



John Black & Associates White Paper #1 – NICU Design Attributes

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The True North of all Lean design is the patient. Therefore, the overriding concern in the design of a NICU is to support the best possible care of babies.

“Best possible care” is defined differently from place to place and has evolved over time. In the 1980s best meant the best equipment. In the 1990s it was defined as providing developmentally appropriate care, environmental influence became known and units became quieter and dimmer. More recently, concepts of family-centered and developmental care have evolved and NICUs have recognized the value of breastfeeding and kangaroo care in providing the best long term outcomes for the baby.¹

Unwarranted assumptions are frequently made about space design. We tend to think that more space, bigger space, and a separate space for every function are desirable. However, there are times when more space has detriments that become apparent from observing work flow. For example, more rooms for separate functions create silos and can contribute to a limited ability to know the current status of patients and providers. That, in turn, leads to the need for elaborate electronic signaling devices that can augment, but cannot fully replace line of sight and proximity. More space frequently means more walking and moving, not just for staff, but for patients and families. More silos may also mean patients and their families lose track of their care provider’s location and availability.

The current move to all private or semi-private rooms is driven by the following concerns:

- *Infection from exposure to other newborns.*² Yet the leading cause of infection tends to be failure to adhere to hand washing, not failure to isolate.³
- *The need to control noise levels from equipment and reduce sound from normal adult activities near the newborns.*⁴
Noise levels are controlled primarily by the surfaces surrounding the child – ceilings, floors and walls.⁵ Further, noise levels are generated not necessarily by lack of private rooms, but from equipment beeping, overhead speakers, and staff voices. One study found old incubators to be the most significant noise problem.⁶ Additionally, “[c]aregiver voices and activities are a major component of the noise created in an NICU environment. Education of staff on the stressful effects of the environment can have a measurable impact.”⁷ Changes in equipment and behavior have a large impact. For example, “in the pediatric intensive care ward, outfitting staff with small hands-free personal communicators that operate much like cell phones enabled them to be signaled quietly and directly” significantly reducing staff noise levels.⁸
- *The need to adapt light levels to the developmental needs of the newborn.*^{9 10 11}
Light exposure should be indirect and adjustable to support circadian rhythm.¹² However, it can be zoned for developmentally similar babies without the need for private rooms for each baby.

Rooms with dimmable light sources must also be designed to allow sufficient light to support specific tasks. For example, staff must have sufficient light for preparation of medications and to observe skin tone.¹³ “Some very dim-lighting situations may actually be disadvantageous for both babies and their caregivers, having been based more on theory than evidence.”¹⁴

- Studies have determined that bed type and respiratory support are the leading contributors to adverse noise and light levels that extremely low birth weight infants experience during hospital stays.¹⁵

A deeper understanding of the core attributes of best possible care is needed to optimize space.

In a NIC, the core attributes of best possible care may include the following:

1. Needs relevant to different levels of intensity of care for the newborn.
2. An efficient and nurturing physical environment
 - a. Reduction of ambient sound levels
 - b. Adjustable indirect lighting levels to support Circadian rhythms
 - c. Size and type of infant bed
 - d. Room for kangaroo care/skin to skin contact
 - e. Support for breast feeding
 - f. Family areas
 - i. Lactation rooms
 - ii. Nourishment centers for family
 - iii. Family consult rooms
3. Infection Control
 - a. Support for hand washing
 - b. Isolation as needed to prevent transmission
4. Support for current and future technology
 - a. Hands free communication system connected to baby heart monitors and ventilators
 - b. Incubators that provide monitored heat and humidity
 - c. In bed scales and mattresses that rotate 360 degrees so babies do not need to be removed for treatment
 - d. Total body cooling therapy
 - e. Bedside attenuated EEG brainwave monitoring
5. Design elements
 - a. Workstations with JIT supplies located in proximity to the newborns
 - b. Sound-absorbing ceilings and floor tiles
 - c. Dimming lighting systems
 - d. Adjustable natural lighting
 - e. Enhanced air handling
6. Security
 - a. Secured access to the unit
 - b. Identification of visitors

Summary of the current practices driving design:

A signature component of the modern NICU is to make privacy a priority. Whether in single-bed rooms, private cubicles, or a pod or pinwheel arrangement, planned visual control of patient care areas have replaced the “fishbowl” unit. Designs to accommodate practices of skin-to-skin contact, breast feeding and pumping, and security issues have all developed through the increased participation of the patient’s family as part of the caregiving team.

