



Academy Journal

November 1, 2007 | Print this page | Email this page

Designing for Family-Centered Care in the Newborn Intensive Care Unit: Designing for the Future

Abstract | ***Article***

Changing patterns of care in high-risk maternal-fetal medicine drive this major project. The hospital currently has a cramped open bay neonatal intensive care unit (NICU) of 60 beds. The new addition adds 140,000 square feet to the existing Women & Infants Hospital in Providence, including a new 80-bed NICU comprising 70 private rooms totaling 56,000 square feet; a floor of 30 ante-partum beds totaling 24,000 square feet; and a new lobby with retail space, social services, a conference center, and chapel.

We defined design strategies to support the premise that the single-room NICU care model is the optimal model to improve neonatal infant outcome and the best way toward a family-centered healing environment.

The intent of the architecture is to support the mission and guiding principles established by the Design Committee early in the design process. The challenge for the architect is to understand the relationship between design of physical space and the influence it has on the outcome of patient care, as it affects the neonates, their families, and caregivers. Through a highly participatory design process with the Design Committee, the architects could fully comprehend the complexities of this relationship.

The hospital anticipates a NIH research grant to measure the relationship between the single-room NICU design and infant and neurodevelopmental outcome. The results of this study will contribute to the growing body of evidence-based medicine that builds foundations for evidence-based design.

Academy Journal Home

> Letter from the Editor

The Design of Psychologists' Offices: A Qualitative Evaluation of Environment-Function Fit

Nicholas J. Watkins, PhD, Cannon Design
Kathryn H. Anthony, PhD, University of Illinois at Urbana-Champaign
[Abstract](#) | **[Article](#)**

Historical Hospital Buildings: Should They Be Reused?

H. James Henrichs, AIA, Hobbs+Black Associates
[Abstract](#) | **[Article](#)**

Rebranding Services and Facilities at a Community Hospital for Improved Satisfaction

Greg Heiser, AIA, OWP/P
Jocelyn Stroupe, IIDA, AAHID, OWP/P
[Abstract](#) | **[Article](#)**

Designing for Family-Centered Care in the Newborn Intensive Care Unit: Designing for the Future

James F. Padbury, MD, Women & Infants Hospital and Brown University
Johan Verspyck, AIA, Anshen+Allen+Rothman
[Abstract](#) | **[Article](#)**

Sound Practices: Noise Control in the Healthcare Environment

Roger B. Call, AIA, ACHA, LEED AP, Herman Miller for Healthcare
[Abstract](#) | **[Article](#)**



Academy Journal

November 1, 2007 | Print this page | Email this page

Designing for Family-Centered Care in the Newborn Intensive Care Unit: Designing for the Future

Abstract | **Article**

Introduction

At the groundbreaking ceremony for the new Women & Infants Hospital addition were some of the parents and their children who had graduated from the hospital's existing neonatal intensive care unit (NICU). The parents delivered emotional testimonies about their experiences in the NICU, stressing the value of their participation in the caring process of their newborn and how the collaboration between caregiver and parents had been vital to their children's long term future development once the child had been released from the NICU. This inclusive and holistic philosophy towards delivering care is the fundamental premise for the design of the new NICU. How an owner and its architect address the design of future facilities for premature newborn infants under intensive medical care that emphasizes family centered care is the subject of this paper and the building currently under construction.

Women & Infants Hospital, a Brown Medical School teaching hospital, serves the women of Rhode Island, northeastern Connecticut and southeastern Massachusetts for gynecology, maternal-fetal medicine, oncology and other women's health needs. The changing patterns of care in high-risk maternal-fetal medicine are the drivers of this major project. The hospital currently has an open bay NICU of 60 beds in very cramped conditions. Adding 140,000 square feet to the existing hospital, the new addition includes a new 80 bed neonatal intensive care unit (NICU) comprised of 70 private rooms totaling 56,000 square feet (the balance of ten beds will be in multi-bed rooms for multiple birth newborns), a floor of 30 ante-partum beds totaling 24,000 square feet, and a new lobby with retail space, social services, a conference center, and chapel.

