient healing environment, increasing exposure to hearing loss, increasing stress and cortisol levels, blood pressure, respiratory rates and irritability. The onslaught of hospital noise has been linked to sleep deprivation, sensory overload, and increased pain perception.

More importantly, the problem of too much noise correlates to patients' decreased confidence in the hospital and its staff, and could impact and impede healing overall.[2]

The issue of noise in our hospitals is more than a troublesome dilemma that needs to be addressed. Those involved with hospital design state healthcare providers have a *responsibility* to advocate for healthy healing environments, and while many hospitals are committed to creating a healing environment, the auditory environment, laced with noxious, inappropriate noises, is often not addressed.[3]

The effect of noise on hospital patients generally has been well documented. However, there exists an even more fragile population in our medical facilities: premature infants.

Neonatal Intensive Care Units: Amplifying the problem

Every year in the United States, some 500,000 premature babies are born. Three decades ago, the mortality rate for premature babies was unacceptably high, with few preemies surviving. Fortunately, doctors can currently save most premature babies, with even the most critically received infants now leaving the neonatal intensive care unit, developing and reaching adulthood.

However, research is beginning to show that even with the best outcomes, under the best circumstances, preemies who survive without a medical disability still encounter difficulties socializing and taking risks later in life. Some of the findings include:

- The earlier babies are born, the less likely they are to marry, become parents or earn high salaries – *New England Journal of Medicine, 2008,* following 1 million former premature babies through the ages of 20 to 36.

- Individuals in their 20s who were former preemies were less likely to leave home, live with a romantic partner, and prone to be more inhibited – *Pediatrics, 2008.*
- Former preemies are more likely to have symptoms of autism spectrum disorder ranging from mild to severe - *Journal of Perinatology, 2003.*

With those findings in mind, consider that during a premature infant's admission to the NICU, it can undergo an average of *60 procedures,* many of them painful and invasive. Moreover, the preterm infant is exposed to intense and persistent stress during a time when its brain is developing at a profound rate. An infant's brain does not complete its inutero development and neuro-connective wiring until 37 weeks of gestational age. It is at this time, the baby's brain development is especially vulnerable. It is also at this time that it is undergoing severe physiological stress.

Though genetics and biology play paramount roles in basic brain architecture, environment is also a key component to full and healthy brain development. If an infant's experiences are abnormal, non-nurturing, traumatic, or chronically stressful during this time of development and growth – especially if final brain development is occurring in a NICU environment – the impact may leave a permanent imprint on brain structure and function.[4]

The average NICU noise environment

Keeping in mind the EPA's 45 db daytime hospital noise threshold, the typical NICU acoustic environment fluctuates between 40 and 90 db, with prolonged noise ranging in the 70 to 80 db range. In some cases, sound events in the NICU can peak as high as 140 db.

These unwanted sound events come from a variety of sources:

- Respiratory and medical equipment such as cardiac monitors, oxygen supply, ventilators, infusion pumps, isolettes, suction equipment, and the attendant alarms and operating sounds.
- NICU design: Telephones, overhead paging, doors/entrances, automatic paper towel dispensers, HVAC equipment, and the close proximity of bed spaces.
- Staff and family behaviors such as conversations and laughter, housekeeping services, other infants crying, centralized nursing stations, and tapping of incubators.

While at first blush these acoustic sources might seem minor or inconsequential, from the premature infant's perspective, they can be deafening.

According to *Sound in the NICU, Philbin K, 1997,* neonates hear things much differently than adults. Consider the following equivalents to a premature infant's ears:

- Closing both incubator portholes simultaneously is the equivalent of a jack-hammer at 122 db.
- Placing infusion pumps on top of an incubator is the equivalent of a jet plane takeoff at 114 db.
- Setting a milk bottle softly on top of an incubator sounds like a lawnmower at 96 db.
- Normal conversation registers at 60 db.
- Ambient NICU noise sounds like bustling traffic or a vacuum cleaner at 70 to 80 db.

