

# Building For the Future of Rhode Island's Newborns

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The discipline of neonatology is recognizing that “best practices” and “standards of care” are necessary to improve outcomes of critically ill newborns.<sup>1</sup> Numerous studies demonstrate that environmental conditions in an Intensive Care Unit can have significant effects on outcome. For caregivers, environment influences their work performance, satisfaction and health.<sup>2,4</sup> For patients, the physical environment can have a profound effect on rate of recovery and development. While these observations are best documented in adult patients, physical and environmental conditions also affect the outcome of critically ill newborns.

In 1986 the Lying-In Hospital moved into the current location to become **Women & Infants Hospital (WIH)** with a 41-bed **Newborn Intensive Care Unit (NICU)**. However, upward pressure on NICU census due to increasing number of deliveries and more importantly increasing survival began not long after that move. Since 1990, deliveries at WIH have increased from 6,500 to nearly 10,000 a year. WIH is a nationally recognized leader in dramatic improvements in survival of extremely low birthweight infants. The most recently published data from the **National Institute of Child Health and Human De-**

velopment (NICHD) Neonatal Research Network in which WIH participates, demonstrates 30-40% of children born at 23 weeks' gestation (only a little over 5 months' gestation!) and greater than 75% of children born at 24 weeks' gestation survive.<sup>5</sup> With these trends the average daily census at WIH since 1995 has risen from 50 to nearly 70 patients per day. This created significant crowding in the NICU. (Figure 1) The existing WIH NICU was an open-bay design with approximately 10,900 square feet. The resulting space around each baby was at best 35 square feet providing significantly less than the present standards of 150-180 sf/baby. It was clear a new NICU was needed.

## THE PLANNING PROCESS: A TEAM EFFORT

A team of inter-departmental, interdisciplinary individuals was mobilized to examine both neonatal and obstetrical service lines with a special emphasis on capacity. These task forces included members of the medical and nursing staff, administrative leadership, support staff and private voluntary physicians who use the facility, with support from outside professional health consultants, epidemiologists and demographers. We

reviewed delivery trends and NICU utilization from 1990 to the present. In order to project future needs, we reviewed the 2000 census and included adjustments for changes in population, race and ethnicity in our community. These data were used to generate different projection “scenarios” for delivery rates and NICU beds, forming the basis for a new 80-bed NICU.

In order to explore the most recent approaches to NICU design and the ‘*models of care*’ that lead to the best outcomes, the team made a series of site visits to selected NICUs across the United States. The team included physician and nursing leadership, staff nurses, architectural consultants, a parent from our *Family Advisory Council* and members of our philanthropy team. The NICU sites chosen were comparable in size, based in an academic teaching program, recently-constructed, and spanned the spectrum of ‘*models of care*’ from open bays to single-family rooms. The programs visited included: Vanderbilt University Children's Hospital in Nashville, Tennessee; Blank Children's Hospital in Des Moines, Iowa; Northside Hospital and Scottish Rite Children's Hospital in Atlanta, Georgia; and Children's Hospitals and Clinics in St. Paul, Minnesota.

Before finalizing the design of the NICU room, the staff and designers built an actual working mock-up room. The mock-up helped the staff to determine the location of materials, the staffing flow patterns, and the best equipment configuration. A staff-wide participatory process enabled acceptance of the single room model concept and was crucial in deciding the final design solution for the NICU room.

## MODELS OF CARE

While it was clear that a new NICU was needed at WIH, it was not clear what physical design and which of the several contemporary styles or ‘*models of care*’ should be chosen. ‘*Model of care*’ refers to the physical environment for the pa-



Figure 1: Crowding in the old NICU at WIH

**Table 1: Guiding Principles for Design of New NICU**

- Family-Centered Care: Parents as “Partners”
- Developmentally Supportive Care Environment
  - Sound and light
  - People, other stimuli
- Promote Clinical Excellence
  - Support medical model
  - State-of-the-art: design, equipment, electronics, information technology (IT), PACS
  - Teaching environment
- Staff Invested/ Involved
  - In design
  - In governance: “collaborative teams”
- Utilize Established Evidence
  - Evidence-based clinical outcomes
  - Safety practices
- Point of Service Care
  - De-centralize services to patient and patient room
  - Rational zone size
  - Minimize patient movement
- Planning/Incorporating Future Flexibility
  - Sustainability: engineering, materials, environment, natural light
- Location
  - Single NICU
  - Adjacency/access from Labor & Delivery
- Unique Institutional Identity
  - Learn from examples
  - Develop W & I model

