Developmental Care: Changing the NICU Physically and Behaviorally to Promote Patient Outcomes and Contain Costs

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This article explores the effect of a physical renovation and a comprehensive developmental care training program on medical outcomes and costs of care for premature infants. Environment, medical outcome, and hospital charges were recorded one year prospectively and one year post-implementation of the NICU design and developmental training. (The sample consisted of 852 infants: 419 pre- and 433 post-intervention.)

More than eleven percent of all babies born in the United States are premature. Of these premature births, over seventy percent of these infants are admitted to the Neonatal Intensive Care Unit (NICU). The NICU provides high-tech, expensive care, which is estimated to be $2,000.00 per day.[1] Very low birth weight infants, less than 1500 grams, can stay in the NICU for two to three months, depending on birthweight and medical complications. These infants are also at increased risk of developmental delays and disabilities. Outpatient care, therapy sessions, and special education create additional costs for these infants.

Over the past ten years, evidence has shown that premature infants that are cared for in a developmentally appropriate environment can have the following improved medical outcomes:[2]

- Decreased intraventricular hemorrhage
- Decreased number of ventilator days
- Decreased chronic lung disease
- Decreased hospital days
- Decreased retinopathy of prematurity (ROP)

We had the opportunity to design a state-of-the-art, developmentally appropriate NICU, which was combined with a comprehensive developmental care program (Wee Care Children's Medical Ventures). The alteration in the physical environment, as well as a developmental care approach by health care providers led to decreased length of stay, decreased costs, and improved medical outcomes.

The goal of our NICU renovation was to convert an existing 37-bed level III unit built in 1980 into a 46-bed level III unit and remain operational throughout. Occupancy of the original 37-bed NICU was always greater than 95% and the space only allotted 60 square feet per bed (6,500 sq ft). No storage or family space was available, and the unit featured a linear design with high decibel readings, outdated fluorescent lighting, and little privacy.[3]

The design of our NICU included three goals: 1) meeting developmental needs of the infant (focusing on noise and light issues); 2) family needs; and 3) staff needs. The newly-designed NICU more than tripled in space at 21,000 square feet, which provided an average of 110 to 125 square feet per bedspace as recommended by the NICU Design Standards. [4]

DEVELOPMENTAL NEEDS OF INFANTS

Acoustic Issues

Sources of noise in a typical NICU (environment, equipment, health care providers) were reviewed to provide the best noise control in designing the NICU.[5] Many sound control features were incorporated into the design of our NICU. Sound-absorbing ceiling tiles were placed in all patient care areas. Porcelain sinks with electric eyes, rather than stainless steel sinks were also used to minimize noise. Carpet was utilized throughout the unit to help decrease the noise level and promote a home-like environment. Business equipment was located away from patient care areas. Physician and administrative support spaces were also located away from the patient care areas. The walls also help decrease noise levels directly at the bedside. Acoustical partitions were placed between bedspaces and corridors to additionally minimize noise.

The Communication System was an innovative wireless phone system that each healthcare provider carried. The ringer was set on vibrate to minimize the noise level. This phone system also

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enhanced efficiency by allowing the caregiver to provide care rather than talking on a stationary phone. Incoming calls were transferred directly to the wireless phones instead of using intercoms or pagers to alert nurses of a phone call.

A decibel monitoring system was installed to regulate the levels of conversation and incidental noise throughout the NICU. The decibel monitoring limit was strategically dialed down weekly and excessive noise activated a light alarm. These measures reduced the overall unit noise level to approximately 55-60 dB at any given time.[6]

Light Issues

Trying to balance the need for dimmed ambient lighting, natural lighting and brighter task lighting is always a challenge. Strategies to provide caretakers with supplemental lighting without affecting ambient light levels for babies were examined.[7] Each bedside was designed to be individually-controlled, with indirect sconce lights and bedside exam lights, all of which are on dimmer switches. Exterior windows provide the recommended natural light and assist with diurnal cycling, yet have automatic blinds that filter the light at a very high level. Lights over each sink area are also on dimmer switches to help lower the overall light level. Lamps are at workstations to provide "light showers" for staff working, especially at night.[8] The management of noise and direct light promotes infant organization and self-regulation.