As noted above, chronically high noise levels have been shown to have negative effects throughout the hospital environment. In the NICU setting, the problem is exacerbated to the extreme. In the NICU, infants are exposed to excessive noise levels at a time when silence should be a source of strength.

Even brief auditory stimuli in a range greater than 70 to 80 db can cause significant physiological reactions in premature infants. Such sound events have effects that include:

- Apnea
- Tachycardia, bradycardia and/or abrupt fluctuations in heart rate
- Abrupt blood pressure fluctuations
- Decreased perfusion
- Decreased oxygen saturation from exaggerated startle response
- Increased intracranial pressure and hemorrhage risk
- Elevated cortisol and stress levels[5]

Those physiological responses coupled with behavior reactions not only put the premature baby's health at immediate risk, but studies have shown the links to long-term consequences as well. Inability to rest and heal can translate to longer hospital stays. Adverse changes in cerebral blood flow have been related to noise bursts. Growth and developmental disorders, deficits and delays such as learning disabilities, ADHD, chronic lung disease and feeding problems can also result, along with hearing and speech difficulties.[6]

If silence can be regarded as a source of strength, it can be argued that noise can be a source of profound difficulty for a premature infant later in life.

The effect of noise on staff

Patients and preemies aren't the only individuals adversely affected by chronically high hospital noise levels. Those who work in noisy environments for prolonged periods of time also display stress-induced behaviors, including:

- Exhaustion and burnout
- Depression and irritability
- *Increased medical and nursing errors due to ineffective communication with co-workers and patients*
- Decreasing performance with daily tasks and increased inattention to detail
- Increased blood pressure, respiratory rates and cortisol (stress) levels

The evidence supports the conclusion that not only are hospital patients adversely affected by undue noise in wards and rooms, but the performance of the caregivers is diminished as well.

Rethinking the NICU environment

There is now a move to reduce noise levels throughout the entire hospital environment and especially in the NICU. Patient outcomes and hospital revenues are among the drivers behind this movement, but experts now believe that quieter healthcare is a medical necessity.

"Creating a quieter NICU environment should be a priority. Experts in perinatology agree that the adverse effects (of noise) are severe enough to warrant detailed investigation, arguing that hospitals hold an obligation to measure sound levels in infant nurseries and within incubators. Clinicians need to know the parameters of their own nurseries' acoustic environment and improve conditions accordingly."[7]

However, solving hospital noise problems involves more than incorporating silent technology. It requires changes in knowledge, attitudes, behaviors, and performance. In the end, it is up

to the institution to routinely monitor sound levels and conduct ongoing evaluations of their environments.[8]

Experts recommend altering caregiver behaviors such as decentralizing nursing stations, educating staff, patients and parents on how their actions contribute to an unacceptably high acoustic environment with laughter and conversation throughout the unit.

Additionally hospitals may consider modifying their existing physical environment by moving toward single-bed intensive care design, implanting lighting reduction measures, using sound-absorbing tiles and building materials, and selecting medical equipment with an eye toward overall noise reduction.

However, where physical and/or financial considerations preclude altering or remodeling care centers and environments, behavior modifications may be the only practical intervention. In this case, the installation of sound pressure monitors and reduced lighting can increase staff and family awareness of unacceptable noise levels to effectively decrease noise levels within the NICU.[9]

> *Regardless of the means, experts have come to the conclusion that hospitals should incorporate a regular system of noise assessment in order to comply with the recommended standards for newborn ICU design as well as develop and maintain a program for noise control.*[10]

Sonicu is the solution to sound problems in hallways, rooms, and NICUs

Managing the acoustic environment involves more than a coherent design, quiet technology and noise-dampening materials. Loud behavior and actions can lay waste to even the best laid plans and noise-reduction strategies. Staff and caregivers must have real-time, first-hand access to actionable sound data that tells them what is happening in their units in order to provide the best care possible.

Sonicu employs patented, digital wireless sensors that can measure sound pressure at a variety of locations – rooms, individual incubators, and hallways – to provide immediate awareness of current sound levels.