The intent of the architecture is to support, in every way possible, the mission and guiding principles that had been established by the design committee early on in the design process. The challenge for the architect is to understand the relationship between the design of physical space and the influence it has on outcome of patient care, as it affects the patients, their families, and the caregivers. Only through a highly participatory design process with the design committee was it possible for the architects to fully comprehend the complexities of this relationship. This process included site visits to existing facilities and

Academy Journal Home

> Letter from the Editor

The Design of Psychologists' Offices: A Qualitative Evaluation of Environment-Function Fit

Nicholas J. Watkins, PhD, Cannon Design
Kathryn H. Anthony, PhD, University of Illinois at Urbana-Champaign
[Abstract](#) | [Article](#)

Historical Hospital Buildings: Should They Be Reused?

H. James Henrichs, AIA, Hobbs+Black Associates
[Abstract](#) | [Article](#)

Rebranding Services and Facilities at a Community Hospital for Improved Satisfaction

Greg Heiser, AIA, OWP/P
Jocelyn Stroupe, IIDA, AAHID, OWP/P
[Abstract](#) | [Article](#)

Designing for Family-Centered Care in the Newborn Intensive Care Unit: Designing for the Future

James F. Padbury, MD, Women & Infants Hospital and Brown University
Johan Verspyck, AIA, Anshen+Allen+Rothman
[Abstract](#) | [Article](#)

Sound Practices: Noise Control in the Healthcare Environment

Roger B. Call, AIA, ACHA, LEED AP, Herman Miller for Healthcare
[Abstract](#) | [Article](#)

attending professional conferences to learn about the state of the art of neonatal care. The lessons learned will be evaluated after the facility is open and functioning. We have applied for a research grant with the NIH to measure the relationship between the single room NICU design and infant neurodevelopmental outcome. The results of this study will become a valuable contribution to the growing body of knowledge that builds upon the foundations for "Evidence Based Design". In this paper, we will attempt to define the design strategies that have been implemented to support the premise that the single room NICU care model is the optimal model to improve patient outcome and the best way to create a healing environment that focuses on family centered care.

The chosen model of care

While it was clear that new physical space for the NICU was needed in the new hospital addition, it was not clear what physical design and what "model of care" should be pursued. As the specialty of newborn intensive care evolved, so have the models of care. "Model of care" refers to the physical space for the patient and the principle that the design of space surrounding that care is intimately related to outcomes. We identified several contemporary "models of care."

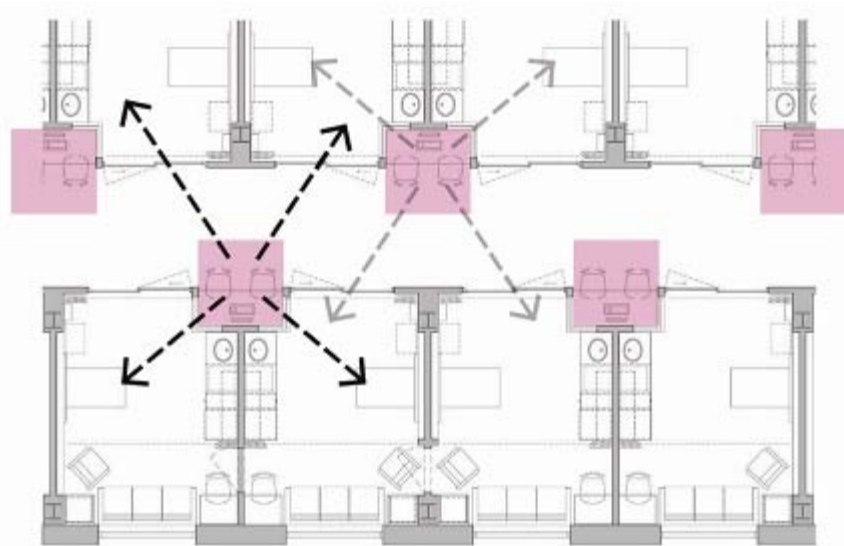


Figure 1. Single-family room model

These models include open bays where infants are cared for in a large open space, or in a modification of the open plan called a "Pinwheel." These models are similar to the existing NICU at Women & Infants Hospital, albeit with new construction a much larger open bay would be needed. A rapidly emerging approach to newborn intensive care involves "single-family rooms," Figure 1. This model of care recognizes that caring for critically-ill patients (especially the very young and the very old) in an open bay is often disruptive. The clinical instability of children in shared space often leads to disruption of their neighboring