NEEDS OF FAMILIES

The needs of families were determined by focus groups, questionnaires and exit interviews. The biggest need verbalized was the need for privacy. The L-shaped, pinwheel design created an area of privacy at each bedside, which could be personalized by the family. Pods were designed with half walls to create an open environment, yet still provide privacy for families. This increased privacy encouraged the involvement of families through participation in rounds and shift change. Additionally, when there were multiples, co-bedding was facilitated by the creation of a specially designed "Multiple Pod."[9] There was more hands-on baby care provided by parents, longer parental stays in the NICU, and a significant increase in Kangaroo Care by both parents.

Separate breastfeeding rooms provided additional privacy. "Rooming-In" rooms also provided space for parents to be with their infant alone before discharge. A family lounge was created with a vending area, lending library and computer resource center.

The visitation policy was liberalized to allow 24-hour visitation. Private drawers were built for parents to have their "own" space. Additionally, bulletin boards and inset shelves could be personalized with pictures, notes, and stuffed animals. All of these changes enhanced bonding and participation.

PROGRAM CHANGES

A parent coordinator position was created to focus on needs of families and a parent advisory panel was created. Sibling Care was initiated to enhance sibling involvement. A parent newsletter was created, which incorporates information from all disciplines to promote communication. A lactation consultant that was dedicated to the NICU was added to promote breastfeeding and Kangaroo Care. Staff initiated a quilt committee in which all infants received a personalized quilt, which assisted with noise and light reduction. These quilts then become a family heirloom on discharge. Special, handwritten notes by staff were sent to parents "from their infants" if they had returned to work.

A unit specific developmental committee met monthly to address developmental needs and issues in the NICU. A developmental coordinator spearheaded efforts to address needs of infants, as well as educational needs of staff. The developmental coordinator educated all new staff and monitored current practices of staff to address compliance issues. Ongoing efforts by the developmental care committee focused on the admission process and provided one-to-one inservicing.

Involvement by developmental, occupational, physical, and speech therapists was enhanced to focus on developmental needs of infants, such as positioning and feeding.

STAFF BEHAVIORAL ISSUES

To address behavioral issues of staff, the Wee Care Educational Program was implemented to reinforce and expand the concepts of developmental care. The Wee Care Neonatal Developmental Care program involved an initial in-hospital 5-day multidisciplinary course that included didactic and hands-on education related to developmental needs of the premature infant.[10] All individuals involved in the care of NICU infants were included in the training (nursing, environmental aides, radiology, laboratory, occupational and physical therapy, nutrition, pharmacy, respiratory therapy, as well as physicians and nurse practitioners).

The program focused on four aspects of developmental care: 1) the physical environment; 2) understanding neonatal development; 3) understanding special feeding needs of infants; and 4) the incorporation of families into the entire NICU process.

Specialized positioning aids were used to facilitate normal positioning for appropriate muscle development, as well as provide boundaries. By implementing containment principles of infants through the use of these products, the stress level of these infants decreased and thus they were much easier to console.

PATIENT OUTCOMES

Specific measurements pre/post-design and education were

TABLE 1: Good Samaritan NICU Sound Levels
Pre/Post Implementation
NICU Design Change & Developmental Care Program

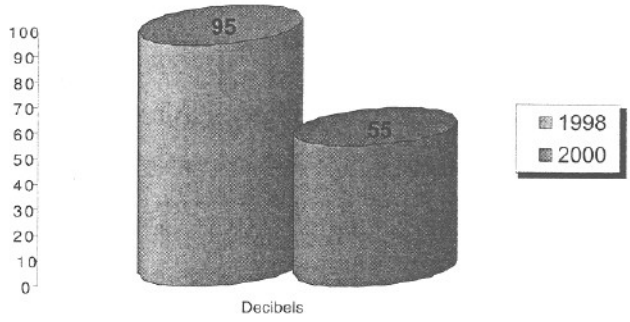
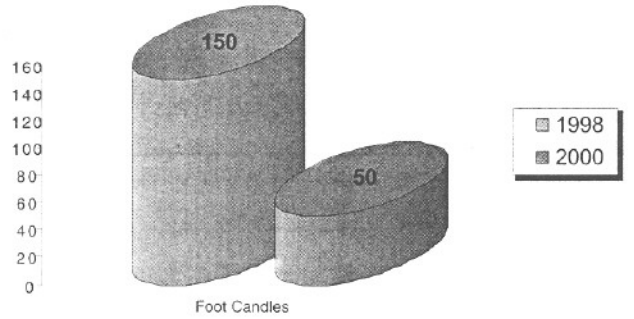