**Table 2: Design Principles for Design of New NICU**

- Welcoming and Reassuring
  - Sense of openness
  - Preservation of privacy
- Single Family Rooms (Standard of Care)
  - All rooms similar
- Zones within Room
  - Baby
  - Parent (single sleeping accommodation, desk; no toilet, no VCR, no TV, no radio)
  - Staff/ Caregivers
- Clarity of Organization
  - Clear way-finding
  - Smooth flow
  - Ergonomic
- Zoning of NICU
  - Optimum zone size determined based on:
    - Staffing
    - Operations
- Balance Between Staff and Family Needs in Locating Support/Staff Areas
  - On unit
    - Family support area
    - Dirty/clean utility
    - Satellite Pharmacy
    - Staff lounge
    - Conference room
  - Adjacent to or off unit
    - Offices (MD, NM, LCW)
- “Green Design”
  - Maximize use of natural light
  - Evaluate impact on cost and operations
- Sensitivity to end-of-life issues

tient, the way in which the design of the space complements the clinical approach to the patient and family.

One model included open bays where infants are cared for in a large open spaces or a partial modification called a “Pinwheel.” These were similar to the existing NICU at WIH, albeit the new construction would require a much larger open bay.

Another emerging model of newborn intensive care involves “single-family rooms.” This ‘*model of care*’ recognizes that caring for critically ill patients (especially the very young) in a group or cohort can be disruptive to the clinical stability of other patients in shared spaces. This is most apparent in NICUs where stability of vital signs (e.g. heart rate and breathing) is precarious. Even minimal visual, auditory and/or tactile stimulation can result in apnea and bradycardia. The single-family room design has garnered widespread acclaim for its many distinct advantages.<sup>6</sup> These advantages include: 1) less disruption from their neighbors, staff, or other activities related to adjoining patients, 2) better isolation of patients from nosocomial infections, and 3) a unique level of privacy. In addition, the single family room facilitates a truly family-centered approach wherein the families can be present throughout most of the hospitalization becoming partners in the care of their infants rather than episodic “visitors.” We believe the benefits go beyond just the acute medical to improved neurodevelopmental outcomes for the babies.

The results of the visits were surprising and compelling. After completing our site visits, we convened the entire group to synthesize our experiences into a list of “*Guiding Principles*” and “*Design Principles*.” (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 WIH, after visiting these recently constructed nurseries there was unanimous consensus that it was the only ‘*model of care*’ for WIH. We believe that, before the next 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.

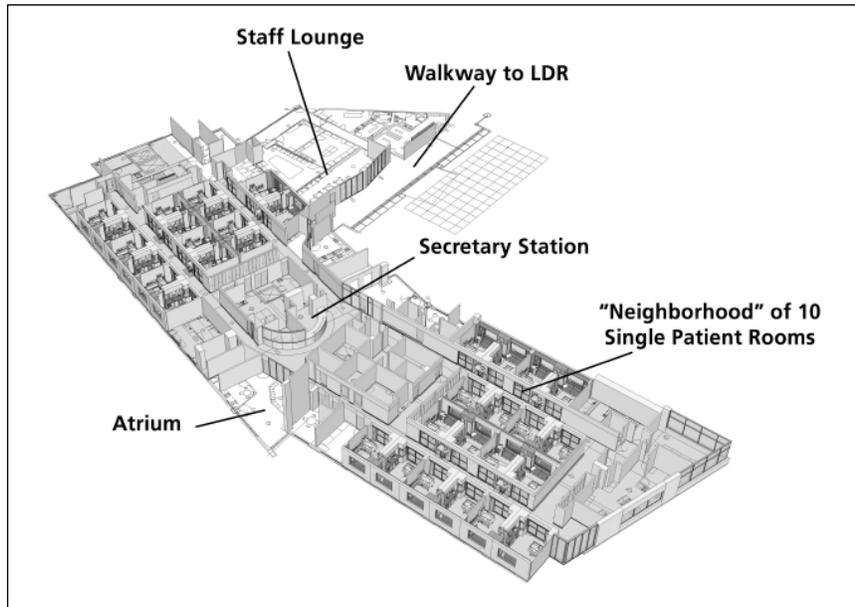


Figure 2: Three-D layout of NICU floor showing clustering of specific programs.