partners. This is most apparent in newborn intensive care units where stability of heart rate and breathing is precarious. Even minimal visual, auditory and/or tactile stimulation can result in cessation of breathing (“apnea”) or in a decrease in the baby’s heart rate (“bradycardia”). The single-family room design has garnered widespread acclaim for its many distinct advantages.¹ Patients cared for in individual rooms are less likely to be disturbed by their neighbors, the staff or other activities related to adjoining patients. This model of care also allows for better isolation of patients from nosocomial infections. This model of care provides for the only form of privacy that is consistent with federal regulations in the United States known as the “HIPPA Regulations.” Lastly, the single family room allows for a truly family-centered approach wherein the families can be present throughout much of the hospitalization and really become partners in care of their infants rather than episodic “visitors.”

After completion of numerous site visits across the country, we convened the entire group to synthesize our experiences into a list of “Guiding Principles” and “Design Principles.” These are shown in Tables 1 and 2. While there was some concern that the single-family room model of care was beyond the scope of the large service at a facility like Women & Infants Hospital, after visiting these constructed nurseries there was clear consensus that it was the only model of care that should be considered. We believe that, before this decade is completed, this will be the dominant model of care in NICU design. In the fall of 2006 the American Institute of Architects made this very recommendation.

Guiding Principles:

- Family-centered care: parents as “partners”
- Developmentally supportive care environment
- Staff invested in decision-making
- Evidence-based clinical and safety practices
- Point of service care
- Future flexibility/sustainability
- Sustainability LEED Silver certification

Table 1. Guiding principles for design of new NICU

Design Principles:

- Welcoming and reassuring
- Clarity of organization
- Zoning of NICU
- Balance between staff and family needs
- "Green Design"
- Sensitivity to end of life issues

Table 2. Design principles for design of new NICU

Evidence-based practice

Our conclusions are based on the results of the experiences of the people at the sites we visited. We have also examined published and unpublished data from centers that have recently changed to different models of care. They are summarized in the next few paragraphs. At the outset we should note that there are no data which conform to the "gold standard for evidenced-based practice" which is a randomized, controlled "head-to-head" trial comparing single family rooms to other models of care. The information to date is either anecdotal or based on retrospective, historical comparisons. In 1997 Vanderbilt University embarked on a major construction project to build a new children's hospital and to re-design the critical care services. Considering the data reviewed above, the Division of Newborn Medicine at the Vanderbilt Children's Hospital adopted the single-family room model of care. They replaced their 44-bed, open-bay neonatal intensive care unit with a NICU with 65 single-family rooms. Data were collected after moving to the NICU on outcomes, staff satisfaction and safety-related issues.

Staff satisfaction is an important consideration in the successful evaluation of this single family model of care. Professional staff, especially nurses, have a well-established and honored tradition of advocacy for patient outcomes and in recognition of details and design that improve outcome. The preceding figures show that the overwhelming majority of staff feels that the single-family room unit is better than the group setting regardless of the illness severity or acuity. Moreover, staff feels the single family room is better for growing premature infants and also for critically ill infants who are on mechanical ventilation

Likewise, a staff survey demonstrated significant preference for the new design, a greater ease in providing developmentally appropriate care, improved family interactions and generally improved outcomes. These

experiences were compelling in our decision to exclusively employ the single family room model of care in our NICU.

Nonetheless, documentation according to the best standards for "evidence-based practice" is still lacking. Women & Infants Hospital and Brown University are in the midst of conducting a prospective, longitudinal study of the impact of this model of care on outcomes. The interdisciplinary research team includes PhD trained developmental specialists, neonatologists, neonatal nurses, OT and PT specialists and, of course, parents. The theoretical model underlying our study is shown in Table 3.