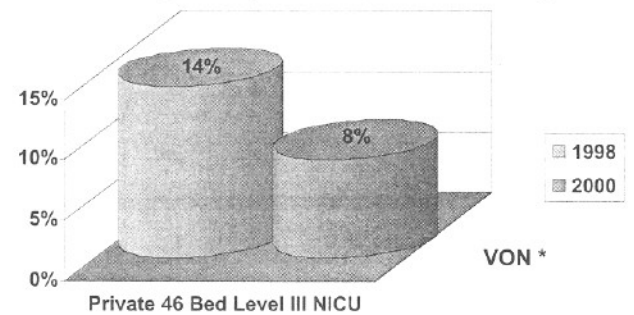
TABLE 2: Good Samaritan NICU Light Levels
Pre/Post Implementation
NICU Design Change & Developmental Care Program



taken. The noise level went from an average decibel level of 95 to 55 (see Table 1). The light level was decreased from 150 foot candles to 50 foot candles (see Table 2).

By creating a new design, as well as focusing on behavioral changes of our staff, significant improvements in patient outcomes were observed. Rates of severe ROP (stages 3 and 4) were reported by the Vermont Oxford Network. [11] A six percent

TABLE 3: Reports of Severe ROP*
Pre/Post Implementation
NICU Design Change & Developmental Care Program



decrease was reported in this two-year period (see Table 3). During this time frame, there was no change in our approach to the target oxygen levels.

Rates of severe intraventricular hemorrhage (IVH), grades 3 and 4, decreased from 11% in 1998 to 3% in 2000 (see Table 4), also

TABLE 4: Reports of Severe IVH*
Pre/Post Implementation
NICU Design Change & Developmental Care Program

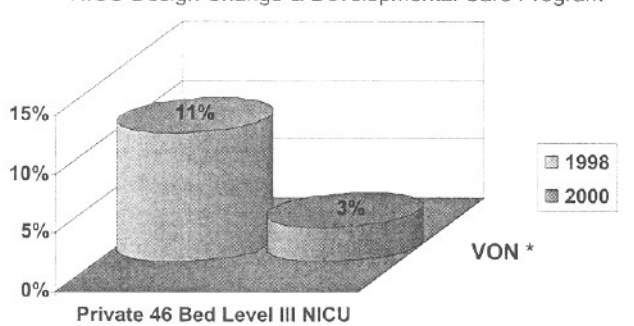
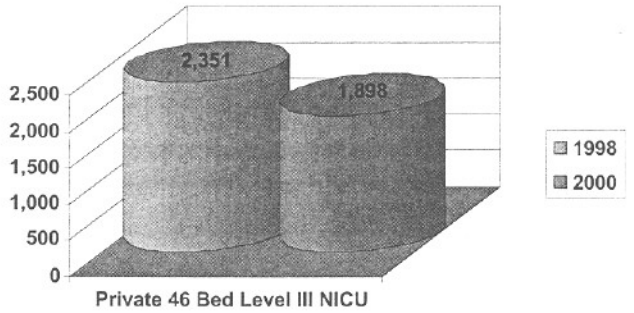


TABLE 5: Ventilator Days
Pre/Post Implementation
NICU Design Change & Developmental Care Program

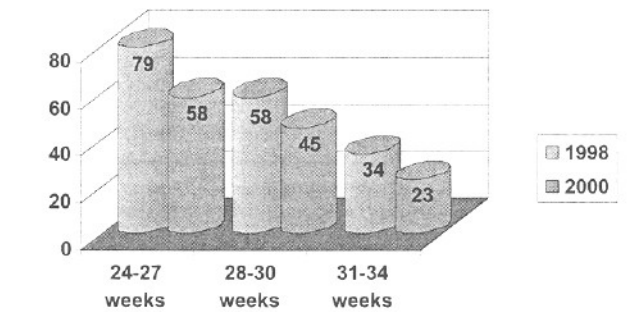


as reported by the Vermont Oxford Network. During this time prophylactic indomethacin to prevent IVH was not implemented.

Ventilator days were significantly decreased in the two groups (see Table 5). Ventilator days in the 1998 group (n = 419) were 2,351 and in the 2000 group (n = 433) were 1,898.