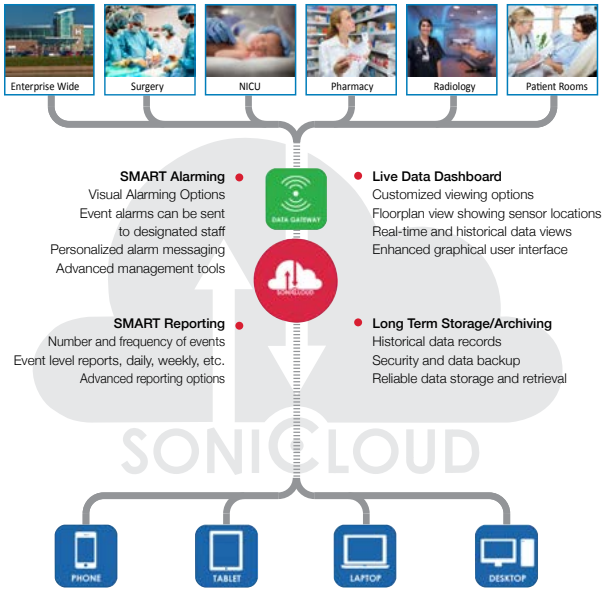
Additionally, that sound data is sent to a cloud-based software platform that can be accessed from any PC or mobile device and viewed via customized dashboards and reports to understand when and where problems exist.

Weekly summary reports are sent via email, and alerts can be delivered via phone, text or email to plan, initiate, and track noise-reducing initiatives.

By combining real-time monitoring and measuring along with actionable data, Sonicu makes sound visible to help NICUs manage their environments for optimal healing.

Sonicu sound monitoring:

- Provides 24/7/365 sound monitoring and access to real-time and historical data.
- Establishes your NICU's average sound level, sets specific noise parameters, and sends alerts for "sound events" above those parameters.
- Includes a complete training and education session with NICU staff upon implementation to ensure familiarity with the system.
- Provides quarterly reviews with a SONICU sound consultant to maximize system effectiveness.



In essence, sound monitoring and measuring systems such as Sonicu's become an additional caregiver in the hospital's arsenal to provide a constant, consistently quiet healing environment.

Real world results for real world problems

Sonicu technology is already at work monitoring NICUs and providing healing environments in major hospitals throughout the country. One of these institutions has been recognized for its safety initiatives as a direct result of an installation of a Sonicu noise monitoring solution.

Immediately after Sonicu assessed and installed its monitoring technology, routine noise maintenance in the NICU patient areas dropped below 50 db. More importantly the effect of that noise reduction was observed with a 40 percent decrease in adverse heart rate, oxygen saturation and respiratory rate alarms in the NICU.

With such dramatic success demonstrated by the hospital's NICU initiatives, administration quickly set in place plans to install noise monitoring systems in hallways outside patient rooms throughout the facility.

Users of Sonicu sound monitoring technology all report significant noise level reductions and improved patient outcomes in their respective units. Staff members reported a calm, improved healing environment after installing Sonicu's system. Moreover, hospital officials have noted an increased awareness on the part of parents and staff for noise control, improving the efficacy of the NICU environment even further.[11]

Customer Testimonials

"Sonicu's monitoring system is unmatched in the industry, with real-time data and historical trends that are valuable tools in protecting our babies."

Robert White, MD, neonatologist, South Bend Memorial Hospital

"Premature and sick babies are extremely vulnerable in the NICU and we must do all we can to protect them from adverse stimuli, while they are in our care. Sonicu weekly cloud reports are very useful in helping us monitor how we are doing in creating a quiet healing environment for babies in the NICU.

We noticed significant improvements almost from the moment we installed Sonicu. Parents appreciate the sound monitor light indicators because it is easy to see when the noise level is too loud. Even our staff is noticeably quieter. Sonicu has definitely been a positive culture change in our hospital. Thank you Sonicu for helping us to create a quiet healing environment in our NICU."

Raylene M. Phillips, MD, director of neonatology,
Loma Linda University Medical Center

"With Sonicu we know which areas of our NICU are the quietest, and we place our earliest babies in these environments."

Stacy Zediker, developmental specialist, NICU at
Gulf Coast Medical Center HCA

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