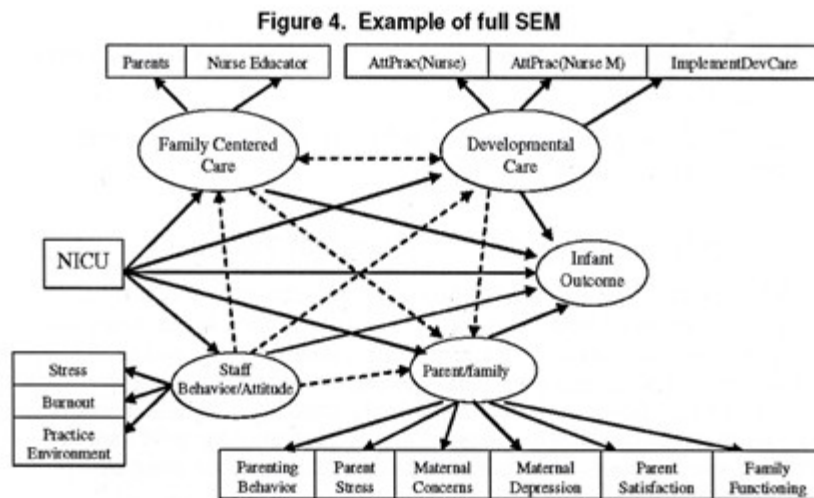


Table 3. Theoretical model

Physical environment in the intensive care setting
Numerous studies have been published which demonstrate that environmental conditions in the Intensive Care Unit can have significant effect on outcome. For caregivers, the environment influences their work performance, their satisfaction and their health.²⁻⁴ For patients, the physical environment can have a profound effect on rate of recovery, and/or development of what is commonly known as "the ICU syndrome". The ICU syndrome is a transient psychosis that is seen in patients who are subjected to long periods of invariant lighting, sleep deprivation and/or auditory disruption. While these observations are best documented in adult patients, it is clear that physical and environmental conditions also affect the outcome of critically-ill newborn infants.

Optimal lighting for babies in Newborn Intensive Care Units has been studied extensively.⁵⁻⁶ It is clear that fetuses and newborns have well defined circadian rhythms by their third trimester. These are entrained by maternal activity, temperature and hormones. Likewise, the visual and hypothalamic tracts of newborns are functional by 28 to 32 weeks. Given these significant developmental milestones, it is not surprising that alternating lighting between day and

night has been shown to be better than continuous light in newborns in neonatal intensive care units.⁷⁻⁸ This has been shown to benefit postnatal growth, developmental milestones and establishment of circadian rhythm. Preterm infants born at less than 31 weeks gestation have improved growth in cycled light compared with continuous near darkness. Similarly, varying light levels are beneficial to the providers. Numerous studies have documented the effect of light on mood, attitude, performance and overall psychological well-being of adults in healthcare workplace settings. Nightshift workers become drowsy and lower their body temperature during the night. This is mediated by melatonin. This can be modified by exposure to bright light for as little as 15 minutes. It is clear that different intensities are needed in intensive care settings, whether for procedures, paperwork or computer use. Likewise, there is significant interaction between light and noise levels, often referred to as the "library effect". In order to provide optimal care for the newborn, individualized settings are preferred where the light levels can be adjusted to the child's developmental level, illness level and personal care needs throughout the day.

Noise is another significant environmental variable in the newborn intensive care unit. In low birth weight infants, it has been demonstrated that intermittent loud noises increase intracranial pressure and decrease oxygen levels.¹⁰ Loud noises also interfere with the establishment of sleep patterns.¹¹ Sound levels in neonatal intensive care units frequently exceed 75-90 decibels, levels considered safe for later auditory development. As already noted, there is a substantial interaction between light and noise, and this is particularly acute during caregivers' activities such as rounds, changes of shift and unit maintenance.

Infection control is a critical issue that can be supported or obfuscated by the physical plant. At least one episode of bacterial infection ("sepsis") was observed in 15-33% of extremely low birth weight newborn infants in the Neonatal Research Network of the National Institutes of Health.¹² It is clear that overcrowding increases the risk of nosocomial infection. Design flaws including improper sink placement and poor airflow have been associated with nosocomial outbreaks in newborn infants in newborn intensive care units. The layout and design of the NICU can also contribute to inappropriate physical contact between providers and patient care areas and thus, an increased risk of spreading infections. This is particularly common in open bays where inadvertent casual contact with the isolettes, the patient's records and/or supplies in individual areas leads to poor quality of infection control.