Figure 3A: Nursing charting and work area showing line of site into each room.



Figure 3B: View into Single Patient 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, the new NICU required more than 56,000 sf. A key requirement for the new NICU was to locate it next to the existing Labor and Delivery Suite (LDR). A single floor NICU would have had an enormous footprint, creating huge distances between service areas. Locating the NICU on two floors reduced that footprint (and cost) and allowed better geographic consolidation. Thus, the New South Pavilion was designed as a 5-story building. The basement houses building support services. The ground floor includes a new lobby, conference center and public support spaces. The new NICU is on Floors 2 and 3. The 4<sup>th</sup> floor is a 30-bed, dedicated high-risk Antenatal Care Unit. The fifth floor houses central mechanical and electrical equipment.

To unite the two NICU floors, the design includes vertical connections utilizing open atriums and stair cases. This architectural design allowed us to provide visible and direct access to program spaces while clustering other essential program spaces, see Figure 2.

### BUILDING ORGANIZATION

Each floor of the NICU is supported by one medical team and is organized into four 10-bed “neighborhoods” for a total of 80 beds. The 2<sup>nd</sup> Floor is immediately adjacent to the LDR and contains clinical programs such as Pharmacy, Respiratory Therapy, and Staff Lounge. Staff/service elevators are at the north entry, while public elevators service the sun-filled central lobbies leading directly to a Secretary Station. Team space is centrally located, supporting terminals for electronic charting, a radiology imaging station, physician on-call room, staff offices and conference rooms.

The 20-bed areas at the North and South ends of each floor have similar elements including a small charting station between each pair of rooms, clean supplies, soiled utility, equipment storage and a family space that intimately accommodates several people. Each area is organized with two neighborhoods. The rooms are staggered to allow maximum visibility,

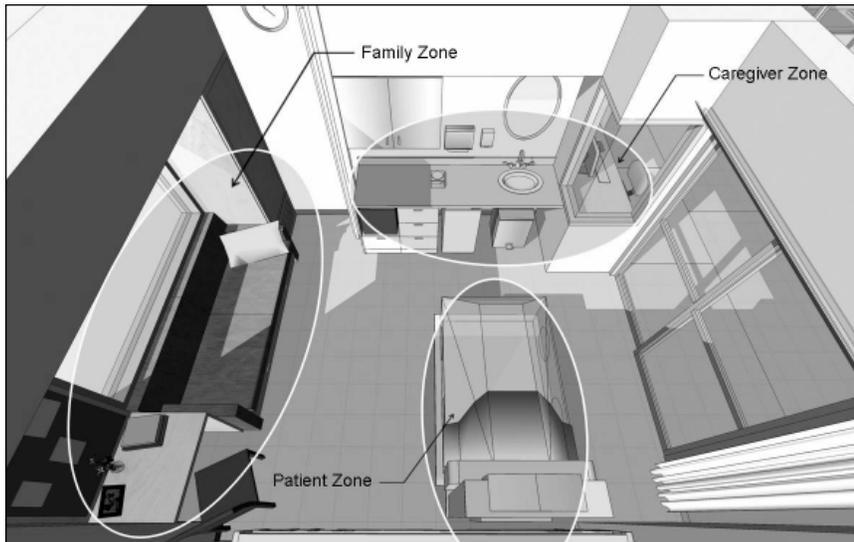


Figure 4: Patient zone, Caregiver/staff zone and Family zone in each room.

staff communication and interaction. Each area has two rooms for twins and three single rooms that when connected can accommodate triplets. None of the rooms are physically isolated, a very important feature for staff. (Figure 3 A & B)

### THE INFANT'S ROOM

Each infant room is 175 square feet and has three distinct zones: Patient, Caregiver/staff, and Family. (Figure 4) Each room provides an opportunity to individualize and personalize its space according to each baby's developmental needs. The patient's room provides the privacy and separation necessary to perform critical procedures, without affecting other infants. The patient zone headwall provides medical gases and electrical services for ventilators, pumps, and monitors.

The caregiver zone has a sink, a dedicated refrigerator and storage cabinets for needed supplies. The family zone accommodates a sleeper for parents, desk and storage, and can be separated by a privacy curtain. Every room has indirect dimmable lighting and temperature control that can be adapted to individual needs related to circadian rhythms and delivery of services.