Length of stay (LOS) in days was measured by gestation rather than weight to account for small for gestation (SGA) babies. Several determinants for discharge were nippling all feedings, gaining weight, and absence of apnea and bradycardia episodes, and which are more gestationally associated rather than weight associated. The gestational categories were 24-27 weeks, 28-30 weeks, and 31-34 weeks. Four hundred and nineteen infants between 24 and 34 weeks gestation were admitted to the NICU in 1998. The LOS in days were 79, 58, and 34 respectively. These were compared to 433 infants born at the same gestation in the

TABLE 6: Length of Stay
Pre/Post Implementation
NICU Design Change & Developmental Care Program



year 2000 with the LOS being 58, 45, and 23 respectively (see Table 6). Interventions (design change and education) significantly decreased the LOS when evaluated in all three gestational categories.

The costs of health care have received considerable attention over recent years. In a study by Petryshen, infants receiving conventional care spent, on average, more days in the acute care NICU than infants in the developmental care group. These costs were $25,072 per infant compared to $18,919 respectively.[12] Extremely tiny babies are very expensive and are consuming more resources as the complexity of their care increases.[13,14]

Costs related to LOS in a NICU are great. The national daily average cost is $2,000. This accounts for the room and nursing care only. Other charges such as physician fees, ventilator charges, pharmacy charges, laboratory charges, as well as the charges of disposables are quite costly. Costs related solely to the LOS are demonstrated in Table 7. Cost analysis was

Table 7

Costs Related to Decreased LOS National Average = $2000/Day		
Gestational Age	**Days Saved**	**Cost Savings**
24-27 weeks (n = 153)	21	$6,426,000
28-30 weeks (n = 132)	13	$3,432,000
31-34 weeks (n = 148)	11	$3,256,000
Total Yearly Cost Savings		**$13,114,000**

determined by multiplying the total days saved by the number of admissions in the year 2000 in each gestational category by the average daily charge of $2,000.00. These numbers represent charges, not collections.

In addition to these positive financial changes, family-centered care was enhanced. Parents were supported from admission to discharge by staff, care coordinators, and the parent coordinator. Parents were encouraged to participate in medical rounds and included in shift change. Parents were included as part of the care team, which led to greater interaction by parents with their babies. This increased involvement improved their ability for caretaking upon discharge and decreased stress throughout their stay. This participation led to improved family satisfaction as documented in exit interviews.

STUDY LIMITATIONS

This data presented was univariable analysis and other potential confounding variables were not controlled for; however, there was no change in population characteristics (Table 8) or care practices (Table 9). Specifically, there was no change in the use of antenatal steroids or the approach to respiratory care.

Table 8

Population Characteristics	1998	2000
% Inborn	100%	100%
Race: (African American)	21%	23%
(Caucasian)	79%	75%
Prenatal Care	98%	98%

Table 9

NICU Medical Care Practices	1998	2000
Antenatal Steroids	86%	81%
Surfactant	40%	37%

Table 10

Birthweight Distribution	1998	2000
400 - 500	4%	3%
501 - 750	14%	21%
751 - 1000	21%	23%
1001 - 1250	27%	27%
1251 - 1500	35%	26%

Additionally the cesarean section rate was unchanged at 59% (1998) compared to 62% (2000). The multiple birthrate was similarly unchanged at 36% (1998) and 33% (2000). The birthweight distribution was significantly higher in the lower weight categories (Table 10).

DISCUSSION

These results show that a change in the physical NICU environment, as well as a comprehensive developmental care training program can be effective in improving the NICU environment, improving infant medical outcomes, decreasing LOS, and decreasing hospital costs.

Staff acceptance of these changes was varied. Medical and nursing staff required reassurance that the hierarchy of medical care would not be impacted. Developmental care was often not seen as a process, but rather a program to implement after the baby was admitted and stabilized. Once the concept of developmental care was incorporated from admission through discharge, actual changes in noise, light, positioning, and patient outcomes were observed. Staff satisfaction was greatly improved, which was reflected by decreased turnover rate (15% to 2%), improved morale, and a waiting list for employment.

It is predicted that long-term infant outcomes may be improved after physically changing the NICU environment and behaviorally changing health care providers' practice. Additionally, significant cost savings can be realized simply by decreasing the LOS.

As the age of viability keeps decreasing, the need to protect the infant from the external environmental stressors keeps increasing. Although resistance to change is always high, timing is everything. Research related to developmentally supportive caregiving in the NICU has existed for more than 20 years. Developmental care is becoming a standard of care. Developmental care needs to be incorporated into the entire process of care, as well as the unit design to support infants and stabilize each of their subsystems as they mature. Although most units profess to be providing some level of developmental care, implementation remains uncoordinated and inconsistent. Much is yet to be learned about supporting the development of high-risk infants while we care for them in the neonatal intensive care unit.

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