The infant's room

The NICU room is the building block for the new facility. Each room is 175 net square feet (nsf) and has three distinct zones: Patient, Staff, and Family, Figure 2. Each room provides an opportunity to individualize and personalize the space according to each baby's developmental needs. The NICU room provides the privacy and separation that is necessary to perform critical

procedures with restricted admissions, without impacting other infants. It significantly displaces the existing and obsolete open bay NICU.

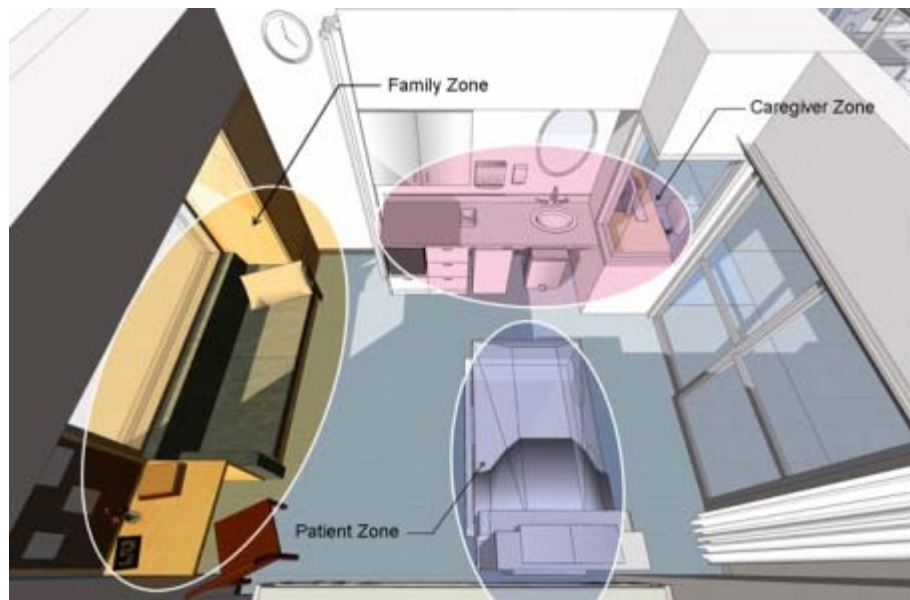


Figure 2. Patient zone, staff zone, and family zone in each room

Each caregiver/staff zone has a sink, refrigerator and storage cabinets for needed supplies. The patient zone headwall provides medical gases and electrical services for the hookup of equipment, including ventilators, pumps, monitors and other developmental equipment, as needed. Family space accommodates a sleeper for a parent, desk and storage which can be separated by a privacy curtain. Every room has indirect dimmable lighting that can be adapted to individual needs related to circadian rhythm and delivery of services. Every room has a heating, ventilation and air conditioning (HVAC) system that facilitates procedures being performed within the room.

The new NICU at Women & Infants Hospital of Rhode Island

In order to incorporate all of the clinical programs within 80 single family rooms, a new NICU requires more than 56,000 departmental gross square feet (dgsf). Compared to the existing open ward NICU, this represents a significantly larger floor plate. While the single room NICU is undeniably the preferred model of care, the design challenge is in how to configure 80 patient rooms so that there can still be a strong sense of community, in an environment that fosters interaction between family and staff, and where the family can feel at ease in a welcoming environment despite the intensity of the clinical setting.

A key requirement for the new NICU was to locate it next to the existing Labor and Delivery Suite. Initially, the goal was to locate all beds and core programs on one floor. An advantage to having all programs on one floor was that all

support spaces could be centrally located. A disadvantage of the one-floor scheme was that the floor plate was too broad, restricting the opportunity to bring natural daylight to interior areas, with long distances creating isolated zones. Furthermore, one large floor versus two smaller floors would be more expensive to build. For these reasons, and in order to preserve more land for future hospital expansion, the NICU was located on two floors. Because the Labor and Delivery Suite is located on the second floor of the existing hospital, required adjacency dictated that the NICU be located on floors 2 and 3. Thirty ante-partum beds are located on floor 4; and a new entrance lobby that includes retail space, a resource center, chapel, and conference center occupies the first floor. Maintenance and support services are located in the basement, with a tunnel connection to the existing hospital, Figure 3.