### FAMILY PARTICIPATION

Space is provided for the family within and outside of their individual rooms. Family members have a place to congregate with other parents or to find respite from the stressful NICU environment. Our family advocates are located in the Family Center

with its comfortable lounge, kitchenette, sibling play area and resource space. The family program elements are distributed over both floors but are all centrally located in an "open atrium" with salt-water aquarium. (Figure 5)

### STAFF SATISFACTION AND RETENTION

Dedicated support spaces, access to daylight, and a less stressful environment are paramount for the well-being and retention of staff. The staff lounge was designed as a comfortable space separate from the workspace to support complementary activity with plenty of natural light to reduce stress in a highly charged unit.



Figure 5. The Family Center which joins elements and interactions between the floors.

### ENVIRONMENTAL DESIGN

We designed the new clinical addition with the goal of improving patient and staff well-being, reducing energy consumption and minimizing negative impact on the environment. We are the first hospital building in New England to achieved certification as a **Leadership in Energy and Environmental Design (LEED®)** at the Gold level.<sup>7</sup> Highlights of the environmental aspect include the use of daylight, water, energy, and materials. Seventy-five percent (75%) of all occupied spaces receive daylight with ninety percent (90%) having views to the exterior. A water management system decreases run-off and treats storm water. Mechanical and electrical systems were designed to improve performance by twenty percent (20%) below US national code. Ten percent (10%) of materials contain recycled content including steel, concrete, linoleum flooring and ceiling tiles. Low-emitting materials were utilized such as adhesives, sealants, paints and carpets. For complete details about the WIH LEED® details, visit: <http://www.womenandinfants.org/body.cfm?id=89&action=detail&ref=354>.

### STUDYING THE IMPACT OF PHYSICAL ENVIRONMENT IN THE INTENSIVE CARE SETTING

We examined published and unpublished data from centers that have recently changed to different 'models of care.' Presently there are no data, which conform to a "gold standard for evidenced-based practice" from a randomized, controlled trial



Figure 6. Family in the new NICU

comparing single family rooms to other models of care. The information to date is either anecdotal or based on retrospective, historical comparisons. The experiences of the units we visited were compelling, nonetheless, documentation according to the best standards of “evidence-based practice” and “evidence-based design” is still lacking.

We are in the midst of conducting a prospective, longitudinal study of the impact of this model of care on outcomes. We believe that infants in the single room NICU will have better medical and neurobehavioral outcomes at discharge than infants in the open bay NICU. Medical outcomes include length of stay, gestational age at discharge, weight gain, illness severity and resource utilization, gestational age at enteral feeding, sepsis and necrotizing enterocolitis. Neurobehavioral outcomes include the NICU Network Neurobehavioral Scale (NNNS) profiles,<sup>8</sup> sleep organization and sleep physiology, infant mother feeding interaction scores, and pain scores. We are carefully collecting prospective measurements in the new NICU. We believe that findings from this study will influence the future of NICU design and model of care throughout the Nation.

## SUMMARY AND RECOMMENDATIONS

Women and Infants Hospital’s design principles reflect a commitment to family centered care, which is at the heart of the Hospital’s *Building for the Future* programs. We have created a welcoming, reassuring

environment with a sense of openness, along with provision of privacy for patients. We have created a contemporary, LEED® Gold certified building that complements our existing structure and promotes our goals in the design. Importantly, we recognized the significance of design in creating optimal safety practices. With the building has emerged among our staff and administration the unanimous view that the single-family room ‘model of care’ is the only model able to meet our goals. There is a balance between staff and family needs in achieving optimal patient outcomes.

On September 16, 2009, the NICU moved into its glorious new space. As we began to fill the new spaces, family members were summoned to be in their new room when their child arrived. By late afternoon, we closed the doors for the final time in the former NICU. Every child was in his/her own room with space for parents to be with them – hold them quietly and bond even in the middle of one of the most high tech units ever built, Figure 6. We have been there for almost half a year now; it is absolutely spectacular! It is quiet, light, and uplifting. The families are happy. The nurses are happy. The trainees are happy. We love our new home...come and visit!

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## Disclosure of Financial Interests

The authors and their spouses/significant others have no financial interests to disclose.

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