Technology has replaced large viewing windows with video viewing for family and visitors who are unable to enter the unit. Visual and audible controls ensure comfort to the newborn and promote a positive healing environment.

Design features in modern units also include greater access to natural light, and enhanced air handling systems for better air filtration and temperature control, draft elimination and hypothermia prevention. Improved headwall design and pod or pinwheel planning arrangements have given units a universal application to the flexibility necessary in the modern acute care environment. Finally, adequate storage for health care equipment and patient and family needs has increased to keep technology and supplies close to the patient and to give the ability to flex, grow and shrink as patient loads fluctuate...

The effort to develop standards for neonatal intensive care unit (NICU) design is an ongoing evolutionary process. Various portions of the *Recommended Standards for Newborn ICU Design* have been adopted by the Facility Guidelines Institute (FGI) *Guidelines for Design and Construction of Health Care Facilities*, the American Academy of Pediatrics /American College of Obstetricians and Gynecologists (AAP/ACOG) and several countries around the world. But, as new evidence from research becomes meaningful, the Committee to Establish Recommended Standards for Newborn ICU Design convenes to evaluate and debate its relevance to new standards.¹⁶

¹ Hardy, Natalie Paige, “Cost and Design Analysis of Neonatal Intensive Care Units: Comparing Single Family Room, Double-Occupancy, Open-Bay, and Combination Settings for Best Design Practices. University of Florida Thesis, 2005.

² Daze Floyd, Ann Marie, “Challenging Designs of Neonatal Intensive Care Units,” *Crit. Care Nurse*, October 1, 2005 (25/5) 59-66.

³ Lam, Barbara C.C., et al, “Hand Hygiene Practices in a Neonatal Intensive Care Unit: A Multimodal Intervention and Impact on Nosocomial Infection,” *Pediatrics*, November 1, 2004 (114/5) e565-e571.

⁴ Daze, supra.

⁵ Anjali, Joseph, “Sound Control for Improved Outcomes in Healthcare Settings,” Center for Healthcare Design, Issue Paper #4, January 2007.

⁶ Lasky, Robert E and Williams, Amber L, “Noise and Weight Exposures for Extremely Low Birth Weight Newborns During Their Stay in the Neonatal Intensive Care Unit,” *Pediatrics* 2009 (123) 540.

⁷ Williams, Susan T and Burger, Cynthia A, “A NICU That Feels Like Home,” *The Academy Journal*. 1998. <http://www.app-arch.com/documents/NICU.pdf>.

⁸ Science Daily, “Making Hospitals Quieter,” Science Daily, May 1, 2006, citing West, James E and Busch-Vishniac, Ilene, “Rise in Hospital Noise Poses Problems for Patients and Staff,” *Journal of the Acoustical Society of America*, November 21, 2005.

⁹ Daze, supra.

¹⁰ Mann NP et al. Effect of night and day on preterm infants in a newborn nursery: randomised trial. *Br Med J* 1986;293:1265-7.

¹¹ Miller CL et al. The effects of cycled vs. non-cycled lighting on growth and development in preterm infants. *Infant Behav Dev* 1995;18:87-95.

¹² Daze, supra.

¹³ Sizun, Jacques and Browne, Joy V, “Design and Staff Issues in Light Control,” *Research on Early Developmental Care For Preterm Neonates*, John Libby Eurotext, 2005, 45.



¹⁴ White, Robert, "Lighting – Circadian Rhythms," Consensus Committee to Develop Recommended Standards for Newborn ICU Design.
http://www.pediatrx.com/documents/lighting_circ.pdf.

¹⁵ Lasky, supra.

¹⁶ Harrell, James W, "Designs for the delicate: A look at evolving NICU design standards," Health Facilities Management, 2008.