Figure 3. Stacking diagram for new NICU

Site design and massing

The new wing is sited along the western edge of the property, creating an urban edge along Gay Street and defining a new entrance forecourt off Dudley Street, the principle direction of travel for arriving patients, Figure 4. Secondary entrances, one off Gay Street, and another off the ED drop-off area, are oriented towards longer term parking areas for visitors and staff.



Figure 4. Site plan



Figure 5. Massing model

The massing for the new addition is configured in such a way as to maximize potential daylight to interior spaces, Figure 5.

A maximum perimeter of building envelope benefits from east-west orientations, without blocking views out from the patient floors of the existing hospital. The new wing bends gently at its mid-point, a strategy that not only serves as a

way to break up the perceived length of the structure, both from inside and out, but also locates the main family lounges of the NICU at the bend, an important visual cue from the exterior. It furthermore helps to spatially define the forecourt, like an extending arm that embraces arriving patients and their families. The main structure is connected to the existing building by a two story link. Clad by a tilted glass plane, it articulates the joint between old and new, defining the new main entrance, with a light filled lobby serving both the existing and new buildings. A central reception desk controls all entry points into the building and a public concourse has been created with a cafe, retail spaces and social service, bisecting the ground floor along the east-west axis connecting Gay Street with the existing hospital, Figure 6.



Figure 6. Section through main lobby

The second floor of the link serves as the connector between the NICU and the Labor and Delivery Suites, as well as housing staff lounge and locker facilities, equipment storage and sterilization. The roof of this link building is designed to receive a healing garden, accessible from the second floor of the NICU, and visible from the upper floors of both buildings.

The new wing is clad in traditional materials such as red and beige brick to provide unity with the hospital campus. The architecture responds in an open and dynamic way to the site, expressing a certain confidence and hope about the future, Figure 7.



Figure 7. Perspective view from Dudley Street

Plan organization

To minimize duplication and to unite the two NICU floors as much as possible, the design includes a vertical connection at the center of the building, utilizing an open atrium and open stair interconnecting the two floors. This architectural design allows for visible and direct access to program spaces that includes the family center and staff lounge. Clustering specific programs around the atrium clarifies way-finding, and enhances physical and visual communication between floors, Figure 8.



Figure 8. Atrium at family lounge

Each floor of the new NICU is organized into two 20-bed zones, totaling 80 beds. Each floor is supported by one medical team, the central team room located at the center of the building, at the juncture of two bed zones. Figure 9

Patient and service elevators are located at the north end,

as close as possible to the Labor & Delivery Suite, thus providing the shortest possible travel access to Floor 3 NICU. Isolation rooms have been designed with separate air systems in the event of an outbreak of airborne infection. A 10-bed area has been designed with both positive and negative air pressure flow. Negative pressure is activated to evacuate air-borne pathogens.



Figure 9. Second-floor plan of new addition, showing location of NICU

Each 20-bed pod is designed with core support elements that include a charting station between each two rooms, clean supplies, soiled utility, equipment room and a family space that intimately accommodates several people. Each pod is organized with two blocks of rooms that are highly visible from one another to allow for staff communication and interaction. Each zone has two rooms for twins and three single rooms that are connected and can accommodate triplets. There are no rooms anywhere on the floor that are physically isolated, a feature very important for staff.

Families access the NICU via public elevators located off the main lobby, bringing them directly to family reception lounges located on each floor.

Family participation

Because family participation is one of the principle goals of the family centered care clinic, space is required for the family both in individual rooms and in space outside the NICU room on the same floor. It is important that family members have a place to congregate with other parents or otherwise find respite from the stressful NICU environment. In addition to smaller family rooms located at the end of corridors in each pod, we have created a family space with a comfortable lounge, kitchenette, sibling play area, conference and resource space. It is centrally located with a communicating open stair in the "open atrium" previously described, Figure 8, and within close proximity

to the central team room.

Staff retention

Staff support spaces, access to daylight, and a less stressful environment are of great importance for the well-being and retention of staff, as well as for the overall ambiance of the NICU. Although it was not possible to locate all staff work rooms and stations next to a window, the design provides interior glazed partitions, Figure 10. Staff can view out: daylight is transmitted through adjoining spaces, while allowing staff discreet visual control over the family lounges. The importance of locating the staff lounge remote from the workspace should not be overlooked. It is crucial that this space be comfortable, have natural lighting, and be a location where staff are able to reduce stress from the highly charged NICU environment. At Women & Infants', the lounge is designed to support alternative activity arrangements with plenty of natural lighting. Its position above the main lobby offers respite from the intensity of the NICU environment, offering views out to the entry forecourt and the passing activity below.



Figure 10. Lines of sight from staff, family, and lounge areas

Summary and recommendations

Women and Infants Hospital design principles reflect a commitment to family centered care which is at the heart of the Hospital's Building For The Future programs. Our goal has been to create a welcome and reassuring environment with a sense of openness, along with provision of privacy for patients and their families. There has emerged among the staff and administration the unanimous view that only within a single-family room model of care will we be able to provide the benefits noted above. Families and patients' well being and outcome are clearly at the center of our professional goals. We recognize the importance of a balance between staff and family needs in achieving those optimal outcomes. We have paid careful attention to providing adequate support areas for our professional staff and for ancillary professionals who contribute so much to the newborn outcome. Our design will maintain the clinical excellence that the Hospital has demonstrated in the past and of which we are proud. More importantly, we recognize the significance of design in creating a holistic environment that seeks the right balance between the technical demands of the clinical environment and the qualitative needs for creating family centered care.

REFERENCES

1. **Walsh WF, McCullough KL, White RD. Room for improvement: nurses' perceptions of providing care in a single room newborn intensive care setting. *Adv Neonatal Care.* 2006 6:261-70.**
2. **Copyright 2005 Meyer GS, Massagli MP. The forgotten component of the quality triad: can we still learn something from "structure"? *Jt Comm J Qual Improv* 2001; 27:484-493.**
3. **Fottler Eisenberg JM, Bowman CC, Foster NE. Does a healthy health care workplace produce higher-quality care? *Jt Comm J Qual Improv* 2001; 27:444-457.**
4. **Ford RC, Roberts V, et al. Creating a healing environment: the importance of the service setting in the new consumer-oriented healthcare system. *J Healthc Manag* 2000; 45:91-107,**
5. **Mirmiran M, Ariagno RL. Influence of light in the NICU on the development of circadian rhythms in preterm infants. *Semin Perinatol* 2000; 24:247-257,**
6. **Rivkees SA, Hao H. Developing circadian rhythmicity. *Semin Perinatol* 2000; 24:232-242.**
7. **Mann NP, Haddow R, Stokes L, et al. Effect of night and day on preterm infants in a newborn nursery: randomized trial. *BMJ* 1986; 293:1265-1267.**
8. **Miller CL, White R, Whitman T, et al. The effects of cycled vs noncycled lighting on growth and development in preterm infants. *Infant Behav Dev* 1995; 18:87-95.**
9. **Brandon DH, Holditch-Davis D, Belyea M. Preterm infants born at less than 31 weeks' gestation have improved growth in cycled light compared with continuous near darkness. *J Pediatr* 2002; 140:192-199.**
10. **Long JG, Lucey JF, Philip AG. Noise and hypoxemia in the intensive care nursery. *Pediatrics* 1980; 65:143-145.**
11. **Philbin MK. The influence of auditory experience on the behavior of preterm newborns. *J Perinatol* 2000; 20:S77-87.**
12. **Stoll BJ, Hansen N. Infections in VLBW infants: studies from the NICHD Neonatal Research Network. *Semin Perinatol* 2003 27:293-301.**

James F. Padbury, MD, is pediatrician-in-chief, Women & Infants Hospital, and professor and vice chair of pediatrics at the Warren Alpert Medical School of Brown University. He can be contacted at JPadbury@wihri.org .

Johan (Jay) Verspyck, AIA, is project architect and associate principal of Anshen+Allen+Rothman in Boston. He can be reached at jv@anshen.com

The Academy Journal is published by the AIA Academy of Architecture for Health (AAH). The Journal is the official publication of the AAH and explores subjects of interest to AIA-AAH members and to others involved in the fields of healthcare architecture, planning, design and construction. www.aia.org/aah

This article originally appeared in *The Academy Journal*, published by the AIA Academy of Architecture for Healthcare (Volume 10 – November 2007).